CLIMATE CHANGE MITIGATION AND DEVELOPMENT: A STUDY OF SELECTED ASEAN MEMBERS

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**CLIMATE CHANGE MITIGATION AND DEVELOPMENT:
A STUDY OF SELECTED ASEAN MEMBERS**

ABSTRACT

Climate Change is a human induced global common problem, which require collective action. While the focus should be global, members of the Association of Southeast Asian Nation (ASEAN) should act collectively to address it. Consequently, this thesis seeks to evaluate the alternative proposals put forth to assess the impact of Climate Change on ASEAN members as a whole, and three bordering nations by deploying a Computable General Equilibrium (CGE) regional model, viz., the ASEAN Regional Integrated model of Climate and the Economy (ASEAN-RICE). Hence, the first objective of this thesis is to formulate a non-linear CGE "ASEAN-RICE" model to assess climate mitigation impact from the Intended Nationally Determined Contribution (INDC) submitted to the United Nations Framework Convention for Climate Change (UNFCCC) for ASEAN and for Malaysia over 100 years following the Paris Accord of 2015. The second objective is to analyse climate mitigation impact on the Association of Southeast Asian Nations (ASEAN) using the INDCs of these nations submitted to UNFCCC but over 50 years following the Marrakesh Proclamation of 2016. The third objective is to construct a low carbon economy index for Indonesia, Malaysia and Thailand. Dynamic non-linear CGE modelling and the 2010 input-output tables were deployed to estimate climate mitigation consequences under the INDC scenario and the business as usual (BAU) scenario (if existing practices are continued). In the Malaysian case an additional national plan scenario was included. The period 2010-2100 was selected for the first objective and 2010-2060 was selected for the second and third objectives. The results show that climate damage over the period 2010-2100 will fall from 2,722mtoe under the BAU scenario to 1,203mtoe under the national plan scenario and 699mtoe under the INDC scenario. Carbon concentration will fall from 11,912ppm under the BAU scenario to 9,714ppm under the national plan scenario and 8,592ppm under the INDC scenario. Since the abatement costs of the latter two are almost the same, the UNFCCC's INDC scenario is the best option. In the ASEAN as a whole case, the results indicate that atmospheric concentration of carbon and temperatures under the INDCs scenario will fall from 390ppm and 0.80°C respectively in 2010 to 298 ppm and 0.71°C respectively in 2060. Under the BAU scenario it will fall from 390ppm and 0.80°C respectively in 2010 to 351ppm and 0.79°C respectively in 2060. Cumulative climate damage under BAU and optimal scenarios will rise from MYR8billion for both in 2010 to MYR579Billion and MYR513Billion in 2060. The reduction in carbon emissions under the optimal scenario can be achieved without compromising GDP growth. The low carbon economy index estimations for Indonesia, Malaysian and Thailand suggest that Indonesia will have to introduce aggressive Climate Change mitigation strategies to catch up with Malaysia. Thailand appears to keep up the pace with Malaysia. Overall, this thesis produced results that show that the introduction and strict application of INDCs will help mitigate Climate Change and global warming among ASEAN economies in general, and Malaysia in particular**.**

Key Words: Climate Change, Global Warming, Carbon Emissions, Carbon concentration, Low Carbon Economy Index, ASEAN

MITIGASI PERUBAHAN IKLIM DAN PEMBANGUNAN: SATU TINJAUAN KE ATAS AHLI-AHLI ASEAN

ABSTRAK

Perubahan iklim adalah masalah yang dicetuskan oleh kegiatan manusia, yang memerlukan penyelesaian kolektif. Sementara ia memerlukan tumpuan sedunia, ahli-ahli Persatuan Negara Asia Tenggara (ASEAN) seharusnya bertindak secara kolektif untuk menananganinya. Dengan itu, tesis ini cuba menganalisis cadangan-cadangan alternative yang telah diutarakan demi menilai dampak masing-masing keatas perubahan iklim di negara-negara ASEAN amnya, dan tiga negara bersempadan hasnya dengan menggunakan model Keseimbangan Komputer Umum (CGE) dan ASEAN sebagai sasaran perhitungan, iaitu., the model berpadu serantau iklim dan ekonomi (ASEAN-RICE). Jadi, objektif pertama tesis ini adalah untuk membentukkan model bukan-linar CGE "ASEAN-RICE" demi menganalisis dampak pertabahan iklim berasaskan Sumbangan Penentuan Nasional Dijanka (INDC) yang dihantar kepada Konvensyen Kerangka Perubahan Iklim Bangsa-Bangsa Bersatu (UNFCCC) untuk ASEAN dan Malaysia selama 100 tahun berdasarkan Perjanjian Paris 2015. Objektif kedua adalah untuk menganalisis dmpak pertabahan iklim ke atas negara-negara ASEAN berpandukan INDC masing-masing yang diserahkan kepada UNFCCC tapi selama 50 years tahun sejak Perjanjian Marrakesh tahun 2016. Objektif ketiga adalah untuk membina indeks ekonomi karban rendah untuk Indonesia, Malaysia dan Thailand. Permodellan CGE dinamik bukan linar dan jadual input-output 2010 dipakai untuk menghitung dampak pertabahan iklim dibawah sinario INDC dan pernigaan seperti biasa (BAU) (jika amalan kini diteruskan). Bagi kes Malaysia satu lagi rancangan nasional disertakan. Jangkamasa 2010-2100 terpilih untuk objektif pertama kerana Penjanjian Paris memilih tempuh itu dan 2010-2060 dipilih untuk objektif kedua dan

ketiga disebabkan tempuh yang ditetapkan oleh Perjanjian Marrakesh. Dapatan menunujkan bahawa kerosakkan iklim dalam jangkamasa 2010-2100 akan menurun daripada 2,722mtoe dibawah sinario BAU kepada 1,203mtoe di bawah rancangan nasional dan 699mtoe di bawah sinario INDC. Pemusatan karbon akan jatuh daripada 11,912ppm di bawah sinario BAU kepada 9,714ppm di bawah sinario nasional dan 8,592ppm di bawah sinario INDC. Oleh kerana kos pengubahsuiaan sinario kedua dan ketiga agak sama, sinario INDC UNFCCC merupakan pilihan terbaik. Dalam kes keseluruhan ASEAN, dapatan menunjukkan pemusatan karban alam sekitar dan suhu dibawah sinario INDC akan jatuh daripada 390ppm and 0.80°C masing-masing pada 2010 kepada 298 ppm and 0.71°C masing-masing pada tahun 2060. Di bawah sinario BAU ianya akan jatuh daripada 390ppm and 0.80°C masing-masing pada 2010 kepada 351ppm dan 0.79°C masing-masing pada 2060. Kemusnahan iklim kumulatif dibawah sinario BAU dan optimum akan naik daripada MYR8billion untuk kedua-duannya pada 2010 kepada MYR579Billion and MYR513Billion pada 2060. Pengurangan buangan sisa karban dibawah sinario optimum boleh dicapai tanpa menjejaskan pertumbuhan KDNK. Perhitungan indeks ekonomi karban rendah untuk Indonesia, Malaysia dan Thailand menunjukkan bahawa Indonesia perlu memperkenal dasar perubahan iklim agresif untuk mengejar Malaysia. Thailand memperlihatkan prestasi yang agak sama dengan Malaysia. Pada umumnya, tesis ini menjanakan dapatan yang menunjukkan bahawa pengenalan dan perincian INDC boleh mempertabahkan perubahan iklim dan pemanasan global antara negara-negara ASEAN amnya, dan Malaysia khasnya.

Kata kunci: Perubahan Iklim, Pemanasan Global, Buangan Karban, Pemusatan Karban, Indeks Ekonomi Karban Rendah, ASEAN

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&

My Supervisor, Distinguished Professor Dr. Rajah Rasiah

THEY ALWAYS ENCOURAGED ME BY SAYING, *"YOU CAN DO IT"*.

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LIST OF SYMBOLS AND ABRIVATIONS

10MP	: Tenth Malaysia Plan
1MBAS	: 1Malaysia Biomass Alternative Strategy
ASEAN	: Association of Southeast Asian Nations
BI	: Low Carbon Economy Contribution Index
Biotech Corp	: Malaysian Non-Renewable Corporation
BS	: Low Carbon Economy Shares
BTP	: Low Carbon Economy Transformation Programme
DCGE	: Dynamic Computable General Equilibrium
DOS	: Department of Statistics
DP	: Domestic Production
E&I	: Export and Import
EPU	: Economic Planning Unit
ETP	: Economic Transformation Plan
FGS	: Final Goods and Services
GAMS	: General Algebraic Modelling System
GDP	: Gross Domestic Product
GNI	: Gross National Income
HIES	: Household Income and Expenditure Survey

I-O	: Input-Output Table
KeTTHA	: Ministry of Energy, Green Technology and Water, Malaysia
LFS	: Labour Force Survey
MIDA	: Malaysian Investment Development Authority
MOA	: Ministry of Agriculture & Agro-Based Industry
MOSTI	: Ministry of Science, Technology & Innovation
MPIC	: Ministry of Plantation Industries and Commodities
NBC	: National Low Carbon Economy Council
NBP	: National Non-Renewable Policy
NBS	: National Biomass Strategy
NGO	: Non-government Organization
NGP	: National Green-tech Policy
NRE	: Ministry of Natural Re-sources and Environment
R&D	:Research & Development
ROW	: Rest of the World
SAM	: Social Accounting Matrix
SEDA	: Sustainable Energy Development Authority Malaysia
UNFCCC	: UN Framework Convention on Climate Change
IPCC	: Intergovernmental Panel on Climate Change
INDC	: Intended Nationally Determined Contributions
NASA	: National Aeronautics and Space Administration

BAU : Business as Usual

RICE : Regional Computable General Equilibrium

NAHRIM : The National Hydraulic Research Institute of Malaysia

MMD : Malaysian Meteorological Department

ADB : Asian Development Bank

SLR : Sea Level Rise

GAMS : General Algebraic Modelling System

CCS : Carbon Capture and Storage

UNEP : United Nations Environment Programme

WMO : World Meteorological Organization

LULUCF : Land Use, Land Use Change, And Forestry Sinks

SCC : Social Cost of Carbon

CGE models : Computable General Equilibrium Models

CES : Constant Elasticity of Substitution

DICE : Dynamic Integrated Model of Climate and The Economy

CFC : Chloro Fluoro Carbons

ASEAN : Association of South -East Asian Nations

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This research commences with the scientific fact, pointed out by "Inter-governmental Panel on Climate Change (IPCC)" account, referred as IPCC (2007) which advocates that "Climate Change" is occurring at an escalated speed. This human-made universal common problem is affecting and distressing the whole biosphere. Following the IPCC (2018) report, if we do not act in time to mitigate the problem, we may reach to the "Point of no return" within by the next 20 to 30 years. The severe consequences of Climate Change that has been referred to by IPCC (2014a) report includes deviations in temperature pattern, higher or lower rates of precipitation, unexpected rise in Sea level and higher rate for Glacier mentation. The IPCC (2014a) report also expressed that all of these incidents can result in extreme weather conditions. Such conditions may and can cause damage to the economy of any country. According to (IPCC 2014b, p. 8)

> *"Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems."*

The IPCC (2014b, p. 35) also stated that the impact on humanity of such environment and climatic changes would be strong, with the recent emissions levels for greenhouse gases are the maximum ever. Climate Change has extensive effects on the earth's natural environment and its surroundings (IPCC, 2014c, p. 32). Since 1950s, global warming in the climate system has resulted in rising water levels. As the air in the atmosphere and ocean warms up, water levels start to rise from melting ice caps in glaciers and other frozen locations (IPCC 2014a, p. 2.) According to IPCC (2018, p. 32) we are already close to the 1.0 °C temperature rise tipping point, from where the Earth will reach to "Point of no return". Main difference for "Climate Change" that happening today besides that took place the ancient age. according to EREC.Report (2008), and Eggleton (2012), is the speed of change that is happening. As, we appeared from the last ice age, the average global temperature increased annually on an average by 1.0 °C for every 1000 years. After that, as it starts to cool very slowly, at the rate of almost two-tenths of a degree for every next 1000 years.

As Climate Change is a serious regional issue capable to effect numerous sectors of the economy and thus, it is difficult to solve exclusively or individually. So, the study done by OECD. (2009) and (Overland et al., 2017) , both suggests that the nations that belong in a specific region, or border sharing territories, can combine their efforts and experience together to mitigate the impact of f Climate Change more effectively besides efficiently. The findings from both the Montoya et al., (2014) and Overland et al., (2017) study, can be useful for this research to validate our specific findings, and enhance the mitigation options for the three selected ASEAN nation's (Malaysia, Indonesia and Thailand) national policymakers. This will support them to arrange and align the regional mitigation efforts more efficiently and effectively for Climate Change with comparable economic and ecological settings.

Mitigation of various impacts of Climate Change, entails a multidimensional tactic, and to manage environmental crisis over borders are indispensable. It demands for substantial regional linkup efforts and work plan to be effective. According to Overland et al., (2017) the selected ASEAN nations like Malaysia, Indonesia and Thailand are vulnerable to neighbouring nations Climate Change impacts. So, for such issues resulting from Climate Change, its better for the region-specific nations to combine their mitigation efforts to attain a better result.

This thesis seeks to analyse the effects of impacts from Climate Change among ASEAN nations in general, and Malaysia in particular. The study will use the Regional Computable General Equilibrium (ASEAN-RICE) model under various climate and ecological settings of selected "Association of Southeast Asian Nations (ASEAN)" member nations. Here, the intended modelling focus to use of a dynamic strategy known as "proposed INDCs" will help generate a regional basis for assessing climate damage and economic returns under existing climate change mitigation proposals. There are only a few past climate change related regional studies using CGE modelling, such as the works of Schimmelpfennin (1996); Alexandratos (1999); Socolow (1999); Reilly (1999).

1.1 Study Background

Climate Change is known as a multi-dimensional global crunch that spans around the most significant number of problem dimensions comprising: scientific, economic, social, ethical, religious, and political. The magnitude of complexity, of the matter, is so complex and enormous, we are capable of seeing or making an idea of only a minimal part that we can individually fathom and sometime may ignore the other dimensions (IPCC, 2014). It is just like the story of blind men, who are trying to assume about an elephant's outlook. So, it is, ubiquitous to find people from different or similar backgrounds talking entirely different aspects of impacts happening from the change in Climate. Like, a doctor may discuss the impact happening from Climate Change on health, an engineer can talk about the effect of Climate Change over manufacturing activities. Similarly, a farmer may talk about the impact of a change in climate on different crops or the changing pattern of agriculture in totality; a fisherman may talk about influence of Climate Change on marine properties like fisheries . In the same way, a busy chief executive officer may complain about the impact of a change in climate on the daily traffic besides the overall warming. Here are striking economic and geopolitical significances of change in climate happening, and throughout recent times this issue has become highly polarized and sensitive for prompt mitigation initiative.

Hardin (1968, p. 1243-1248) had cautioned us about the dangers of overpopulation by putting forward an economic theory acknowledged as the "tragedy of the commons". That theory, focussed on the damage what innocent actions by community individuals can inflict on the environment. This is true for almost every nation in the universe, and we are closed to "destroying our own house," even if we act and feel as sovereign, balanced and free in doing so. Such complications, according to Hardin (1968, p. 1245) have no methodological solutions. All that is necessary to solve the problem is a complete transformation in our central value system. Initially, Hardin (1968) was concerned with overpopulation but his theory can relate to any given conditions that link the misuse of public resources by private business entities. Let us assume, for a specific city, a shared resource includes a grazing of land where all resident ranchers are allowed grazing their cattle. This is also a fact that all of the ranchers know that, the chosen land can allow only a certain number of cattle to graze appropriately at any given time and so the ranchers agree to graze only a decided number of cattle to evade overgrazing. Under such a condition, the individual ranchers' selfishness and logic in bringing in and grazing more cattle than the agreed number might result in overgrazing. Although the profits of browsing the additional cattle accrue to the selfish rancher, the costs incurred from overgrazing are borne by all participant ranchers. This is what is meant by the "tragedy" of the commons. For discharging carbon into the atmosphere, the same concept can be considered. Using fossil fuels like coal, gas or oil ensures low costs and high profits then renewables like solar, or hydro or wind power. Although it may bring profits for energy manufacturers and users, the costs and perils from worldwide Climate Change in addition pollution of air are borne by everybody in the globe.

Stern (2007, p.14) and Nordhaus (2008) scientifically proved that Climate Change is a human-induced problem resulted from carbon emissions and additional greenhouse gases (GHGs) that have gathered in the atmosphere mostly in the past 100 years. This is one of the supreme challenges facing living beings in the biosphere. Scientifically, the changing patterns of climate of a specific region often detrimentally upsets economic progress across the world, and hampers economic progress of the nations concerned. Consequently, research on this topic has been mounting (Cahill et al., 2007; Bonfils, et al., 2008; IPCC, 2007; Lobell et al., 2008; Ahmed et al., 2009; Lobell et al., 2011; Georgescu et al., 2011; Rowhani et al., 2011.).

Stern (2015, p. 10) have clarified the problems that can result from rising temperature in the globe as follows:

> "The effects from rising temperatures are not mainly about local temperatures. It is a global problem, and the scientific evidence points to enormous consequences from higher average global temperatures. The World Bank (2012) review report (updated June 2013) of the latest scientific literature examines the risks and likely

consequences of a world that is 4°C warmer than the preindustrial period. Unexpected heat waves, the severe drought would characterize such a world, and serious floods in many regions, with serious impacts on human systems, ecosystems, and associated services".

The (World Economic Forum [WEF], 2018) have noted three global environmental risks that will affect the future of mankind, *viz*., 1. life-threatening climate, 2. natural adversities and 3. Inability to act at in time to mitigate climate variation impacts. Hence, instead of working for a single nation from a specific regional viewpoint, legislators and ecologists with similar thinking are attempting to develop the instruments and the working tools for managing change impacts on climate by becoming region and global. Detailed studies include lasting mitigation methods, organizational barriers and executing barriers, center on assimilating Climate Change apprehensions. Yet, however, enduring suitable regional mitigation modelling directing toward deciding a change in climate arguments are still missing.

1.2 Problem Statement

According to (Asian Development Bank [ADB] 2017) report, Climate Change can generate serious impairment for the economic growth, and will bring catastrophic impacts on human livelihood for the ASEAN region. Changes in climate patterns are blamed as a cause of destruction of natural deposits of minerals and fossil fuels, infrastructure besides environment, and health (Al-amin and Leal Filho, 2014). Intermittent evaluations carried out by IPCC (2014,p. 26) that provide systematic findings on Climate Change, and this is good enough to refer that, the biosphere is deteriorating with unusual variations and weather conditions, which is the cause of worsening climate outcomes (IPCC, 2018).

The measurable and visible changes that can be observed in climate patterns includes changes in temperatures, fluctuations in precipitation patterns, higher frequencies in droughts, rising sea levels, and higher occurrence of diabolic weather conditions (Houghton et al., 2001). According IPCC (2007, 2011) report rise in atmospheric concentration of GHG from human activities affect the stability of the environmental and cyclical changes in temperatures, and this is anticipated to raise risk for economic collapse in the future. The reasons of change in climate have been explained in numerous investigations, although the evidence used, the methods and forecasts considered are still being explored (Aldy, Stavins, and Barrett, 2003 ; Beckerman and Hepburn, 2007 ; Carter et al., 2006 ; JRC Annual Report, 2013). For instance, related studies and IPCC have reported various climate hazards from time to time happening around the globe (Hansen et al., 2006 ; IPCC, 2007 ; Stern, 2007 ; Nordhaus, 2008). Nearby are similar indications that the earth would experience geological alteration in the long run due to human activities that impede the sustainability of economic development in the next century (Pizer, 1999 : Tol, 2003 ; Byatt et al., 2006 ; Carter et al., 2006 ; Nordhaus, 2007 : Weitzman, 2007). Averting such destructive properties of climate change need to be incorporated in diverse national climate change mitigation policies in future as ASEAN is a regional organization representing the South east Asian nations that are considered to be mostly affected by global impacts of change in climate. "Climate Risk Index (CRI) 2019" is presented in UNFCCC at the 24th Conference of Parties (COP24) in 2019. In that list ASEAN have three of the ten most climate affected nations of the world, which makes the ASEAN region as one of the most vulnerable regions globally. According to ADB (2017), ASEAN is heavily affected by Climate Change, while the inhabitancy of its population of around 600 million in 2016 in cities close to coastline make the regional vulnerable to serious flooding.

Moreover, except few, all of these ASEAN nations are mostly dependent on agronomy besides manufacturing to keep up their pecuniary progress. In the last two decades, few ASEAN nations have seriously suffered from multiple natural catastrophes. According to ADB (2009) report and Hassan, Heidari, Lesion (2015) also refers such climatic incidents that includes of famine, cyclone, hurricane, tsunami and increasing sea level. For instance, in 2004, Malaysia, Thailand and Indonesia were devasted in a massive tsunami. Both “the Philippines" and "Vietnam" were agonized by taiphoon “Haiyan” in the year 2013 and Indonesia, and the Philippines were struck by a gigantic Earthquake followed by Tsunami at 2018. At 2016, the United Nations Climate Change Conference, recognised as COP 22 was hold at Marrakech, Morocco, from 7-18 November 2016. In that conference, almost all the participating nations as well as the ASEAN nations made the pledge to revise the climate target set in COP21. Such decisions were made as most of the nations agreed that the pre-set targets appear to be over ambitious and practically unattainable in the given time period. So, after a sophisticated scientific and economic-based discussion sessions, a new climatic target was agreed upon by all with a new time frame to reverse the effects of Climate Change both globally besides country specifically. ASEAN member nations also revise their prior targets set in INDC’s and agreed on new target at COP 22, and then resubmitted to UNFCCC. For the prior INDC agreement at COP 21, the ASEAN member nations agreed on a time limit till year 2030 to implement their set promises into tangible and measurable actions. But, later in COP 22, the extended their time limit to implement their climate actions for mitigation, ensure transfer of renewable and green energy technology, within year 2050. The (World Bank Development Report [World Bank], 2010, p. 214) was focused on issues of "Development and Climate Change" which also point out that the selection of the correct mitigation mix for any given region depends on certain key factors as mentioned in the report:

"Energy mitigation paths and the mix of policies and technologies are necessary to reach them differ among high-, middle-, and low- income nations, depending on their economic structures, resource endowments, and institutional and technical capabilities."

The revised INDCs presented in UNFCCC at COP 22 by the ASEAN nations and agreed to implement within year 2050 are potted in the subsequent table:

Table 1.1: Summary of ASEAN Member State submitted INDC at COP 22.

Sl	Country	Emission Reduction (conditional)	Emission Reduction (conditional)	Reference Year	Target Year
1	Brunei Darussalam	Activity Related Targets: Energy: reduce energy consumption by 65% increase share of renewables Land Transport: reduce morning peak due hour CO2 emissions from vehicles by 40% Forests: increase total gazette forest reserves from the current 41%-55% of the total area			2050
2	Cambodia	-	27% (+land use, land-use change and forestry)	BAU	2050
3	Indonesia	29%	41%	BAU (2010)	2050
4	Lao PDR	Activity related targets: Energy: reduce renewable energy to 30% of its energy consumption Forests: increase forest cover to 70% of total land area.		2005-2015	2015-2050
5	Malaysia	35% (per unit of GDP)	45% (per unit GDP)	2015	2050
6	Myanmar	Sectors are identified for mitigation but without specific emition targets.			
7	Philippines	-	70%	BAU (2000)	2050
8	Singapore	36% (per unit GDP)		2005	2050
9	Thailand	20%	25%	BAU (2005-)	2050
10	Vietnam	8%	25%	BAU (2010)	2050

Source: http://environment.asean.org/awgcc/

The table 1.1 presented above helps us to select, the same level of economic performing nations among the ASEAN member nations, which nations are located geographically close, and have set similar target, have similar economic growth trends and by using such considerations, we have selected the three ASEAN member nations for this research and they are namely, Malaysia, Indonesia, and Thailand. All the three nations participated in COP 22 and develop their own individual national determinants. We try to consider those nations national determinants to compare and construct the regional targets with average to maximum mitigation treatment

Few studies have already identified the change in climate as per the main reason for natural disasters of that kind (Emanuel, 2005; Stern, 2007; Nordhaus, 2008; IPCC, 2011). Humans have continued to contaminate the air by making haze for certain ASEAN member nations like Indonesia, Malaysia, Singapore, and Thailand as open burning of the jungle is carried out for cultivation. All of the ASEAN nations states have placed they are reviewed voluntary That's how the "Intended Nationally Determined Contributions (INDC)" with a reviewed target to be attained by the period of 2050 with accepted Paris agreement in focus. Till today, ASEAN nations don't have any instruments for regional collaboration. This is because such collaborations are in reality very complex and critical to envisage, to plot, and to implement. It requires to relate alternative approaches, that are captivating interpretation of their nation detailed conditions.[1] To reduce such effects, ASEAN nations have to measure and maintain the agreed upon environmentally sustainable emission thresholds. Only by doing so, they can begin to instrument provincially suitable sustainable development policies, with supportive carbon lessening, supportive renewable foundations of energy, and supportive reduction technologies. Till today expect a few ASEAN nations like Malaysia, Singapore, and Indonesia, others do not have any comprehensive mitigation plan to minimize their overall carbon discharge and climate loss. So, if the ASEAN nations according to ADB (2013) report, fail to shift towards renewable sources of

[1] The subject is more noticeable because of the recent haze catastrophe originated (e.g., intentional human activities) from Indonesia and affecting seriously mainly to Malaysia and Singapore.

previous energy investigation showed that, they would suffer irreversible economic and environmental damages. So, this is significant to study economic growth besides the Climate Change nexus for any given country then investigating a cluster of nations that uphold the identical commons. The only specific initiative undertaken by Malaysia for reducing emissions of carbon will not be victorious except the neighbouring ASEAN member states like Indonesia and Thailand (the two border sharing nations) follow the same course. It also spread over “Singapore,” which in spite of its cutting-edge policies to control climate sustained to have acute “haze pollution” from the neighbouring state “Indonesia.”.

Even when the researchers were doing this research, during 2018; certain catastrophic climatic events like earthquake and volcanic eruption followed by tsunami, and cyclone and flooding shook parts of Indonesia and the Philippines. Although emission of the greenhouse gases is not that much significant for these nations, but they suffer terribly and pay the substantial price. Although ASEAN nations have undertaken individual schedules for adaptation and mitigation activities to deal with such impacts of Climate Change those environmental, economic and social actions, seems inadequate. So, this is a timely demand that these nations need to combine their available resources and means to plan and move forward with long term regional mitigation efforts following the proposed INDCs.

1.3 Research Gap

This section effort to find out the research gap in mitigation actions to deal by the effects of Change in Climate. For searching besides selection of published literature work, the following few keywords was considered like “Climate Change Mitigation, Carbon Emissions, Carbon concentration, Low Carbon Development, Low Carbon Economy Index."

We also conduct a profound literature review (discussed in detail at Chapter 2 of this thesis) based on prominent and ground-breaking research like the Stern review (2006) and Nordhaus (2008, 2015), Doll (2009), Urban and Mulugetta (2010). Then we identified the following research gaps, which are significant for this research:

1. Although the CGE model is usually used for global climate assessment and mitigation consideration, (DICE and RICE model) but no model for the “ASEAN regions focused” was developed so far. So, this research finds a research gap, and try to fill it in by modifying the RICE model to an “ASEAN Regional Integrated climate and economy Model” (ASEAN-RICE model). Later, we use the ASEAN RICE model to compute the scenario-based long-term (100 years) Climate Change projection for only Malaysia. Then we determine the most cost-effective mitigation option following INDC agreement of Malaysia from COP 21 and using the ASEAN-RICE Model.

2. To utilize the newly formulate ASEAN- RISE model to project for Climate Change mitigation scenario for all ASEAN member nations for the next 50 year considering INDC Proposal presented at COP 22. The researcher’s will also calculate the effective and efficient scenario based on overall Abatement cost.

3. To arrange the ASEAN RICE model for developing the Low Carbon Index (LCI) for the selected ASEAN nations (Malaysia, Indonesia, and Thailand) and also for all of the ASEAN nations for the period from year 2010 to year 2060. This Index was developed in the past, only for Indonesia by price house copers. However, for Malaysia and Thailand and also for All of the ASEAN member nations, it has never been formulated so far. As we try to summarize the above findings, of the expected research gap in a diagram, the research gaps for this research work can be linked in the following manner:

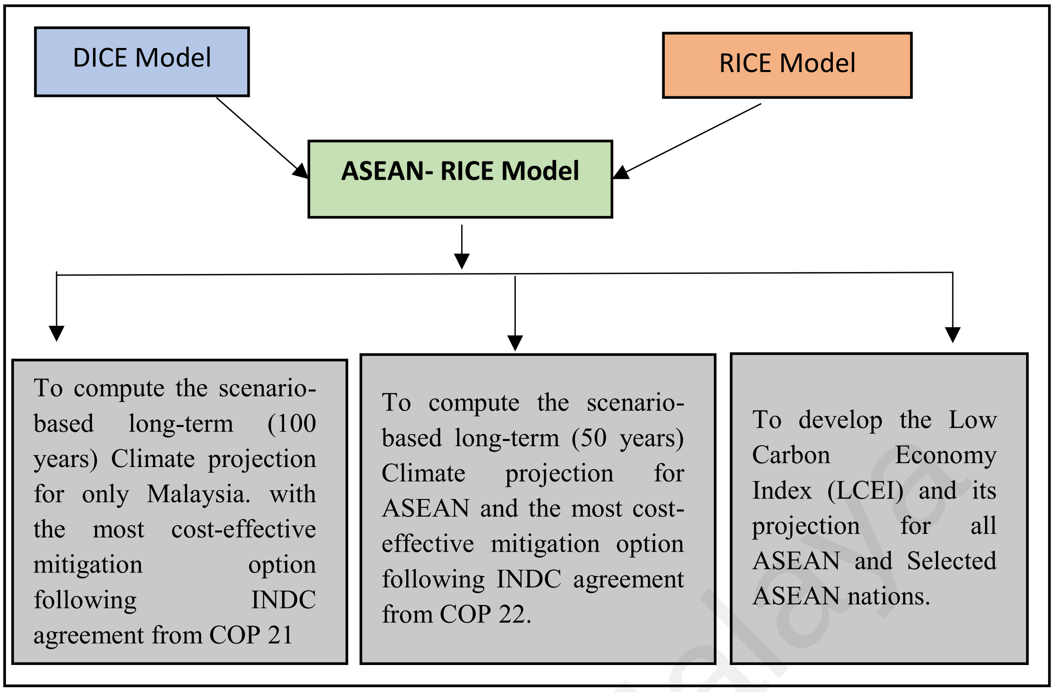

Figure 1.1: Research Gaps for this Research.

Source: Articulated by the authors

We have recognized the precise Research Gaps for this research, now let us set our Research Objectives (RO's) on the basis of our Research Gaps in the following section.

1.4 Research Objectives (ROs)

Nordhaus (2008), established the fact by scientific investigation, in his well-known book "The question of balance" that threat from Climate Change can happen from temperature variations , change in participation pattern or sea level rise. Most of the damage for the considered nations start from water surplus or lacking, usually in the form of storms, droughts, cyclones, tornado or flood. The levels of warming are also harmful to all ASEAN nations, regardless of its rich and poor classes. The extreme change of the physical topography of the earth will also oscillate human livelihood. If those occurrences affect where we live in, it will affect how we live our lives in the future, our day to day practices too. ADB (2017)

The primary goal of this proposed research is to explain how selected ASEAN nations can counterbalance negative bearings of Climate Change in the future by prioritizing needs for different mitigation techniques and methods from local implementation. Henceforth, this study decides to review the effect of variation in climate through scenario forecasting, then considering the mitigation options as the means for Malaysia. It also does the same for the selected ASEAN member nation's (Indonesia and Thailand) future climate mitigation policy and their relative dimensions and advantages aimed at investment selections to decrease future effects and exposures.

According to Stern (2007) review worse is yet going to happen in the future. He warned us by the fact that, in reality most of the nations of the world are just thinking or planning to act. They are thinking about mitigation actions, as an option available to us. But either we continue using the previous technologies, approaches, or else can grip modification, novelty, and global or regional alliance for our future survival. The economic and technological analysis shows us that, if we cannot do it individually, then we need to collaborate for greater benefits. This is why, we need to act regionally, in a more focused manner to solve the ASEAN climate crisis.

According to Stern (2007, 2015) we cannot wait any further, or the damages resulting from Climate Change will be irreversible. The way we are emitting CO_2, if we do not try to reduce it significantly, soon we will reach the point of no return for the world as a whole (IPCC, 2018). Thus, this research proposes the following research objectives for further investigation:

1. To develop a scenario-based long-term (100 years) Climate Change projection for Malaysia and best mitigation option following COP 21 INDC agreement.

2. To project for Climate Change mitigation of ASEAN nations for 50 years considering the INDC Proposal of COP 22 and calculate the abatement cost by using an “ASEAN Regional Integrated climate and economy Model (ASEAN RICE model).”

3. To develop the Low Carbon Index (LCI) for the selected ASEAN nations (Malaysia, Indonesia, and Thailand) and also for all of the ASEAN nations for the period ranging from 2010 to 2060.

1.5. Research Questions (RQs)

As the research objectives are determined now, they will help this research to move forward to identify its need to investigate. Only the mitigation options are considered as the means for the selected ASEAN nations future climate mitigation policy. Their relative dimensions and advantages for investment, selections to diminish future effects and exposures are considered for ASEAN nations. So, the research questions formulated for this research analysis can be as follow:

1. What is the Climate Change effect for the Malaysian economy, by using ASEAN- RICE model can the researcher’s forecast (100 years) best

Climate Change mitigation scenario is for Malaysia with COP21 INDC proposal? Which scenario is the best for Malaysia and why?

2. What will be the long-term (considered for 50 years) Climate Change Business as usual (BAU) Scenario and INDC based mitigation Scenario and abatement cost for the ASEAN nations following (COP22, 2016) Marakccash proclamation? Which Scenario is the best for ASEAN nations?

3. How to develop the "Low Carbon Economy Index (LCEI)" for the selected ASEAN nations and rank them (Malaysia, Indonesia, and Thailand) and also for all of the ASEAN nations for the next 60 years ranging from 2010 to 2060?

These research questions are formulated, following the research gaps identified based on literature review conducted and the research objectives determined and the conceptual outline of this research.

1. 6 Conceptual Framework

For this research, we try to develop a conceptual framework that provides a graphical presentation of our overall work plan. It reflects about what we are doing, how we are considering things and what are those considered variables, what and which comes after whom in this study, and how all components are inter linked and reviewed to determine the anticipated findings. For this research, we emphasis on certain economic resources like capital, labour Investment, government institution, and trade.

Here we try to measure how the unpredictability in Climate Change can influences, over the economic performances of selected ASEAN member nations, and thus measure the amount of damage incurred in total. So, here we consider the extra damage cost, cost of mitigation and capability to mitigate such deviations to determine the optimum mitigation level and then to develop policy response accordingly. We consider two core theories in the conceptual framework of this research, to justify the model deployment as follows:

A. **Social-ecological Mitigation Theory:** The theory of low carbon-based development as discussed inside our Literature helps to ensure the resilience of Socio ecological ecosystem and low-cost green technology with the target of providing energy efficiency, applying clean regional mitigational development by dropping CO_2 emission and also maintaining the global as well as regional ecological balance as sustainable one. According to IPCC (2014a) report UNFCCC continues to involve in prolonged discussions with different governments in Individual and regional forums over in what manner to implement decreases in GHGs emission in future

   IPCC (2014a) report also suggest the likelihood that different regions and society will face disturbances from extreme climatic incidents. There is thus a need for better realization of the process, through which regional mitigation take place and, in what way the different nations from same societal, ecological and formal characteristics of a arrangement impact important picks along a pathway as of ecological disturbance toward mitigational consequence. Thus, this research links the correlated ecological and social organizations under a general framework for mitigation and to develop a conceptual outline for the culture of mitigative courses. This framework permits academics to examine how government plans and other features of the socio-ecological setting affect the capability of actors to attain a sequence of regional mitigation efforts

B. **Theory of Transitions:** The Transitions movement is empirically thought-provoking as it involves through systems of provision and search for ways to institutionalize innovative (resilient, low-carbon) social norms and institutions. Different individualistic policy instruments can be used here to effort pro-environmental change in traits The Transitions drive clearly practices the notions of resilience and conversion. It also includes both of them within an overall approach, when applied to a community-level actions to address the hazard of climate variation.

Following Wesely et al., (2013), there are extreme consequences of inaction for the challenge of Climate Change, numerous authors (Stern, 2007 ; IPCC, 2011) partake concerned for approaches that can empower transitions, fluctuating from formerly leading damaging regimes towards in the direction of additional sustainable arrangements.

Such transitions suggest methods of fundamental change to novel arrangement configurations supported out by numerous performers over long term (40-50years) in addition involve multiple variations in social arrangements. According to Wesely et al., (2013), Transitions stand for "a set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behavior, culture, ecology and belief systems”.

Study “on transitions” takes added thrust in past decades. Now, “transition research” links a broad assortment of theories like “innovation studies, history, and ecology with sociology, political and governance studies as well as psychology”. Wesely et al., (2013) also differentiate four theoretical features including transition studies as: “technological innovation systems, the multi-level perspective (MLP) on socio-technical transitions, deliberate niche management and transition administration”. Wesely et al., (2013), also confirms that the initial double aim at evaluating and relating transitions by way of methods of radical besides structural variation concentrating for arranged transition dynamics.

The last twofold course includes prescriptive in addition focus on matters of agency besides how actors influence may processes the conversion., and also added perceptions for “transition dynamics.”. "Theory of transition" was considered in the conceptual framework of this research, as it is critical for implication at the policy level. As it supports the necessary conversion from using the traditional energy source, like using fossil fuel or combustion engine and shift to renewables and clean energy options, like Solar power and other available and low-cost options for minimizing the effects of Climate variation for ASEAN region.

Achieving such social transformation towards regional mitigation of Climate Change will need time and profound commitment from selected ASEAN nations to accept the followings actions:

1. To alter their (Malaysia, Indonesia, and Thailand) individual and collective energy using pattern, as well as travel and consumption behaviours and habits.

2. To invest, purchase and spend (Malaysia, Indonesia, and Thailand) in Renewable Energy in a sustainable and low carbon manner.

3. To give consent from authorities (Malaysia, Indonesia, and Thailand), for changes in the buildings and landscapes where they live and work, in the markets in which they participate, and in the services and products, they buy or receive.

Here, we actually try to determine the level of mitigation action is efficient and effective on selected country-specific measurement as well as for ASEAN region from the aspect of mitigation action. The conceptual framework of this research is presented below:

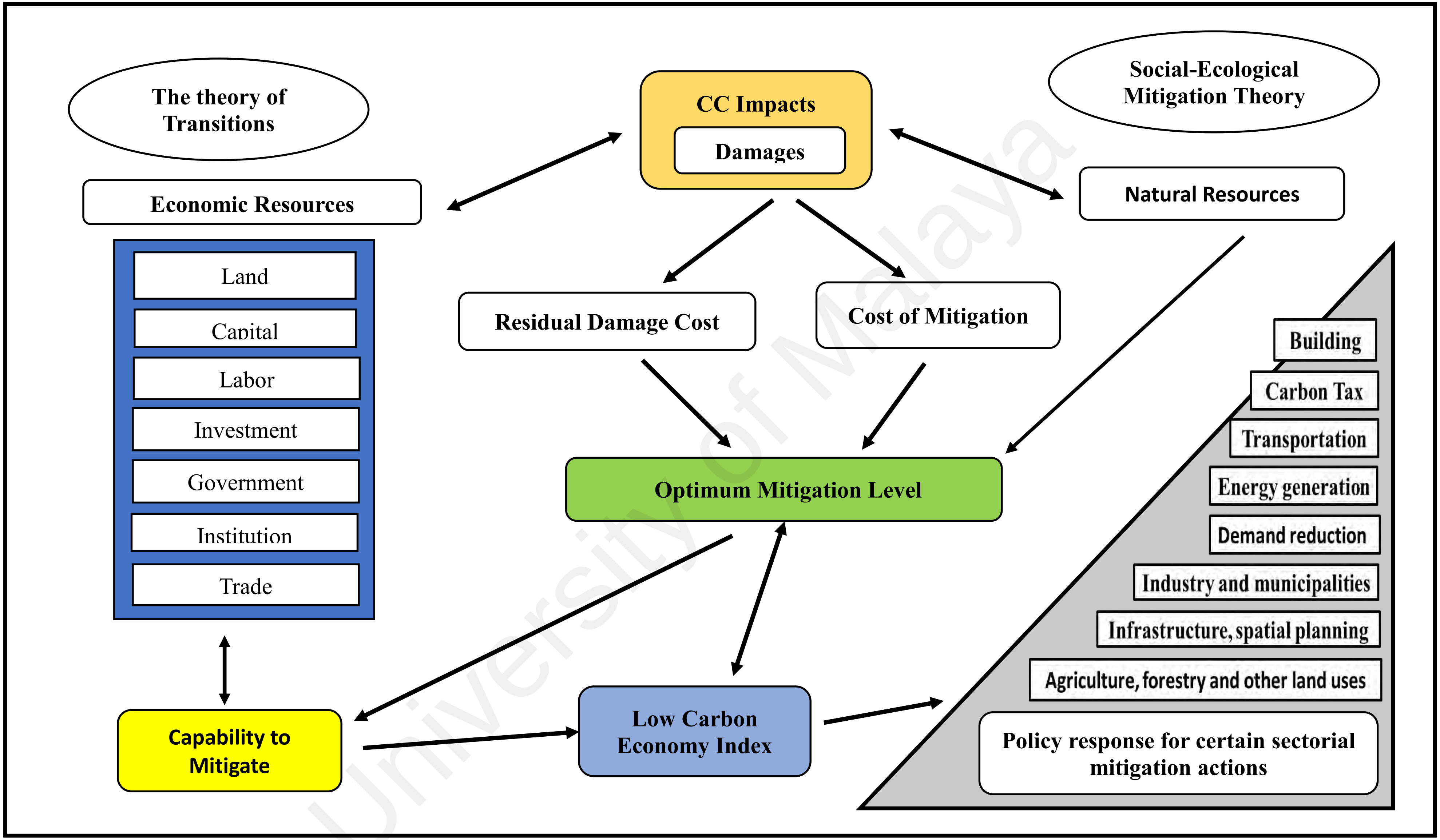

Figure1.2: Conceptual Framework

Source: Developed by the author

1.7 Research Methodology

For research questions (RQ) 1 and 2, we try to quantify the impact of CC on the economic, environmental, and ecological constituents as variables[2] by using a dynamic dual multidisciplinary framework to analyses a long term scenario valuation of climate destruction.[3] This double multi-disciplinary framework used here is lively, non-linear numerical model organizing a "Empirical Regional Downscaling Dynamic Integrated Model of Climate and the Economy" that accepts suggestions and programs for ASEAN BAU plans and Malaysia local regime planned climate roadmap presented at COP 21 (IPCC, 2007). The ASEAN RICE model accepted the links for input of factors of climate, as climate variation, sequence of carbon, loss from climate incidents, and discharges from carbon, which impacts economic progress and development as the endogenous variables for populace, the funds, productivity, storage of fossil fuel, besides the proportion of technical adjustment.[4]

Aimed for scenario of Malaysia, we contemplate approaches developed through the government to diminish emissions of carbon for this nation, that comprises the basic outline for the "Carbon Tax" policy which remains anticipated toward changing the related charges of carbon so users will be eventually influenced to substitute to renewable energy source from fossil fuels. In the model, we will pick up the stringent environmental policy already built by Singapore, but the other ASEAN nations have to formulate their own.

2 The work elaborated in this thesis resembles the model advocated by Nordhaus (2008) known as the DICE model which was applied at the global level. Nordhaus (2008) later tweaked the global level parameters to derive the RICE model. This thesis is an adaptation of the RICE model at the ASEAN level. More specifically, the ASEAN-RICE model applied here investigates the country level probable results by the downscaling adoption of a specific region.

3 The model runs by means of "mathematical optimization with geometric, algebraic modeling system (GAMS) programming".

4 "Technological change" used thought out "exogenous" by type for this study, preferably provided as a result of changing market players.

Table 1.2: Top Green House Gas emitters of the world and all ASEAN nations

Years/Countries	Top Emitters				ASEAN COUNTRIES									World Total
	China	**USA**	**Russia**	**India**	**Indonesia**	**Myanmar**	**Thailand**	**Malaysia**	**Vietnam**	**Philippines**	**Cambodia**	**Singapore**	**Brunei**	
1990	3,8	6,115	3,582	1,376	1,161	875	208	198	99	96	20	33	18	38,258
1995	5,0	6,342	2,637	1,637	1,312	943	282	252	121	125	21	45	21	39,028
2000	5,0	6,983	2,647	1,873	1,445	562	283	254	156	140	22	48	17	40,234
2005	7,8	7,082	2,585	2,128	2,884	511	349	336	225	146	61	48	23	47,269
2008	10,	6,923	2,605	2,434	2,015	340	360	334	258	153	172	50	19	48,748
2009	10,	6,515	2,481	2,584	2,620	344	362	356	283	154	138	47	20	49,329
2010	11,	6,715	2,510	2,692	1,946	362	413	330	306	159	192	50	20	50,101
Average	7,6	6,668	2,721	2,103	1,912	562	322	294	207	139	89	46	20	44,710
Average global share (%)	17.15	14.91	6.09	4.70	4.28	1.26	0.72	0.66	0.46	0.31	0.20	0.10	0.04	100.00

Source: European Commission (EU, 2015 JRC/PBL, EDGAR) .

The variable which are exogenous, and used within ASEAN RICE model are selected based on a policy initiative following the "top-down" method. Computable units remain worth of properties besides facilities with exposures measured in minimal and in present values. The study prototype is used for measuring long term economic growth for sustainable development by seeing Malaysian and ASEAN growth through a forthcoming idea, venture in the capital, consumption, and technological progress in contradiction of linked climate effects and susceptibilities.[5]

Discharge forecasts prepared in this research followed the references of forthcoming targets existing within the 4th assessment report published by IPCC (2007). Carbon discharges from Nonindustrial discharges besides particulates remain also measured in the loss approximation as recommended by both 3rd besides 4th Assessment Reports by IPCC (2007, 2001). The particulars of my research resources and methods are presented below.[6]

1.7.1 Data Source

Climate dimensions considered in this research were collected mostly from the Malaysian context with rest other selected ASEAN nations. For the three selected ASEAN nations climatic data was initially collected from the GTAP 9 database. Beside these, the following data sources were also used to collect specific data for the three ASEAN nations as follow:

1. For Malaysia, the Malaysian climatic data used for this study derives from the Malaysian Meteorological Division (MMD) Economic Planning UNIT (EPU),

[5] Although there are some doubts in the forecasts as they are delicate to timeline, consumer and manufacturer favourites, nationwide and global schedules, significance, and the obtainability of backstop knowhows; yet, the assessment is useful against the current plan announced in Malaysia and ASEAN recently.

[6] The details of the equations used in modeling and also the procedures used for this thesis are given at the end of the appendix.

Putrajaya, Malaysia and ASEAN Secretariat. we also consider data from World Bank, NASA and other relevant sources whenever necessary.

2. For Indonesia, the climatic data for the year 2015was collected from “ASEAN Secretariat” and INDC Proposal proposed in UNFCCC (COP-22) by their respective government. Indonesian SAM 2015, was collected from Department of Statistics (Badan Pusat Statistik).

3. For Thailand the climatic data was collected from “ASEAN Secretariat” (2015) and INDC proposal proposed in UNFCCC (COP 22). Thailand Sam sectors for 2010 and 2015 was collected from “National Statistical Office, Bangkok”. This is a data center maintained by the “Ministry of Information & Communication Technology, Thailand”

1.7.2 Economizing Empirical Method

We expected an optimal route from Malaysia through a strategy inclination, resolute by the "market price" as the base, at which the entire usages of fossil fuel based energy in The market will be substituted willingly by energy generated from environmentally friendly renewable or "Backstop technologies" as mentioned by Nordhaus (2008). A perimeter of the temperature of 1.5 °C, considered as a target as it was promised in their INDC, and also following confirmations from IPCC (2007) report, Stern review (2007) and Nordhaus (2008). The effect of such policy based back up promotes new technologies that emissions significantly. It begins with a modest rate of reduction trailed by the high upward rise in the middle term, also later by severe rates in the extended time.

Assuming if the "Marginal Cost" for carbon discharge decreases can be steady at different segments of the economic sectors and the aspects of climate like discharge of carbon and its sequence, the alteration in climate, the impairment in atmosphere, probably stocks of fossil fuel, and the pace of technological change rate, all are assessed by imposing a synchronized carbon price. However, in reality, we all know the fact that the emissions and goods are likely to face the failure of the market. Campiglio (2014), argued that, people need to deliberate such facts and set a tax for use of carbon, usually recognised as "Carbon Tax". This Carbon tax will help us in speeding up our efforts by subsidizing specific industries to shift from the use of fossil-based fuels to Non-fossil-based fuels besides, to adopt environment-friendly know-hows. So, for this research, we have considered the practical limit of the carbon price in "real terms" amid 4 -5 % annually untill year 2110, which is an "extensive period" for our first research objective. The kind of practices and use of new know-how deployed, the "discount rate", the considered "interest rate," "consumption patterns," "national GDP growth," "investments in the capital," "changing aspects of the carbon cycle," "the climate system" also remains persistent. Here, we have the cast off economizing experiential technique to analyze collaboration amid "global warming" and "Climate Change" besides "loss and damage" happens from it for the specific economy. The economizing mitigation dimensions indicate a series of stable climate incident-based results from the period of 2010 toward 2110.

For this research, we accepted the "top-down" approach[7]For modeling emphases on effects on the selected ASEAN nations (Malaysia, Thailand, and Indonesia). Considering a wide variety of probable outcomes of climatic events, and thus shifting from global outcomes towards regional outcomes, then to country-based level which

[7] The "top-down" approach specifies worldwide alteration and then specific nations attempting "climate initiatives" to disaggregate them to measure.

provides precise and most accurate results, which varies significantly from global results and thus creates strong evidence and acceptability to measure such impacts from regional settings.

The adopted methods used for this research by an actual observation based recorded extensive dataset to forecast the annual sequence of experiential like "temperature change" besides "large-scale movement of rainfall." The quantity is then comprised in "annual average circulation" limitations as per "Predictor variables" besides "annual average temperature variations" by "carbon concentrations" as per "Predicted variables" to approximation variations in future. Forecasted yearly sequence are downscaled in view of certain factors per annum, and includes the following: (i) emissions from industrial, (ii) net damages with output level, (iii) damage from climate events (total and portion of gross yield), (iv) price of carbon (per ton), (v) regulator rate for emissions, (vi) social cost of carbon, and also (vii) the real rate of return for controlling the weather.

For this research, we also considered the "Malaysia's climate scenario" employing endorsements provided in "National Climate Roadmap" offered at "COP20" by following the guiding principle provided in IPCC (2007) report.[8] Here we also estimated the scenarios of climate for other ASEAN nations with a view of their economic progress outlines and also the INDC proposal presented by their respective government in Conference of Parties "COP-22" happened from 7th to 18th November 2016 at Marrakech in Morocco. This analysis utilizes several instruments to analyses the data. The main instrument used is the "General Algebraic Modelling System (GAMS)" besides "Syntax Programming (SP)." Usually, in this thesis, GAMS along with the SP is utilized for an explanation of non-linear besides mixed-integer glitches, and to formulate the essential mitigation policy based on that results for climate

8 Otherwise, forecasts may be influenced by environmental variances, as it is considered as a global common, hence, emissions from the neighbors diffusing into Malaysia.

variations for Malaysia, Indonesia, and Thailand. The forecasts are usually computed by "Year intervals" of five years starting from 2010 to 2110.[9]

The forecasts according to Popper (1961) and Stern (2007) are really sensitive due to the consideration of many assumptions considered, and so there are possibilities of the rise in uncertainties, and thus, the validity of the estimated value becomes less consistent. Such trial can still produce a reliable forecast if they can do constant adjustment and updates with the real output information and detailed methodology that can develop over the period. For this specific research, we have used two particular sets of data. The first set mentions to macroeconomic data, which is achieved from the GTAP 9 Database. The second set of data is reached from "meteorological record of climatic parameters (MMD, 2009; NAHRIM, 2006)".

All large-scale predictor data used in this study for Malaysia are taken from the Climate Change scenarios for "Malaysia 2001-2090, Malaysian Meteorological Department (MMD) (MMD, 2009)", whereas the data for the selected ASEAN nations and other ASEAN nations are accomplished from "GTAP 9 Database". Malaysian and selected ASEAN nations temperature were collected from "MMD's historical records" besides "GTAP 9 Database" archives correspondingly. We used them to forecast changes in extensive distinctions by measuring the concentration of GHGs 280-927 PPM by approximately necessary adjustments within the data collected from MMD besides GTAP towards attaining the study scope. It also considers the investigation of long-term effect of Climate Change from year 2010 till towards the year 2110 for the ASEAN member nations.

Al-Amin and Leal Filho (2014) indicated that throughout 1969-2007, the yearly data collected from four seasons and two monsoons were used to estimate the baseline year

9 The initial year is considered as 2010 rather than in 2015 because the up-to-date data available for Malaysia only comes ill 2010.

data of 2010 for Malaysia. The first monsoon in Malaysia is known as "Southwest Monsoon" (SM) which occurs in the period of “May to September” every year. Malaysia’s "Second monsoon" which is also known as "Northeast Monsoon (NM)" extends from the months of “November to February” and both of these monsoons are significant in determining Malaysia’s climatic parameters.

“Climatological limits of weather data” aimed at “ASEAN region” is collected as of GTAP archives. The modeling technique aids to calculate the thresholds from environment susceptibility, the effect for selected ASEAN member nations.[10] The limits for change in climate required as follows:

(a) The likelihood of unanticipated climatic tremors happening,

(b) effect from possible exposures at the present period and in upcoming.[11]

We also estimate future differences in temperature which lies in-between 0.8 °C to 3.1°C for all ASEAN nations, and level of carbon (CO_2) concentration using a reasonable level of variations.

1.7.3 Climate considerations

The reason we focus on regional Collaboration and inclination to embrace Climate Change strategies rest on our insight of reimbursements and expenses results from such policies. Evaluation of these costs and benefits requires more precise and region-specific economic analysis. We are rational about the mitigation efforts in the regional level; reason it is important mostly for the following causes:

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[10] The threshold at this point designates a specific point elsewhere which, the conventional and socio-economic arrangement may be exaggerated otherwise primarily reformed by climate change. Poor of perceptive the social and economic setup and establishments that can create impact or variation in climate settings besides consequence for global warming, which may be not conceivable to structure a substitute guidelines for checked climatic loss [27].

[11] The choice of climate-related and edge level variables were smoothed by the MMD [29.]

Firstly, The mitigation encounter for the ASEAN nations according to Nordhaus (2013). recounts in selecting among the diverse development tracks with different mitigation possibilities. Because of the limited resource state besides extreme capacity restrictions, their ability to choose low-carbon development paths and their chances to wait for more atmosphere friendly know-hows is strictly controlled.

Secondly, the development paths for ASEAN Nations may vary and may be costly. According to a recent book published by Nordhaus (2013) through sufficient access to money, know-how, and the proper established setting, few of the emerging economies within the ASEAN nations might be smart to leapfrog in too low carbon development tracks that encourage their economic progress besides subsidizing to mitigating the long-term impacts of Climate Change. Economies that are emerging in ASEAN, and trying to find ways to carbon-intensive progress, are capable of adopting various mitigation options faster than others, but in such cases, their benefits from such technological leapfrogging may be comparatively minor.

Thirdly, for most of the fast- flourishing economies, according to Nordhaus (2013) the chances to ensure different mitigation course are higher, as they are capable to rapidly accept the novel energy manufacture capacities and escalate transportation and set-up new smart green cities.

However, once the choices are made, the lock-in properties will turn it expensive for modification of pathways, if necessary. For industrialized nations, any chance to leapfrog are limited, and most primary challenge is to reorient the prevailing development tracks, besides technologies in the direction of attaining lower-carbon dependency for manufacturing besides consumption. It is also known as the ‘Provincial heterogeneity' issue.

Thus, for any "Regional Collaboration," it is an influential force in global economics and governments, which was seeming in various contracts linked to trade, a collaboration of know-how, collaboration of water, collaboration for energy, collaboration for transport. Some regions, like EU, is already collaborating each other among the member states on mitigation of Climatic impacts by employing a scheme, known as “Carbon Trading Scheme (CTS)”, and providing strict obligatory regulation on the emission of CO_2. As the strategic focus of this chapter is to augment Regional collaboration to mitigate the effects of Climate Change. The Optimal scenario of the model comprises the construction of specific mitigation-based strategies for Malaysia towards avoiding detrimental bearings from Climate Change incidents. Here, we have explored few alternative scenarios following IPCC (2007),(2014b) endorsements.

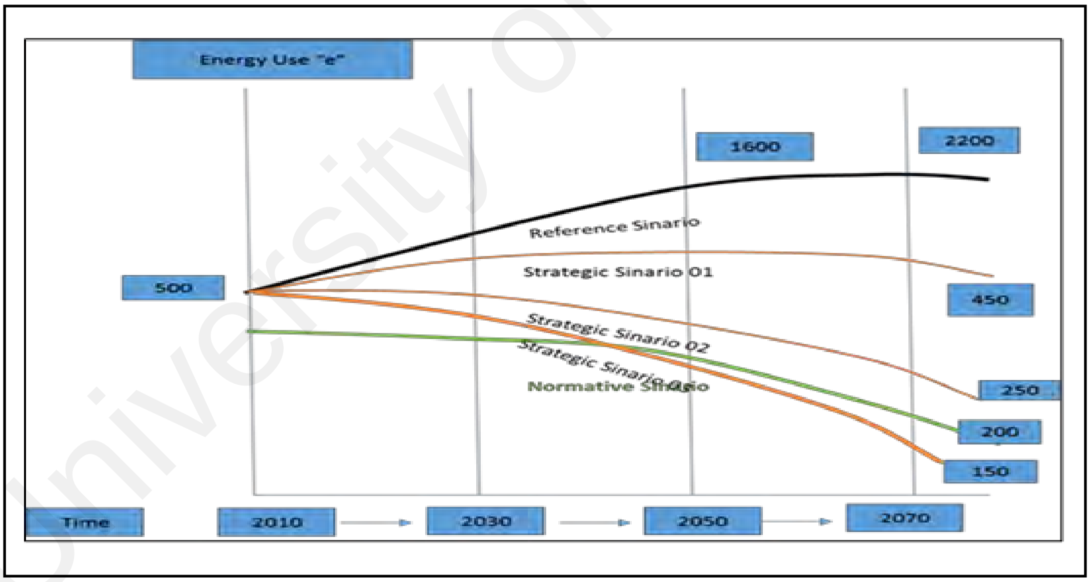

Figure: 1.3: Methodological Considerations

Source: Developed by the author

Regularly, some climatic limitations, like, industrial discharge restrictions in the year 2060, founded with the initial value from levels of 2010, that is used for the cost-benefit methods, which follow methods agreed through IPCC (2007), Stern (2007), and Nordhaus (2008). Initially, we start by seeing temperature deviation effects grounded on “COP-21" proposal for Malaysia besides the selected ASEAN member nations towards an approximation of different scenarios of the probable course of climate system accomplished in next 50 year.[12]

Here we consider this situation as the Business as Usual (BAU) or Reference Scenario. Then we use recommendations provided by Nordhaus (2008) aimed at calculating the carbon prices for the ASEAN member nations. Malaysia has already launched its strategy for carbon prices by using it,[13]So we considered the actual market prices for carbon for measuring the cost for selected ASEAN nations as a whole.

The strategy inclines to accept backstop technologies as prescribes by Nordhaus (2008) that can ensure discharge reductions mainly of uncertain rates in the adjacent period tracked through high standards in the intermediate term besides radical charges during longstanding decreases employing climate vision targets like INDC's. Here we consider this as the Normative Scenario, where the presence of Carbon Tax within the selected scenario of ASEAN nations to reduce emission of carbons, here we did not think of any replacement for fossil fuels by using non-fossil based fuels because the economic mediators did not face any prize or compression to progress in backstop based know-hows (Yamaguchi, 2012).

1.7.4 Rate of Discount and Price of Carbon

For this thesis, we also consider a discount rate of 1.50% for Malaysia and other ASEAN member nations 1.45% respectively. Such discount rate was set and was used following Nordhaus (2008), in this forecast to convert future expenses into present standards.[14]

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[12] A distinct scenario using present outlines of manufacture to development, damage by climate imposed by the 2010-2105 period is maintained in the study done by Al-Amin et al..[35].

[13] The full description of backstop technologies is available in the studies done by Nordhaus[25].

[14] This study chose to utilize constructive values for the discount rate, although throughout the depression, it is probable to remain negative[25].

The actual “discount rate” remained accustomed for current and forthcoming prices at Malaysian Ringgit (MYR) net of growth. This specified research considers a specific rate of inflation, 3% annually for Malaysia and also for the two other selected ASEAN nations, which stayed strained by the “Malaysia National accounts dataset” (MMD, 2009, DOS, 2010, 2013a, 2013b) and “ASEAN Secretariat” (2015).

In conclusion, charge for carbon emission is quantify through assessing it by conferring toward the "Social cost of carbon," that characterizes contemporary worth of extra damage in the forthcoming economic performance from currently shaped extra carbon discharges within Malaysia besides the selected ASEAN nations.[15]

1.7.5 Research Framework

For this specific research, two kinds of research approaches were used as follow:

1 Science module: This RICE module principally considers research appraisal and evaluation of data generation for long-term optimized scenarios for a given Region. Explicitly, the research appraisal will be involved to assess possible green growth systems for applicable mainstreaming mitigation and the evaluation system will be engaged on experiments to locate the Climate Change transformation components and suitable scenario data generation. Eventually, the science module will be advanced for region-specific assessment (ASEAN) and data invention (i.e., environmental and technological co-efficient) on scenario green growth, scenario technology options, possible (i.e., sustainable) future strategies and scenario climatic parameters (i.e., temperature, rainfall, production loss.) The specific guidelines are as follows:

[15] ASEAN case also measured “social cost of carbon” by associated approximation for relating the consequences of Malaysian mitigation action even though no extra climate action is measured prevailing the impacts of Climate Change.

a) Appraisal: region-specific assessment of an optimized Mitigation-system by new and latest green or alternative technology options.
b) Innovation: building technology options to support sustainable future strategies and scenario evaluation on climatic parameters
c) Assessment: country-specific mitigation focused green growth co-efficient based on mathematical (or maybe by the laboratory) experiments.

2. Social-Science Module: This module considers appropriate solution points by examining the parameters from the science domain and Malaysian national accounts. Explicitly, this module will be involved in construction of environmental focused "Social Accounting Matrix (SAM)" by utilizing the dataset of science module to economic analysis for long-run planning and policy. The specific guidelines are as follows:

a) Database: building essential Social Accounting Matrix (SAM) for Malaysia. This database will be complex by national economic parameters, agricultural production, and finally simulated data by science module on future scenario and preferences. For the other nations, the researcher's buy and use secondary Data from GTAP 9 Database.
b) Method: utilize the ASEAN-RICE Model framework for an analysis of regional climate sustainability for future demand and preferences for the selected three nations.
c) Economic investigation**:** short-term besides long-term targets are grounded over lasting sustainability ideas, scenario analysis, trend studies, effect analysis.

1.8 Significance of Study

Climate Change is a complex problem, that affects many dimensions of a given region. This research is a unique one in the category of climate research, because of the following observations:

1. It formulates a dedicated CGI based model for ASEAN member states to measure the influence of Climate Change over the total economy as a whole and to identify the best avenue for effective and efficient mitigation options.

2. To calculate the abatement cost and time necessary for attaining INDC Promises.

3. Focus on the technological know-how requirements and green technology necessary for the transformation of low carbon technology

1.9 Scope of the Study

This research is an extensive and exclusive one by the category of mitigation research on Climate Change for the ASEAN region, considering the following reasons:

1. It helps to set up the monitoring process for measuring the proper implementation of INDCs promises by the selected individual ASEAN members as well as a regional whole.

2. It assists ASEAN member nations to frame their mitigation policy and to do necessary modifications (if necessary) for a regional coordination effort for active regional mitigation.

3. Creates a reference point for beginning the regional collaboration in the mitigation aspect for ASEAN members.

1.10 Expected Outcomes

This research as proposed earlier will contribute to framing a "long-term Climate Change mitigation policy mechanism" for applicable programmes and options, particularly on the issue of National Low Carbon Development Policy. The outcomes of this research will undoubtedly lead to a cautionary worry in the scheming alteration in climate, leading extension into related subject like low carbon development and provide a productive, meaningful result. Here we reconfigure the RICE model (Regional Integrated Climate-Economy model), for making the lorn term (100 or 50-year scenario projections) projection for selected ASEAN member nations, and so we named it as "ASEAN-Rice" Model.

This research aims to appraise the degree of change in climate and economic progress significances arising from the dual alternate scenarios such as Business as Usual or no action and the combined INDC induced scenario, as those are black and white promises made through the ASEAN member nations to the UNFCCC.

By applying “Regional Integrated Climate and Economy (RICE)” model for evaluating the effect of “Climate Change” upon national economy, here we will examine all the INDC induced scenario, and their practical implication and then identify the most effective and efficient option. So, the expected outcomes of this research are as follows:

1. To develop a scenario-based long-term (100 years) Climate Change projection for Malaysia and best mitigation option following COP 21 INDC agreement and to determine the best mitigation option for Malaysia.

2. To project for Climate Change mitigation of ASEAN nations considering INDC Proposal of COP 22 and calculate the Abatement cost by with an “ASEAN Regional Integrated climate and economy Model (ASEAN RICE model)” to determine best mitigation option for selected ASEAN nations.

3. To develop the Low Carbon Index (LCI) for the ASEAN nations from 2010 to 2060.

1.11 Organization of Thesis

The chapters in this thesis are organized as follows. Following this introductory chapter, Chapter 2 discusses the literature review. This chapter summarises a few past and most contemporary research studies, which is focused on measuring and found avenues to mitigate the effect of the variation in climate on different economic settings. It presents arguments from IPCC (2007, 2011, 2014a, 2017, 2018); Glaeser &

Kahn (2010); Leiby & Rubin, (2013) and Sachs (2015) to formulate the basic description of severe and detrimental impacts of climate variations, and the scientific explanation for such happenings and the way that lead to a sustainable and cost-effective solution for interested and willing nations.

The second part of the chapter starts with the argument presented by Stern review (2006) and discussion from Nordhaus (2008) for explaining the “Dynamic Integrated Model of Climate and The Economy (DICE)” model. Their core disagreement was on determining the Discount rate. When Nordhaus (2008) proposed a gradual growth in the considered discount rate, Stern (2006) intends to use a higher discount rate in the initial phase of the pricing of carbon. Both of them offers to familiarise about Carbon tax within fiscal policy, as this might help the government toward subsidize the abatement cost for green and zero carbon know-how transmission from the developed nation.

The third part of literature review illustrates concept for “Low carbon development” as clarified by Urban and Mulugata (2010); Phdungsilp (2010). As we try to probe ways to reduce carbon emission, the beginning of focus on low carbon development usually initiates from there. It justifies the fact that, low carbon-based development is better for our future growth and development, as it controls and minimizes emission and use of carbon as well as help us to attain the IPCC research findings. It is a great concept, that can be explained in detail with its six different phases. All of the stages are discussed thoroughly here for framing a clear understanding of the reader and to ensure that it helps any fossil fuel-based economy to gradually transform into a non-fossil fuel or renewable based economy. It also deliberates by Parry (2014). about how to compute the low carbon economy index for the next 50 years, and how it can change the future of the designated ASEAN nations. This chapter summarises all the theoretical consideration we made for this thesis.

Chapter 3, is the "Research Methodology" chapter of this thesis. It is the heart of this whole thesis. In this chapter, we have described the components of the integrated assessment model and the DICE model developed by Nordhaus (2008). So, the step by step procedure of how we set up the DICE model and the basic equations used to transform it into the ASEAN RICE model are debated here. For this, we downscale another integrated assessment model is known as "RICE model" developed by Nordhaus (2008), and this is used to measure mitigation bearings of change in Climate for selected ASEAN nations. Here we describe the detail of different mechanisms that were deployed to calculate the LCEI till year 2060 for the selected nations of ASEAN as well as for the whole of the ASEAN region.

Chapter 4, is the first analytical chapter of this thesis. It deliberates to measure the capacity of only Malaysia as an individual nation, to achieve the promises it made by INDC submitted in UNFCCC conference known as COP 21. For this chapter, we have use CGE based ASEAN RICE Model to analyze climate data collected from GTAP 9 database for three different scenarios as, "Scenario I" or "BAU" and Scenario2 and Scenario 3 respectively. Here Scenario 3 follows the mitigation option that Malaysia promised to attain within the next 100 years by implementing INDC. The BAU Scenario, actually refers to a situation where no action or intervention is considered to curtail Change effects of the Climate. Scenario 2 follows and implements moderate interference to decrease the effects from Change in Climate. In this analysis, Scenario 3 seems to be most viable for Malaysia to attain the promised INDC targets fully and to ensure low carbon development. Thus, from this chapter, it is established that "it is possible for Malaysia to attain its INDC promises if they do not delay and act from the present day.

Chapter 5, contemplate the revised target set for the all ASEAN member nations in COP 22, starting from the year 2010 until the year 2060, which is a target period of the next 50 years. These 50 years were definite after a long scientific debate by top scientists of the globe in COP 22. This chapter seeks to scrutinize that if the accepted targets in COP 22 are handy and can bring significant transition for ASEAN member nations to achieve the promises made in the INDCs and move forward "Low carbon economy."

For this chapter analysis, we again use the CGE based ASEAN RICE Model. Here we try to identify which Scenario, among the considered Scenarios, is the best one considering cost and green technology access for all the selected ASEAN nations. This chapter assess the influence of Climate Change over definite key macroeconomic indicators like private consumption, trade balance and GDP growth rate to a general equilibrium framework to determine which Scenario uses the lowest carbon and cost. Then we select that Scenario which one, actually maximizes the effectiveness and efficiency for overall mitigation option for the ASEAN member nations.

Chapter 6, is the last analytical chapter of this thesis. Here the CGE based ASEAN RICE model was deployed to run a micro simulation using the selected ASEAN nations data to develop Low Carbon Economy Index (LCEI) from 2010 to till 2060. We developed LCEI for Malaysia, Indonesia, and Thailand, as they were the core focus of the third research objective. It is a unique contribution of this thesis to develop the LCEI for the three selected ASEAN nations. Here, we also develop LCEI for the whole of the ASEAN region to determine where the whole region is heading in efforts for Climate Change mitigation. This index helps us to gain a specific, bird's eye view for "low carbon development" that's taking place within ASEAN region. Here analysis focused to help us to identify more precise sectorial input necessary to attain the effective low carbon economic progress.

Chapter 7 is the concluding chapter, and also the last episode of this thesis. It summarises the overall research by summarising the finding of my past three analytic chapters and help to formulate policy recommendations for different sectors, where interventions are necessary to attain low carbon development properly. Finally, separately from the discussion in each chapter, the main results are compiled by objective in "Conclusions" and summarise the most significant contributions of this doctoral study. This chapter finishes with research recommendations for policy and theory as well as for the future actions.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Sachs (2015) specified that climate transformation is a complicated long term issue, which has universal economic impacts that draws one of the hardest public policy problems. There is an enormous number of literature available on different Climate Change issues. So, sorting the most prominent and relevant one was a tough call for the researchers. Climate Change (CC) according to IPCC (2014a) is assumed as a global crisis that can impact almost every corner of the world, and there is no means for people to avoid from its severity and hazard. Sachs (2015, p. 114) also approved the impact of Climate Change by declaring the following,

> "till today humanity has faced many terrible threats, but among them, Climate Change ranks the ultimate on the scale of risks and impacts, especially for our forthcoming generations."

Sachs (2015), who advocates the "Polluters Pay" principle as one of the logical principles for mitigating Climate Change to solve it on a per capita basis. However, Sachs (2015); and Mansouri, Inayat and Ayako (2016) demonstrated the fact that its only few developed and large powerful nations like the United States, China, India or Russia always oppose such initiatives. Sachs (2015) also added that, those few opposing nations are either giant or emerging emitters countries including the United States, China, India, Russia, United Kingdom, France or Canada.

Following Fusel, Toth, Mennen, and Caspar (2003); IPCC (2014a); Glaeser and Kahn (2010) the worst contributors to climate damage in the world are actually the most developed nations. The IPCC (2014a) report also documented the fact that, GHG emissions are taking place in proportion to countries income level growths, which indicates the fact that the richer countries are generating the highest GHG emissions per capita by default. Indeed, according to Fusel et al., (2003) and IPCC (2018) report, this is a fact that, most of the poor and least developed nations are always severely affected and become long term victims of such human-triggered change in climate because of the actions of the developed countries.

IPCC (2014a) also noted the fact that, for global catastrophe like Climate Change, global coordination is required in between all nations of the world to organize corrective measures simultaneously. Initiatives can start from a regional basis. However, according to IPCC (2018) the only regional organization that signed the UNFCCC agreement is the European Union (EU). Hence, this thesis looks to develop a platform for the ASEAN members to consider adopting a similar collective regional stance on mitigation of change in climate.

The early works on "Climate Change" drew from the contributions from those studying specific impact from overpopulation. Malthus (1798) & Ehrlich (1968) set the tone by arguing that the world will not be able to support the population growth rates experienced. This was followed by the work of Meadows et al., (1972) that took the same line and warn us about the limits for economic growth over the environment. These arguments were not attractive to economic latecomers as their conditions of living required transformation to quicken economic growth.

Then, came the work of Panayotou (1993) who modelled his study around Kuznet's (1955, 1963) work linking economic growth and income inequality. Panayotou (1993) argued that countries will experience initially a rise in pollution intensities as the grow from low capita levels with the marginal utility of material accumulation (MU*m*) exceeding the marginal utility of the environment (MU*e*). This relationship will then plateau when MU*e* equals MU*m*. The environment will then enjoy improvements as the above threshold is passed and MU*e* exceeds MU*m*. However, following the convincing arguments of Stern (2007) and Nordhaus (2008) that takes on Harding's (1968) notion that the environment is a global common, it is clear that the world cannot wait for everyone country to pollute the environment until their (MU*e* = MU*m*) thresholds are passed. Similarly, the alternatives advanced by Stern (2007) and Nordhaus (2008), (which support all countries efforts to grow so long as they shift energy manufacturing from fossil to non-fossil-based fuels), has been a relieve for the developing countries as they no longer need to slow down their growth rates. Hence, this thesis follows from the framework developed by Stern (2007) besides Nordhaus (2008) by focusing on assessment on climate change models at disposal for ASEAN members.

2.2 Model Projections

The projections from DICE-model for emissions of GHG and change in climate patterns display a different outline from the forecasts used by Nordhaus (2008). The DICE-model baseline is significant because, according to International Food Policy Research Institute [IFPRI], (2012) report, emissions of CO_2 is considered from the lower part of the forecasts till 2030. But, after that, the ASEAN RICE scenario incline towards collapse, although from "DICE- model" the forecasts beneath a baseline, endure to Illustrate fast growth with no-controls strategy.

The baseline for DICE model temperature forecasts are vital at the middle end, or lower part of the forecasts separated in the "Fourth assessment report" by IPCC (2007). It illustrates the constraints of limiting temperature rise due to climatic incidents are alike toward the optimum circumstance excluding that extensive modification of temperature is controlled if there are fewer observations than a set maximum. Only four such cases used to measure the crucial impact of this analysis are as follows:

1. A rise of temperature is restricted to 1.5 °C (Considering since 1900 par)
2. A rise of temperature is restricted to 2 °C (Considering since 1900 par)
3. A rise of temperature is restricted to 2.5 °C (Considering since 1900 par)
4. A rise of temperature is restricted to 3°C (Considering since 1900 par)

The Fourth Assessment Report, known as IPCC (2007) report also illustrates that most excellent approximation of the mean temperature rises for global level ranges in between 1.8 °C to 4.0°C considering from the year 1980 to the year 1999 and from year 2010 to year 2100. The ASEAN-RICE model uses the same baseline for this research that tells us that a global temperature average of increase 2.2° °C to consider for the period studied.

According to Sachs (2015), the first signatory of 195 nations in the UNFCCC treaty have vastly different perspectives from what was set to attain. Importantly this suggests a vital weakness of this argument as presented by Sachs (2015) is that, some of the parties involved in this treaty are also the exporters of fossil fuels; others are importers. Some are being developed nations can deploy massive amounts of renewable energy (such as hydroelectric power); others can do very little due to their economic incapacity. Some parties are wealthy; others are inferior and least developed. Some are incredibly vulnerable to change from climate (such as Srilanka, Mauritius) similar others believe themselves to be less fragile (such as those nations in cold climates, and high latitudes). Some are democracies, and others are not.

Sachs (2015) also illustrated that the nations who came together were soon divided with different ideologies on this issue of acting with effects of climate variation, on the foundation, the unusual interest from various diverse groups. Sachs (2015), also explained the fact that the outcome from such a treaty was awful as the parties were unable to choose the best alternative for the long run. So, the world scientist forms an alliance like IPCC, that comes forward to research and presents the facts about Climate Change. According to Janet and William (2009); Jiang, Chen, Dong, and Kennedy (2013) it calls the attention of the various government of the developed nations to investigate what is happening in reality, the impact of a change in climate in the biosphere and also what we should do to minimize it, and how much time we, the ASEAN nations have to do it.

Janet & William (2009) and Jiang et al., (2013) also claimed, Climate Change is an intricate two-dimensional crisis. It not only affects numerous nations at a given time but also it touches fewer generations. Sachs (2015), also illustrated that the individuals who are going to be most affected in this change of climate impacts are not yet been born. According to Nordhaus (2013) we are not performing adequately to eliminate the impacts from climate variation, which poses multigenerational adversity. However, for our future generations, the fact that we are leaving behind a complicated situation to survive.

As illustrated by Sachs (2015), the core challenge of Climate Change is not only significant but also quite intricate since the problem of GHG emissions is the principal of development of any modern economy. So, to conduct an economic analysis for Climate Change impacts, we must consider the following as his central issue:

(i) The economics of uncertainty and risk

(ii) The connection among ethics in addition to economics, as well as responsibilities and constitutional rights relative to the environment.

(iii) The part of international economic policy.

According to Azam (2016), Climate Change is a very slow-moving crisis. It is a very speeding crisis from the perspective of geological periods. Here he wanted to say about the speed of positive happening, which is very sluggish from our daily events and the political calendar. If the change in climate crisis were going to culminate in a single event in a year, there could be little uncertainty that humanity would get itself organized to prevent or adapt to the crisis. Which is significant about Climate Change crisis, is that they will continue over decades (IPCC, 2018). Marland, Boden, & Andres (2005), Stern, (2006) also made the very valid point that where changes stand necessary in retort to human-induced climate shift comprises almost all sector of any given economy, for example, buildings, conveyance, production of food, generation of power, city design, besides manufacturing procedures to function in a low carbon emission practice.

ADB (2013) report illustrated that the operational complexity lies on the pathway to deep decarbonization. It is not uncommon that only a very few nations in a given region have equally effective preparation for dealing with such a technical preparedness problem. Still, ADB (2010) report and Fahimnia, Sarkis & Davarzani,

(2015) mentions that there are many small, developing and least developed nations that will continue to depend on coal profoundly for their necessary power production for the subsequent 30 to 40 years.

So, the solution to this crisis is not that easy. As, it is systematically established, anticipated upsurge in the number of Green House Gases (GHGs) molecules are getting in the air are from man-made manufacturing systems and that have the capacity to change the climate patterns and temperature, precipitation in numerous portions of the biosphere (Özdoğan, 2011), (IPCC, 2007, 2014c) , (Kawase, Matsuoka & Fujino, 2006). The proportion at which the stock accumulation happens to rest on the "global carbon cycle," with absorptive abilities and other response properties of the world. Thus, the total amount of GHGs in the air stats to traps warmth and that outcomes in global warming: in what way it is much, it rests above "regional and national sensitivity of the climate." According to IOM (2008) the evolution of global warming affects the Climate Change for national, regional besides global consideration. Such change in climate affects people, species, and floras in an assortment of the process, most complexes among them are via water, like by droughts, floods, storms, cyclones, typhoon, and sea-level upsurge. Such changes will possibly alter the physical and humanoid geography of the planet, affecting people to migrate for survival

Stern (2009) methodically illustrated the change happening involves a significant level of uncertainty of happening. The uncertainty of each phase, as known "Absorption-stock accumulation," "Climate-sensitivity" besides "warming-Climate Change links," results from altogether of them involved uncertain time frame. It is just like holding a time bomb in our hand which is life and ticking, with its timer being invisible. Nordhaus, (2013) also established that, the problems of Climate Change on Economy including the understanding in detail of global warming and reducing its properties which remain very multifaceted and have overlapping borders.

As evidence from scientific and observation-based reflection on global warming loads up each day, inquiries for economic policy choice have taken centre stage. Nordhaus (2008) in his critical work, "The Question of Balance”, explains a whole new range of economic choices besides scientific investigation toward considering the expenses of dropping discharge of GHGs for reducing the long-run damages resulting as of global warming using CGE modelling. His work actually demonstrates one of the thorough, comprehensive and scientific studies on the economy besides ecological kinetics for greenhouse-gas discharges. Beside change in climate parameter, it also offers a mechanism for appraising substitute tactics for decelerating universal warming. A weakness of this argument, however, is that it was more focused on measuring and presenting the global impacts and its actions for global mitigation. Thus, his analysis completely overlooks the regional implications, although it helps to draw the guideline for global mitigation actions towards tackling “the impacts of Climate Change” over the economy from global scale.

Nordhaus (2008) tries to highlight here and points out the need to initiate an effective mechanism, named as "Carbon Tax." This tax was at first conceptualize and proposed by him, to harness the carbon marketplaces and match the efforts of various nations to alleviate the impacts of Climate Change. Nordhaus, (2008) methodologically presents the scientific analysis and glitches for achieving widespread global agreement in COP conference proceedings and then advise us on our next best alternatives for mitigation of Climate Change impacts. Nordhaus (2013) and Fahimnia et al (2015) also suggested that, we still have sufficient time to resolve the problems shaped by Climate Change and move out of the risk. Scientifically, he presented the plan (Nordhaus, 2013) for this activities and clarified the method of global mitigation actions. These actions can be followed by anyone of us to perform them gradually. Nordhaus (2013) presented the scientific proofs back by economic justifications, and also linked his political reflection. Here Nordhaus (2013) also consider the present critical issues prudently and immediate to the climate discussion. It includes the sequential steps that are essential towards mitigating the influences happening from Climate Change till 2100.

Two of the limitations of the explanation provided by Nordhaus (2013) is that many uncertainties can change the final predictions in the long run and its result is more focus for the global scale, and as usual, here the regional reflections and considerations were overlooked. Nordhaus (2013) always considers the problematic of Global heating and change in climate on a global scale. So, here Nordhaus (2013) attempts to explain the findings of his research, about the causes of failure for slow down the CO_2 emissions by earlier environmental policies. Here he attempts to explain, why the Kyoto Protocol, they failed to solve the problem and their technical flaws for such situation. He also presented the new tactics that can be successful in the long run mitigation efforts, and which policy tools will be most useful to reduce and compensate such emission levels (Nordhaus, 2013). The shortcoming of his research model consideration (Nordhaus, 2013) includes that he also overlooks the regional difference and its impacts in a global model. Moreover, he also did not provide any region-specific guidelines for regional mitigation solutions.

2.3 Science for Climate Change

General people started to realize about change in global climate and its impacts just before 20-30 years ago. For scientists, the problem related to Climate Change has a long history. The issue of Change in Climate started with the research study of Joseph Fourier (1827), who for the first time voices that, the atmosphere is trapping the heat. Importantly this suggests the birth of the critical ecological concept known as "Global Warming," and three decades later, Tyndall (1861) clarify us about different types of GHGs that are accountable for such heat getting, and trapped within the atmosphere. In 1896, Svante Arrhenius (1896) for the first time calculate the possible impacts of GHGs doubling effect. According to Arrhenius (1896), essentially forecast for GHG emissions are an externality, that is quite diverse in four of the following ways:

(a) Climate Change stays global, and its impacts create a global crisis.
(b) Few of the effects of Climate Change remain for extended lasting thus follows the flow-stock course;
(c) There is much ambiguity in linking up its core causes scientifically;
(d) Some of its effects are massive and may be irreversible.

By the year 1988, “World Meteorological Organization (WMO)” besides “United Nations Environment Program (UNEP)”, considering this serious situation made by impact of Climate Change decide to jointly form another organization named as “Intergovernmental Panel on Climate Change” (IPCC). This organization sequentially disclosed a series of scientific evidence based reports on climate variation and finally resolute it in the fourth scientific assessment report (IPCC, 2007) that maximum of the observed rise of global temperatures level from 1970 ahead is probably due to the detected increase in human tempted concentrations of GHG’s.

According to IPCC, (2011) report most important query that concerns the universal civic is, in the upcoming future, what will happen to this problem ? This is not so easy to answer this question, as the future is undefined and unpredictable. Such uncertainty remains subsequent from the ambiguity about future demand and usage capabilities of energy by the whole world. Also, the climate system is very involved with many constantly changing interconnected variables. Although the system is known to us for some extent, many doubts made it hard to predict and quantify the local, regional and global effects of upcoming change in climate.

One major milestone on this journey, was to arrange a formal announcement in 1992 at the UN Earth Summit, (IPCC, 2001) conferring to which entirely signatories nations agreed to follow the Climate Change Agreement, voicing the determination to soothing the concentrations of greenhouse gases to a level which is possible to handle by the climate system. They all agreed to deploy country-specific adaptation and mitigation measures to a device this announcement which was accepted in 1997 at Kyoto and known as "Kyoto Protocol, and implemented from the 16th February, 2005.

On 2009, December a "U.N. Resolution on Climate Change" occurred in Copenhagen. The accord, according to Sachs (2015) failed to become a binding agreement, which was sought by various states, it only determines a specific, quantifiable target to restraining global warming beneath 2° Celsius (which is equal to 3.6° Fahrenheit) before the pre-industrial period. It allows each nation freedom to determine their targets until 2020. This freedom of time provided to all signatories nation, according to Stern (2009) points out one of the limitations of this accord.

The fact is, the accord seems to be less mandatory than the Kyoto Protocol for the signing nations. It is true for the experts that without setting a clear, achievable target and appropriate implementing of the practical actions aimed at reducing the present global warming. According to Sachs (2015), about forty years ago, a group of scientists and legislators started to recognize that humankind was moving towards an extreme impact possibility as the expanding economy and population of the world exposed to crash with the planet's scarcity of natural resources and delicate ecologies. So, this is not possible to achieve without the support of global and regional cooperation.

In 1972, the UN organized a Conference initially focusing the “Human Environment” (UNCHE) at Stockholm, where, danger of Worldwide warming and Climate alteration were interlinked, also highlighted globally. The same year a great book "Limits to Growth," (Rome, 1972) warned us that maintaining the business as a typical situation can lead us to an economic collapse in the twenty-first century. The alternatives we have according to the study of both Stern (2007) and Nordhaus (2008) validate that it is not essential to have few trade-offs among economic progress and alteration of climate and very small endeavours are critical to opposite Climate Change problem. Price et al., (2012), also point out the need to mitigate the climate catastrophe, and so we need to follow certain general principles of deep decarbonization that will be applicable regionally and later can be extended globally. According to Price et al., (2012), there are three critical steps of deep decarbonization as follow:

1. **To ensure energy efficiency:** The consideration of individuals and regions to organize and implement efficient energy utilization process which provides much higher output per unit of energy input given. Price et al., (2012) expressed that, if done properly, we can save much energy from our day to day usage like heating, cooling, and ventilation of buildings; electricity uses by appliances; and energy directed toward transportation.
2. **To decrease the emissions of CO_2 on per megawatt-hours of electricity.** It means it is to raise the quantity of electricity produced from zero-emission renewable source as much as possible, like by using solar power, wind power, geothermal, hydroelectric, along with nuclear power, also at the identical period decrease the production of electricity by using fossil fuels. According to

Price et al., (2012), this also contains a complex method like Carbon Capture and sequestration as a fallback technology, depending on the eventual costs of capturing and storing CO_2.

3. **To initiate and approve a complete Fuel shift:** Price et al., (2012) also suggests that our future energy sources need to be based on low carbon reliant. So, shifting from the fossil fuels means, using electricity or renewable based clean energy sources. Such switch to clean energy from fossil-based fuel can happen in reality for certain specific sectors only. For example, the combustion engines used inside cars may be replaced with electronic motors powered by hydrogen cells. Electronic pumps may substitute furnaces for boilers used to heat the buildings and factories. Open furnaces in the industrial production line may be replaced by fuel cells run on hydrogen produced from electricity. We need to need to think of a sustainable future, accept, embrace and authorize a complete fuel shift.

According to the World Bank (2014), there are many ways in which almost for every sector we can shift from using fossil fuels to non-fossil fuel. The trick is to generate the necessary electricity with low or zero carbon-based renewable technology. The World Bank (2014) report indicated that making quality material for insulation and ventilation properties of buildings depends on the choice of systems for cooling and heating, and on various types of power usages. With efficient combination of such factors, one can make a huge difference in the energy efficiency of the buildings. It is significant to note that, there are several methods available and affordable for gaining low-carbon energy for the ASEAN region. One readily available and vital option is photovoltaic (PV) cells. They hold the capacity to convert Sun-ray's energy (photons) to electrical energy. According to Nordhaus (2008), the Photovoltaic systems will be the essential element for large-scale power generation in the future.

According to World Bank (2014) report, "Wind power" is another potentially zero-carbon electricity source. Wind turbines use induction of electromagnetic (which means spinning a coil of a conductor material such as copper inside a magnetic field) to produce electricity. Both Wind and Solar produced power is competitive by the cost of production with fossil fuels for many windy places. The same report of World Bank (2014), also mentions about another zero-carbon alternative energy source as, “Geothermal Energy”. In favourable locations, like, along with the corner of tectonic plates, it is likely to capture significant heat energy that is coming out from the Ground's mantle. The geothermal energy is utilized to boil water to move steam turbines for the generation of electricity. Geothermal energy already powers much of Iceland and Indonesia (which people uses the energy both to produce electricity and to heat water that is then piped to homes and offices) and is being deployed at an increasing scale in the Rift Valley of East Africa and other geothermal sites. The limitations of this energy system are not available everywhere, and it is more of location specific.

The World Bank (2014) report also presented ideas about the “Nuclear Power” as another non-carbon based energy source. The British nuclear plant, already offers zero-carbon based energy at a relatively low-cost option. This single power plant supply accounts almost 12% of global electricity generation. The weakness of using nuclear plants includes the probability of accidents or can be used as nuclear weapon. Such accidents or use can cause the release of nuclear radiation into the surrounding environment. According to World Bank (2014), report such accidents happened in Japan, known as the 2011 "Fukushima disaster" (when a tsunami hit the power plant) and the 1986 "Chernobyl disaster" in the Ukraine (when nuclear fuel rods were accidentally allowed to overheat as the result of inappropriate procedures).

Another big challenge of using Nuclear power identified by the World Bank (2014) report is the, long-term disposal of nuclear waste materials. This Nuclear power is set to grow in East Asia, notably within China and Korea, while few other nations, including Germany, have decided to discard it. Other nations, like the United States, France are still undecided. Mao (2009) and Phdungsilp (2013) notes that, there are multiple ways available to "Decarbonization," Starting one is using "Battery-Powered" vehicles that use a fuel cell as a source of energy produced from low-carbon electricity. Similarly, buildings heating by utilizing fossil fuel like coal, oil, or natural gas can also be heated by a solar-powered heater, where the energy is produced from a low-carbon based renewable power source. In this way, the direct emissions of CO_2 from the building can be reduced significantly and possible to be eradicated.

The World Bank (2018) report suggests that , to mitigate the impacts of climate variation, effective means includes curtailing the usage of fossil fuels; and also using diverse energy manufacturing techniques, substitute fuels or energy sources. Different civilizations and nations use different energy priorities to the changing energy production patterns. About climate damages, the knowledge related to this technology is inadequate for least developed and developing nations. The world-wide climatic outlines have changed within a very slim range, changing by utmost a few degrees Celsius (°C) from one century to the following century.

Stern, (2015) notes that, the findings from in his recent publication "Why are we waiting?" stresses on two of most critical and impactful challenges of the present world. These comprise of: “Management of Climate Change “and “Conquering Poverty”. According to Stern (2015), if we fail to manage change in climate in time or properly, then eventually, it will alter the environment. It will be so hostile out there, that lives and livelihoods will be devastated and destroyed ".

Stern (2015) studies the future impacts of Climate Change, by seeing it from three dimensions of inquiry as: (1) the scientific view; (2) the political perspective and (3) the ethical and the practical view. Stern critically pointed out the fact that Climate Change requires potential Mitigation pathways for regional success to tackle the impacts. In the first part of his book (Stern, 2015) sets the phase by assembling what climate knowledge has to describe for the level of hazard that change in climate upholds. In the Second part of his book, Stern (2015) develop a powerful morally, economically and ethically justified argument about the cost of delay to deal with Climate Change, its long-term effects on the national besides Global economy. So, here he literally explained how Climate Change can put barriers in the way to overcome poverty.

He points out, through scientific explanation about what we need to manage, how both of them can be tackled together successfully in national and regional policies. According to Stern (2015) the reason for such actions are significant is, "If we fail on one, we fail on the other." He also advised us to see "impacts of Climate Change" from three different viewpoints of consciousness as the scientific view; the political and the ethical view; and from the practical perspective. It is a fact that for doing so we need to go beyond the financial investigation of the hazards and expenses of fumbling to deliberate courses of change by projecting possible ways for regional and worldwide collaboration.

2.4 Importance of Mitigation Research on ASEAN nations

The IPCC (2018) has made it clear that future Climate Change will be rapid, and as such, will influence the occurrence, spread, and harshness of extreme incidents. Exactly where and how such extreme events will happen is unknown, and past tendencies can no more be useful to forecast for future life-threatening climate outlines. Such limitations bring a significant number of stakeholders for extremely vulnerable consequences.

The ASEAN as a region is a critical regional platform to begin such a study as three of the ten most climate change affected countries are located in the region, i.e. Myanmar, the Philippines and Vietnam (IPPC, 2018). In addition, the study can also focus in greater detail where such data is available, (i.e., Indonesia, Malaysia and Thailand) than using countries where such details are not available (e.g. Myanmar and Cambodia). The purpose of such a regional focus is to test the global parameters established by Stern (2007) and Nordhaus (2008) at the regional level where countries can undertake collective actions to check climate change.

The recent TRS (2014) report suggests that resilience needs considerable resources, a lot more than just shielding of hazards. ADB (2018) confirms that most of the hostile effects of future Climate Change impacts will happen in the emerging nations, where inhabitants are most defenceless and weak to adjust to Climate Change effortlessly. Fluctuations in temperature, aquatic supply, and quality according to IPCC (2001) will influence on local farm productivity, influence on human accommodation and physical wellbeing.

The limitations of such climatic mitigation effects include the fact that only good initiative undertaken by Malaysia to reduce carbon discharges will not take its full effect unless its surrounding border sharing neighbour nations also take up the same course. Here, we will look for the combined efforts to judge the optimal Climate Change policy to lessen its damaging properties contrary to the situation of ASEAN as an integrated region and also for the three individually selected nations. This would be done in absence of strategies adopted for Climate Change mitigation. Although the findings of this research are targeted to be important for the three selected

ASEAN nations to identify the gravity of climate mitigation policies; thus, their proceeds can be appreciated by altogether. This research emphases on growing cost of climatic loss for the year 2010 to the year 2110 with best climate mitigation strategy beneath the climate policy implemented over Malaysia, Indonesia, along with Thailand.

Here we finally decide the selected nations from the ASEAN region. For this research "Selected nations" refers to "Malaysia, Indonesia, and Thailand," the three-border sharing neighbouring nations were selected on the subsequent standards:

1. If anyone country's Climate Change incidents can impact the Climate of other nation.
2. These nations have developing economic condition
3. These three nations have close or similar economic growth rate
4. The three selected nations may be economically related to one another.

Evidence gathered from IPCC (2007,2011) , MMD (2009) and Stern (2006) review enforced Malaysian legislators and scholars to assess their findings on the economic influence of a change in the climate more prudently for the future.

Following the ADB (2009) report , this research acknowledged that change in climate is happening and the situation is deteriorating faster than assumed. So, we need to act rapidly towards mitigating the effects of Climate Change for selected ASEAN Region. Therefore, the selected ASEAN member nations need to prioritize their necessities besides mechanisms necessary for reducing the level of scenario vulnerabilities combinedly.

The IPCC (2014c) report scientifically points the fact that the current greenhouse gas discharges, which are the maximum because of recorded actions done by the humans. Conferring to recent ADB report (2009) the average temperature patterns in Southeast

Asia is also showing signs of snowballing, rising gradually from 0.1to 0.3 degrees centigrade per ten years over the last fifty year. Forecasts of temperature upsurge done by ADB (2009) and Mao (2009) for the South East Asia region also indicate that the temperatures of this region will continue to rise, almost from 2 to 4 degree centigrade within the end of this century, confirming the most significant growth of temperature forecasted for nations like Indonesia, Thailand, and Viet Nam within the ASEAN region.

According to (ADB, 2009), considering the impacts from Climate Change, for Asia, the South-eastern part is one of the most hazardous sections within the biosphere. Four out of the ten member ASEAN nations are considered maximum defencelessness to Climate Change globally by WEF (2018) includes Myanmar, Indonesia, Philippines, and Viet Nam. It is an alarming situation for the predicted impacts of such climatic incidents on the ASEAN as a region, and will affect its border sharing neighbours like Malaysia, Singapore, Brunei, and other ASEAN nations. Thus, it is critically important and critical that we have to get the idea of future Climate Change impacts by predicted scenario and such issues need a well-coordinated, prepared regional response. According to a few recent reports of ADB (2009, 2017) and WEF (2018) definite hotspots for multi-hazards (mostly hazards resulting from hydro-meteorological incidents) comprise numerous of the inhabited islands of Indonesia; at Thailand the “Chao Phraya Delta”; within Myanmar the “Ayeyarwady Delta channel”; at Cambodia the “Mekong Delta” besides in Viet Nam among the coastlines, “Eastern Coastline of Viet Nam”; and in Philippines its “Manila” along with few extra regions.

According to ADB (2009), Mao (2009), Mao, Liu and Du (2015) the incidence, strength, timing and three-dimensional attention of meteorological and hydro-meteorological adversities are impacting the economy of the few ASEAN member nations regularly. Conferring to the IPCC (2014) report, the impacts of Climate

Change also creates an upsurge in the occurrence of “heat waves," substantial change in rainfall patterns, sea level increase, besides growing power of floods, tropical typhoons, within the ASEAN region. The rising of temperature, joint with increasing demand for food, can create significant risks for food security regionally. Following Mao et al., (2015) and ADB (2017) report we can also justify that, from the middle of the 21st century onward, worldwide marine species will suffer from relocation and reduction in marine biodiversity for sensitive regions, and this will demand the permanent establishment of productivity of fisheries besides additional ecosystem amenities.

For crops like rice, wheat, and maize in the tropical region, another study conducted by ADB (2010) illustrated that particular level of Climate Change impact specifically result in changes happening in local temperature, and it is going to impact negatively on regional productivity. The study done by WEF (2018) also demonstrated that the impact of Climate Change likewise rises struggle for water accessibility as the overuse and climate impacts affect the surface water level and underground water reservoir levels during dry subtropical ASEAN nations. For the mega city parts, according to IPCC (2018) the impact of variation in climate is likely to increase risks for, peoples, assets, economies , besides adjacent ecologies. Risk may result from climatic incidents like excessive heat stress, hurricanes and rainfall, internal and seaside flooding, storms and tornados, landslides, pollution of air, drought, scarcity of water, and rise in the sea level. Climate Change impact might also trigger up the dislocation of communities in this region. The IPCC, (2018) also mentions that inhabitants go for planned migration due to that lack the resources face more significant exposure to life-threatening weather events, predominantly for developing nations with little income. According to World Bank (2014), report Climate Change can influence ASEAN economic progress, slow down the reduction of poverty, and thus generate more poverty traps for the ASEAN region.

A report published ADB (2017) illustrated that most of the vulnerable seaside counties of Asia are threatened by climate variation connected rise in the sea level. Flood risk is snowballing in seaside metropolises due to rising inhabitants and resources. Another ADB report (2017) focused on flood losses of 136 cities, point out the fact that losses incurred from a regular global inundation at 2005 stood almost \$ 6 billion each year, also, can rise to \$ 52 billion within the year 2050. Among of top 13 metropolises within Asia, considering the highest rise of yearly losses in amid the year 2005 and year 2050, three cities are situated within our ASEAN area: in Vietnam, it is "Ho Chi Minh City," for Indonesia its "Jakarta," and for Thailand its "Bangkok." According to the same report (ADB, 2017) during 2013, the total GHG emission levels in ASEAN is quantified to be 3,414. Million tons of CO_2 equivalent ($MtCO_{2e}$) which is the highest emission recorded due to day-long energy-using actions.

2.5 Stern Review, A Question of Balance

In 2006, November, United Kingdom published a detailed report based on individual study conduct by, Nicolas Stern, on the economic impact from Climate Change, commonly known as Stern Review, which focuses over economic effects of Climatic variations on economic productivity on monetary value. This review is known as: "Stern Review on the Economics of Climate Change". Stern (2006) review estimates that if we do not perform to deal with "the impacts of Climate Change", then total charges besides perils from Climate Change would be corresponding of losing minimum 5 % from the total worldwide GDP annually, starting from today on and forever. If a broader variety of jeopardies and effects are considered, the estimates of harm from a climatic event can increase up to 20% of global GDP or even more.

However, Stern (2006) review illustrates that our day to day actions and activities in the following decades might generate more hazards on a measure alike to those related by war or depression of economic resources. In realization of the researcher, the Review done by Stern checks us the simple economic questions elaborate on global warming. Though, the review was more focused to find the research studies that sustenance its strategy endorsements, while reports holding the opposing views about the dangers of Climate Change was overlooked. The review done by Stern has studied multiple alternate means to deal with policies with global warming.

One significant batch of changes enhances climatic limitations to the cost-benefit method to determine the optimal strategy. Like, through this research we try to identify the ways which may reduce the intentness of CO_2 in certain sectors by almost two times then its pre-industrial level in atmospheric. Here, Stern(2006) point out the fact that the constraint of carbon taxing might restrict the worldwide temperature rise to 2.5˚C. Designed for the weather restrictions cases, the total worth of the strategy remains considered close to the best scenario. Furthermore, Carbon taxes, that might be practical for limiting the climatic variation, excluding for very severe cases, remain similar to the best considering economic analysis. So, in the end, the review done by Stern put more stress over the necessity intended for thriving the price of Carbon to reduce overall releases.

Stern (2006) recapitulates his argument with the following Statement: "Developing a clear and equal carbon value signals the world that this is a crucial trial for global joint efforts." According to IPCC report (2018) on bad mitigation policy, this is important to take a consistent price for carbon to distribute inducements aimed at distinct firm and families to inspire investigation besides expansion for processes at know-hows for low-carbon progress. It is indispensable to increase prices of Carbon to spread the societal expenses of GHG discharges to the ordinary picks of billions of institutions, organizations, and individuals. The most straightforward economic logic behind this is the core of the solution, but unfortunately, it is sad that it is not available within most of the political debates and negotiations of climate alteration policy.

Questions of discounting percentage are serious and important for long term policy formation to understanding economic growth theory. Stern (2006); Holland, Hughes and Knittel, (2009) also considers the severe losses occurring from different impacts of climate alteration and so there are prompt requirements for actions to decrease or stop the emanation of GHGs. The course of carbon prices needs to upsurge sharply in the coming years to ensure rising damages are condensed as much as possible. It is the strategy upgrade for setting the future costs of carbon.

The best price of carbon needs to increase progressively over time, following a rate amid 2% to 3% annually considering the impact of climate damage in the real monetary value. In the best option, the carbon price may increase from $27 or RM 108 for every ton of carbon, in first term to $90 or RM360 by the year 2050, and it will reach to $200 or RM800 for every ton of carbon, by the year 2100. (considering 1 US$= 4RM.) According to Stern (2006) and Holland et al., (2009), as the higher limit for the carbon value might be set from considering price necessary by which all the utilization for fossil fuels, might be economically replaced through additional fuel of know-how.

For this thesis, we have considered such steps as the charge of the spread of backstop technology. The estimated that the higher border for per ton of carbon would be around $1,000 or RM 4000 over the next half-century, but outside of that time range it is tough to forecast the market price for carbon, as the forecasts for technical progress are resourcefully difficult. This points out the situation for framing strategies which are not only cost-effective but also helps to evade incompetent procedures for failure to deal with Climatic issues. The term "cost-effective" considered by Stern (2006) illustrated a tactic that helps to realize a specified objective at the lowest cost. The economic tactic is to identify pathways for attaining this objective employing spending the lowest cost in the economy. One important prerequisite occasionally termed as "where efficiency" is the marginal costs of discharges decreases which is to be steady across segments of the economy and also across the partaking nations.

Stern's (2006) approximations for the probable damages happening from the change in climate settles, "Tapping all of such factors together probably upsurge the cost of change in climate, equal to a 20% reduction in per-capita usage, for the present performance, and also in the coming future." Such alarming declaration indicates, the world is heading towards a dangerous turn in the future of the road, and may drive off the road. Prominent limitations of the review of Stern, as presented by Weitzman (2007) was that it did not deliver useful answers to a few essential queries. The Stern (2006) assessment has a clear assumption about the fact that we need instant replacement of fossil fuel by renewable fuel as new energy source. Later, also vital queries for universal alarming strategy includes the answer of "how much, how fast, and how costly are the options that we have to implement" by Stern (2006).

Nordhaus, (2008) have also developed a computer-based Dynamic climate-economy model and named it as "DICE" Model, and published a book based on his research findings as "A Question of Balance." Here he (Nordhaus, 2008)was attempting to measure the effect of the future change in climate over worldwide economy using the DICE Model using the global temperature rising trend within a range of 1 to 6-degree centigrade increase and its expected outcomes that will affect the globe is demonstrated. According to the Review done by Stern on, Economics of Climate Change, which is also recognized as “Stern review” and following work of Nordhaus "A Question of Balance". (Nordhaus,2008) study is considered as the base of this research for the selected ASEAN regions.

According to both of them if we do not start to act, the consequences will be devastated for humanity in the upcoming future. For the modelling part, we developed the ASEAN-RICE model using ASEAN regional climate parameters and following the guideline used by Nordhaus (2008) from his global DICE model. For a theoretical explanation and policy formation, interested readers can follow Stern (2006) guidelines.

Although Nordhaus (2008) also divided the world into 12 different regions for better and proper analysis, but when he prepared the final results, unfortunately or may be intentionally, he did it for the total global average, He did not focus on any specific region of the globe. His study outcome shows that, we can continue to have the same level of economic growth to support our population energy demand. But in order to do so, what we need to do, is to made some change in global energy generation mechanisms, like deploying Green or Renewable technology, and go for a complete or partial fuel shift, like changing combustion engine with solar or electric powered engines for individual or public transport. The impact and analysis summary of both Stern (2006) and Nordhaus (2008) study are obtainable in their work, are portraited here by a graphical illustration by me to visualize their estimation in Climate variations and impacts as follow:

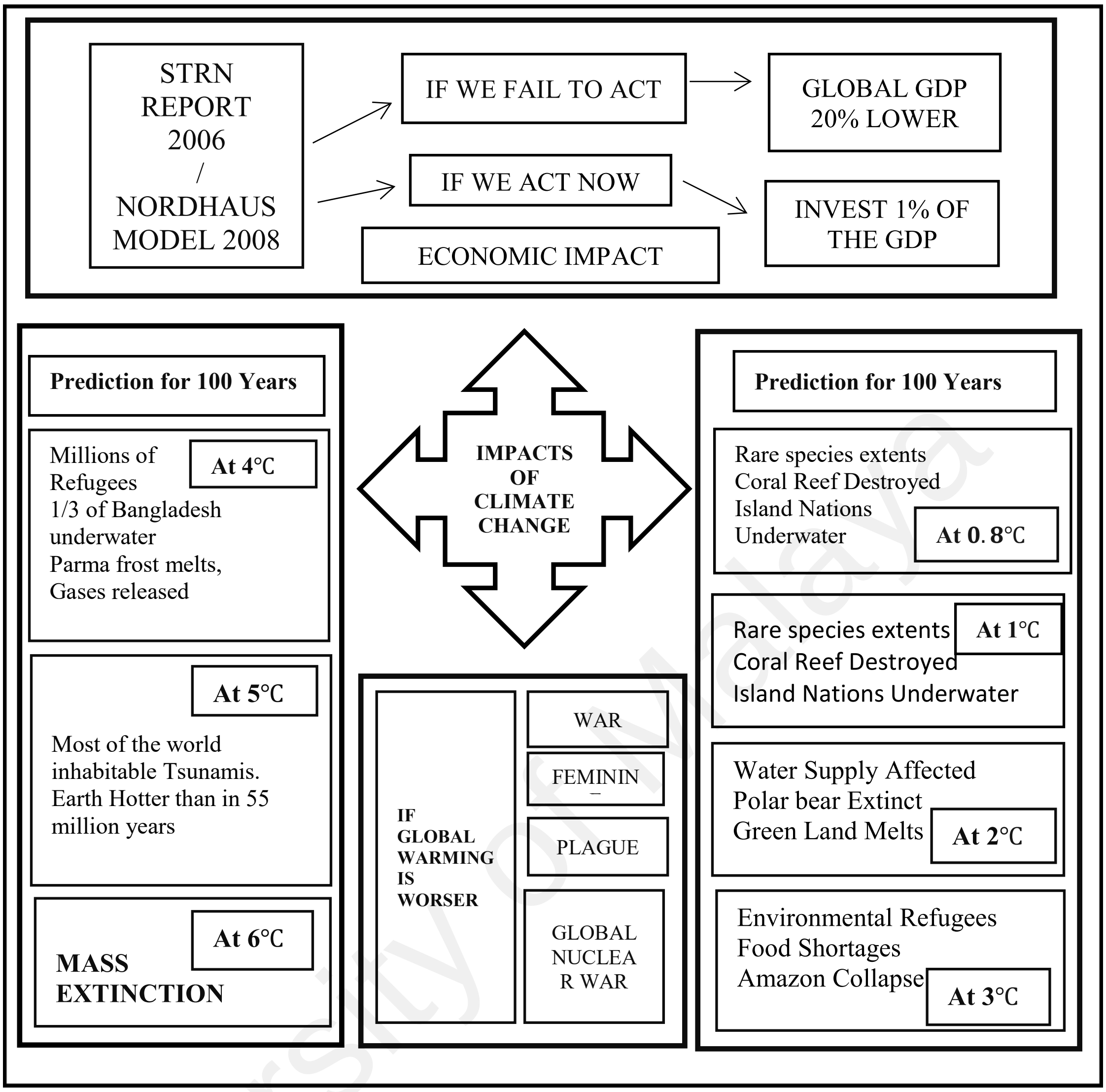

Fig 2.1: Effects resulting from Climate variation

Source: Adapted from study findings of Stern review (2006) and Nordhaus (2008)

As part of the solutions both of them agreed to introduce the "Carbon Tax", where the user of carbons, will have to pay a certain percentage as a damage cost, and this collection can be reinvested as a subsidy in Green Technology or Backstop technology to abate the impact of additional GHG in the atmosphere. Imposing of the Carbon Tax for Fossil fuel use will push up retail price for the fuel, and thus people will look for alternative energy option. Besides that, both of them advised scientists to develop a more efficient mechanism to harness solar and wind energy with higher efficiency.

The significant difference among both of them is on Carbon Tax proportion. Nordhaus (2008) proposed to charge the Carbon tax rate lower in the initial stage and later gradually grow with time. In the stern review, Stern (2006) proposes competitive and higher carbon tax rate, which means, initially charging a premium price as a Carbon tax, later reduce the interest rate at the ending stage when carbon price falls on the long run. His logic behind such scheming was simple, (Stern, 2006) showed that green technology and conversion cost is enormous, and so we need to charge from the carbon used to help those who are environment-friendly.

Stern's (2006) estimation about the loss of output till today is zero. It is because Stern believes the anticipated impacts from the change in climate will happen in the forthcoming. So, he proposed that we must take the initiative to shift from carbon-based energy to renewable, no fossil fuels, and thus can bypass the catastrophic events resulting from Climate Change. According to another research study, "Resilience to extreme weather" (The Royal Society, 2014) report points out that, all significant Climate Change impacts in the past forced the population to migrate and noticeable changes incur on land surface besides ocean flow patterns. However, the speed of variation of such incidents that cause Climate Change are happening more frequently, and regularly then past occurrence. So, it is becoming tough for civilizations and natural biosphere to predict or to get adopted with such incidents. So, if we do not start to mitigate from today, there are possibilities of mass annihilation for humans as well.

According to TRS, (2014), study, the current estimations about the upsurge in average global temperature subsequently are only 4 to 5 °C (7 to 9 °F) till the end of the previous ice age. The changes which are happening according to this study (TRS, 2014) happened over a historical period of around 7,000 years ago, beginning from almost 18,000 years earlier. According to TRS, (2014) the CO_2 emission is so high that almost 40% CO_2 has accumulated in the atmosphere during the last past 200 years, and scientists assume it actually happened from human generated CO_2 emission, and already the Earth is warmed by approximately 0.8 °C (1.4 °F).

If emission of CO_2 is unrestrained like this, the increase of warming of the similar magnitude in the atmosphere will result in the same kind of the global warming happened during the ice age, within the end of this century. The current degree of warming according to the TRS (2014) study is more than ten times higher than what was during the finish of the last ice age, when the swiftest recognized natural climate alteration incident occurred .Though the rise of few degrees, of global temperature sounds so quite insignificant and straightforward, the reality is completely the opposite. According to TRS (2014), report the answer to this question is, quite disturbing. In reality, the changes of a few degrees of temperature in the Atmosphere can be a grave matter in the long run. Lynas (2007) also systematically demonstrated that an upsurge of a few degrees in global temperature on an average can bring catastrophic effects and sufferings for the living beings, in a hot planet. The worldwide average temperature from the previous ice age remained around 4 to 5 °C (almost 7 to 9 °F) lower than the present temperature.

According to Heikkinen, Johnson, Robinson, Vidovic and Sacramone, (2010) and also the ADB (2017) report findings the effects of change in climate vary across diverse regions, intensities besides scales.. So, by following Heikkinen et al (2010), ADB (2017) report it is rational to remark that a global mitigation policy may not adequately solve the climate problem of all the regions of the world. So, we need to focus more critically on regional based climatic impacts and their severity, and then to quickly develop the solutions, that are more region specific. This is the reason, why this research emphasises more efforts of explaining the regional effects of Climate Change and its future course for the ASEAN region. Moreover, it tries to find out how some selected nations can combinly plan and mitigate those changes. According to Chappin and Ligtvoet (2014), IPCC (2014b) most of the world best researchers approve that the likelihood of remaining under the 2°C threshold by 2100 is conceivable and tolerable. According to IPCC (2014b) this is not impossible and all we need is to follow some specific regulations and practices. Climate Change becomes less likely a severe global problem if proper mitigation actions are performed in time (Richardson et al., 2009; Urban and Mulugetta, 2010; CCICED, 2009; Urban and Naess, 2011, Cadiz, 2013).

According to Heikkinen, Johnson, Robinson, Vidovic and Sacramone, (2010), and ADB (2013) report on Low Carbon Development, where both focus on the essential element , and it is aimed at mitigating CO_2 emissions that will probably decreases the impact of a change in climate meaningfully. The ADB (2018) report also designates that, the high-income nations are also turning as the evolving emitters. This is because of plummeting their total CO_2 emissions and also to uphold Industry competitiveness and economic growth.

According to Smith (1776), and Yan, Du, Yang and Deng, (2017) low carbon development offers a new possibility for lower-income nations to access green and clean energy, and also to reduce poverty. Climate Change is considered to be one of the utmost universal barriers that reduce the efforts of global progress. It also relates the jeopardies to people, the atmosphere and the economy Urban and Mulugata (2010). From IPCC (2007, 2014b, 2018) report, this is scientifically proven that the emissions of GHG's contribute mostly for human tempted Climate Change. Although the GHGs comprise: "Carbon di oxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydro fluorocarbons (HFC), Perfluoro carbons (PFC) and Sulphur hexa fluoride (SF_6)". But it is the "Carbon di oxide (CO_2)", who is the key offender meant for this issue. Often mentioned in this thesis as "Carbon," it seems to be the most harmful element for the Climate. Carbon di oxide (CO_2), are mostly released after the combustion of the fossil fuels, from changes in land usage besides deforestation, from industrial activity like transport and logistics. (IPCC, 2007; Forsyth, 2014).

The IPCC (2007) report also presented for change in climate, the average surface temperature of the globe have already, “increased by 0.74°C ± 0.18°C throughout the last century”. Such a rise is primarily critical over the past 50 years (IPCC, 2007). Considering the IPCC (2007) report and (Forsyth, 2014) as both illustrates that high rises in heavy rainfalls, while droughts are more recurrent from the 1970s, particularly for these subtropics. It is true that, the variations in the large-scale atmospheric movement results in rises of tropical cyclones from the 1970s (IPCC, 2007, 2014a; Urban and Mulugetta, 2010).

Lockwood and Cameron, (2012) published a study report as “Approaches to Low Carbon Energy and Development” with a focus on bridging perceptions and practice aimed at “Low Carbon Climate Resilient Development,”. Here Lockwood and Cameron, (2012) presents the fact that, multiple economies already implementing low carbon development framework with specific focus on "Green Growth" .In countries like Denmark, New Zealand, funded by World Bank (2018). Here individual nations have their own formulated Green Growth strategies to attain the set targets. Despite such effort, transforming in to low carbon-based economy is still a new concept for developing nation governments. The donors for such projects are looking to strike a proper balance across three core dimensions as follow:

1. To ensure effective carbon abatement and poverty reduction.
2. To provide attention to factors which are critical to mitigate carbon emission and incorporate them in related institutions, policies, and practices.
3. To ensure the effective and efficient use of limited resources.

According to Feng and Niu (2009); Forsyth (2014), the agenda of low carbon development is all about putting the whole economy of any given nation into a different growth path. According to Dagoumas and Barker (2010), such kind of changes require major policy shift and great change in political understanding. So, a proper balance between ambition, resource pool and time is critical to attain it. The donors always put pressure the recipient nations for immediate results, but for low carbon development, the only possible result that can provide immediate results is to affect the reduction of poverty, so linking it to climatic impact is critical, and may vary from country to country.

Usually, low carbon development (Cranston and Hammond, 2010); (Lockwood and Cameron, 2012) covers a wide range of areas such as low carbon-based energy, deforestation low carbon agriculture, cities, infrastructure, and transport. So, it is crucial for (Cranston and Hammond, 2010) to focus more on understanding the challenges each ASEAN member country faces individually to shift to a growth and development path in which energy is generated from either low carbon or renewable sources. According to (Hallegatte et al., 2016) managing the "impacts Climate Change" incidents and "Dealing poverty" is entirely two different subjects, but Climate Change have the capacity to raise the stable prices of agricultural commodity and thus can lurk the "food security" in developing nations regions like Sub Saharan Africa or South Asia. By analyzing the results from household surveys conducted in 92 nations, (Hallegatte et al., 2016) acknowledged the fact that among the urban population the poor and urban households, are more visible to downpours than the average. Hallegatte et a'., (2016) also identify the factor that "Climate Change" can amplify numerous threats to human health, as poor individuals are extra vulnerable to climate-related diseases like Malaria, Diarrhoea etc. The report done by (Hallegatte et al., 2016) also explains the fact that "poverty reduction" is not only a one-way avenue.

There are countless cases identifies where, individuals annually, as "exit" so also "newly fall back" into poverty. The poor people here living in such a condition that a single incident of natural disaster can result in losing everything they have.

To lessen such effect of Climate Change over the poor, according to (Hallegatte et al., 2016) we need reliable, cost-effective and carbon efficient, climate-informed development in mitigation practices to reduce the sudden impacts. It requires, mainly if we can organize effective "social safety net" programs and "universal health care" programs for the poor. Such efforts need to be joined together through target-based resilience measures for climatic impacts, such as the "introduction of heat resistant, saline tolerant" crops and effective and efficient "disaster alert systems."

The report done by (Hallegatte et al., 2016) confirms that without such progress, Climate Change may influence more than 100 million individuals into “extreme poverty” by 2030. However, deploying quick, inclusive development plan that is altered toward to deal with the altering climate circumstances, such influences can be barred. In the imminent, good development and risk management consequences will be limited to support our need. Only instant "emissions-reduction policies" could stop the "long-term effects" of change in climate for the deprived nations.

This study (Hallegatte et al., 2016) also illustrates that such strategies are not a problem, and can help the deprived, to mitigate the impact of higher energy prices. The developer community must come forward in need to support the poor and weak nations, that do not have such technology for climate impact protection. The (Hallegatte et al., 2016) study results produced from the 92 states that were considered on the basis of their demographic constructions and avenue of income, with the most updated modeling predictions for impacts of Climate Change on “agricultural productivity" besides "food prices" including natural threats alike heat waves, water logging, floods, droughts; and climate-sensitive diseases and other health significances. Based on such findings and results, the report stretches a new urgency to eliminating extreme poverty by 2030 while mitigating Climate Change. Effective progress initiatives besides efforts for poverty alleviation reduce people's defence lessness state for the climate variation impacts.

Another report from Overland et al., (2017) on the "Impact on Climate Change on ASEAN International Affairs," also illustrated the facts that, mitigation efforts for Climate Change can generate risks and opportunities in international affairs. The report was published by Norwegian Institute of International Affairs (NIIA) where it was focused that every ASEAN nation need to be cautious about the hazards of Climate Change and requires to prepare themselves for mitigation in advance. The Global Climate Risk Index (GCRI)[16] validates that for the years 2018 and 2019 among the most affected top ten nations of the world, four are from Southeast Asia region, as specifically "Thailand, the Philippines, Vietnam, and Myanmar." These nations are comprising almost 40% of the Climate Change impact in ASEAN region, ensuring development within in such situation is not an easy mission.

The part of the "Southeast Asia" region suffered the most from impacts of Climate Change incidents for its enormous population, long coastline, dependency on agriculture, intricate border as well as powerful neighbours, so interstate relations are also affected. For the ASEAN region the effect of Climate Change conferring the report, create impact at different level such as it affects inter-country relationships by humanitarian crisis and a higher import of essential goods. Also, to minimize the emission of CO_2 requires technical support and coordination from the international community and such shift in energy policy may create a massive change in the

[16] Source: https://germanwatch.org/en/16046

geopolitical situation of the ASEAN region, following the world. Every Climatic alteration like rising sea level, altered river flow, more utilization of hydropower, haze pollution and food productivity and crisis, affects the ASEAN member states. Overland et al., (2017) also suggest that a particular part of the ASEAN region might get affected by rising of the sea level, as it has over 50 coastal cities with large inhabitants. Problems of mass migration can take place here due to Climate Change impacts. This report also suggests that to mitigate such crisis of change in climate, we need to move away from using fossil fuel to energy sources which are renewable within the entire energy mix. This may affect the relationship in between the ASEAN region and the Middle East, as it is the leading supplier of fossil fuel for this region. Failure to shift from fossil fuel to renewable poses a new challenge, as such shift was assured in their individually stated nationally determined contributions.

The report by Overland et al., (2017) also present the fact that, since ASEAN summit in year 2007, the ASEAN member nations has recognised Climate Change as a urgent matter, and thus the declared nationally determined contributions (NDCs) of its member states may provide a solid groundwork aimed at “combined regional climate policy” construction besides implementation. Yet, although the ASEAN member nations are positive to mitigate the impacts of Climate Change, most of them remain followers, insignificant climate actions. ASEAN as a regional platform, can change the scenario and take the lead to attain the INDCs more effectively as a regional team. According to authors, as a regional organization for ASEAN, it is easy to take measurable actions such as:

1. To uphold a focus for achieving the NDCs of every affiliate with Paris Agreement targets.
2. Confirm useful targets for the “ASEAN Plan of Action for Energy Cooperation (APAEC)” for reduction of “Greenhouse gas emission”.

3. Involve relevant experts, civil society and institutions to conduct useful research and publish relevant research and analysis for effective and efficient mitigation.
4. To deploy an improved system to identify the financial risk resulting from Climate Change over the governments and respective investors.
5. To keep “Climate Change” as a maximum priority in the Agenda list of every ASEAN summit.
6. To simplify the process for regional electricity trade and supply by expanding the “ASEAN Power grid” for enhanced management of “renewable energy”.
7. To encourage faster phase-out of the fossil fuel-based organizations.

According to the report, to be effective, the authors remarked that initiatives related to climate change need to consider the ASEAN regional practices for doing ethical business, with focus for national interest and control, non-interference besides agreement in regional decision making. Here, authors also assume that initially, ASEAN may face few problems of collective deed on regional climate policy, as weaker member nations are viewing that ASEAN may accept strict targets. ASEAN need to look for its capable member states which can lead such initiative with clear and noncompromising signals. For this, the ASEAN Secretariat need to restructure with effective climate staffing, necessary funding and capacity enhancement.

Stern (2015) in his new book "Why are we waiting?" also logically and scientifically describes that, we have to perceive the issue of Climate Change impact from three diverse perspectives, as, (1) the practical and scientific analysis, (2) the ethical analysis and (3) the political analysis. We need to use three different perspectives of analysis because, the impacts of Climate Change remain involved, sometimes difficult toward link up environmental has implications for cause and usually goes beyond only an economic analysis. To mitigate the risks and costs of Climate incidents we need to act quickly. Fumbling to operate by identified trajectories of change according to Stern (2015) can be costly in the forthcoming. We need to plan specific, potential low carbon pathways for local execution through cooperation and performance consequently.

2.6 Climate Models, Carbon Tax and Social Cost of Carbon

According to Nordhaus (2000), the imminent progress of World's climate reacts very quickly to the contemporary instant rate of growing atmospheric CO_2, which takes no exact analogs in the past, nor any research laboratory trials can correctly comprehend this. As we cannot carry out any carefully controlled experiments on the Earth itself, so till today computer-based integrated models are the most significant apparatuses used today for studying the climate system of the earth. A study report published from IFPRI (2002) also suggest that models used to predict climate are constructed on scientific and mathematical equations. This characterizes the ideal empathetic from the fundamental laws of physics, biology, and chemistry which administer actions and comportment of the ambiance, sea, ground surface, frost, and ice, with additional fragments from the weather arrangement, besides the relations and exchanges between themselves.

According to IFPRI (2002) report, the forecasts of the most significant aspects for a specific long-term human created change in climate results that are prominent, as new generations of more multifaceted models can generate more details of the variation going to happen because of the climate. Models can also be deployed to experiment specific and isolate the causes of Climate Change. According to IPCC (2014c) report models actually helps the scientists to discover the significances of different scenarios from future greenhouse gas emission besides additional effects on climate. Variation of climate patterns can enhance the power and occurrence of droughts, floods, cyclones, storms, and twisters surprisingly. This can lead to additional water flow into certain areas by hurricanes, which could result in an extra inundating or long-term water submergence. With a certain range of degree rise for the temperature (like 1 to 6-degree centigrade), there can be catastrophic effects in some zones of the globe.

The effect of the change on climate for various segments from any economy also remains a subject of ongoing studies. According to IPCC (2018) although the variations in temperature, patterns of rainfall and rising of the sea level endure uncertainty, elementary physical interpretation and model outcomes suggest that impacts (once they happen) are expected to convert more strong and possibly more prominent in volume over the target population, and certain vital sectors of the regional economy.

The most inclusive climate models, like the DICE model, is intended to simulate whole of "Climate System" of the globe with maximum detail impact possibilities as permitted by our accessible supercomputers. According to ADB (2017) study, the capability of climate models to perform has enhanced intensely after the 1960s with the improvement in supercomputers capabilities to compute and to frame projections. With equations grounded on physics and mathematics, climate models can test and numerous comprehensive varieties of meteorological conditions and stimulate climate situations, for example from individual storms, category 5/6 level cyclones, El Niño, besides even can predict the weather of the next century. According to Nordhaus (2000), the intention for developing models to predict climate is to comprehend the natural progressions that yield climate and also forecast the properties of such changes besides interactions. Such exchanges, always function at different space, balances and have different reaction periods. So, for any new model, some explanations are needed in developing models for the climate.

Following an ADB (2009) report a variety of climate models are available based on the number of different progressions encompassed and the range of period intervals considered. Any model in reality is a depiction of somewhat that permits individuals to perceive about what the real entity is like besides how does it functions. A model may be accommodating particularly when sometime it is not feasible to have a look at the actual situation. Universal climate models define the mechanisms of the climate system of the world to the best of their ability. It is used primarily to forecast how the world's arrangement may respond in the forthcoming if we uncontrollably add GHGs besides aerosols in the ether, continue to do deforestation to made cultivable and liveable property, or else modify our world surroundings.

IFPRI (2002) report, in order to characterize the atmosphere of the world precisely, universal climate models usually employ a three-dimensional network arrangement that covers total world, separating the above atmosphere into multiple layers where every layer may comprise thousands of points, by which the model can analyses atmospheric progressions by deploying CGE (Computer Generated Economic) Model is extraordinarily multifaceted and uses a network of points through an exact mesh (IFPRI, 2002). Universal climate replicas usually use mathematical based equations for defining activities and arrangement within the world, for example, atmospheric progressions, the quantity of solar energy that arrives in the atmosphere and the rotation of the earth. Multifaceted models for climate variation measurement (IFPRI, 2002) like DICE model obtain data about world processes besides anthropogenic variation from the analysis of hundreds of diverse mathematical equations besides evaluates what categories of climatic events can happen at sites inside the considered network.

According to World Bank (2017) report, the effects of climate variation are factual as well many republics are mostly exposed to its significances, partially as of their inadequate capability to mitigate. Against such contextual, this research proposed specific plans based on models to familiarize some philosophies and notions concerning the tasks toward combining multiple national policies as a means for attaining enduring regional solutions to the issue and to examine few of the technical basics on appropriate Mitigation measures, which are novel progresses in the Climate Change study arena. According to IPCC (2018), reducing effects of Climate Change denotes towards the efforts to avert greenhouse gas emission as much as possible within specific capacities.

Mitigation defined by the IPCC (2014a,p. 22) report as "a human intervention to reduce the sources or enhance the sinks of greenhouse gases. For the last 20 years, negotiations were held by UNFCCC with the aim of attaining stability in the atmosphere for the concentrations level of different greenhouse gases in such a manner that can avert hazardous scuffle resulting from climate arrangement. Such level attainment needs to be achieved within a certain time, sufficient to allow the ecologies to familiarize naturally toward climate alteration, and also to confirm that production of food is not hindered then to continue of economic expansion by a sustainable means."

Mitigation can also be understood as using new know-hows and energies generated from renewable, modifying backdated equipment for more energy efficient, or altering administration practices otherwise behaviour of the end users. It can be multifaceted as like a plan for an original metropolitan, or as simple as an enhancement for a table lamp design. Hard work is ongoing globally ranging from advanced subway arrangements to Cycling paths beside walkways. Defending carbon basins which are natural by category and similar to forests besides oceans, or forming fresh carbon sinks by performing green agriculture are similarly components for effective mitigation. An extensive assortment of damaging apparent climatic outcomes and a relative advantage of mitigation alternatives would be measured to find concerning prioritizing necessities to reduce the likely forthcoming exposures. According to IFPRI (2002) report the consequences would be analysed through Regional Computable General Equilibrium (RICE) modeling engaging diverse climatic and environmental settings. The modeling here plans to use a dynamic strategy which emphases on a regional basis for conceivable economic loss under several climatic condition's subsequent observational archives of global warming-related climatic features.

There are some prior research studies on modeling which was acknowledged in the earlier literature, like those completed by " Schimmelpfennin (1996) ; Alexandratos (1999) ; Socolow (1999) ; Reilly (1999) ; Tilman et al., (2002) ; Slingo et al., (2005) ; Naylor et al., (2007), and Lobell et al., (2008)". This research will use the available and accessible climatic data for the specific region, (In this case for Malaysia and Selected nations) to predict climatic findings for the next or enduring forthcoming scenarios solely. However, no study to date assesses the comparative measurement (i.e., benefits) of regional mitigation alternates for Malaysia. Besides selected ASEAN member nations to rank necessities to decrease vulnerability level for policy issue with a short-run to long-run vision. If we consider the background of research; a lot have freshly made reference to the topic, considering eminent publications done by "IPCC (2007) ; Cahill, KN et al., (2007) ; Lobell, et al., (2008) ; Bonfils et al., (2008) ; Burke et al., (2009, 2010); Hertel et al., (2010) ; Lobell et al., (2011) ; Rowhani et al., (2011) ; Georgescu. et al., (2011) and Ahmed et al., (2011)".

Therefore, after a national and regional outlook, policymakers and conservationists will look for the operative apparatuses for handling the properties of Climate Change mutually, regionally and also for a country-specific basis. Detailed investigation of longstanding Mitigation method, technical basis, organizations and operative blockades centre on assimilating Climate Change worries. Suitable enduring Regional Mitigation Modelling and outlines directing to determine the Climate Change evidence advocates that the effect of Climate Change is growing (Lobell et al., 2011).

The direct effects of Climate Change include annihilation of natural properties and the damage of life; human relocation besides migration; then destruction to infrastructure, environment, and economy. In disparity, the indirect impacts appear to be much frequent, as stated in current scientific works, such as by Stern (2007) ; Cahill et al., (2007) ; Naylor et al., (2007); Lobell et al., (2008); Bonfils et al., (2008) ; Burke et al., (2010) ; Georgescu et al., (2011) ; Rowhani et al., (2011) ; Ahmed et al., (2011). As the subject, it represents global anxiety, Malaysia and selected ASEAN nations will not be left out from such effect and susceptibility.

For the Malaysian scenario, the government used the following strategy to decrease carbon emissions within the nation, that comprises the outline for a new kind of mechanism, named as a carbon tax, which is anticipated to move the relative prices to rouse, mass expansion and replacement of fossil fuels by renewable energy. Among the ASEAN members, Singapore has a strict environment policy that will be chosen in the prototypical analysis as it is, while the remaining nations are yet to manufacture one. The intermittent valuations organized by the UN-funded IPCC (2014b) which recaps and appraises scientific studies for Climate Change widely and credibly, assert that the earth is moving to a period of extraordinary changes in weather which will be an effect of detrimental human actions from the past. The probable variations of weather patterns will be evident in intensifying temperatures, wide variations for precipitation patterns, augmented danger of having the drought, growing levels in ocean, and further occurrence of extreme weather conditions (Houghton et al., 2001). Also, the projected growth in atmospheric concentration for climate-linked GHGs is expected to alter the stability from a cyclical difference of temperature in maximum portions of the world, which is anticipated to upsurge the hazard faced by human civility in the forthcoming. (IPCC, 2007, 2011).

The exhaustive foundations of Climate Change are already clarified in numerous studies, although the models used, approaches considered, and projections made are still questioned (Hood and Wilson, 2001 : Aldy et al., 2003 ; Füssel et al., 2003 ; Carter et al., 2006 ; Beckerman and Hepburn, 2007 ; JRC, 2013). For example, hazards that are happening from climate are extensively testified by IPCC besides other associated research “(Hansen et al., 2006 : IPCC, 2007 ; Stern, 2007 ; Nordhaus, 2008).” An indication is there, that the deleterious climatic outcome by nation, which have impacts on pecuniary progress of those nations (Schimmelpfennig, 1996 ; Kelly and Kolstad, 1999 ; Keith, 2000 ; Nordhaus, 2001 ; McKibbin and Wilcoxen, 2002 ; Oreskes, 2004 ; Bonfils et al., 2008 ; Kannan, 2009) .

It is quite vibrant that there is scientific signals leading us towards the fact that the ecosphere will experience key geophysical variations in the upcoming years as a significance of mortal actions, which impends the long term sustainability of civility (Pizer, 1999 ; Tol, 2003 ; Byatt et al., 2006 ; Carter et al., 2006 ; Weitzman, 2007; Nordhaus, 2007,2008; Kannan, 2009). Though the properties of climatic impairment can be recognized in diverse parts of the world, according to ADB (2009) report for the ASEAN region illustrated that out of ten of its member nation, worldwide, three are among the most vulnerable. ASEAN region is characterized as the overpopulation of 600 million and located nearby one of the biggest and busiest sea trade routes, members of ASEAN are profoundly dependent on agronomy and manufacturing to sustenance their economic progress and is experiencing extensive deforestation. According to WEF (2018) report few ASEAN member nations have agonized from expected catastrophes, for example, like an earthquake, rising sea level with big tidal waves, tsunami, and cyclone. For instance, in 2004, Indonesia, Thailand, and Malaysia were struck by a Tsunami, and during 2013, both Vietnam and the Philippines were agonized by Taiphoon “Haiyan”. Throughout 2018, both Indonesia and the Philippines were knocked by Earthquake and tsunami repeatedly.

Many studies have illustrated “Climate Change” as the main reason for such natural adversities (Emanuel, 2005; Stern, 2007; Kannan, 2009; IPCC, 2011). Three main policy questions arise around the inter-linkages amid policies for mitigation of climate variation for the ASEAN nations. Among them, the first one relates to longstanding "ecological" thresholds for Climate Change, which, if recognized, will pressure the accepted level up, and timing of permissible universal emissions down. Any choice on the attractiveness of thresholds will be determined by society's apprehension about the risks related with Climate Change effects and by assessments on Central apprehensions about sustainability. It mainly, consist of certain dimensions like economic, social and environmental which will essentially impact deed in each of the said sectors. Choices and urgencies for each of the said sectors affect the tactic to the valuation of climate policy choices and endorsements for future action. The Social dimension for sustainability promotes a couple of significant "fairness" matters for Climate Change. These might be separated equally based on results and procedure followed (Banuri et al., 1996; Rayner and Malone, 2000; Kannan 2009). The Social Cost of Carbon (SCC) is a new perception gaining massive popularity. For a decided year, the SCC actually provides an estimation, at the Dollar value of the contemporary discounted value of the harm caused by one metric ton rise in CO_2 discharges into the air in that specific year. (IPCC, 2014c).

The SCC is envisioned to deliver a complete measurement of the monetized worth of the total damages resulting as of the worldwide climate distortion. According to Kawase, Matsuoka and Fujino, (2006) from an extra unit of CO_2 not restricted to changes in net agronomic yield, energy usage, effects on human health, and assets damage from amplified flood risk. National agencies use SCC to charge the CO_2 emissions effects of various policies counting emissions and fuel economy standards for vehicles, guidelines for manufacturing air pollutions from industrial manufacturing, emission standards from a power plant and solid waste management and appliance energy efficiency standards.

According to Kawase, Matsuoka and Fujino, (2006) there are unique challenges to estimate a dollar value that reflects all the physical, human, environmental and economic influences of climate variation. According to IPCC (2018) in order to do proper investigations for the social cost of carbon, we have use "Integrated Assessment Models (IAM) “The simple procedure of any IAM may include subsequent stages as follows:

1. To Develop (otherwise to select after current) scenarios for future discharges of GHGs;
2. To use the scenarios to estimate the upcoming atmospheric absorptions of GHGs;
3. To predict variations in usual global temperature besides climate subsequent from such forthcoming atmospheric attentions of GHG’s;
4. To approximate the economic significances of the resulting changes happening in climate;

5. To approximate the costs of reduction for specific amounts of GHG discharges;

6. Summing up all the approximates from steps 4, step 5 to develop a valuation for a total economic impact of diverse scenarios and thus recognize the best route of reduced discharges.

2.7 Institutional Capacity Building and the Substitution of Fossil Fuels

A significant barricade of fair presentation of Climate Change anxieties is the absence of collective policy efforts from different levels like international, regional or national level. Also, the action undertaken to encounter impacts of Climate Change among various government agencies of the local levels of many nations are also not appropriate and effective. For instance, in most of the developing nations, transport, and construction of roads, consumption pattern of energy, and pollution resulted from vehicles are administered by distinct division besides ministries (Rahman et al., in press). To be environmentally efficient and effective to attain the future obligations made by the local government in their respective INDCs, according to IPCC (2014b), it will necessitate active participation and coordination of the developing and least developing nations in any given region. According to the same report from IPCC (2014b) the conciliation to determine the future mitigation efforts must be centred around two important issues as follows:

1. What is the time necessary for reducing environmental emission to a fixed level?
2. How to assign accountability for the essential emission decreases?

Response for the above question is critical, as it will frame the cost needed to respond to impacts of climate variation in the individual and regional level. According to another IPCC (2018) report besides the above questions, also the substitute development pathways, and the baseline year achievement, compared to which the emission reductions will be measured, will also influence the mitigation cost.

One of the earlier report done by IPCC (2007) also explained six different reference scenario that projected opportunity for a wide diversity of future energy possibility. By the end of the 21 century, noteworthy investment in new and sustainable energy sources are taking place, which can make a momentous modification of future energy variety, that may cause the target set to emit less CO_2 to a level much more comfortable.

Most of the energy investment of these days are focused on fossil fuel, but over the 21 century due to technical and mechanical advancement, IPCC (2018) predicts that there will be a diverse energy mix then what we have today. According to IPCC (2018) report, such a progression of energy mix and new technological concepts like low carbon will influence the level and cost of targeted emission levels. Maximum scenarios run for Climate Change mitigation recommend that profound global emission and decreases will require the lead time of at least half a century or more to reach a reasonable stabilization level. Following one of the IPCC (1996) report focuses on blocking emission of CO_2 at the present level will also help to stop the doubling of CO_2 concentrations in the atmosphere until the year 2100. However, it would not be sufficient to avert a continuing rise there afterward. Attaining the lower stabilization level (for example 450-550 ppmv) by 2100 requires more noteworthy reduction of all the GHGs including the primary component CO_2 emission.

The time and level of mitigation essential to attain the targeted emission reduction could also be affected by a need to terminate the degree of Climate Change. Another report published from IPCC (2011) has claimed with scientific facts that the earth can be warmer by 4.8-degree centigrade within the year 2100. As a result of connected occurrences, we can experience an upsurge in sea level, growing up to 82 cm or 32 inches. Consequently, the scientific community according to Stern (2006) and Nordhaus (2008) has removed their focus from arguing on the fact of atmospheric absorption, increase in temperature and emission levels, to ensure the effective mitigation of climate damage.

The European Union (EU) had formulated policies to ensure legally binding targets for active mitigation in COP20 in Lima during 2014. The developing nations were unable to reach the set targets and thus lagging behind the determined thresholds necessary for becoming environmentally sustainable. It requires to block the uncontrolled rise of temperature, and therefore was unable to follow climate-friendly expansion policies efficiently.

The Stern (2007) review specified the impacts of change in climate over the global economy, and temperature involvement in future climate agreements will be grounded on a specific percentage of emission reductions that may be collective from their contribution done earlier among all the participating nations. According to Shukla (2008) philosophies of equity and fairness vary extensively across the nations and likely to determine choices by developing nations influence in joining into any future arrangements on governing mitigation. Moreover, IPCC (2014c) described the future commitment designs are to be such that it omits the possibility for any nations to get the opportunity to be a free-rider through the next negotiation phase and further. All kind of emissions recorded and recognized as harmful to nature and humans need to be collected for each specific country responsible for it during every further negotiation.

By doing such trekking of country-specific future emissions, future talks will be more specific to solutions, can identify and pressure the high-level polluters individually, to reduce their actions and thus the talks will settle faster, leading to links present activities to earlier policy and accomplishments. Irrespective of the result of the negotiations, such emissions can be shown against each individually responsible country, with the result that can help them to incur significant mitigation initiatives to reduce emissions in the future. Moreover, the republics coming forward and taking action in advance to mitigate the need to be awarded, and governments, joining late would have performed additional tasks as a late response.

The effective policy for any given nations Climate Change must be low-cost oriented and also have a substantial bearing on the future low carbon Climate Change scenario. According to Stern (2009, p. 43),

> *"the total present value of the worldwide benefit of the optimal policy is around \$3 trillion relative to no controls. This total comprises \$2 trillion for abatement costs and \$5 trillion of reduced climatic damages. Even after the optimal policy has been employed, there will still be substantial residual damages from Climate Change, which we estimate to be \$17 trillion only".*

A very significant contribution of Stern (2009) is to utilize the DICE model to comment on the approximation of the best carbon price considering the "Optimal Carbon Tax." The term "Optimal Carbon Tax" refers to the price for emission of carbon that balances the incremental cost of minimizing the carbon discharge with the incremental benefits of reducing climate damage. In 2005, in his analysis using the 2005 market price, Stern (2009) calculated economically optimal Carbon tax may be US$ 27 or RM 108 for every metric ton (assuming, 1US$= RM 4).

Primary drive for calculating any Carbon tax as stated by Stern (2009) is toward restraining the total emissions of greenhouse gases as much as possible and to subsidize green technology in any given nation, as a mitigation approach. The tax considers here is a fee on the consumption on fossil fuels used how much carbon they discharge once burned (more on that later). So, to reduce the tax, utilities, business and individuals need to consume minimum energy producing from such fuels. As expected, the following outcome scenario can occur:

1. People may switch to renewable electric or hybrid vehicles and substitute bright bulbs with compact fluorescent lamps (CFLs).
2. A business might raise its energy efficiency by fitting new appliances or upgrading the heating and cooling systems.
3. A utility firm might use wet scrubbers, Nox-burners to decrease their emissions.
4. There is a definite return on costly and exclusive efficiency investments.
5. Carbon tax encourages consumers to accept alternative renewable energy options by making it cost-competitive with fossil fuels.
6. Innovation into new Renewable know-hows and apparatuses leads to Low Carbon Economy for the selected ASEAN nations.

Almost all developing nations still use coal as their primary energy option. The ecological consequences of using coal for producing energy is more focused on economic development within a particular time. Developing nations uphold that any attempt to shift to low carbon-intensive fuels must consider and appreciate the economic sufferings of such a change, and compensate accordingly. The effects of emanating greenhouse gases, according to stern (2013) appears with lags of many past years and they might last for a more extended period. This process is known as: "Flow Stock," In this process the flow (emissions) cause the stock (concentration) to build up for a certain long period as the CO_2 enjoys higher longevity so that it can sustain in the atmosphere. This is one of the important motives, for, delaying for mitigation action against Climate Change impacts is considered as Dangerous."

The more delay we do to start mitigation initiative the higher the concentration of GHG's will be within the atmosphere. As a result, it becomes more difficult to start the action to reduce the emission on the required scale. Delay in the start is also critical, as it increases the cost of capital and infrastructure, which can lock in concentrated carbon activities for many decades. It is expressed that justice being delayed is actually being denied, and it is the same for climate justice.

Helm (2017) his renowned book "Burn Out: The endgame for fossil fuels" tries to explain in what way we can yield besides consume energy by a few generations in the future. It remains a mammoth challenge to fight through a generation's energy shift challenge, but it is possible to attain. His literature recognizes three specific "predictable amazements" that will impact on our future energy use then measures their monetary effects. In his book, he delivers a brief introduction on the antiquity of universal energy economics, the role of governments, and negotiation.

Observing the forthcoming, he distinguishes those nations, who will be nicely prepared to tackle these amazements.

The first prediction of Helm (2017) was, the price of fossil-based fuels, like oil, may decrease with time because, both the supply costs and demand drops. Upsurges of low-cost besides malleable supply resolve after the shale oil besides the gas revolution. He believes although, a decrease in demand will happen from variations in demography like liberating of economic progress in China, and also from the remaining two new superpowers. The second and the third prediction of Helm (2017) remain related and dependent on each other. In his Second Prediction he also said, "Decarbonization will happen soon," and in his third prediction, he told that this would give birth to new technologies and innovations that will make low-carbon policies more acceptable both economically and politically. He adopts that with time, soon there will be dramatic revolution due to technical innovation of new and greener electric generation technology, particularly within the efficiency level and affordability for "Solar Photovoltaics" (PV) cells. Helm (2017) also assumed that, Digitalization may escort the electrification aspect for the transport system and heat transfer and will resolve the transformation of the operation for the electronic network systems and the method in which goods and services are shaped.

By studying the nation and specific provincial considerations, Helm (2017) emphasis for performance trends of Middle East, United States, Russia, China, besides Europe. Aimed at respective country and regions, helm (2017) made a rapid and precise summary for the energy antiquity and afterward drafted consequence of his three expected surprises on those nations forthcoming. Here the writer, hopes may be the weakening prices of fossil fuel will consume the most instant, and obvious consequence scheduled over the economy.

Helm (2017) also mentions that, the nations which already have their economic prosperities depended on fossil-based fuels, may not be able to ensure a smooth conversion from the shocks of lesser prices and deteriorating in a petition. He also trusts that digitalization can create a new era of industrial production within the United States besides Europe, and China. He also assumes Europe and the United States, those who are benefitting by the lower prices for energy and maintains healthy exploration besides manufacturing bases might derive out ahead of all. Already by 2019, it seems surprising that both China and India are leading in the innovation of green technology race, besides the USA, unfortunately, is lagging due to its political indecision by Trump Administration. In the coming century, according to Helm (2017) the regions, which profits from little energy charges besides robust research base drive will do fairly good, in the economic progress. The Horizontally linked energy manufacturing firms, especially in exploring and extracting oil instead of producing electricity which conquered the 20th century, are not anticipated to well. He forecasts that digitalization and new skills that permit smaller increases of the capital venture will upset the economic services that commanded to these firms' accomplishment. These companies, are expected not to be able to keep up with new energy know-how and will fail in the long run. The research study conducted by Helm (2017) presented the fact that the newly developed electric use utilities are focused only on the European market, so we need to think in the same way for ASEAN Region for the issue in the long run. In short, it does not look good for organizations to be stubborn and using carbon-emitting energy generation process.

Helm anticipated in future more, smarter, dynamic, energy efficient and augmented solar as well as wind power production might reduce energy prices in the wholesale-market, anywhere the big and famous power plants earn a good portion of their revenues till today. In the third chapter of his book, Helm (2017) makes an untrue dissimilarity in between the present and future solar or wind power systems efficiency, overlooking the impact of the current technological progress while tapping excessive hope in future technologies from solar PV cells and batteries. Such future advance of renewable technology will rest over the visions established in manufacturing contemporary know-how at scale. In this book, Helm (2017) also let go the effect of existing climate and renewable energy strategies, particularly European strategies, while weakening to identify the straight role of these policies at the beginning of succeeding generation know-how. Such deficiencies do not hamper the original opinions of the books.

2.8 Low Carbon Economy and Low Carbon Development

IPCC (2018) report illustrates that, Climate Change holds severe impacts for future of the economy, and so it is best to deal with it is to deploy mitigation activities. The mitigation efforts related with consumption outlines are mostly centred by changing the goods persons buying to substituting with minor climate effects. Examples include what Lorek and Spangenberg (2014) presented in his study for refining energy preservation behaviour (for instance, putting off the room lights while leaving it or regulating indoor temperatures to moderate level) Though, to guarantee significant decreases at carbon discharges, Clarke et al., (2014) also expressed that it is important and critical for us to act combinedly outside our specific regions to pursue new and more extensive changes for mitigation technology.

According to Clarke et al., (2014) to green any regional society, there are many actions available that individuals can undertake, toward transformation into a lifestyle that ensures low carbon usage. To create a variety of human behaviour correctly, it primarily significant to specify mark behaviour (Darnton and Horne, 2013). Which is substantial from the householder's viewpoint is that there are diverse types of behaviours to make a policy goal positive, like, trying to save energy at house. Such kind of individual reductions can be real by shut down of the air condition, fitting more window and entrance lining in present buildings besides also fitting such components at every novel constructions possible (Darnton and Horne, 2013). What this means is that people can also install new types of machinery like flat and thinner solar panels on their house and garage roofs to generate all of their demanded household energy from the sunlight. Such change in their cooking practices differs from the settings of our livelihood, besides so each of them would require to be endorsed through diverse processes.

We agree with the proposition of, “limits to growth” established through “Club of Rome” (Meadows et al., 1972) and from then till of today it is followed by certain distinguished economists (e.g., Penayatou, 1998; Brown, 2008; Rasiah, 2015; Sachs, 2015). The replacements we have illustrated ensures that there is no need to have any trade-off amid economic development initiatives. The notion "Low carbon economy" is initially projected within the energy focused white paper of United Kingdom (DTI, 2003) and finally it was accepted via "Bali Roadmap." What this means remains, it registered on the high importance of schema by governments around the globe. The fundamental of the Low Carbon notion is towards gaining more efficiency in energy usage, ensure energy saving process and use renewable energy. It is worth noting that because of technical advancement gaps in development and developing stage nations, many nations will choose different pathways to attain low carbon economy, according to their capacity, or by the regional alliance. ADB (2009) report demonstrates ASEAN as per a Southeast Asian regional based organization, it can work as a unique and acceptable platform for combine mitigation and Low carbon economic transformation This objective of low carbon development actually clarifies real learnings for policy originators who pursue to decarbonize the economies, it is initially developed based on the experience from the UK experiment. There are five essential learning from that UK experiment (DTI, 2003) as follows:

First, Any Decarbonisation efforts require a legal foundation toward its reliability and to overcome discrepancy glitches resulting from time differences.

Secondly, assigning a new price for carbon is very essential, but low carbon strategies also have to account for a broader market, investment and behavioural fiascos. It is also known as the "turn rise" matters of policy struggle and harmonization.

Thirdly, Decarbonisation always starts from taking power sector into account. The "low carbon economy" is expected to be a highly enthusiastic approach. Clean and green electricity is a profitable means of several decarbonizing sectors of the economy, for example, transportation, heating system and portions of the manufacturing industry.

Fourthly, the so-called "low carbon transition" is, in reality, an upgrading process of the manufacturing system of energy, not for using it. Although both Supply and demand side alterations in life and behaviour are desirable, the former one always dominates.

Fifth and lastly, the changeover to a low-carbon economy stands now economically as well as technologically feasible. Attaining it depends a lot on strategy fitness and the politically aware determination to initiate both economic and social alteration.

This findings from the UK experiment call attention to the need for individuals to change their existing consumption patterns for a given community to tackle Climate Change. However, according to Evan (1999) here is minor agreement on the sense of lifestyles that are climate-friendly, and what they mean is a level of apparent variations in using and by what means such changes are needed. The limitations of this study according to Jackson (2011) is there is no indication of either if such practical variations are incremental, or appropriate for general publics or add significant variations are desirable for specific Industries. (IPCC, 2014b).

According to Lorek and Spangenberg (2014), there are plenty of activities persons can do to green a civilization as demonstrated through the increasing amount of published articles treating with lifestyle patterns that supports "low carbon lifestyle." To alter human behaviour in the correct course, as illustrated by (Darnton & Horne, 2013) this is significant to establish certain behaviour patterns According to Darnton and Horne (2013) following householder's perspective, there are many diverse behaviour pattern's which can influencing any strategy objectives. For example, we can try to save energy in our own household. This kind of individual reductions can be comprehended through turning off home thermostat, and installing new window and entrance door lining in prevailing constructions, as well as fitting such gadgets in all new structures. According to Darnton and Horne (2013) any nations of the world can effort to renovate itself as a "low-carbon economy" as part of their own national or regional mitigation policy for tackling "Climate Change impacts". A complete plan toward mitigating climate alteration can be attained by ensuring active "carbon neutrality." The purpose of any LCE according to Darnton and Horne (2013) is to integrate all knowhows that can harvest energy and materials with minimum or zero carbon emissions. Thus, it minimizing impacts around the local inhabitants, houses, factories and machineries, that consumes such energies and resources proficiently, and, also recycle its wastes to have a minimal output of carbon.

To Ensure an effective changeover to an LCE is economically feasible, but nations need to consider a cost (output per unit) of reduction of greenhouse gases through means such as emissions trading or a carbon tax. Several of the nations in the world, according to IPCC (2018) have promised to reduce their national emissions of GHGs by 100% through offsetting emissions slightly than stopping emissions of all kinds (this is known as "carbon neutrality"). In another arguments, of IPCC (2018) report it was mentioned that emitting will not stop and will continue and will be counterpoise to a diverse geographical part. The emanation exchange arrangement develops by EU permits the firms functioning in EU to buy worldwide carbon credits; thus, the corporations can send the needed funds for clean and green technologies to endorse in other nations to accept low-carbon developments. According to IPCC (2018) report, some nations of the world are already considered as “low carbon societies" as they are not severely industrialized or inhabited. In order toward evading the impacts from Climate Change at a regional level, selected ASEAN nations to need to consider and admit carbon intensive societies, heavily populated societies need to develop as a "zero-carbon societies" and "zero carbon economies."

This is valuable to note that, popularity for low carbon development recently takes rapidly progress. This concept has gained attention and interest from leading scholars, policy-formulators, experts, the mass media besides the wider public. Conferring to

Urban and Nordensvärd (2013) "Low carbon development" is simply functioning as per, a border of two major areas of study, mostly the "Climate Change mitigation" and the "International Development." Urban and Nordensvärd (2013) also expressed that, “Climate Change and Development” stand as mutually twins of the most critical global issues of our times, but all together they are very contentious and argued.

The recent publication of IPCC (2018) report explains that most of world top scientists seem to agree to the fact that, likelihood of remaining beneath the 2°C by year 2100 is a feasible target. Increase above 2°C by year 2100 is probably indicates that we are moving towards unexpected and irretrievable variations. Such variations according to Urban and Mulugata (2010) besides Urban and Naess (2011) can create severe disruptions in a social, economic and ecological performance that might strictly lurk international development through the 21st century then onward. This is worth noting that Nordhaus (2013) who presented the idea that as the high income developed nations of the globe are the best emitters so they should focus more on efforts for mitigation and conversions to minimum carbon user economies. According to (Urban and Nordensvärd, 2013) about 75% of total accumulated emissions of the world are reported to be generated from the Developed nations although the balance of emission has altered significantly in current years with an increase of other developing nations such as Brazil , China, India and South Africa have quickly risen their emission levels. All of these nations have inspired by attaining "low carbon development." But according to IPCC (2018), “Climate Change” is categorised as a worldwide common catastrophe, so it is being treated as a global problem. To mitigate it, worldwide implication and significance of “low carbon development" in reality is significantly low for concerned nations. However, its features can differ significantly depending on regional or national priorities, economic performance beside related concerns.

According to Urban and Nordensvärd (2013), only China alone emits almost 25 ppm in each hundreds of total worldwide CO_2 discharges, but then again in per capita terms of average, than the average US citizen, the citizens of China is accountable for approximately three times less emission of CO_2 (IPCC, 2012). This is a fact that certain developing and Least Developed Nations (LDCs) have done minimal emission to start the impacts of Climate Change there. The Least Developed Nations were designated to provide justification for only around 4% of worldwide GHG emissions in 2005 besides 0.3 % of accrued discharges CO_2 were due to energy use (IPCC, 2007). While during the same time all these nations were the greatest susceptible to the influences of climate alteration (IPCC, 2007).To effectively decrease CO_2 discharges while retaining economic growth, according to a World Bank (2014) report various nations have started to explore for a novel, progress pathways. Amid such demand, the "Low-carbon development" conferring by Urban and Nordensvärd (2013) has developed as an extensively accepted option for minimum carbon usage, while development is ensured. Diverse writer and scholars have attempt to define it from a different perspective.

Defining Low carbon development is critical, and two of the most popular definitions of low carbon development are crucial for this research. One of the definitions is more focused on broader development, and provided by Skea and Nishioka (2008); Urban and Mulugata (2010); Urban and Naess (2011) as follows:

> *"Low carbon development is a development model that is based on climate-friendly low carbon energy and follows principles of sustainable development, contributes to avoiding dangerous Climate Change and adopts patterns of low carbon consumption and production."*

In another definition, considering the progress aspect, low carbon development is defined by DFID, (2009, p 58); Urban and Naess (2011). as follow:

> "Low carbon development is defined as using less carbon for growth, which includes switching from fossil fuels to low carbon energy, promoting low carbon technology innovation and business models, protecting and promoting natural carbon sinks such as forests and wetlands, and formulating policies that promote low carbon practices and behaviors "

To focus on the important aspect of Low carbon development, for any given community or society, Urban & Nordensvärd (2013, p. 5)[17] said,

> "Low carbon development is crucial for mitigating emissions that lead to Climate Change and for enabling development in a carbon-constrained world. Low carbon development is being pursued by high-income nations and emerging emitters to reduce emissions, increase economic growth and firm competitiveness. At the same time, low carbon development is an option for lower-income nations to access new energy, low carbon technology and to reduce poverty."

Even different nations or organizations also have given their various interpretations. In literature, according to Urban and Nordensvärd (2013) there present in an amount of fundamental perceptions pertinent to Low-carbon expansion.

For instance, "low-carbon energy", "low-carbon life", "low-carbon society", "low-carbon city", "low-carbon community", "low-carbon tourism" besides "low-carbon world". Yuan , Zhou and Zhou (2011, 2012), have demonstrated multiple low-carbon

[17] Urban, F. and Nordensvärd J. (2013). Low Carbon Development: Origins, concepts and key issues. Taylor and Francis. PP 01

related concepts that are available and useful for implementation of "Low carbon development" and combining them from literature to apply to ideas.

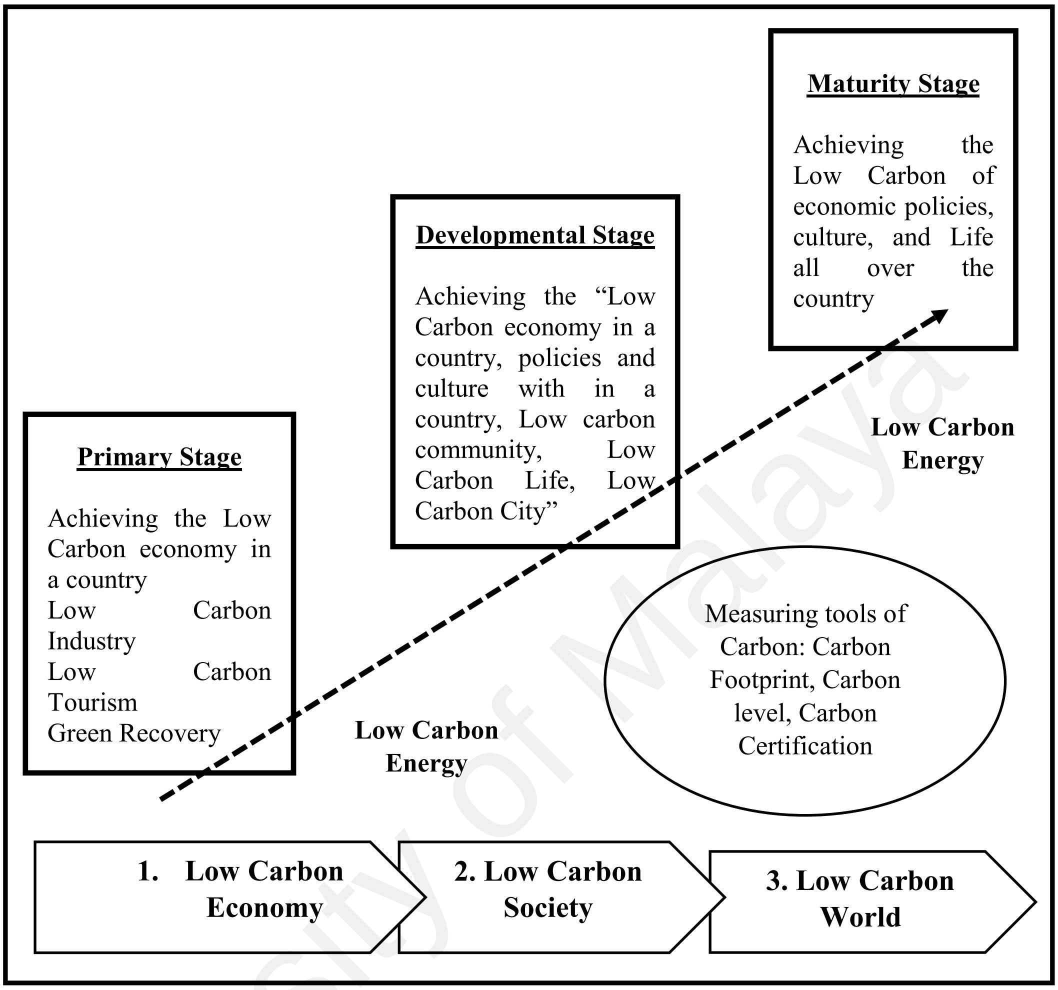

Figure 2.2. Three phases of Low Carbon Development

Source: Yuan et al., (2011) "What is Low-Carbon Development? A Conceptual Analysis"

With the above Yuan et al, (2011) developed and interpreted the three essential stage figures of future low-carbon development (see Figure 2.2) for those nations who were interested for accepting this low carbon development for them in the future.

Figure 2.2, presented above presents the Low-carbon Development Process as specified by Yuan et al., 2011). In his article, it demonstrates the whole process, as it is divided into three specific phases, as follows: 1. "Low carbon economy," 2. "Low carbon society" and 3. "Low carbon world."

First phase of “Low-carbon economy” following Yuan et al., (2011) is also the initial segment of the “low-carbon growth”, through which for any given country, the reduction of CO_2 emissions is the chief goal, while holding up the economic progress. To attain this target, a nation requires to frame a clear strategy to inspire maximum decarbonization in the future economic expansion plans. The strategy here according to Yuan et al., (2011) focuses more on the Research and Development for “low-carbon technology” over financial subsidy, minimizing tax besides ensuring finance for necessary legal support, so the expansion besides procedure for low-carbon based energy rises, thus the modification to restructure to low-carbon industry accelerates.

Many ASEAN nations are in this phase of the Low Carbon Development Process. According to Yuan et al., (2011), there are two subsets of "low carbon economy" known as "Low-carbon tourism" and "Low-carbon industry." "Green recovery" termed here as another set of recognised strategies besides actions directing for building a “low-carbon economy”. They suggest that the second phase of “low-carbon development” is known as "Low-carbon society" and it initiates as soon as the nation completes the First Phase. This phase includes steps as "Low-carbon life", "Low-carbon culture", "Low-carbon politics", etc. In this phase, an initiative must be taken by a government to endorse low-carbon based specific life patterns and consumption styles for Individuals including actions like inspiring people to select and adopt transport modes which are grounded on low-carbon fuels as their regular means of transport. When a city attains such low-carbon practices in different aspects of their life including budget, regular life, economy, politics, and culture, it then may be well defined by means of a "Low carbon city."

According to Yuan et al., (2011) the “Low carbon community" remains a central essence for predetermined "low-carbon city." Any society will try to transform into a "low-carbon society" only as soon as its economy, regular lifestyle, and its culture accomplish a certain level of low carbon usage. Afterwards, when most of the nations of the world have converted in to "low-carbon societies," then "low-carbon development" converts to maturity then next phase “low-carbon world” initiates. By course of "low carbon development," we also require several devices to monitor and update, as well as to rectify actions to ensure the achievement of expected progress level.

The concepts presented by Foxen, (2011) and Yuan et al.,(2011) in their study indicated that components like "Carbon footprint, Carbon label, and Carbon certification" can help the determination of Low carbon transformation easily for any community. Yuan et al., (2011) also argued that “Carbon footprint” is total emissions of CO_2 triggered by any specific society, specific merchandise or any definite individual. “Carbon label” besides “Carbon certification” both is a combined arrangement use to quantify and exhibit the emissions of CO_2 happens from merchandiser entire lifespan.

2.8.1 Origin of Low Carbon Development

“Low carbon development” as presented by Urban and Nordensvärd (2013) is a recent concept, gaining popularity among world leaders. As a concept, it was first recognized by the "Department for International Development" (DFID) at United Kingdom (UK). They pioneered in using this term for development aid agencies of the developed world. The good thing is in recent years, and many governments around the world have accepted it. For this thesis, we recognize two key definitions used by scholars for defining low carbon development. The First definition is more focused on broader development terms, and the other is attentive to the growth of green technology and Sustainability.

From the development perspective, according to Urban and Nordensvärd (2013), "Low carbon development" is a prototype that is built on utilizing climate-friendly and low carbon based energy. In addition, this prototype also follows the values of “sustainable development”. Thus, it contributes in avoiding dangerous effects of Climate Change and adopting patterns of low carbon usage besides production. From the Green technology growth perspective, according to Urban and Nordensvärd (2013) LCD is well-defined as a manufacturing process by using less carbon aimed at economic progress. It comprises the process for shifting from fossil fuels to non-fossil fuels for endorsing low carbon technology invention besides corporate models. Its actually shielding besides encouraging protection of natural carbon sinks such as jungles, wetlands, forests in addition formulating new policies, practices and behaviors that encourage low carbon usage.

The critical intention of low carbon dependent growth is toward lessen discharge of CO_2 to evade the hazardous effects of Climate Change, although at a similar period realizing social and economic progress (Urban and Naess, 2011). In her book Urban and Nordensvärd (2013) also illustrates that activities essential to accomplishing low carbon development in reality. To do so, according to Urban and Nordensvärd (2013, p. 32), “a nation must follow the philosophies and principles of sustainable growth and also to ensure the growth requirements of all groups inside a civilization remain met." The goal of LCD includes attaining sustainable development; although it never addresses the matters of ecological sustainability outside the effects from Climate Change (Urban and Naess 2011). This is worth noting that although Green Growth and Low carbon development have many similarities, two critical differences amid them do exist. Conferring to Urban and Nordensvärd (2013) “Low carbon development” is a newly arisen idea which purposes to alleviate emissions to evade hazardous impacts of change in climate and guarantee societal and economic expansion at the same time. For mathematics terms, if you want to present by an equation it looks as follow:

"LDC = Mitigation of Climate Change + Development".

The following figure represents in what way low carbon development evolve from collaborations that exist between economic progress and mitigation of climatic impacts.

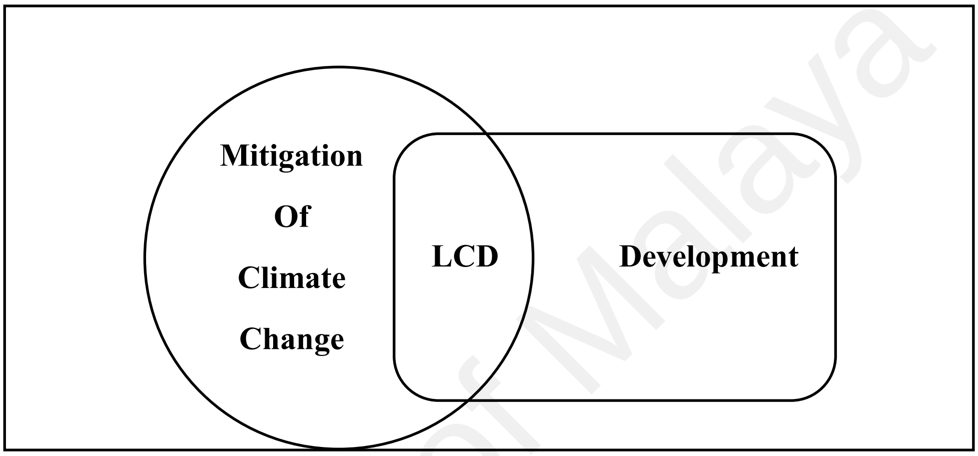

Figure 2.3: Schematic overview of low carbon development (LCD)

Source: Developed by the Author

According to Urban and Nordensvärd (2013) firstly, the "Green growth" stress over attaining economic growth by inspiring : "green investments" besides "green fiscal policy". "Low carbon growth" in reality, considered as the subset of low carbon development besides it is a lot comprehensive, then concentrating only over economic progress. Critical considerations of Low carbon development are focused around social justice, relatively than only about growth alone. Secondly, "Green growth" described by Urban and Naess (2011) refers at friendly growth ecologically. This can also be aligned with policies for Low carbon development; yet, sometimes it can drive outside low carbon matters like ecological sustainability also. According to IPCC (2001) Climate Change mitigation defined as in their initial debriefing as, "an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and to enhance greenhouse gas sinks."

The initial report was trailed by more than a dozen scientific papers and study reports by IPCC (2014a) that finally was able to establish the facts that the planet is getting warmer by days. The same facts with scientific analysis were proven again by the recent publication of IPCC (2018) that till the 20th century, it is most likely going to be the warmest decade within the last 1000 years. So, this alarming situation triggered the urgent need for mitigating CO_2 emissions as much as possible, because it is leading to the so-called Climate Change. If we can control and mitigate the cause at source then, the effect will be counterbalance automatically. Urban and Nordensvärd (2013) made the very valid point that although "low carbon development" have deep roots within mitigation process of "Climate Change", still there are specific difference among the both as follows:

Table 2.1: Difference between Low Carbon Development and Mitigation

Sl	Criteria	Mitigation	Low Carbon Development
1	Scale	Still, now the focus is Global.	The focus is Global and local
2	Geographic benefit	Global	Global and local
3	Actors	Sectoral (like, energy, transportation, Cross-sectoral, but still limited for forestry)	Few approaches
4	Priority	The major emitters	Emitters with development needs
5	Outcomes	Measurable	More difficult to measure
6	Approaches	Narrow: technical approach, broader: mitigation for achieving	techno-centric development needs (co-benefits)
7	Time perspective	Longer term	Medium term

Source : Composed as of Urban & Nordensvärd (2013, p. 207)

So, Nordhaus (2013) finally asks us the most critical question, why the developing and least developed nations, who contributed so little in the current state of carbon emission would uptake such transformation? To answer this question, we can look at facts illustrated by Urban and Nordensvärd (2013) where they mentioned that "Low Carbon Development" possibly could generate new openings and benefits meant for both developed and developing republics. The only few limitations of "Low carbon development" identified by Urban (2013) also includes the fact that is it may only be applied when a pleasant atmosphere is in place, which reports the vital issues of social, economic, political, and technical aspects.

As Urban (2013) summarized the fact that, for low besides lower-middle-income nations, matters like societal fairness and decrease of poverty remain the crucial components toward ensuring less carbon based progress, whereas aimed at the higher middle income and high-income based nations, invention of low carbon technology in addition, decrease of GHG's emissions are the core focus for employing low carbon development. According to Höhne, Wartmann, Herold and Freibauer (2007); Urban and Mulugetta (2010), Chappin and Ligtvoet, (2014) it is frequently assumed, the core benefits of low carbon development lies with developing low emitters, at present most of them are actually middle-income nations with thriving economies like "India, China, Mexico, Brazil, South Africa, and Middle East". Following Urban and Nordensvärd (2013) the Low carbon development, is defined as a platform which can provide certain benefits to poorer nations by providing access to climate-friendly energy for day to day activities, and also could provide low-carbon energy option for revenue earning activities and for educational purposes. Samples for such cases include solar-powered electricity produced for operating a mobile phone charging station or wind-powered electricity used for running an institute. It is also a fact that, such initiatives increase the energy security and energy access for the community. Urban and Nordensvärd (2013) timely point out the fact that Low carbon development can lead us in to more social profits, like ensuring better health services. As example, by reducing the interior pollution of air by switching from wood to modern options of energy. Additional societal benefits comprise new opening for green technology-based career creation. This includes professions created within the renewable energy sectors, like solar besides wind power associated jobs.

2.8.2 Challenges and barriers of Low Carbon Development

The Danish Institute for International Studies (DIIS) (2009) published a report focusing Low Carbon expansion by indicating "not all of the low carbon development initiatives are pro-poor, and some options by default offer far better benefits for the poor than others (DIIS, 2009, p. 1)". According to that findings of the report, there are certain vital challenges and also few barriers to low carbon development, as follows:

Firstly, the emphasis is often on "low carbon growth rather than a focus on Low carbon Development." It entails separating contribution of economic development from total carbon emissions, which in itself is problematic.

Secondly, various nations which are poor till today have inadvertent "low carbon economies," besides they also face a sum of trade-offs in relative towards low carbon development, mostly in relative to biofuels besides hydropower.

Thirdly, a significant number of "economic, political, social and technological" crucial matters need to discuss beforehand Low carbon development can be performed at the universal level. Political viewpoint, attacking the change of Climate according to Urban and Nordensvärd (2013) has received much attention, and politicians and governments have made many promises and pledges, but the real-world execution has often been slow or none. Mitigating Climate Change besides employing low carbon development cannot delay, because waiting would lead us towards risky, irreversible climatic impacts. Disabling political barriers besides mostly political disagreement to modification are thus main urgencies for able to attain effective Low carbon growth.

From the social standpoint, conferring a ADB (2013) report also confirms that general public are now more or less, conscious of the urgency of Climate Change. Social arrangements like climate conference by UNFCCC, to pressurize Government policy-makers into tackling Climate Change. However, according to Urban and Nordensvärd (2013), the global political inaction has caused frustration among many groups who were interested in donating in mitigation efforts of Climate Change.

There is a possibility as assessed and explained by Urban (2013) investigation, that there is a risk that low carbon development may not remain much functional at the cost of the poorest people within any civilization. This means the poor with in the developed nations, may face higher energy bills and face "fuel poverty" because of utility companies that pass on the costs of renewable energy investments to customers. The poor developing nations, may be faced with higher prices for food due to inadequate availability of land or may be due to massive biofuel expansions. They may be even disqualified to use their land for biofuel growths or large dam building and thus may face a bleak future.

Urban and Nordensvärd (2013) also correctly argues that Low carbon development requires to accomplish following a method which encourages both social and economic profits for every layers of the social order, predominantly more to the poor. From the economic viewpoint, this is frequently demanded funds for "low carbon energy," like installing "wind turbines" or solar panel in parks, needs a big start-up investment. Nevertheless, renewable energy, typically have minimal operation besides maintenance costs and very inferior fuel prices related to that of the fossil-based fuels. From a technological point, with significant start-up and running costs still now "non-fossil fuel-based energy" remain typically inexpensive then "fossil fuel -based energy".

Urban and Nordensvärd (2013) appropriately claims that low carbon technologies, energy technologies mostly renewable alike solar, wind, besides hydropower have been used commercially for some decades which appear in the market as stable and mature industrial technologies. Technologies like electric vehicles, Carbon capture with storage (CCS) plants to produce power are not properly commercialized and requires further study and exploration. They have good budding to developed in to a mature technology in the forthcoming. Still, we need both regional and global technological advancement for that.

One of the limitations of this Low carbon technologies is that as point out by Urban and Nordensvärd (2013) is it often need a complete system change, and also demand new infrastructure. For instance, electric vehicles need new charging stations. A large-introduction of wind or solar energy also need smart-grid interface and systems that help them to get connected to the national grid. This is a significant barrier for Low carbon technologies to attaining a changeover to Low carbon development in the forthcoming.

Key suggestions were drawn from a World Bank (2014) report for Low carbon development, where it seems crucial for justifying the emissions of CO_2 important to mitigating the impact of Climate Change and for allowing progress in a low carbon-based world. Low carbon development capable to fetch prosperity besides profits for developed besides developing nations equally.

But we have to remember that, low carbon development is possible to be executed when a satisfactory qualifying setting is in place that includes political, economic, social and technical states. According to the WB (2014) in nations with low and lower-middle income, matters of “Social fairness” besides “reduction of poverty” remain vital element meant for Low carbon development, though for nations with higher middle then high income, innovation of Low carbon usage besides emission decrease of CO_2 are the essential reason for employing low carbon development.

2.8.3 Benefits of Low-carbon Economies

According to a World Bank (2014) report, the most significant inquiry of any economic transformation includes: for any given nation, what is, are the main benefits it offers after such transform? According to Harto, Mayers and Williams (2010) following by Yuan, Zhou and Zhou (2011) all efforts to answer the such low carbon-based economic transformation offers some direct benefits in reality, which truly helps the natural environment to challenge the impacts of Climate Change by enhancing certain characteristics as follows:

a. Ecosystem resilience: A report published by DIIS (2009) validates that Low emission progress approaches in land use sector may confirm a shield from carbon enrich ecosystems by reducing the certain level of CO_2 discharges, but to defend biodiversity and protection of resident livelihoods from poverty, all may lead to added schemes for climate resilience. To ensure the resilience, we need to move toward preserve, accomplish sustainability, and reinstate carbon-rich ecologies, that are vital for natural carbon capture and confiscation.

b. Job creation: Asian Development Bank (2013) report shows a transition into a low-carbon, actually help an environmental and social impact based economies to convert a robust initiative for the new creation of job, up-gradation of the available job, ensure social justice, besides eradication of poverty. IPCC (2018) report also recommend that unmitigated change of climate, by associated adverse impacts on firms and workforces, which will suffer from effects of negative output in various trades, through decrease at expected output by 2.4%

by 2030 besides 7.2% within the year 2050. Study done by ADB (2015) also illustrates that transforming into a low-carbon economy resolve source changes in volume, configuration, besides excellence of service across segments and will impact the circulation and quantity of income. The study shows that only eight sectors of the economy hire 1.5 billion labours worldwide, almost half of the international workforce, would experience a vital transformation in the workplace: agronomy, forestry, angling, energy, means concentrated manufacturing, salvaging, buildings, transportation.

c. Competitiveness of business: According to a World Bank (2018) study the low emission manufacturing development besides supply efficiency may suggest various opportunities to raise competitive capabilities among various companies and economies. Conferring the Low emission progress approaches the strong business case for converting to inferior technologies for emission, through repayment stages ranging mostly from one to five years, creating leverage for the commercial venture and quicker return on investment.

d. Improved trade policy: Following the World Bank (2014) report, if certain national trade policies are focused for low-carbon economies, then it can contribute to other effectual use of properties and global exchange of climate-sensitive technologies, properties, and amenities. It can be possible by removing the prices and nontariff blockades to trade in green energy besides technologies based on efficiency in producing energy for a given nation. In any given sector of the complete products comprise of numerous mechanisms that cross borders more than a few times, even minor tariff cuts can decrease costs significantly. It will make green and clean technology more accessible besides affordable in the international market, as fossil fuel substitutes for us.

e. Energy policy for efficiency and Renewable energy: New technical advances in renewable energy efficiency, according to IPCC (2018) is allowing the renewables to play major roles in trading fossil fuels with zero emission technology. It allows nations to meet the rising global energy demand, an at the same time reducing emission of CO_2. Energy technologies for renewable are quickly commercialized and, more focus is in efficiency gains, can look for ways to ensure greater emissions reductions. The renewable energy can be manufactured by using natural properties like sunlight, wind, rain, waves, besides geothermal heat, which are known as renewable (naturally restocked).

According to current IPCC (2008) report during year 2008, around 19% of the universal final energy used was shaped by renewables. Through the five years from 2004 to 2009, global renewable energy capacity raised at rates of 10% to 60% yearly at different regions due to several new technological advancements. Anticipated at wind power and supplementary renewable know-hows, development was heightened in 2009 compared to the last few years. Additional wind power and grid-connected photovoltaics capacity started to rise from 2009 onward and getting the fastest expansion of all renewable technologies.

According to Yuan et al., (2011), who in his article made the point clear that energy is essential for control, warmth, freezing, mobility, and it is the critical ingredient for expansion and progress. The World Bank (2017) study also suggests that, as the clean energy a prerequisite for rapid and continuous low carbon economic growth, perhaps makes it the most crucial issue aimed at any energy policy.

The World Bank (2017) study also points that any low emission development policy can expand a country's energy selections and decreases depend on using a fewer amount of fossil fuels. This call attention to the study done by IPCC (2018) that also demonstrates that now renewable energy bids lower monetary and economic hazard for business entities over a more constant and probable cost base for energy supply. As energy efficiency is gaining its momentum in recent decades, we are hopeful that much will be comprehended soon. With a strenuous effort besides robust strategies being used, forthcoming energy efficacy will improve significantly, will be interconnected among the regions and get more efficient.

2.8.4. "Low Carbon Future": a solution for Climate Change.

Following the IPCC (2018) on Climate Change happenings around the globe, the shifts in the political and social agenda pushes the Climate Change at the bottom of the civilizations priority agenda list. The study done by Yuan et al., (2008); Leiby and Rubin (2013) also promotes the fact that the majority of predictions for earth concerning the future days present an impoverished wasteland in our mind. So, what we anticipate is a negative situation in the future for influences of Climate Change on ourselves and coming generations.

"Low Carbon Development" according to Yuan et at., (2011) and Wang, Che, Yang, Wang, Xiong and Huang (2011); Li, Wang and Shen (2012) is experimental as a 'surviving technology' which provides low-cost green energy and in the long run than investment low-carbon energy technologies are growing. The fact is for this research we our focus is to identify and invest in low-carbon technologies which are efficient and effective, based on both affordable and available technologies within these selected nations.

According to Yuan et al., (2011); Wang et al., (2011) the "Low-carbon economy" refers a novel economic system through target for refining "energy effectiveness", implementing clean national growth, dropping CO_2 emissions and upholding the worldwide ecological equilibrium. Conferring to Yuan et al., (2011) "Low-carbon society" is demarcated as a progressive phase of "low-carbon economy", positions aimed for the low-carbonization in all aspects of society as well as economy, culture, besides life. As Yuan et al., (2011) designates the "Low-carbon city" as a metropolitan, somewhere all the diverse features for Low-carbonization have been already executed. Engaging the core of the low-carbon city, an integral component is the low-carbon community of such city. Here Low-carbon life refers to energy saved by us in our everyday life use to decrease CO_2 discharges. Evidence that we have is profound, scientific and undeniable, and we need to act fast on this issue.

According to IPCC (2014a) report, the rising temperatures globally, take a severe turn and creating significant change in climate patterns. Various locations in the world have experienced changes in precipitation quantity, subsequently following into floods, intense and more frequent cold weather, as well as severe heat waves. The oceans besides glaciers of the world always experience small concurrent changes. The oceans are slowly warming up, and gradually their acidity level is changing. Further in the mountains, the ice caps and layers of glaciers are melting rather quickly and the sea levels are also changing.

Such variations according to IPCC (2018) report are become more noticeable during the future and will create new occupation for the wellbeing of our environment and society. This Composition of RICE model formerly follows the DICE model developed by Nordhaus (2008) and his team use it to measure the global climatic impact on economic performance and then consider the regional variance and using a newly constructed regional model, which uses available meteorological data as input to predict for economic outcome and policy formation on regional basis .

This option encourages us to develops an ASEAN-RICE model with a particular focus for Malaysia and selected ASEAN Member nations, namely Indonesia and Thailand that we can access and use reliable and authentic climate data available to predict future change in climate and its impact on Economy for multi-country analysis. The recent research offers us the Global DICE model and its results, but minimal required information is existing for regional analysis. No regional impact study was conducted so far using CGE Modelling for Malaysia and the selected ASEAN nations combinedly to date.

2.9 Interpreting the 2018 IPCC Special Report

IPCC (2018) report focusing over the properties of worldwide warming named as "Global warming of 1.5 °C". This report portrait's the forthcoming bearings of this problem. According to it, above the pre-industrial levels correlated to universal pathways for greenhouse gas emission, can be a significant threat for sustainable development, besides attempts to get rid of poverty.

The IPCC (2018) report is the utmost up-to-date, inclusive scientific clarification for the problem of Climate Change besides the future scenario projections for the whole world. It was compiled by a specialised team "consisting of 91 well known contributors besides 133 other authors who were nominated from 40 different nations to evaluate 30,000 scientific papers with 42,000 linked comments" .

Their conclusions drawn from IPCC (2018) report are really alarming for mankind, and cannot be overlooked. This is because it is agreed by leading climate scientists and specialists from around the world, as a happening fact. The report was disseminated to the member government heads, policy-makers, and individual researchers. It cautions all the nations, that by the biosphere has become warmer by 1°C, and if can prevail this warming rate, then it can grasp 1.5 °C easily by the mid of this century. The caused by which such change that can be only half a degree difference is a new uncovering, and the difference is substantial and due effective mitigation action. Following the report, there will be inevitable consequences of such warming rise, ever for a half degree as follows:

1. If worldwide temperature increases by 1.5 °C, human societies will face extraordinary risks associated to climate- and meteorological conditions occurrences.
2. We are following the course that is moving us towards a rise in future temperature by 3 to 4°C.
3. This is a final warning from the international scientific community for the world leaders; the most comprehensive warning, for the risks of increasing global temperatures.

The IPCC (2018) report actually sends the biosphere a strong and attainable massage. We have to decrease the level of discharges of all GHGs to" zero levels" within the mid of this century. Only if we can ensure this targets success, it can bring us an opportunity of restricting universal warming up to 1.5°C. This large target places out the mitigation instruments we have at our disposal to use properly towards mitigating the effects of Climate Change. We require to confiscate emissions of carbon and direct earth's future on a course which is towards a sustainable future One of the main answers to this report is that we all are on a scheduled course for approximately 3°C increasing of temperature. Limiting the rise of temperature over the point of 1.5°C will require certain instant actions, and may harvest better outcomes for the whole world.

There is no opportunity to compromise with the issue. To stay below 1.5 °C, we need universal, adequate, rapid, extensive and extraordinary "mitigation actions" in all facets of our civilization.

2.9.1 Significance of 0.5 °C

Only "Half a degree" might sound very little, IPCC (2018) report on Global warming, demonstrates that this half degree can be confirmed with a significant variance amid a world with coral reefs, arctic summer, sea ice, and a world short of them. This is an ultimate result we are looking forward. The critical differences are accessible in the following table:

Table2.2: Impacts of 0.5 °C difference in Global Warming

Effects of Warming	At 1.5 °C	At 2 °C
1. Heat Wave Duration	.1. For 1.1 months	1. For 1.5 months
2. Freshwater Availability (For vegetarian nations)	2. Only 9%	2. Only 17%
3. Heavy Rainfall (Increase in Intensity)	3. Only 5%	3. Only 7%
4.Crop yields -Wheat	4. Production down by 9 %	4. Production down 16%
5.Crop yields -Maize	5 Production down3%	5 Production down 6%
6. Crop yields -Soya	6. Production up 6 %	6. Production up 7 %
7 Crop yields -Rice	7. Production up by 6%	7. Production up by 6%
8.Sea Level Rise (By 2100, relative to 2000)	8 Sea Level Rise by 40 cm	8.Sea Level Rise by 50 cm
9. Coral Bleaching from 2050	9. 90 % of the coral reefs at risk	9. 98 % of the coral reefs at risk

Source: IPCC, "Global warming of 1.5 °C", 2018. Chapter 2 (Summarized by author)

2.9.2 Cost and Impact of Inaction

According to IPCC (2018), an essential aspect of a reporting system for Climate Change is every report done so far available always measure the effects of any Climate Change impacts in average terms, at the global level. But in reality, as a direct result of such a reporting system, the extreme climatic events are technically averaged and get hidden behind the mask of the global averages as a general incident. These extreme climatic events are typically more recurrent and forceful in effects like heat waves, more destructive like hurricane and tornados, tsunami and earthquakes. The world and its inhabitants are frequently affected to such events disproportionately. At the local level, the impact of such incidents is severe and can be fatal. So, we all need to play our part right, and with honesty, and dignity. We need to take up dangerous mitigation actions to reverse the entire warming scenario. The consequence of rising CO_2 in the atmosphere may take decades to impact the planet's temperature.

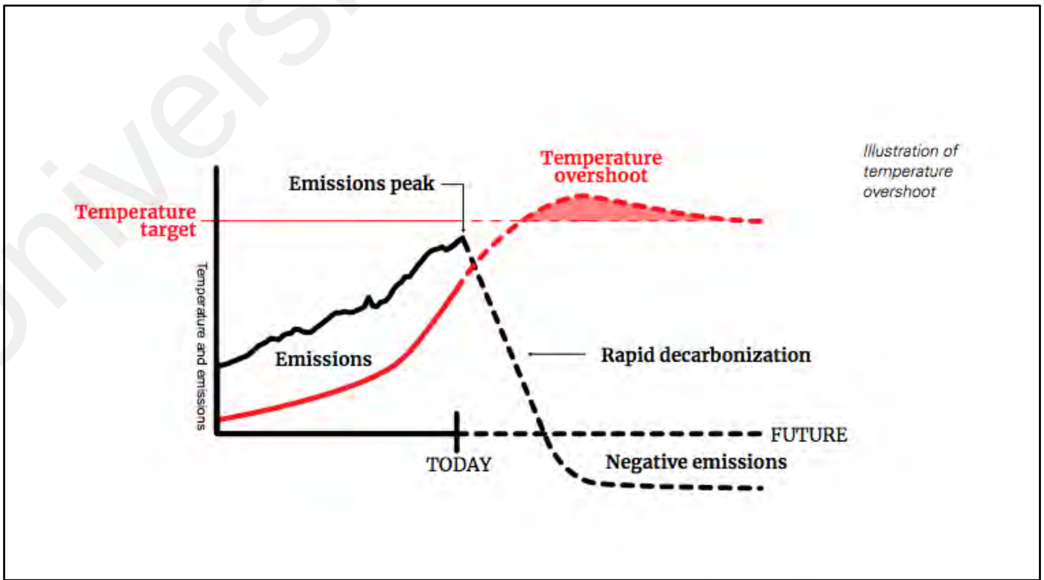

Figure 2.4 Justification for Rapid Decarbonization

Source: IPCC (2019)[18]

[18] Available at https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter2_Low_Res.pdf

Even we completely stop all of the known emissions within today, the temperature rise will endure, due to the snowballing effect from the past and present climate events. To encounter a goal of dealing up with 1.5 °C warming, it is necessary to cut the planet's current emission levels by 45 % immediately, which is below 2010 levels within 2030.

2.9.3 Key findings and Required actions

The critical findings identified from the report analysis, "Worldwide warming of 1.5 °C" published by IPCC (2018) includes the followings as a summary:

1. Globally the actions of human are discharging almost 42 billion tonnes of CO_2 annually.
2. The carbon budget, at this rate, let us a fifty-fifty chance for controlling this warming increase to be within 1.5°C, within approaching 20 years.
3. Restraining warming of globe at 1.5 °C, related this with 2 °C, might decrease the amount of public both unprotected to climate-related risks besides vulnerable to poverty by few hundred million within year 2050.
4. It is s not impossible to limit the warming to 1.5 °C but, this will require extraordinary conversions for every energy production features of our society.
5. Since the 1850s onward the temperatures have risen to almost 1°C. For our survival in this planet, according to scientists, every bit of warming matters.
6. Currently, the INDCs pledged by the by world governments are not adequate to limit increase of universal temperature increases to 1.5 °C.
7. By 2030, we want to reduce worldwide discharges by almost 45 % related to levels of 2010.
8. The world is on a course of temperature rise by 3°C to 4°C in the future.

According to IPCC (2018), it is not easy to be hopeful when confronted with such a report. To start acting, we need to selects and accomplish the long-standing target of emission reduction, encouraging optimism, quickly increasing the comprehensive backstop solutions, and using renewable knowledge to guide future targets. To avoid our present 3ºC course, we need pressing, extensive changes resulting from both governments and individuals' level for emission reduction of CO_2. It also endorses investing loads of money during the early phase for mitigation methods, which remains almost about 2.5% of global GDP aimed at the next few decades.

According to Chen et al., (2016,2019), by merging the use of land and technical alteration, minimizing deforestation, besides shift to renewable-based energy totally, and thus we can decrease emissions seriously and also rise sequestration of carbon. According to the IPCC (2018) report, trees are identified as enormously competent carbon stores, an acre of tropical forest can store almost 260 tonnes of carbon. This is not only about carbon, but forest can provide homes to wildlife, provide an essential element for the global water-cycle, minimize corrosion of soil besides vital for global native values. Quite a few fragments of research endure pointing to a tropical forest, as a vital component for forthcoming of carbon-based mitigation. We need specific, measurable, attainable realistic, and tangible (SMART) regulations for ensuring "rainforest protection" and "low carbon" as key a part of our lives every day.

2.10 Summary

"Low carbon development" associated notions have extensively encouraged, only very few have in-depth awareness about the differences and similarities within. This chapter tries to fills in this vacuum by presenting a theoretical study of the subject.

Generally, "Low-carbon development" may be defined as, “ a new outline of economic with focus in rapid development aimed to decrease the CO_2 emissions and attaining the sustainable development for associated environment, economy, and culture”.

Policies formulated for developed nations are more focused on economic development then climatic issues. Up till today, according to IPCC (2001a, b) report based scientific evidence illustrates that most of the severe impacts of Climate Change will happen in either in a developing or least developed nations, where inhabitants are the most defenceless and have slightest expectations to adapt to Climate Change quickly. This is also possible Climate Change might degrade the current discriminations more like the unequal spreading of climatic damage costs, adding more to the cost of mitigation efforts.

According to (IPCC, 2014b), this is vital to understand that global promises that promise to determining and realizing the next best things to do for mitigating Climate Change. Comprehensive partaking in mitigation efforts unlocks the possibility to reduce the overall damage costs. In the other hand, slow development for global mitigation of emissions of GHG infers that bearings from climate deviation will coerce the economic growth for some of the poor developing nations. Upcoming agreements for mitigation considering the agreement will want to address the different situations of developing nations concerning their level of economic expansion, their vulnerability to change in climate, and capability to mitigate it. This chapter identifies a few propositions from the finished literature study about the plan for regional mitigation pledges. Specifically, for the growing emissions of each country from a given date, say 1990 may remain considered for starting forthcoming mitigation aims.

For developing nations policy fabricators, “economic growth” besides “poverty reduction” are key primaries to consider. So, the mitigation planning of Climate Change may offer those nations the chance to revisit their development approaches from a completely different and novel perspective. The proof of change in climate can help to set new urgency in our social options. For example, we need to develop low carbon-based energy competence, use of a renewable form of energy, and sustainable policies for land-use, an argument for the effect of Climate Change with other ecological problems. Likewise, it claims for refining the mixing of environment and progress issues along with other issues, such as the distribution of income. Policies made for extenuating the effects of Climate Change might have noteworthy ancillary benefits for the local environment.

The advantages of applying the price-based control approaches, for example, introducing taxes on carbon and its quantity used were measured proposed in the Kyoto Protocol. One noticeable benefit of such cost-based approaches is they can easily assimilate the economical prices and benefits of emissions decreases, whereas in the Kyoto Protocol no such visible connection was possible to link with the environment or economic targets. This situation leads to significant uncertainties and growing facts about this area. Emission based taxes are efficient to manage huge difficulties because of the relative linearity of the profits linked with the prices. The related point is that quantitative limits will produce high volatility in the market price of carbon under an emission targeting approach. A tax imposing approach can apprehension the revenues more easily than quantitative tactics, and a price-type approach will, therefore, cause fewer extra tax distortions. The tax based tactic also proposed in IPCC, (2014b) can ensure less scope for corruption than measurable limits because this approach of setting tax can avoid artificial scarcities to inspire the rent-seeking performance.

Taxes set for carbon do not execute any firm limits on emissions, or change in temperature. But this is mostly an elusive shortcoming. Here are countless worries on what emissions or absorptions or temperature may lead to hazardous interferences. Summary message of this chapters discussed the pieces of literature that summarize as the change in climate is a multifaceted phenomenon, and it a subject too great indecision, and changes in our acquaintance happens every day can help us to mitigate it in future. We have all scientific proves and pathways of how to solve it, need political unification of the global and regional leader for low carbon development. In the end, as we try to summarize the literature, we consider the learnings from that help us to develop a specific realization of his own as follows:

1. Climate Change is a scientifically proven complex problem, in addition this is happening.
2. It can affect the overall economy, performance of development of nations and wellbeing of future generations
3. It is possible to solve the problem and mitigate the difficulty of Climatic problem, but we need to act as soon as possible.
4. We need political commitment and mitigation initiatives not only country-specific but also regionally and globally
5. As Europe got a regional platform like European Union, that is helping all the European nations to deal with Climate Change mitigation issues more effectively and proportionately; we need a similar regional platform like ASEAN to come forwards to enrich the South Asian nations to get more proactive for mitigation of such issues.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This section efforts on a systematic procedure to be incorporated and followed by this research, which can always vary with the objectives of that specific research. According to IPCC (2014b) for developing and developed economies around the globe, the use of Computable General Equilibrium (CGE) models for policy analysis has become extensive for its wide range of applicability and variations. According to Hoseo (2010), CGE models use the social accounting matrices (SAMs) to capture the impact of specific climate incidents on national income, annual production, and input-output tables for specified years. The aim of CGE models is to simulate and evaluating the existing economic policies for any given nation, region or economy.

According to Shoven and Whalley, (1984), a CGE model to be applied must hold the following indispensable features:

1. The consumer's endowments for production factors.
2. Consumer’s preference, demand for commodities.
3. The production expertise is accessible to organisations.
4. The set of conditions necessary for market equilibrium.

According to Shoven and Whalley (1984), the demand functions deployed for CGE model remain homogeneous by nature and profits are linearly comparable in prices. So, the Equilibrium used in the model is sincerely considered by a combination of pre-set of prices and output points for the respective industry in a way that, for all commodities, the demand besides supply of the market always remain equal. Therefore, following to Shoven and Whalley (1984) the total price level lost its impact on the equilibrium conditions, besides only the relative prices are only meaningful to position in the model. The demands of market are grounded on the total sum of household demands of all individuals, which fulfill the "Walras' equilibrium," as pointed by Shoven and Whalley (1984). In General equilibrium model, the behaviour of household is resolute by ensuring maximization of discounted lifetime utility. Immediate utility function in the model, stands as well-defined over the domain of consumption properties in the economy and for some different models; it can also comprise vacation (Pereira & Shoven, 1988).

At the beginning, according to Shoven and Whalley (1984) we need to collect and check to complete an equilibrium dataset for a given single year designed for a determined nation. This is done based over the assumption that, the data is characterize for an equilibrium of the considered economy. Useful parameters, like the share and shift-based parameters, input output tables and social accounting matrix, all need to be standardized. Here they are estimated in such a way that the model solution duplicates the original dataset, which is termed as "Benchmark equilibrium" or base year equilibrium. Some parameters, such as the elasticities were used in the model, as considered and occupied exogenously from contemporary literature.

Following a dynamic setting, the Calibration used in CGE Modeling conferring to Nordhaus (2008) entails the model to parameterized to produce an intertemporal stable growth pathway after the base policy is sustained. Exogenous shocks like Climatic disaster (like the cyclone, typhoons earthquake, drought or sea level rise) point out by

Nordhaus (2008) are then considered and applied in the set model, to calculate counter factual equilibrium resolute by the novel policy management.

The influence of policy modification due to such variable impact is measured by assessment between counterfactual besides benchmark equilibrium. In analyzing a wide range of policy matters, according to Shoven and Whalley (1984), the General equilibrium method had a first lead over the partial equilibrium analysis. As it explicitly allows the opportunity of capturing the chain of actions and their exchanges in the economy altogether. Bandara (1991) also advocated that to investigate the far-reaching impacts of reduction in import tariff, the chain of events taking place when specific tariffs are revised need to be analysed.

Computable general equilibrium (CGE) model analyze the impacts of Climate Change are designated by Nordhaus (2008). This model is more focused on calculations of climate impact damage and mitigation options through modelling. The Empirical CGE models established by Nordhaus (2008) are used in the field of comprehensive climate policy analysis. For this research, the regional based values are critical. The respective matrix used to generate the regional based values is known as "Social accounting matrix (SAM)". For the SAM matrix, databases for that specific nations, "Input Output tables" are considered. Those tables are used to record and measure the effect of Climate Change damages, and to find a cost-effective and efficient solution as a mitigation option.

The ADB (2017) report, designates the fact that reparations from Climate Change that already arise are inescapable. So, now our focus is more on the effective mitigation plan for next decades as the impacts are becoming more uncertain, destructive and frequent. According to ADB (2017) report a model by obvious mitigation at the resident level is necessary. It must comprise the socio-economic effects that remains absent in the Global Model. So, a regional focused CGE model like "ASEAN RICE" can be more effective and convenient to analyze the welfare effects where mitigation efforts are more critically focused and therefore is vital for regional decision making.

3.2 Configuring the CGE model

According to the common notion for any CGE modeling, we need to configure it before deploying it. This is necessary to apply the theoretical aspects in economic models empirically for the real-world situation. After that we can quantify its impacts, according to different scenario settings. Following the IFPRI, (2002) report it is critical to replicate the “wellbeing properties” from diverse strategies. Any “general-equilibrium” method stands by the available empirical data shared, and try to attain the most cost effective and efficient solutions.

The CGE model, according to Nordhaus (2002), is grounded on the Walrasian general equilibrium philosophy. The equation is explained by Arrow (1954), and can represent the demand and supply of goods by consumers and producers, and equilibrium state for any economy. It also signifies the source level for the amount of demand happening at each market stands that resolved concurrently. However, the CGE model can also tolerate a certain level of internal adjustments, like the use of defective markets besides few exclusivities.

In order to configure the CGE Model, first, we need to consider the research philosophies of this specific research. This study attempts to examines the structure besides dynamics of earth's climate system for certain selected ASEAN nations. It attempts to understand how the global, regional and local climates could be sustained by Low Carbon Economy Index (LCEI) to lessen the climate change in the selected ASEAN regions. As well as in the processes it develops the ASEAN RICE model by which we can monitor the change and recalibrate over time if necessary.

The justification for using different time periods, in this thesis is simple. We have used different COP proposals for Chapters. For the first research objective, we use COP 21 proposal which advice to run climate scenario forecast for 100 years. So, for Chapter 4, we are following COP21 proposal and thus run ASEAN - RICE model from year 2010 to year 2110, which is 100 years. For the second research objective, we follow COP 22 proposal which advice to run climate scenario forecast for 50 years. So, this time we run our model from 2010 to 2060. For the third Research objective, we use COP 22 proposal which run forecast for 50 years. So, this time we run our model from 2010 to 2060. Such time periods are set in COP Conferences, where scientist and climatologists from almost 195 nations represents. After much scientific discussion, they reach to a global consensus about number of years decided for model use. This is why the three analytical chapter (Chapter 4, 5 and 6) of this thesis considers different time period.

On the way to clarify the name of the model as, "CGE" Nordhaus (2002) describes that it is useful to ensure by defining every word in the name. The word, "Computable" means for mathematical computation done by the computer. The term "Equilibrium” denotes to the idea of market symmetry. So, this notion includes the micro-foundation of profit-maximizing firms and utility maximizing households. Thus, the agents here have no incentive to revise their decisions. Lastly, the method stands “General” as every marketplace are consistent and not measured separately, as it is naturally done in an incomplete equilibrium analysis.

The Walrasian equation scheme as referred to earlier by Nordhaus (2008) signifies the interdependencies among markets via commodity, and consistent payment flows amid marketplace mediators. Such circular flows characterize a closed exchange system. Here the term "Closed" refers that here a payment or commodity that cannot move from one agent until he or she has no recipient.

So, budgets for every agent included in the circular flow must have to be balanced. According to Wing (2004, p. 4-5), agents who obtain a specific level of income may be consumed on properties. Meant for extra particulars on the idea on circular flows of supplies, besides expenses, helps to follow the concepts illustrated by Wing (2004, p. 4-5). In the following Figure, 3.1, A demo SAM is setup and presented for a static economy, according to Bro¨cker (2004, p. 273-277) here we focus on only two specific industries as (I_1 and I_2), two specific factors of production such as (here labor represents by " L "and capital by " K”) and two given households as (H_1 besides H_2).

Not any public sector is measured here, in addition neither taxes nor investment and savings are well-thought-out in the model. So, if I_2 pays four units for inputs that are produced from it, six units are for using inputs from I_1, four units are for labor and seven units are for capital (similarly for I_1). If three units of labor income going for H_1, and correspondingly the seven units go to H_2. “Capital income (eleven units)” goes to H_1 (five units) and H_2 (six units). H_1 (H_2) spends one unit (eight units) of its income for goods from I_1 and seven units (five units) for goods from I_2. The “Gross production” here is 37 units (the totality of $I_1$and I_2), of which, only 16 units remain as intermediate goods (as they are flows from I_1 to itself, to I_2 and vice versa). Gross Domestic Product (GDP) here is 21 units; it can be either measured as the units manufactured by the two industries with labor besides capital inputs or else as the expenditure of the two households intended for produced units.

	I_1	I_2	L	K	H_1	H_2	SUM
I_1	1	6			1	8	16
I_2	5	4			7	5	21
L	6	4					10
K	4	7					11
H_1			3	5			8
H_2			7	6			13
SUM	16	21	10	11	8	13	79

Figure 3.1: The Social Accounting Matrix (SAM) for a static economy

Source: Bro¨cker (2004, p. 274).

The basics of CGE, an ideal introduction which usually follows nine steps as illustrated by Bro¨cker (2004, p 273-277). Entire process practices formal equation scheme of Walrasian provided general equilibrium theory as follows:

1. The First step of the CGE model initiates with defining all the agents involved (consumers, producers, state) and markets (for cars, food) considered.
2. Next stage is to unify the data aimed at the computer package. It is finalized by formulating a special kind of matrix known as “Social Accounting Matrix” (SAM) where each agent appears only twofold, once in the row by payments besides in columns by receipts.
3. A stable market system (typically perfect competition) stays presumed.
4. An arbitrary standard worth is selected.
5. The practical forms of source besides demand stay quantified toward arranging in the respective model.
6. Then, as all equation is ready, we run the model and do the "calibration" for the model. This is a critical stage for any CGE analysis. Earlier only one period is comprised in the SAM and parameters are chosen, to repeat the

standard data. There is not any data on responses of the mediators, which is desirable to specify the slope parameters. Approximation of such slope parameters is possible only with long periods like 50 to 100 years.

7. In the next step, we compute the policy formation and effects necessary for consideration. For this step, the process endures with a study of welfare effects employing methods alike Hicksian corresponding variation.
8. The next stage of this model is the execution of the sensitivity examination.
9. The last step for CGE modeling is to decrease the unpredictability of the selected elasticities as of additional study outcomes, sensitivity investigation through changing elasticities is useful in a CGE technique.

3.3 Pros and Cons of the CGE model

According to Bro¨cker (2004) and Nordhaus (2008) for all general equilibrium models, the changes in price results in instantaneous reactions in all other related markets. This property according to Nordhaus (2008) is quite noteworthy for two critical paybacks as "micro-based foundation" and "inclusion of economic feedback" in the complete processes. According to Nordhaus (2008) what this means by the micro-foundation is comprising of the three core conditions, as mostly known as, market clearance, income balancing of the households and zero profit of firms. All three principles according to Nordhaus (2008) are necessary preconditions in the construction of a CGE model. The inclusion of economic feedback processes according to Walz (2009, p. 33-34) due to worth variations, it can guide to the total amount variations, and thus CGE model can also remain applied for longstanding outlook study.

As pointed out by Nordhaus (2008) a noteworthy drawback of CGE modeling is the deprived observed foundation of the calibration. Only observations collected within one year are used to calibrate the preliminary change parameters. Production and utility functions are subdued to a constant elasticity of substitution (CES). The limitations for these purposeful forms according to Walz (2009, p. 33-34) exogenously originate from an experimental estimation of elasticities which are recorded not after the calibration process. According to West (1995, p. 217). Such "best guess" values rise with a significant uncertainty into the CGE model. Particularly the chosen elasticity level has a significant result on the outcomes.

3.4 Integrating "Climate Change" module into CGE Models

According to Walz and Schleich (2009, p. 33-34), to enumerate the costs and benefits of environmental policy CGE models is a frequently used tool. The main aim of CGE modeling as identified by Nordhaus (2008) is to simulate how environmental change affects economic activity, and the opposite is also true. Furthermore, CGE models anticipate the inquiry of how industrial expansion and manufacture are affected through ecological strategies (Ierland 1999, p. 595).

Effects of universal warming typically come in the CGE model, in the form of monetized reparations. Aggregate monetized gross harm GDt remains demonstrated as a purpose of a weather variable:

$$GD_t = i \quad T_t^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (1)$$

Here,

GDt = Aggregate monetized gross harm

Tt = the alteration of “global mean temperature” related to specific base year

Wherever typically the alteration of “global mean temperature” related to a base year (T_t) is used. Typically, a practical method is presumed near to be quadratic (i.e. the power is > 1). It permits the growing influence expenses after temperature increases. The climate effect function can be depicted as follows:

$$T_t = {}_j\, T_{t\ \ 1} + {}_k\, Em_{it} \ldots\ldots\ldots\ldots\ldots (2)$$

Here,

Tt = the alteration of “global mean temperature” related to specific base year

EMt= An upsurge of emissions of CO_2

An upsurge of emissions of CO_2 (EMt) through a specific quantity, generates an exogenous shockwave, which centrals for an upsurge of the “global mean temperature” (Tt) linked to certain level with dated previously considered. Typically, a CO_2 doubling likened to the pre-industrial period conduct to temperature rise by about 2.5°C - 3 °C, over the current level of temperature. Subsequent works of Pearce et al., (1996) for the standard indemnities for the temperature progress stay expected to stay in between of 1.3 % - 2.5 % of global revenue. Strictures of a “climate impact model” are then adjusted to replicate such affiliation (Tol and Fankhauser 1998, p. 70). Relations of climate influences through residual CGE model comprehend three key apparatuses.

First, the consequence of additional “non-climatic variables” on climate is familiar with this prototype. Second, significant impacts from mitigation progressions remain measured. Third, responses on the effects of mitigation into the remaining of the CGE model are investigated. Impact of Climate Change over civilization in addition to the economy according to Nordhaus (2008) rest on mainly by the interchange by the unique climate conditions as well as the vulnerability to life-threatening climate events like earthquakes, cyclones, droughts, tornados, and tsunami. The notch of susceptibility is resolute by features like methodological and financial competence, demographic, socio-economic besides behavioural borders with a cluster of civilization. As such issues diverge over the period, vulnerability must differ accordingly. (Tol & Fankhauser 1998, pp. 70).

However, for the maximum of the other representations except CGE do not yield different susceptibility into interpretation. In the modest instance, the "damage" is a continued portion of the total GDP. Henceforth, reparations raise linearly with overall GDP growth. Such a linear trend can be affected by additional issues, which will shift the number of indemnities either higher or lower. Like, population growth impacts on the total number of individuals troubled. Then, the income growth also affects people's assessment capacity of effects and these consequences in a change of tastes upsetting assessment. According to (Tol and Fankhauser 1998, p. 70), the mitigation is typically comprised in the common monetized damage function.

Moreover, the mitigation costs are summed to the remaining harm costs (like loss of insecure land). Since maximum models stay very combined concerning sections and areas, where there is an only small room, it is destined for response loops and modification devices. Usually, damages get feedback we get just by deducting the monetized marketplace harm from total yield for a given period. According to (Tol and Fankhauser 1998, p. 70) “climate impact model” provides un satisfactory reply for the inquiry on which agent himself is affected by climate consequence.

3.5 Transformation of DICE/RICE to ASEAN RICE Model

Nordhaus (2008) in his discussion about "Dynamic Integrated model of Climate and the Economy" (DICE) model compare it with one big free-floating iceberg. According to Nordhaus (2008), the obvious part comprises only a small amount of mathematical calculations representing the hidden part that includes “laws of motion” of economic impacts on production and discharge of CO_2, for Climate Change. So, under the surface, such equations depend on hundreds of related studies of distinct mechanisms complete by experts from the ordinary besides social sciences.

According to Nordhaus (2008) the DICE model comprises an illustration of each of the critical mechanisms that essential for measuring and considerate “Climate Change” through the forthcoming. Respective components that are used here is a sub model of the research that was done on the specified topic. For instance, the module for climate practices the outcomes of most sophisticated climate models for predicting Climate Change as an effect of emissions of GHG’s. The module that measures the impacts is drawing on many of the research conducted to measure and record the effects from change in climate. Framework of the DICE model, as described by Nordhaus (2008) links all the features moving economic growth, including emission of CO_2, carbon cycle, change of climate, damages resulting from the climatic event, and policies for Climate Change. The equations used in this model are elaborate from various aspects of ecology, economics, and earth sciences. All of the educations are then combined with justification and linked, and then the model is run through “mathematical optimization software” so that the environmental besides economic consequences may be predictable with maximum accuracy. According to Nordhaus (2008, DICE model usually asses the money matters of Climate Change considering from the economic progress theory. Here, certain economies can finance in education, capital, and certain technologies, and thus abstaining from contemporary consumption level, to ensure its availability in future.

The DICE model as explained in detail by Nordhaus (2008) illustrates that it helps to extend the economic growth theory method by considering the "natural capital" by means of an extra type of capital stock for climate system. By dedicating output to investments within natural capital by decrease of emissions, dropping usages, economies avert economically detrimental Climate Change and thus increasing the consumption potentials for the forthcoming. For the model, diverse mitigation strategies continue to measure their involvement to economic wellbeing (more precisely, ingesting) of diverse groups.

One form of the carbon price is known as "social cost of carbon." According to Nordhaus (2006), this measures the cost of total carbon emissions within a given period. More just, it is the contemporary value of supplementary economic indemnities in addition to the future caused by an extra ton of emitted carbon. We guess that, “Social cost of carbon” with no limits for emissions in contemporary prices results from almost US$ 30 or RM. 120 for each ton of carbon with specific standard considered for expectations are measured. (Considering 1US $= 4RM) Following Nordhaus (2008), the DICE model is capable of answering the queries about Climate Change in a solid outline. The relations that connect economic progress, emissions of GHG’s, carbon cycle, climate system, impacts and indemnities, besides possible strategies remain exceptionally multifaceted. Nordhaus (2008) also explained in point that, it is very tough to contemplate how deviations in one portion of climate scheme may disturb different fragments of the scheme. For example, Nordhaus assumed many questions as follow: what will be the result of advanced economic progress over discharges of CO_2 besides temperature paths? What may be the consequence of higher prices of fossil-fuel for climate change? How the Kyoto Protocol and carbon taxes may impact over weather, emissions and the economy in upcoming future?

The resolution of integrated assessment models similar to the DICE model, according to Nordhaus (2008) it did not to offer definitive answers to such questions. Because specific responses are likely to be available in reality, given the inherent worries about various of the associations. Instead, the DICE model struggle to make us confirm that the answers at least are internally reliable and at best provide a state-of-the-art account of the effects of diverse services besides strategies. Market value of the carbon can rise by a "Cap-and-Trade" scheme. Nordhaus (2008) point out that this is the standard design for recent global-warming policies. Under this approach, according to Nordhaus (2008), total emissions remain restricted by government rules (the cap), besides emission permits, which quantify the total that were given to firms and entities for any given year. However, those who own the licenses that are allowed to resell them to others (the trade).

The significant advantage of using the DICE model according to Nordhaus (2008) is that it helps him to examine substitute policies in an inclusive and robust outline. The charges and impacts of substitute policies on the economy and the environment can be analysed simultaneously. It also helps Nordhaus (2006) to recognize the trade-offs considered in a mitigation effort. There are various probable approaches to a climate-change strategy for mitigation, but Dice allows researchers to compare and choose among the best scenario is considering future deviations and technological advancements.

There are according to Nordhaus (2008) numerous approaches to potential climate-change policy determination. The “baseline policy” is a world situation in that there are "no controls" for at least two centuries. For this scenario, carbon emissions are unrestrained till year 2250, after that a complete set of controls is obligatory. The subsequent scenario considered is best from economic value, in which utility is maximum for the discounted value. Scientific foundation for such concerns for “Global warming” originates from IPCC (2007) report. As a consequence of the build-up of atmospheric GHGs are considered, this is predictable that, a noteworthy level of Climate Changes may happen within the imminent decades as a direct impact. The primary manufacturing GHGs that are well-thought-out includes Methane (CH_4), Carbon Di Oxide (CO_2) , Nitrous oxides (N_20), in addition Chlorofluoro carbons (CFCs). The greatest significant of GHGs according to Nordhaus (2008) is CO_2, which discharge quantity have increased quickly in the last few eras. The atmospheric absorption of CO_2 was of 380 ppm recorded in 2005, which exceeds the range over the past years (it was estimated to be between 180 and 300 ppm). calculations done by Nordhaus (2008) predicts from DICE based models for climate, that the doubling of the volume of CO_2 or alike in air associated with pre-industrial levels may result for an steadiness also, but this will result in an rise of the world-wide temperature of the surface by 2 °C - 4.5 °C, by the greatest estimation for 3 °C.

The emissions scenarios and models deployed by the IPCC (2014b) predicts an assortment of temperature change within the twenty-first century of between 1.8°C to 4°C. Extra projected properties include upsurges in precipitation patterns besides evaporation, a rise in extreme events like earthquake, thunderstorm, volcanic eruption, tsunami, with an upsurge in sea levels by 0.2 to 0.6 meters throughout this century. Both economic and geophysical relationships constrain the consumption path. According to Nordhaus (2008), any economy holds two primary “decision variables” for the model as, the general savings rate for physical capital besides the emissions control rate for GHG gases. The typical neoclassical decisions for capital accumulation besides this consider the geophysical restrictions. Nordhaus (2008) also points out that there is a solitary commodity, that can be use either for consumption otherwise for investment.

According to Nordhaus (2008), consumption, should be considered broadly not only for food and shelter, but also for nonmarket environmental amenities in addition to services. Every county is measured with primary stocks of capital and labor and a primary and country-specific level of technology. rate for population growth besides technological change are also country-specific and exogenous, although capital accumulation is resolute by optimizing the drift of consumption over time. National productions and capital stocks remain combined from total "Purchasing power parity (PPP)" and existing exchange rate.

According to Nordhaus (2008) the output of this model is produced by following the "Cobb-Douglas production function" for energy, capital and labor. Energy holds the form of either carbon-based fuels (like, coal, oil) or non-carbon-based technologies (like as solar or wind power or nuclear power). Necessary technological change can happen in twofold arrangements: usually by economy-wise technological change besides by introducing technological change for carbon-conservation. Technological change necessary for saving Carbon is also model by Nordhaus (2008) as curtailing the ratio of CO_2 emissions to productivity is critical. Same forms of technological alteration remain exogenous in the present version of the DICE model Nordhaus (2008) correctly points out the fact that there is a severe limitation of this model, particularly for carbon-saving technological change. It is a problem because fluctuating carbon prices are expected to inspire research and advancement of new technologies for energy. One of the vital structures of public goods like the rise in temperature comprises there are extensively different inducements to join in actions to mitigate the climate damages.

According to Nordhaus (2008), the variances mirror different insights for damages, income levels, environmental attitudes, political structures, besides country sizes. The effective policy for mitigating climate-change entails rising the market price for carbon emission. According to Nordhaus (1992), this can be done using two alternative approaches. The first one is a price-based approach termed as per "Carbon taxes," and the second one is a quantity-based approach known as the "Cap and Trade" schemes that are intended within the Kyoto Protocol and in further policy suggestions.

For setting up the Carbon tax, according to Stern (2006) and Nordhaus (2008), there are many approaches. One approach among them is popularised by Stern (2006) known as "consistent carbon taxes." Under this method, all nations would decide to penalize for carbon emissions from all sectors following a worldwide consistent carbon price or a carbon tax. The “Carbon price” may be established by estimations of the price required to limit GHG absorptions or changes in temperature under some level that may trigger "dangerous interferences" with the climatic arrangement (“This is the term used in the United Nations Framework Convention on Climate Change as a goal of international climate policy”).

On the other hand, Nordhaus (2008) also expressed that, Price might be the element that can induce the projected "optimal" level of control. The outcomes of this analysis propose, as specified earlier, a tax of approximately US$ 27 or RM 108 (Considering 1$= 4RM) for each ton of carbon, rising within 2% to 3% per year in real values. As carbon prices is usually fixed for nations and sectors, this tactic can satisfy wherever efficiency is sustained. If the carbon-tax course grows at this fitting rate, it would also meet the conditions for when efficiency is continuous.

A tax approach as illustrated by Nordhaus (2008) allows the public to get the view of revenue inflows as of restrictions than quantifiable allocation tactics, and this might, be appreciated as a reasonable means. It can also curtail the alterations triggered by the tax scheme. Since as taxes increase revenues, so community revenues may be utilized to relax the economic effects over households with low-income. It can also help to fund required research for low-carbon based energy, and to benefit emerging nations to shift from carbon-based fuels to renewable energy sources. The tax approach by Nordhaus (2006, 2008) also offers fewer opportunity for financial corruption beyond a certain limit because a price-type tactic creates no artificial shortages to inspire "rent-seeking" behaviour. Carbon taxes have the seeming weakness that they do not direct the world economy to a particular climatic goal, such as either a CO_2 absorption or to limit at a global temperature.

The DICE model, by Nordhaus (2006, 2008) adopts that both economic besides climate policies should be planned to optimize the flow of consumption over period. Consumption should be understood by way of "generalized consumption," which comprises not only general market goods and services (like food and shelter) but also non-market things such as vacation, health status, besides environmental amenities.

The mathematical illustration of this hypothesis according to Nordhaus (2006, 2008) is that strategies are preferred to exploit the social welfare purpose that is the reduced sum of the "population-weighted utility of per capita consumption". Nordhaus (1992) also recognized that such illustration is a "standard" for modern theories of "optimal economic growth". The abatement cost equation is a compact-form-type model in which the charges for emissions declines are presented as a function of the "emissions reduction rate, (t)". The" abatement cost function" undertakes that abatement costs are relative to global yield and a polynomial function of the discount rate. Nordhaus (2000) developed calculations for "DICE-2007" model as it applies CONOPT solver in GAMS system of modeling formulated by Nordhaus. This whole system is grounded on the “Generalized reduced gradient (GRG) algorithm”. The model of this analysis comprises 1,368 equations and 1,775 variables. The elementary method is to insert a linear programming procedure inside a process that linearizes the non-linear equations.

The model according to Nordhaus (2000) for each run will need almost 30 seconds by means of a 5.0 GHz Intel processor. It must be distinguished that DICE model is theoretically a “Mathematical optimization model”, rather than the typical “recursive time-stepped model” often deployed for natural sciences analysis. Optimization, on the contrary, entails special tools and utilize long time than the recursive calculation for a likewise problem. The Dynamic Integrated Climate and Economy (DICE) model" was formulated by Nordhaus (1991) then later modified and made error-free by a group of his research colleagues. According to Nordhaus (2000, 2006, 2008) when it analyses by a universal level, it does not distinguish subdivisions or economic, non-economic classes. The related models and DICE and are functioning grounded on a “Cost-Benefit Approach”.

Nordhaus (2006) also explains that these models are utilised to evaluate the perfect balance among GHG’s reductions besides the damages on the economic eco system due to Climate Change to exploit intertemporal wellbeing. The models consist of “CES production function” through which capital and labor as inputs in order to stipulate “gross world product” besides “exogenous technological growth”. Following Nordhaus (2008), as DICE, almost all correlated models comprise “emissions of greenhouse gases” as a function for reduction of carbon emission. If discharges of CO_2 can be reduced, then in the long run, it can reduce climate vulnerability and thus stimulating the growth rate for “gross world product”. Legally the “abatement cost” enter in to production function as segment of GDP and decrease potential output that may be generated with a specified stock of capital in addition to labor (Nordhaus 2008, p. 41-42). Greenhouse gases remain accountable for the rising temperatures globally. The following equation (equation 3) presents the "damage function" which links increase in average worldwide temperature to financial compensations which are consequential from alteration in climate:

$$\frac{GDt}{GDPt} = 1 \quad Tt + 2 \quad Tt\ 3 \ \ldots\ldots\ldots\ (3)$$

Here,

GDt= for gross damages

GDPt i= Gross Domestic Product

DTt = temperature variation compared from year 1900.

The parameter 1, 2 besides 3 relates change of temperature for potential damages. The standards for the constraints according to Nordhaus (2006, 2008) are accomplished by deploying the calibration procedure. For this standard data for damages resulting from climate and temperature variations for the base year remain established into equation number (3). Because as equation three is defined more significant than 1, costs according to Nordhaus (2008) raise more than correspondingly through cumulative temperature variations as advocated by Bruin, Dellink and Tol (2009, p. 67-69).

Consequently, estimated impairment for change in climate goes in the "production function" by plummeting the maximum output that may be accomplished by using same level of capital, and energy stock (Nordhaus 2008, p. 42). Bearing in mind period consist of ten years remain measured in the model, it is acceptable to adopt such damages from a change within climate may happen only once in single deliberated period besides do not endure much lengthier.

The "RICE model" is actually the downscaled version of "DICE model". In other words, it is the regionalized version of global model developed by Nordhaus (1996). The DICE model has only single damage group in total, which is then further divided among 12 similar regions for easy of considerations. Using RICE model, conferring to Nordhaus (2008) various reduction strategies for emission of GHG's in those regions can be easily measured. Moreover, it is presumed that, the considered regions are entirely supportive to each other for formulating their shared emission approach or maybe the diverse regions follow diverse strategies to make the most of their local advantage, that can also be measured. It is a fact that, for the non-cooperative cases, only insignificant emission decreases are learned by Ierland (1999, p. 599).

For "RICE" model, as illustrated by Nordhaus (2008) every region is selected with a diverse function for considering its climate damage, founded on precise region-based effect classes. For the global (DICE) model besides the regional (RICE) model the aggregate damage functions are attained from a detailed examination and study of climate effect. This investigation is built on a "willingness to pay" approach presented by Nordhaus (2000) to evaluate value for mitigating Climate Change in forthcoming. Both of the "DICE and RICE" model do not consider "adaptation" as a "decision variable" into account although their extensions "AD-DICE and AD-RICE" model do. (Bruin, Dellink and Tol 2009). For such models, "adaptation" can be considered as zero as it reduces the possible damages that can happen from a change in climate. In the adaptation models according to Nordhaus (2002) three classes of impairment are well-defined and allied in equation (4): Gross damages GDt happen when no "adaptation" is executed. Residual damages RDt are the damages that result when adaptation action happens at a level ALt. Net damages Dt enhance the adaptation costs ACt (costs necessary for implementing adaptation) to the other losses (de Bruin, Dellink and Tol 2009, p. 67). Within the gross damage function according to Nordhaus

(2008), the postulation is signified that, protection costs and the residual damages are divisible then is articulated as a fraction within GDPt:

$$\frac{Dt}{GDPt\ Pt} = \frac{RDt(GDt;\ ALt)}{GDPt} + \frac{ACt(ALt)}{GDPt} \ldots\ldots(4)$$

Here,

RDt = Residual damages, Dt = Net damages

GDt = Gross damages, ACt = Adaptation costs

ALt = the considered level of adaptation, Pt = Product

Contrariwise residual losses rest on "gross damages" as well as the considered level of adaptation ALt and adaptation costs, it mainly contingent first on level of adaptation as advocated by Bruin, Dellink and Tol (2009, p. 67). For equation 5 , when 1 > 0 and 2 > 1 then it is growing through the level of adaptation since cheaper adaptation measures that are initially available and are nominated for implementation by Bruin, Dellink & Tol (2009, p. 68). The adaptation cost function is:

$$\frac{Act}{GDPt} = 1ALt\ 2 \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Here,

ACt = Adaptation costs

ALt = the considered level of adaptation,

GDPt i= Gross Domestic Product

The aim of adaptation according to Bruin, Dellink & Tol (2009, p. 68) is selected every single epoch, that is measured as ten years for the model. Considering time horizon until 2100, much time is considered as the time necessary for the total calculation procedure may increase. It is also practical to accept that the execution of adaptation actions may require more than one year until it is completed. Per assumed adaptation considered in one period does not affect the damages happening in the next period. This suggests that together the costs and paybacks of adaptation fall within the same period and for the same skill- amid costs and benefits happen during every echelon. As long as, adaptation is executed optimally, Bruin, Dellink and Tol (2009, p. 68) contend that with this inference the paybacks of adaptation will always compensate the costs necessary. This sort of modeling fits within group of "responsive editions of adaptation".

"Anticipatory adaptation" alike constructing "sea-walls" permits for time-lags within prices besides paybacks which could be encompassed through an "adaptation capital stock" within the considered model by Bruin et al., (2009, p. 68). "Adaptation costs function" conferring to Nordhaus (2008) is increasing with following the level of adaptation. It means that considering aspects of cost-benefit, and when it is optimal to select an adaptation level by the amount of a certain fraction of total gross damages. This will never be an ideal aspect to familiarize in Climate Change because adaptation costs are growing totally. So, the best clarification to mitigate all of the future damages than any other choices.

For the best policy considered by least costs according to Nordhaus (2008) (costs plus execution charges), combination of both mitigation and adaptation policy has to be employed by Bruin et al., (2009, p. 70). For RICE model considered for this research, it seems that some colder northern regions profit from the stated Climate Change (For example we can say its applicable for "Northern Europe, Russia, and Canada". Consequently, adaptation to be executed otherwise than it is typically undertaken into consideration in DICE model .So, the modified gross damage function considered here will be as follow:

$$\frac{Dt;r}{GDPt;r} = \frac{RDt;r(GDt;r;\ ALt;r;\ ABt;r)}{GDPt;r} + \frac{ACt;r(ALt;r;\ ABt;r)}{GDPt;r} \quad \text{……… (6)}$$

Here,

Dt = Net damages, RDt = Residual damages,

GDPt i= Gross Domestic Product, ACt = Adaptation costs,

GDt = Gross damages, ALt = the considered level of adaptation

The damages are represented by Dt;r is again being the total summation of "residual damages, RDt;r and adaptation cost $AC_{t;r}$", but then again both are distinguished used to each different regions. "The adaptation level" in equation (4) is split up into two effects. In equation (4) the adaptation level ALt comprises adaptation to Climate Change damages, as denoted by $AL_{t;r}$. To signify possible benefits of adaptation measures like Bruin, Dellink and Agrawala (2009, p. 47) advocates that more productive agriculture within the northern nations, so the additional variable $AB_{t;r}$ is included. Residual damages and additional costs to adaption depends on the level of adaptation efforts.

"Residual damages" for this model depends on the "gross damages GDt;r and the degree of variation. According to Nordhaus (2008), mitigation is not modeled in AD-RICE. For this model, reduction comes into consideration almost indirectly by differentiating the "input of carbon-based energy" conferring to, Bruin, Agrawala and Dellink (2009, p. 16) with "AD-DICE and AD-RICE" models. The properties of diverse "mitigation and adaptation" stages are possible to assert here with specific considerations and degree of activity difference. The four assignments scenarios considered for AD RICE model are:

1. “No adaptation as well No mitigation” (S1).
2. “Optimal adaptation as well no mitigation (S2).
3. “No mitigation as well optimal adaptation” (S3).
4. “No adaptation as well optimal mitigation” (S4).

The levels of “Utility” according to Nordhaus (2008) for “Reference scenarios” are considered as the objective of Optimization process from the “DICE and RICE “model. The maximum level of utility, according to Bruin, Dellink and Agrawala (2009, p. 20-21), is achieved by S2 optimal scenario. The S3 scenario (no mitigation, optimal adaptation) and S4 scenario (no adaptation, optimal mitigation) trail with a practically equal level of utility. S1 scenario with no action is in terms of efficiency by far wickedest possibility available.

Table 3.1: Build-up of climate costs for different actions and impacts

Annual Costs (billion US Dollar)	S1 - no adapt-tation and no mitiga tion	S2 - optimal adapta-tion and mitiga-tion	S3 - no mitiga-tion and optimal adapta-tion	S4 - no adapta tion and optimal mitiga Tion
Period 2025-2034				
Adaptation costs	0	7	7	0
Mitigation costs	0	21	0	30
Residual damages	204	170	174	199
Total Costs	204	198	181	229
Period 2095-2105				
Adaptation costs	0	247	361	0
Mitigation costs	0	367	0	610
Residual damages	5430	3026	3920	3824
Total Costs	5430	3640	4281	4434
Period 2145-2155				
Adaptation costs	0	1013	1903	0
Mitigation costs	2	1672	2	2902
Residual damages	22083	6926	14437	12033
Total Costs	22085	9611	16342	14935

Source: “Agrawala et al. 2009, p. 22”.

The results presented at Table 3.1 above, conferring to Nordhaus (2008) demonstrates that the total costs of Climate Change for different actions and impact which annually upsurge over considered time. While in the early period of the year 2025 to the year 2034, “the saving effect” for an optimal adaptation and mitigation strategy (S2) equate to no action (S1) with a cost reduction of 3% is very minor. Benefits of such action increase very strongly over time. Most considerable benefits among the available are likely happen in last period from year 2145-year 2155. In this period with an optimal strategy including combined mitigation and adaptation, the total annual expenses can be condensed through over 50%.

Alternatively, the artificial gross damages considered in the model are primarily measured in developing nations besides regions similar to India, Africa. According to a few forecasts of the DICE model, these areas will be affected severely by change of climate and thus will suffer gross damages of 4.6% besides 4.2% of GDP every year correspondingly. With the intention of reducing the impact of “gross damages”, these countries need to deploy the most extensive efforts for adaptation. Still, such efforts can lessen “gross damages” by a significant total. As for instance, Africa was able to reduce its “gross damages” from 35 % to 7% by considering the quantity and different levels of adaptation efforts. Such statistics display that impairment resulting from impacts of “Climate Change” may be consolidated meaningfully for least developed besides developing nations when adaptation receipts proper attention and consideration (Bruin, Dellink and Agrawala 2009, p. 23-24).

For the "Regional Integrated Climate and Economy (RICE) model" is a regional version of the “DICE” model by Nordhaus and Yang (1996). It has one individual damage type focused on Specific regions to consider. For the ASEAN region, it can be used on all ASEAN regions or selected regions according to the preference of the user. However, in this case, region, specific country of regional climatic data is prerequisite.

With the RICE model, according to Nordhaus (2008), several emission lessening policies accepted or promised by these ASEAN member counties can be considered.

Moreover, maybe the regions considered here are completely supportive in joint emission approach, or the different counties follow strategies to exploit their environmental profits. In case of non-cooperatives, only very insignificant and small emission decreases remain continued. For ASEAN -RICE, according to Nordhaus (2008), the region is assigned to consider with ASEAN climate impairment function, founded on the similar effect category. The DICE model (to be used for global assessment) and RICE model (to be used for regional assessment) “aggregate damage functions” are consequent from a climate impact investigation. Following nordhaus (2000) this investigation is guided on a readiness to recompense method to calculate the worth of averting upcoming Climate Change. The “DICE and RICE” model do not yield adaptation as a verdict variable into interpretation while their extensions AD-DICE model and AD-RICE models do so (Bruin, Dellink & Tol 2009, Bruin, Dellink & Agrawala 2009). For ASEAN RICE model, considered here we take mitigation as a key decision variable in the model. So, in the model mitigation actions reduce the possible reparations of Climate Change. For the mitigation models three types of reparations are defined and related in equation (7) as follows:

$$\frac{Dt}{GDPt} = \frac{RDt(GDt;\, MLt)}{GDPt} + \frac{MCt(MLt)}{GDPt} \quad \ldots\ldots\ldots(.7)$$

Here,

Dt = Net damages, RDt = Residual damages,

GDPt i= Gross Domestic Product, ACt = Adaptation costs,

GDt = Gross damages, ALt = the considered level of adaptation

MLt= the mitigation level, MCt = mitigation costs

According to Nordhaus (2008), Gross damages GDt happen once no mitigation remains executed. "Residual damages (RD_t)" are the damages that outcome after "mitigation happens at level ML_t. Net damages (D_t) add the mitigation costs ("costs of implementing mitigation = MC_t") to remaining reimbursements. In "gross damage function", hypothesis is signified that the defence costs in addition to the lasting damages are divisible and can be articulated as a (portion of GDP as GDP_t"):

Where "residual damages" depend on "gross damage" as well as the "mitigation level MLt and mitigation costs" both depend only on level of mitigation. The mitigation cost function is:

$$\frac{MCt}{GDPt} = 1MLt\ 2 \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Here,

MCt = mitigation costs, GDPt i= "Gross Domestic Product"

MLt= the mitigation level, GDPt = "Gross Domestic Product"

where 1 > 0 and 2 > 1. then that represents the fact that it is rising gradually with mitigation level because cheaper mitigation actions are first deployed. Nordhaus (2008) mention in his literature that this type of modeling belongs to the category of reactive mitigation by nature. Preventive mitigation is similar to shifting into hybrid vehicles, or using electric vehicles. It permits for time lags to cover the necessary costs and benefits which can be encompassed by a "mitigation capital stock" in this model. Mitigation cost function for the model is also considered mostly when other accounts like profit and loss are accounted.

According to Nordhaus (2008), the cost is growing with the level of mitigation. For the RICE model, the ASEAN member counties agonized from a different level of

Climate Change. Therefore, mitigation has to be implemented differently than in here. The gross damage function according to Nordhaus (2008) is:

$$\frac{D_{t;r}}{GDP_{t;r}} = \frac{RD_{t;r}(GD_{t;r};\ ML_{t;r};\ MB_{t;r})}{GDP_{t;r}} + \frac{MC_{t;r}(AL_{t;r};\ AB_{t;r})}{GDP_{t;r}} \quad \ldots(9)$$

Here,

$D_{t;r}$ = The totality of residual damages,

$RD_{t;r}$ = Residual damages , GD_{tr} = Gross damages,

MC_{tr} = mitigation costs, AL_{tr} = the considered level of adaptation,

$ML_{t\,r}$= the mitigation level ,AB_{tr} = Adaptation base costs,

$GDP_{t\,r}$= Gross Domestic Product

The mitigation degree in equation (9) according to Nordhaus (2008) is detached into two properties. In equation (9) the mitigation level ML_t comprises adaptation to Climate Change reparations, here represented as $ML_{t;r}$. To characterize probable paybacks of mitigation measures like more productive agriculture in some |ASEAN nations the supplementary variable $MB_{t;r}$ is unified. Mitigation costs besides residual damages depend on both kinds of mitigation. Remaining reparations depend on the "gross damages $GD_{t;\ r}$" and level of justification.

3.6 ASEAN RICE Model for First Objective

While actual reductions in carbon emissions according to Nordhaus (2008) often vary with projections from interventions since they are sensitive to the assumptions used, they offer a rough estimate of trends over some time as the input-output coefficients of economies tend to change gradually rather than abruptly. This study according to Nordhaus (2008) usages a multi-disciplinarian top-down dynamic model through an elaborate account of the 'Climate and the Ecology' notions combining economic theory besides earth science concepts, which is arguably the best method available to model emission changes in an economy at the aggregate level.

3.6.1 Materials and Methods

The modeling according to Nordhaus (2006, 2008) begins through a comprehensive explanation of climatic variables which are regarded as liable for Climate Change and environmental damage with an emphasis for abatement costs, back-stop technology, carbon concentration (e.g., ppm[19] Under 900) over the next 100 years and the temperature cap under 1.5°C to examine, long-run climate impairment impacts.[20] The study model according to Nordhaus (2008) contemplates specific three scenarios to evaluate the effect from Climate Change. The first scenario is known as the "business as usual scenario (BAU)".

The Second scenario in the model uses Malaysia's INDC presented to COP21 until 2030, and subsequent developments if no other interferences are made to decrease carbon discharges as more as possible. The third scenario emphases on initiatives necessary for stopping the rise of temperature up to 1.5°C within the next 60 years. Thus, structural variants, like, "Rate of social time preference, Initial growth rate of backstop technology, Level of total factor productivity, Marginal atmospheric retention rate, Emissions-output ratio, and Discount rate" all these variables are used to visualize long-run outcomes. The model similarly contemplates "Capital stock, Population growth rate, Cumulative improvement of energy efficiency, and Fossil fuel

[19] PPM refers to parts particulate matters.

[20] This model continues utilizing "mathematical optimization" along with "Geometric, Algebraic Modeling System (GAMS)" program.

stock” There are dual significant ‘decision variants' according to Nordhaus (2006, 2008) for the “Climate and the Economy model” we reflect, which represent: “(a) Degree for physical capital (K(t)) accumulation (e.g. equation 1) as a meaning of investment (I(t))”So we get the equation as follow:

$$K(t) = I(t) + (1-\delta_k)K(t-1) \quad \text{.. (1)}$$

Here,

K(t)= degree for physical capital accumulation,

(I(t)) = investment,

(δ_k) = depreciation rate

By the “Depreciation rate (δ_k) “to substitute by green growing in forthcoming, “Rate of emissions controller in the production function, Q(t) through “Factor productivity, A(t)” for GHGs emission over time with a damage, $\Omega(t)$ and abatement cost, $\Lambda(t)$ functions. So, the equation becomes as follow:

$$Q(t) = \Omega(t)[1-\Lambda(t)]A(t)K(t)^{\gamma} L(t)^{1-\gamma} \quad \text{.................................... (2)}$$

Here,

Q(t)= rate of emissions controller in the production function,

A(t) = GHGs over time with a damage,

$\Omega(t)$ = Abatement cost, $\Lambda(t)$ = Functions,

K(t)= degree for physical capital accumulation,

L(t)= degree for labour accumulation

The twofold decision variants according to Nordhaus (2008) are compactly combined by “temperature limit over the period” (e.g., equations 3, 4), “Carbon-saving” besides “Capital accumulation” aimed at green funding. “Accumulation of Capital” is also endogenously destined through enhancing the movement of defencelessness over the period and “Carbon-saving” remains endogenously connected through the abatement or substitute green technology acceptance and is confirmed as reducing portion of emission of carbon from manufacturing procedure.

$$T_{AT} = T_{AT}(t-1) + \zeta_1\{F(t) - \zeta_2 T_{AT}(t-1) - \zeta_3 T_{AT}(t-1) T_{LO}(t-1)\} \text{ ...... (3)}$$

Here,

T_{AT} - = abatement charges,

T_{AT}(t-1) = traditional energy choice,

T_{LO} (t-1) = traditional Labour choice,

F(t) = Future technological change cost

According to Nordhaus (2008), the production is determined using CES and CET output functions, that receipts form whichever (carbon-based or non-carbon-reliant) energy in “productivity manufacture ratio” over longstanding. Yet, besides abatement charges will decrease over time as the significance of shift from “carbon-to non-carbon reliant” energy using know-how as the traditional energy choice might become gradually expensive as a result for strict climatic policies.

$$T_{LO}(t) = T_{LO}(t-1) + \zeta_4\{T_{AT}(t-1) - T_{LO}(t-1)\} \text{ .... (4)}$$

Here,

T_{AT} - = abatement charges,

T_{AT}(t-1) = traditional energy choice

T_{LO} (t-1) = traditional Labour choice

Following the agreed Nordhaus (2008) set-up, now the model can project economic development for Malaysia by weighing the “National growth,” “Venture in the capital,” “marginal injury of Climate Change,” “marginal cost of governing damage,” and “backstop technologies and abatement charge.” All of these equations are linked by climatic effects and susceptibilities founded utilizing three specific set-ups, viz., (a) Climate Change happening with not any reduction (b) Climate Change happening under Malaysia's INDC from COP 21. Until the year 2030, with no additional decrease in carbon releases, and (c) intentness to keep below the doubling rate over next 100 years targeted at meeting 1.5°C temperature rise cap completed within the next century. The particulars for the parameters, variables, explanations, mathematical equation notations and the units implemented in the estimation are provided in detail at the end of this thesis (appendix 1).

3.6.2 Empirical Downscaling and Study Area

For Malaysia, the research area for study is from where the data for climate were composed , and there were four predetermined locations, including: “Kuching (Sarawak), Kota Kinabalu (Sabah) in East Malaysia, and Kuantan (Pahang) and Petaling Jaya (Selangor) in West Malaysia (MMD, 2009), ” with GPS bearing of “1°25'0"N besides 110°20'0"E, 5°58'50″N then 116°4'37″E, 3°48'0"N besides 103°20'0"E and 3°5'0"N then 101°39'0"E” correspondingly. Collected data from here were applied in this research to develop the trend summaries after global level to regional level by experimental rationalizing for detecting collaboration amongst “Global warming, Climate Change and Economic loss” for Malaysia. For ASEAN RICE Model, in this research we have considered a total of 15 sectors for the selected ASEAN Nations. Among them fore are main sectors and the remaining eleven sectors are the sub sectors of those main sectors. Table 3.2 presents the sectors of the model as follow:

Table 3.2: Sectors considered for ASEAN RICE Model

Main Sectors	Sub Sectors
"SEC1-A" Agricultural "SEC2-A" Manufacturing "SEC3-A" Other Industry "SEC4-A" Service Sector (Those are the main sectors)	LAB "Labour" CAP "Capital" HOH "Household consumption" COM "Commodities" GOV "Government" S-I "Savings-investments" YTAX "Tax income" STAX "Sale tax" TAR "Tariff" ROW "Rest of the world" TOTAL "Total account in SAM" (Those are the sub-sectors)

Source: Developed by the authors

The methods accepted here for research are used for analyzing a countrywide observational data set to forecast yearly sequence of experiential "(a) Temperatures besides climate properties, (b) GHGs warming restrictions, and (c) extensive, unexpected climate tremors." The forecasted yearly sequence is economized and accustomed by taking into account of "(i) nationwide discharge, (ii) net damage, (iii) climate vulnerability, (iv) abatement cost, and (v) emission controller."[21] Yearly sequence of experiential limits of forecast variables (e.g., climate susceptibilities by their likely influences) then predictor variables (e.g., annual typical flow limitations) remain carefully imitated by the likelihood of sudden weather tremors within forthcoming. Year 2030 remain an important year in the analysis of this thesis,

[21] The scenario approximations are consider with the postulation, that neighboring nations will track the endorsements for reducing carbon emissions made by Nordhaus (2008) and COP 21 outlines besides recommendation report. If not then, the forecasts may be exaggerated by the environment – being a global common is thus, discharge resulting from Haze pollution from neighbour like Indonesia can diffuse in to "Malaysia or Thailand".

because in COP 22 (2016), all the ASEAN nations also pledge in INDC submitted to UNFCCC at COP 22 (2016) that, from 2030 all the nations will intervene actively for the promised climate actions. So, for this research, we also follow year 2030 as our initial year of Climate action being implemented. Although all the nations are already preparing for this critical and significant task.

3.6.3 Damage Reflections

The damage approximation in "Climate and the Economy" valuation undertakes in this model, where "Climate Change" remain relative for "national economic production process" besides "polynomial functions of mean temperature variation" (e.g., provided in equation 5). Total change of climate expressed is a function follow-on from "Damages over time", henceforth, this is a mathematical equation that combines "(Ω(t)) of Climatic properties and fraction of Productivity, Climatic vulnerability parameters (ψ1, ψ2) and difference of mean atmospheric temperatures, (oC), TAT(t)" since the year 1990. The Climate Change is projected with perceptible and imperceptible damages founded on financial value besides the utility function through the GHG discharge effects. Therefore, affecting intangible damages of Climate Change from "production function to the utility function" shall enhance the projections for "sustainable economic growth". Finally, Climate Change approximation is appraised in this research subsequently factoring in the discharge decrease timetables included INDC submitted to UNFCCC (2015) by Malaysia.

$$\Omega(t) = 1/[1+\psi_1 T_{AT}(t)+\psi_2 T_{AT}(t)^2] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Here,

(Ω(t)) = Climatic properties in addition to fraction of productivity,

(ψ1, ψ2) = Climatic vulnerability parameters and (oC) = Difference of Mean atmospheric temperatures,

$T_{AT}(t)$ = Atmospheric temperatures since the year 1990.

3.6.4 The Discount Rate and Social Preference

According to Nordhaus (2008), we already know that the "Climate and the Economy model" uses the "neoclassical economic growth" theory conventions where "sustainable economic development" remains familiar beneath limitation of a "Discount rate (ρ) of 1.5%" as to be considered for Malaysia to interpret future costs into its present standards. The "discount rate over time (R(t))" stands to measure the "present and future value", since goods and can accept a specific "monetary value" e.g., Malaysian Ringgit (MYR) with considering " Inflation rate" of 3% annually (equation no 6). Here, RICE model is expected to have a "societal favourite for bearable economic progress" as definite by a "social well-being function" that grades diverse pathways of upcoming development that remain controlled mutually through economic besides climate relations.

$$R(t) = (1+\rho)^{-t} \qquad \text{……………………………………….} \quad (6)$$

Here,

(R(t)) = The discount rate over time

(ρ) = discount rate

3.6.5 Data Source

For this research, we use two kinds of data as (a) "Macro-economic data" besides (b) "climate and meteorological data." Macro-economic data for this study was collected from published "National Accounts of Malaysia", with support from "Department of Statistics (DOS), (DOS, 2010, 2013a, 2013b) in addition to "Economic Planning Unit known as EPU, (2010), whereas the climate and related meteorological data are collected from "(Malaysian Metrological Department [MMD] 2009) : NAHRIM (2009)". "Macroeconomic Data" starting from the year 2010 to the year 2015 remains considered to instigate the "macro baseline estimation" for the year 2015, while climatological data remains based on four specified seasons besides two monsoons starting from the year 1969 to the year 2007 historical climate records. National temperature variations are resulting from historical climatic records from the year 1969 to the year 2015 toward forecast variations in GHGs ranging from 280ppm to 927 ppm[22] absorptions in the direction for initiate climatic baseline 2015.[23] According to Nordhaus (2008) this research needs to use few considerations for effective calibration like

(i) temperature variations amid 0.8 °C besides 1.5 °C,
(ii) Carbon concentration through supreme boundary of 650 ppm level of variances till year 2050,
(iii) "Maximum carbon absorption capacity" in upper and lower strata is only 950ppm.
(iv) "Equilibrium temperature" effect of 26 °C.
(v) Early inferior "stratum temperature" alteration by 0.8 °C.
(vi) Ultimate "temperature variation" in atmosphere as of 1900,
(vii) "Optimal abatement costs" for strategies prescribed in IPCC (2007; 2011) reports were followed

Following, Nordhaus (2008) we established few static adjustments to the data attained after MMD (2009,2015), IPCC (2007; 2011), following the guidelines prescribe to encounter the scope of this research.

[22] PPM= Parts per million

[23] Details of the "southwest monsoon" and "northeast monsoon" that impact on Malaysia's climate impacts are discussed .

3.7 ASEAN RICE model for the Second Objective

To measure besides, enumerate the longstanding effect of Climate Change within the ASEAN region precisely on Malaysia through a dynamic dual multidisciplinary model merging “economic, ambiance, earth science, and ecological concepts” are propagated in this research. According to Nordhaus (2006,2008) this dual multi-disciplinary framework used in the model is quantifiable, non-linear prototype grounded over the “Empirical Regional Downscaling Dynamic Integrated framework of Climate and the Economy.”

3.7.1 Materials and Methods

According to Nordhaus (2008), the model used or this research contains certain climatic features, such as “change in climate, carbon cycle, damage from climatic events, and carbon emissions.” All of these features can interrupt the fiscal development with endogenous variables like “population, capital stock, output, fossil fuel stock, and the speed of technological change.” So, here we consider to appraise the overall influence of the INDCs of ASEAN affiliates for future mitigation.

The exogenous variable according to Nordhaus (2008) used for the model remains essentially, a policy thrust that adopts a top-down method. The quantifiable components in this model include the worth of properties and amenities, with exposures utilizing minimal and present values. Here the used model deems for sustainable economic development through bearing in mind about the ASEAN development with forthcoming vision, venture in capital, consumption, and know-hows contrary to associated climatic properties besides exposures. According to

Nordhaus (2008), CO_2 emission forecasts and calculations pursued endorsements on forthcoming targets offered in Fourth Assessment Report (FAR) by IPCC (2007) and the replacement of fossil fuel through renewable, non-fossil renewable energy towards lessening the CO_2 discharges by formulating, an outline for introducing backstop technologies. “Non-industrial discharges of carbon," and “non-carbon discharges” are likewise measured within “damage assessment” as per advised in both “Third and Fourth Assessment Reports of IPCC 2001,2007).” The particulars of this research resources and methods, conversed below.

3.7.2 Empirical Downscaling and Study Area

The scenarios besides assessment deployed for this specific study trail the DICE model closely, which was developed by Nordhaus (2008) with an experimental economizing method to detect exchanges amid “global warming, change in climate and damage happening to economies” (Please see Appendix 1 for related equations). The downscaling mitigation dimensions indicate an assortment of rational climate-based consequences over the years from 2010 - 2060, which by type remain endogenous.

The acknowledged top-down modeling approach[24] emphases on ASEAN affiliate nations, enchanting explanation of a wide variety of probable climate consequences through stirring from a global towards a regional, levels. Here the accepted procedures remain deployed employing an extensive set of climate data to forecast the yearly cycle for experimental “(a) temperatures besides (b) large-scale circulation effects." “The climate dimensions” deployed in such research were carried out for all of the ASEAN member nations. Meanwhile, climatic data for this research was grasped as of

[24] The “top-down approach” starts with changes for global level with specific nations and then undertaking climatic initiatives and allotted in the document through disaggregation by means of specific national statistics

the European Commission “(EU, 2015 JRC/PBL, EDGAR)”. The endeavour towards the collection of data solitary from one source was attentive on safeguarding the data deployed here remained accumulated reliably then over the same epochs.

3.7.3 Data Source

As said earlier, in this research study, two types of dataset were measured. The initial set consists of ASEAN data for macro-economic valuation, which was collected as of the “ASEAN Secretariat”. The second data set remains attained from the “Malaysian meteorological division and NAHRIM” are actually based on climatic constraints (MMD, 2009; NAHRIM, 2006). Every significant predictor for ASEAN information was seized from European Union database “(EU, 2015 JRC/PBL, EDGAR)”.

1. For Thailand the climatic data was collected from “ASEAN Secretariat” and INDC proposal proposed in UNFCCC at COP 22 (2016). For “Thailand” the SAM sectors for year 2010 and year 2015, both was collected from “National Statistical Office, Bangkok”. This is a data center maintained by the “Ministry of Information & Communication Technology, Thailand”

For Indonesia, Climatic data was collected from “ASEAN Secretariat” (2015) and INDC proposal proposed in UNFCCC at COP 22 (2016) by their respective government. For “Indonesian” the SAM sectors for year 2015, was collected from Department of Statistics (Badan Pusat Statistik) Indonesia. Temperature differences of ASEAN region were attained from historical EU archives to forecast variations in significant disparities by the concentrations of GHGs (with a range from 280 ppm to 927 ppm). Though, few alterations were made on the data provided by European Union for attaining the scope of this research study and to visualize the enduring impact from year 2010 to year 2060. The year 2060 is chosen as the end year instead of 2110 following the Paris agreement only for the consideration that due to technological advancement, many belongings are likely to transform over the subsequent decades.

3.7.4 Damage considerations

The two main apparatuses used for this research to examine the attained data includes “General Algebraic Modelling System (GAMS)” besides “Syntax Programming (SP)." Both “GAMS and SP” are deployed here toward resolve the “non-linear besides mixed- base integer” glitches towards constructing the ASEAN economy-wide mathematical equation-based climate replicas. The twofold modeling system assists in quantifying the probability of temperatures increasing above set “thresholds with core data” for measuring vulnerability in addition to their effect.[25] The “threshold variables” address (a) likelihood of unexpected climatic tremors (b) climatic effects through possible exposures happening now and in the year 2060.[26]

This study following Nordhaus (2008) also forecasts variations of temperatures ranging from 0.8 to 3.1°C with concentration of carbon (CO_2) with rational level for differences grounded on “(i) initial atmospheric absorption, (ii) initial absorption in upper and lower strata, (iii) equilibrium atmospheric absorption, (iv) equilibrium absorption in lower and upper strata, (v) equilibrium influence of temperature differences, (vi) temperature alteration in the initial lower stratum, and (vii) likely Climate Change-related damage intercepts on the optimum abatement limitations.” This research starts with the initial consideration of temperature influences based on

[25] The “threshold” refers a specific point after which the socioeconomic system besides institutions would be impacted by “climate damage”. Without perceptive about the institutions besides “socioeconomic system” that can distress or primarily change within climate conditions can generate “global warming”, this might not be probable to articulate any substitute strategies to reduce the damage from climate Change 27.

[26] The MMD29 facilitated the selection of threshold level and climate variables29.

BAU situations for ASEAN member nations to forecast the probable states for the forthcoming course of climate system till the year 2060 through the guess that no other interference will happen in the climate regime since today. According to Nordhaus (2008), this will then be trailed by Scenario two, which trails involvements essential to the device the INDCs by the particular individual ASEAN governments.

3.7.5 Discount Rate

According to Nordhaus (2008), the discount rate was measured as a serious component of this research, and after much analysis, it was taken as 1.45% intended for the ASEAN member nations and then it was deployed in this model towards forecast future budgets in to present values. Discount rate here is evaluated by Nordhaus (2008) for contemporary and also forthcoming goods and services into Malaysian Ringgit (MYR) as "Real Discount Rate" by considering total inflation. This research also considers "inflation rate of 3%" each year used for ASEAN region. This is collected as of "ASEAN Secretariat (2015)". Finally, according to Nordhaus (2008), the "Cost of Carbon discharges" is measured by valuing it conferring the "Social cost of Carbon". This was considered with the contemporary value of supplementary economic impairment in forthcoming.

3.8 ASEAN RICE Model for Third Objective

For the third objective, we use the CGE based ASEAN RICE model to regulate the variable components to forecast the Low carbon index for ASEAN Nations from 2010 to 2060 with a considerable discount rate.

Then following the research objectives, we try to develop a ranking for the selected border sharing nations of ASEAN namely Malaysia, Indonesia, and Thailand and presented accordingly.

3.8.1 Materials and Methods

For this ASEAN RICE model, we use the following four block equations, that are used in this CGE Model design to forecast the Low Carbon Economy index (LCI) as follows:

3.8.2 Low Carbon Economy Index Block:

1. **Quantity of Low Carbon Economy (** $QLCE$ **):**

$$QLCE^{t}{}_{c} = lceltot^{t}{}_{c} \bullet PLCE^{t}{}_{c}(1+tq_{c}^{t}) \text{ ……………. (1)}$$

Here,

$PLCE$ = price of low carbon economy

$lceltot$ = estimated sector-wise quantity of low carbon economy

tq = national taxation composition for the national economy

2. **Price of Low Carbon Economy** (PLCEI)

For Price of Low Carbon Economy component, following equation will be used:

$$PLCEI^{t}{}_{c} = slcei^{t}{}_{c} \bullet PQ^{t}{}_{c} \text{ ……………. (2)}$$

Here,

$slcei$ = sectoral low carbon economy shares

PQ = price of national commodity quantity

3. **Value added price for Low Carbon Economy (** $PLCEVA$ **)**

The value-added price for Low carbon-based Economy is calculated using the following equation

$$PLCEVA^{t}{}_{a} = PLCEI^{t}{}_{ca} - \sum_{ac \in C} PQLCEI^{t}{}_{c} \bullet ica^{t}{}_{ca} \text{ ……. (3)}$$

Here,

$QLCEI$ = total quantity of "low carbon economy"

ica = sectoral input share for "low carbon economy"

4. Intermediate demand of Low Carbon Economy ($QLCE$)

The intermediate demand of "low carbon Economy "is calculated using the following equation

$$QLCE^{t}{}_{ca} = ica^{t}{}_{a} \bullet QLCE^{t}{}_{a} \text{ .... } (4)$$

Here,

$QLCE^{t}{}_{a}$ = activity of demand of Low Carbon Economy

${}_{ca}$ = both activity and commodity in the national economy

5. Low Carbon Economy Index ($LCEI$)

The equation 5 in the equation used to determine the LCEI for this research following research objective 3

$$LCEI^{t} = \sum_{i}^{nt} \left(\frac{QLCE_{c}^{t}}{Qlce_{c}^{t=1}} \right) \bullet \frac{\rho_{i}^{nt}}{\beta_{i}^{n}}_{t \to \in^{t}} \bullet 100 \text{ .... } (5)$$

Here,

ρ_{i}^{nt} = sectoral share of $QLCE$ (current year)

β_{i}^{n} = sectoral share of $Qlce_{c}^{t=1}$ (current year-1= previous year)

$LCEI^{t}$ = Low Carbon Economy Index scenario (over time)

3.8.3 The Price Equation Block:

1. Import Price

The "import price (PMc)" used in the model considers the "Domestic-Currency Units (DCU)" as the price compensated by the "domestic users" for imported commodities are exclusive of the sales tax.

Equation (4-6) states here that it is a conversion of the "world price of these imports (pwm_c)", considering the "exchange rate (EXR)" and imposed "import tariffs (tm_c)" including the "transaction costs per unit of the import (icm)".

For all the considered commodities, market price is always paid by "domestic commodity consumers" as the "composite price, PQ" (in this following equation, PQ applies only to "payments for trade inputs"). The "exchange rate" as well as the local import price are elastic, while the "tariff rate" as well as the "world import price" are fixed, following the "small-country assumption".

$$\mathrm{PM_c} = (1 + \mathrm{tm_c}) \cdot \mathrm{EXR} \cdot \mathrm{pwm_c} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Here,

PMc = import price in DCU (domestic currency units) including transaction costs

$pwmc$ = c.i.f. import price in FCU (foreign currency units)

tm_c = $importtariffrate$

EXR = $e$exchange rate (DCU per FCU)

2. Export Price

The "export price (PEc)" used in DCU is "the price received by the domestic producers when they sell their output in export markets. This equation is structurally similar to the import price definition. The main transformation is that. “the tax” and “the cost of trade inputs” combinly reduce the price established by the “domestic producers of exports”. This study assumes that the set of “exported commodities “considered here all of them are produced mostly domestically.

$$\mathrm{PE_c} = (1 - \mathrm{te_c}) \cdot \mathrm{EXR.\,pwe_c} \text{ …………… … } (7)$$

Here,

PEc = export price in DCU

$pwmc$ = F.O.B. export price in FCU tec = export tax rate

EXR = exchange rate (DCU per FCU)

3. Composite Goods Price

One assumption of LCE modelling is that goods are always perfect substitute for goods produced domestically or imported. This is recognised as the “Armington assumption”. Following this hypothesis, a “constant elasticity of substitution (CES)” function is derived (also known as “Armington function”). It composites of certain “commodity price” for total domestic spending on a given commodity at “domestic consumer prices”. Equation (8) defines it without the sales tax. Absorption is expressed as the sum spending of “domestic outputs”, “imports at domestic sales prices “and expresses as “PDc and PMc. Prices PDc and PMc” which include the “cost of trade inputs” but exclude the “commodity sales tax” as below.

$$\mathrm{PQ_c} + \mathrm{QQ_c} = [\mathrm{PD_c} \cdot \mathrm{QD_c} + (\mathrm{PM_c})_{\mathrm{c\epsilon CM}}] \cdot (1 + \mathrm{tq_c}) \text{…………} (8)$$

Here,

QQc=Quantity of goods provided to market (domestic) (compound supply)

QDc = domestic sales amount

PDc = domestic sales price

PMc = import price

tq_c=Sales tax rate (Compound price of tax on total sales)

4. Domestic Output Price

For every "domestically produced commodity (QXc)", the marketed output value at "producer prices (PXc)" is stated as the "sum of domestic sales and exports values". "Domestic sales (QDc)" and "exports (QEc)" both are valued at the prices received by the " suppliers, PDc and PMc", both of which have been accustomed to justification for the sophisticated "cost of trade inputs".

$$PX_c \cdot QX_c = PD_c \cdot QD_c + (PE_c \cdot QE_c) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Here

PXc = aggregate producer price for commodity

PDc = domestic sales price

QDc = aggregate quantity of domestic output

PE_c = exports price

QE_c = quantity of exports

5. Activity Price

For this model "activity price (PAa)" refers to the "gross revenue" for separately every activity (i.e., "the unit return from sale of an output. It can also be expressed as the summation of the amount of production per activity") unit multiplied by the "activity-specific commodity prices" for all commodities. This consents to the fact that, "activities may produce multiple commodities".

$$\mathrm{PA_a} = \sum \mathrm{PX} \cdot \theta_{\mathrm{ac}} \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Here,

PA_α = activity price

PX_c = aggregate producer price for commodity

θ_{ac} = amount of "commodity c "as each "exported piece of C produced" then "sold locally"

6. Value-added Price

The Value-Added Price equation represents the added value for all commodities, activity and non-exported commodities and is explained below

$$\mathrm{PV_a} = \mathrm{PA_a} - \sum \mathrm{PQ_c} \cdot \mathrm{ica_{ca}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Here

PVA_a = value added price

PA_a = activity price

PQ_c = Composite commodity price

ica_{ca} = non exported commodities

7. Consumer Price Index

The "Consumer Price Index" equation represents the added value for weight of "commodity c" fused in the "Consumer price index (CPI) " and is explained below

$$\overline{\mathrm{CPI}} = \sum \mathrm{PQ_c} \cdot \mathrm{cwts_c} \quad \ldots\ldots\ldots\ldots\ldots (12)$$

Here,

CPI = "consumer price index (exogenous variable)"

$cwts_c$ = "weight of goods c in the consumer price index"

8. Producer Price Index for Non-traded Market Output

The equation presented below is used for measuring the "Producer Price Index (PPI)" for valuation of "Non-traded Market Output" as follow:

$$\mathrm{PPI} = \sum \mathrm{PDS}_c \cdot \mathrm{dwts}_c \ldots\ldots\ldots\ldots\ldots (13)$$

Here,

PPI = producer price index (exogenous variable), and
$dwts_c$ = "weight of goods c in the producers' price index"

Equations (12) besides equation (13) describe the "consumer price index (CPI)" and the "producer price index (PPI)" for measuring the "domestic market outputs".
The "CPI" is actually the "weighted sum of composite goods prices" whereas "PPI" is the "weighted sum of domestic goods prices". Both of the index is used here to determine the "numeraire price". So, in reality all of the other prices are measured as comparative for that price.

3.8.4 The Production and Commodity Block:

As specified with in the "DICE model assumptions", each sector produces a "gross output (xi)" through "constant returns to scale" and thus minimise their own production costs, which are reflective subjects to construct a production function.

The "technology used for production" is usually represented by a series of "constant elasticity of substitution (CES)" of Production function which can be controlled by a "nested structure" reflecting the "production hierarchy" (Shoven & Whalley, 1984). This indicates that the "elasticities of substitution" may vary at "different levels of the nesting hierarchy" and are "independent by nature."

1. Factor Income

As we presented the equation (14) accessible below outlines the "total income" for respective factor (If). Here, this revenue is divided into local institutions in fixed portions afterward payment of direct factor taxes ((1-tf) · YFf and handovers (trnsfr) to the remaining part of the world (ROW). The latter are then fixed in foreign currency and afterwards its altered in to local currency by "multiplying with the updated exchange rate (EXR)". The equation becomes references to the set of domestic organisations ("household, enterprises, and government", all are in reality a subcategory for "Institutions" set. This also comprises as "the rest of the world").

$$YF_f = shry_{hf} \sum WF_f \cdot WFDIST_{fa} \cdot QF_{fa} \quad \ldots\ldots\ldots\ldots (14)$$

Here,

YFf = income of factor f

2. Household Income

Equation (15) defines the total income for each household income for a given community from factor f. The equation is as follow:

$$YH_h = \sum YF_{hf} + tr_{h,gov} + EXR \cdot tr_{h,gov} \ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Here

YH_h = income to domestic institution i from factor f

$\Sigma YFhf$ = total of factor incomes

$tr_{h.gov}$= transfer from factor, $governmentandROW$

EXR = Exchange rate

3. Household Consumption Demand

The Household consumption demand is critical for the model. The following equation (16) represents the Household Consumption demand

$$QH_{ch} = \frac{\beta_{ch} \cdot (1 - mps_h) \cdot (1 - ty_h) \cdot YH_h}{PQ_c} \text{............} (16)$$

Here,

$\beta_{ch} \cdot (1 - mps_h)$ = quantity of fixed consumption demand for commodity,

$(1 - ty_h) \cdot YH_h$ = base year present year difference for fixed consumption demand

PQc = consumption demand adjustment factor (exogenous variable)

4. Investment Demand

Fixed investment demand (QUNV) is defined as the base-year quantity (qinv) multiplied by an adjustment factor ($IADJ$). For the basic version of the model, the adjustments factor is exogenously determined, and therefore the quantity of the investment turns out to be exogenous.

$$QINV_c = \overline{qinv_c} \cdot IADJ \text{.........................} (17)$$

Here

$QINVc$ = quantity of fixed investment demand for commodity,

$qinv_c$ = base−year quantity of fixed investment demand

$IADJ$ = investment adjustment factor (exogenous variable)

5. **Government Revenue**

Total government revenue (YG) is represented in the below equation as "the sum of revenues from taxes ($TINS$)", "specific factors (F_f) besides transfers from the rest of the world" and represented as ($trnsfrgov$,).

$$YG = \sum TINS_i \cdot YI_i + \sum tf_f \cdot YF_f + \sum tva_a \cdot PVA_a \cdot QVA_a + \sum ta_a \cdot PA_a \cdot QA_a + \sum tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum te_c \cdot pwe_c \cdot QE_c \cdot EXR + \sum tq_c \cdot PQ_c \cdot QQ_c + \sum YIF_{gov,f} + trnsfr_{gov,row} \cdot EXR \quad \text{......... (18)}$$

Here,

YG = Government Revenue

(F_f) = factors

($TINS$) = the sum of revenues from taxes

trnsfr_(gov,row)·EXR = the sum of revenues from total Imports

6. **Government Expenditure**

The equation for "Total government spending (EG)" which refers the "total sum of government spending for both consumption and transfers".

$$EG = \sum tr_{h,gov} + \sum PQ_c \cdot qg_c \quad \text{.................. (19)}$$

Here,

EG= Government Expenditures

PQc= Government spending for consumption

$Tr_{h.gov}$ = Government spending for transfer

3.8.5 System Constraints Block

The System Constraint Block of this model consist of the following key factors:

1. **Factor Markets**

"Factor market equilibrium" necessitates that for each specific factor, "total demand (QF)" for that factor must be equivalent to the "supply of that particular factor (QFS)". In the elementary version of the "DICE model", at any given time the supply of factors is usually fixed while the demands are flexible/variables. Here the model uses WFf "(The factor wage paid by each activity) as an equilibrating variable, to satisfy factor market equilibrium. An increase in WFf refers the "wage remunerated by every single activity, WFf. $WFDIS$T", which is inversely, related to the "quantity demands for factor, $QFfa$". If all factors are portable among the demanding events, then the equation takes this form:

$$\sum QF_{fa} = \overline{QFS_f} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(20)}$$

Here,

$QFSf$ = quantity supplied of factor (exogenous variable)

$QF_{fa\,=\,\text{the}}$ quantity demands for factor

2. Composite Commodity Markets

"Composite commodity market equilibrium" entails that, "total demand" for given composite commodity must be "equivalent" to the "quantity supplied" for it. The "demand for composite commodity" comprises of endogenous relations and "changes in inventories" which is exogenous. In the basic version of the model, QG and QINV are fixed. The "supply of composite commodities", as represented by QQc, initiatives "quantity demand for domestic commodity QD", in addition "imports QM". The domestic prices PDD and PDS acts as "market clearing variable" along with representing "quantities of import supply, for the output of the specified "domestic markets".

$$QQ_c = \sum QINT_{ca} + \sum QH_{ch} + qg_c + QINV_c \ldots\ldots\ldots\ldots \text{(21)}$$

Here,

$qdst_c$ = quantity of stock exchange

QQ_c = quantity demand for domestic commodity

QINV = quantity demand for international commodity

3. Current-Account Balance for the Rest of the World

The "Current-account balance" (articulated as foreign currency supply) typically indicates a country's "entire expenditure to the rest of the world" and it must be equal to the country's "total income in foreign currency". This situation interprets that "spending for imports and factor income outflows" must equal to "income from exports and factor income inflows (in the model its used as foreign saving and denoted by FSAV)". For the primary version of the model, FSAV is usually static and the "real exchange rate" acts as the role of "balancing variable in the current account".

$$\sum \mathrm{pwm}_c \cdot \mathrm{QE}_c + \sum \mathrm{tr}_{i,row} + \mathrm{FSAV} = \sum \mathrm{pwm}_c \cdot \mathrm{QM}_c \text{.........} \quad (22)$$

Here,

$FSAV$ = foreign savings (FCU) (exogenous variable)
QE_c = factor income outflows
QM_c= income from exports
pwm_c = factor income outflows
tr_i = the real exchange rate

4. Savings-Investment Balance

Equation (23) presented below describes that total investment must be equal to total savings. The "total savings" used in the model is the "sum of savings of the national non-governmental institutions", on the contrary "the government savings" and the savings from the "rest of the world", the last element that can effect it is of being loss or gain while converted in to local currency. "Total investment" is actually "the sum of the values of the changes in stocks and fixed investments (this is also known as Gross Fixed Capital)".

$$\sum \mathrm{mps_i} \cdot (1 - \mathrm{ty_h}) + \mathrm{YH_h} + (\mathrm{YG} - \mathrm{EG}) + \mathrm{EXR} \cdot \mathrm{FSAV}$$

$$= \sum_{c \epsilon C} \mathrm{PQ_c} \cdot \mathrm{QINV_c} + \mathrm{WALROS} \ldots\ldots..(23)$$

Here,

$\sum \mathrm{mps_i} \cdot (1 - \mathrm{ty_h}) + \mathrm{YH_h} + (\mathrm{YG} - \mathrm{EG}) + \mathrm{EXR} \cdot \mathrm{FSAV}$=Total investment

WALROS = wealth generated in the Rest of the World

$\sum_{c \epsilon C} \mathrm{PQ_c} \cdot \mathrm{QINV_c}$= household consumption expenditures

3.9 Summary

The measurement instruments used in the model according to Nordhaus (2006, 2008) are then comprised in annual average flow limits as predictor variables and annual regular temperature variations with carbon absorptions using forecasted variables to seize the variations over the long-run.

Thus, the foreseen yearly sequence according to Nordhaus (2008) is required to downscale by bearing in mind " (i) industrial emissions (per year), (ii) productivity with disposable damages, (iii) climatic impairment (total and fraction of gross output), (iv) carbon price (per ton of carbon), (v) emission control rate, (vi) social cost of carbon, and (vii) real rate of return of climate controller."

CHAPTER 4

CLIMATIC PROJECTIONS FOR MALAYSIA

4.1 Introduction

This chapter is the first analytical chapter, and it starts with the scientific facts presented in multiple IPCC reports from time to time that greenhouse gas (GHG) discharges from human activities in the atmosphere is rising and the main reason of climate-related seasonal variations in temperature across our planet (IPCC, 2007, 2011). If such Climate Change human actions are allowed without any effort to mitigate, then there is a possibility to extinguish human civilization from the earth (IPCC, 2018).

Among the consequences of such damaging development changes in natural temperatures like rising or falling. Over the period 1900-2015, according to NASA's on-going temperature analysis done by Goddard Institute for Space Studies (GISS)[27] Shows that mean global atmospheric temperature on earth has risen by 0.8° Celsius (1.4° Fahrenheit) (IPCC, 2015). In 2017 from GISS[28] Scientists enduring the global warming trend, the mean global atmospheric temperatures of the world in 2017 was chronicled as 0.9° Celsius (1.6° Fahrenheit) warmer. So, the global trend shows that the mean global atmospheric temperature of the world is progressively intensifying.

[27] Please see, https://earthobservatory.nasa.gov/world-of-change/DecadalTemp.

[28] Please see, https://earthobservatory.nasa.gov/images/91604/2017-was-the-second-hottest-year-on-record

Although the projections on Climate Change is still developing, there are growing evidence that climatic variation and damage as a result of human action is rising the globe's vulnerability (Aldy et al., 2003; Beckerman & Hepburn, 2007; Carter et al., 2006; Füssel et al., 2003; JRC, 2013). Mostly, global warming, its potential speed, and degree are still doubtful as climatic values are affected by periods, nation specificities (Keith, 2000; Kelly & Kolstad, 1999; Schimmelpfennig, 1996), which mean the temperatures and seawater levels are changing indisputably. (Bonfils et al., 2008; McKibbin & Wilcoxen, 2002; Nordhaus, 2001; Oreskes, 2004).

After the COP21 meeting, a vast number of United Nations member nations pledged to do their part to cap temperature increase over the subsequent century to 1.5° Celsius. In harmony with the Paris Declaration, Malaysia and other member ASEAN nations also submit individual "Intended Nationally Determined Contribution" (INDC) at the UNFCCC, that sought to reduce CO_2 emissions by 45% within 2030. This chapter aims to investigate the consequences from Malaysia's acknowledged INDC besides the supplementary proposal of enduring additional climate control so as assist the capping of temperature upsurge up to 1.5°Celcius over the next hundred years.

Thus, here we examine two scenarios against the no interference scenario using a dynamic integrated climate model and for the economy and took 2005 as the base year. Cumulative damage from the climatic change for the period year 2010-year 2100 will sum towards 2,722 more under present climate setting management; it will fall more to 1,203 mtoe considering scenario 2 and will fall sharply to 699 mtoe for given settings in scenario 3.

Subsequently, as the entire abatement costs are necessary for scenario 2 (MYR14,350.6 million) remains nearby to that of scenario 3 (MYR 14,644.7 million), the third scenario-based proposal is measured as the most excellent alternative for

Malaysia. The chapter's findings can support a ‘Climate Control Roadmap' toward sustainable development for Malaysia in the long run of 100 years.

Being an upper-middle-income country in 2010, according to ADB (2010) Malaysia is getting no exception. While the INDC targets were formulated by participatory process under an inter-ministerial/agencies or working groups from Malaysia, which brought 20 national policies in the remit, the stakeholder consultation group realized that there exist significant barriers over their implementation, including higher costs and capacity constraints. It is significant to recognize that effective governance of climate mitigation is critical to meet the government's ambition to meet its INDC targets. Additionally, Malaysia is considered a leader among the developing nations in achieving development targets. Malaysia's entire GHG emissions characterize about 0.6% of worldwide emissions during 2011. The intensity of emission per GDP was 0.41 t CO_2eq/RM1000 for that year, which requires a decrease of about 23% from 2005 values (INDC, 2015).

4.2 Materials and Methods

For this research objective, we accept the fact that, actual reductions in carbon emissions often vary with projections from interventions since they are sensitive to the assumptions used. So, they offer a rough estimate of trends over a while as the input-output coefficients of economies tend to change gradually rather than abruptly. This thesis applies one multi-disciplinary, top-down dynamic model through a full account of the ‘Climate and Ecology’ notions joining “economic theory” besides earth science concepts, which is arguably the best method available to model emission changes in an economy at the aggregate level.

The ASEAN-RICE modeling begins with a thorough account of climatic variables that are thought to be accountable for Climate Change and environmental damage with an emphasis on abatement costs, back-stop technology, carbon concentration (e.g., ppm[29] under 900) over the next 100 years and to ensure the temperature cap below 1.5°C to analyze the long-run climate damage effects.[30] The study model for this analysis reflects three given scenarios as follows: The first one is identified as "Business As Usual (BAU) scenario." The second scenario usages Malaysia's INDC presented in COP21 with consideration until 2030, and subsequent developments if no added interventions are made to decrease emissions of extra carbon. The third scenario emphases on implantations necessary to a stop of temperature rise by 1.5° C, for the subsequent hundred years. Thus, key variables, like, "rate of social time preference," the early growth rate for back-stop expertise, "level of entire factor productivity," "marginal atmospheric retaining rate," "emission-output ratio," also "discount rate" are used here to visualize the long-term properties. The model also reflects "population growth rate," "capital stock," "fossil fuel stock," and "cumulative improvement of energy efficiency." There are two keys 'decision variables' for the model known as 'Climate and the Economy' model in which both are measured simultaneously.

According to Nordhaus (2008), several nations are till now struggling to introduce and maintain a dynamic balance amid ecological order and sustainable economic development. These nations require proper apparatuses for the economic investigation to predict, prepare, and evaluate substitute methods taking account of their specificities, as well as the funds to execute them (Nordhaus, 2008; Stern, 2007).[31]

[29] PPM refers to parts particulate matters.
[30] This model runs using mathematical optimization with geometric, algebraic modeling system (GAMS) programming.
[31] Two major "economics of Climate Change projections" are available, both of which are based on "global options (Nordhaus, 2008; Stern, 2007).

This model represents: (a) proportion for physical capital (*K(t)*) accumulation (e.g., equation 1) as a function of investment (*I(t)*) with "depreciation rate (δ_k) to substitute with green growth in future", (b) "proportion of emissions controller in the production function, *Q(t)"* (equation # 2) through factor productivity, *A(t)* for GHGs over period "with a damage, $\Omega(t)$ and abatement cost, $\Lambda(t)$ functions". The two equations are formulated below:

$$K(t) = I(t) + (1-\delta_k)K(t-1) \quad \text{..................... (1)}$$

Here,

(*K(t)*) = physical capital

(*I(t)*) = investment

depreciation rate to substitute with green growth in future = (δ_k),

$$Q(t) = \Omega(t)[1-\Lambda(t)]A(t)K(t)^{\gamma} L(t)^{1-\gamma} \quad \text{............ (2)}$$

Here,

(*K(t)*) = proportion for physical capital accumulation

Q(t) = emissions controller in the production function

A(t) =factor productivity

$\Omega(t)$ = GHGs over period with a damage

$\Lambda(t)$ = abatement cost functions

Twofold decision variables, considered here set carefully related with "temperature boundary over the period" (for example, this can be clear from equations 3, 4 given below), "carbon-saving" besides "capital build-up for green financing." The build-up of capital is resolute by enhancing the flow of vulnerability over the period, and carbon-saving is endogenously connected with reduction or substitute green technology acceptance, and it is established as reducing the proportion of carbon discharge to manufacturing procedure. Production is resolute using CES and CET equation for “productivity functions”. It receipts the form of either carbon-based or non-carbon-based energy in output production ratio concluded for the long time. Still, technology replacement and charges related to reduction might decrease with the period because of the change to non-carbon-based technologies for energy production from carbon-based energy production as traditional energy manufacturing choice that will turn out to be expensive due to harsh climatic policies. Higher radiative forcing warms the atmospheric layer, which then warms the upper ocean and gradually the deep ocean over time.

Where, T_{AT} is the temperature effect in the present period $F(t)$ is the fossil fuel uses over time, ξ is the quadratic forms of diffusive inertia and $T_{AT}(t-1)$ lags in the system are primarily caused by the diffusive inertia of the different layers (T_{LO}) and case the effect to the atmosphere know as climate change over time.

$$T_{AT} = T_{AT}(t-1) + \zeta_1\{F(t) - \zeta_2 T_{AT}(t-1) - \zeta_3 T_{AT}(t-1)T_{LO}(t-1)\} \ldots (3)$$

Here,

T_{AT} = is the temperature effect in the present period

$F(t)$ = is the fossil fuel uses over time,

ξ = the quadratic forms of diffusive inertia and

$T_{AT}(t-1)$ = lags in the system are primarily caused by the diffusive inertia of the different layers

(T_{LO}) = the effect to the atmosphere knows as climate change over time.

Amplified radiative obliging the warming at the atmospheric layer shown is equation (4), which shows how different layers ($T_{LO,AT}$) affects the atmosphere over time due to fossil fuel uses.

$$T_{LO}(t) = T_{LO}(t-1) + \zeta_4\{T_{AT}(t-1) - T_{LO}(t-1)\}$$ ………………/………. (4)

Here,

Lo= Control Limit of Parts PM

t = present year

(t-1) = number of years considered

The ASEAN RICE model forecasts economic development for Malaysia after considering its “national growth”, “venture in capital”, “marginal damage of Climate Change”, “marginal cost of controlling damage”, “back-stop technologies”, "abatement costs counter to related climatic properties and exposures”. All this were considered based on three predetermined scenarios, *viz*., (a) Climate Change with no cost for abatement (b) Climate Change under Malaysia’s INDC from COP21 until 2030 but no added decrease in carbon emissions, and (c) concentrations below doubling rate over next 100 years targeted at meeting 1.5°C temperature rise cap for the next era. The particulars of variables used, a parameter set definitions, notations for mathematical equations and units used for the approximation are obtainable in appendix 1 of this thesis[32]

4.3 Empirical Downscaling and Study Area

As for this research objective, the study area is within Malaysia, so the data utilize for this study by the researcher’s was abstract from the global level to the local level by empirical downscaling to perceive the correlation between global warming, Climate Change and damages happening due to it in the areas selected in Malaysia. The

[32] . The full details of the modeling equations and procedures are presented in Appendix 1.

acknowledged methods are useful through a national observational data set to forecast the annual cycle of experimental “(a) temperatures and climate effects, (b) GHGs warming parameters, and (b) large-scale unforeseen climate shocks." Although the projected yearly cycle remains rationalized as well as accustomed by considering “(i) national emission, (ii) net damage, (iii) climate vulnerability, (iv) abatement cost, and (v) emission control.”[33]

The annual sequence of experimental parameters for forecasted variables (e.g., climate vulnerabilities with their probable effects) besides predictor variables (e.g., average yearly circulation parameters) remain carefully monitored by the likelihood of unexpected climate shockwaves which are forthcoming. While there is concern over Climate Change, including the surfacing of limits to growth arguments that claim that the world cannot absorb too much of economic expansion, (which was initially advanced by Meadows et al., (1972)).

Also, the arguments of Stern (2007) and Nordhaus (2008) help us dismiss the trade-off argument between the environment and economic growth as depicted by the environmental Kuznets curve (Penayatou, 1993). Thus, in this chapter, we examine Climate Change forecasts besides abatement costs for two scenarios compared to “no intervention" of the BAU scenario for Malaysia. Here the purpose of the analysis is to offer alternatives that can assist Malaysia to meet the objectives of the Paris Declaration, which is to cap temperature increase over 1.5°C. till to the subsequent century.

[33] The scenario estimations are considered with the assumption that neighboring nations follow the recommendations on reducing carbon emissions made in the Nordhaus (2008) and COP 21 agendas and guidelines report. Else, the projections will be affected as the environment – being a global common – is permeable, and thus, emissions from haze fire from the neighbors can diffuse into Malaysia.

4.4 Discretion of Damage

Damage approximation within the model 'Climate and the Economy' is based on accepted facts that Climate Change impacts remain comparative to the production or output or nation-wide economic production process besides the polynomial equation of mean temperature variation (e.g., equation 5). Total Climate Change remains an equation of total loss happening over a certain period, and henceforth, it is a function ($\Omega(t)$) of climatic outcome and fraction of productivity, climatic vulnerability limits (ψ_1, ψ_2) and variation of mean atmospheric temperatures $T_{AT}(t)$ starting from the year 1990 onward. Finally, the variation of climate approximation remains appraised in this research subsequently factoring in the discharge decrease plans confined within Malaysia's INDC presented to UNFCCC (2015).[34]

$$\Omega(t) = 1/[1+\psi_1 T_{AT}(t) + \psi_2 T_{AT}(t)^2] \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Here,

($\Omega(t)$) = climatic outcome and fraction of productivity,

(ψ_1, ψ_2) = refers to climatic vulnerability limits, and

$T_{AT}(t)$ = the variation of mean atmospheric temperatures from 1990

4.5 Social Preference and Discount Rate

The ASEAN RICE model used for this research follows the neoclassical economic growth theory expectations where sustainable economic development remains heightened underneath the restraint of the discount rate (ρ) of 1.5% to interpret future costs into current standards. The "discount rate over time" ($R_{(t)}$) according to Nordhaus (2008) is measured in the contemporary and forthcoming as possessions and receipts a

[34] A different scenario may use existing patterns for production to forcast climate damage for the period year 2010–year 2105 can be found at Al-Amin et al. (2015).

financial worth (e.g., Malaysian ringgit (MYR)) by a “net inflation rate” of 3% annually (e.g., equation 6).

$$R(t) = (1+\rho)^{-t} \quad \text{......................................} \quad (6)$$

Here,

($R_{(t)}$) = discount rate over time

P = net inflation rate

This model is presumed on the way to taking a communal preference for “sustainable economic development” as definite through a “social welfare function” that positions diverse pathways of forthcoming growth that remain controlled by both climates besides economic affairs.

4.6 Source of Data

Twofold categories of data were used for this research, *viz*., “(a) macro-economic data, and (b) climate and meteorological data.” The “macroeconomic data” is attained for this research as of “Malaysia’s national accounts”, with collaboration from the “Department of Statistics and Economic Planning Unit” (DOS, 2010, 2013a, 2013b; EPU 2010), whereas, the climate and meteorological data are composed from Malaysia’s Metrological Department (MMD, 2009; NAHRIM, 2006). Following Nordhaus (2008) pattern the macro-economic data are collected from year 2010 to year 2015 is utilized for originating the macro baseline approximation for year ,2015, although “meteorological data” remains grounded for four seasons besides two yearly monsoons since year 1969 toward year 2007.

"National temperature variations" are attained from historical records starting from "1969 toward 2015" to forecast variations for concentration of GHGs 280–927ppm to create "climatic baseline" 2015.[35]

The study according to Nordhaus (2008) also implied the followings aimed at standardization of "(i) temperature variations amid 0.8°C and 1.5°C, (ii) carbon concentration (CO_2) by a maximum limit of 650ppm level of differences till year 2050, (iii) maximum carbon intentness in upper and lower strata of 950 ppm, (iv) equilibrium temperature influence of 26°C, (v) preliminary lower stratum temperature change of 0.8°C, (vi) concluding atmospheric temperature change from year 1900, and (vii) optimum abatement charges from strategies and guidelines well-defined for IPCC calculation (2007; 2011), Nordhaus (2008) besides Stern (2007). Though, few adjustments have been done to the data provided as of MMD (2009), IPCC (2007), Nordhaus (2008) also Stern (2007) review for attaining likelihood of the research.

4.7 Results and General Discussion

Under the first objective of this research, this research examined three specific and pre-set scenarios on Climate Change mitigation issues aimed at only Malaysia, as follows:

(a) The "Baseline case," which refers to a situation with no control interventions to manage the change pattern in climate (Scenario 1),

[35] Details of the southwest monsoon and northeast monsoon that influences Malaysia's climate from May to September, and from November to February can be found in Al-Amin and Leal Filho (2014).

(b) The Malaysian authority pledged INDC to UNFCCC (2015) with no further interventions after 2030 (Scenario 2),[36] and

(c) Deliberate intervention for climate control to limit upsurge of world-wide temperature to 1.5°Cover the subsequent century besides concentration of carbon near an extreme of 650 ppm since the year 1990 level (Scenario 3).

Figure 4.1 illustrates forecasts for carbon emissions for Malaysia considering the three scenarios over the year starting from 2010 - 2100. In the figure, Scenario1 designates a quick upsurge in carbon emissions from 187.6 million toe in the year 2010 to 247.8 million toes in the year 2050 and 418.8 million toes in the year 2100 through present ecological performances (scenario 1).

When Malaysia submitted its Climate Change pledges to UNFCCC, then emissions of Carbon will decline from 187.6 million toe in year 2010 to 111.6 million toes in 2050 and to 83.1 million toe in 2100 (with a baseline of 2015) (scenario 2). Nevertheless, under the planned climate control framework, the carbon emissions would fall from 187.6 million toe in year 2010 to 163.3 million toes in the year 2050 and 77.1 million toes in the year 2100 (scenario 3).

Although, the pace of emission decrease of the second and third scenarios is different, hence the speed of the fall is almost similar. The findings designate that the outcomes in a carbon emission reduction of scenarios second and third are nearby, but nature and emission fluctuations from the year 2020 to the year 2035 are entirely different.

[36] Malaysia contributed 0.62% of global emissions with an average of 6.7 metric tons/person of carbon emission, which raised the mean surface temperature by 0.14 to 0.25°C every ten years.

The second scenario displays better emission reduction outcomes over the period year 2030 to the year 2080, while the third scenario demonstrates better results over the period year 2090 to the year 2100.

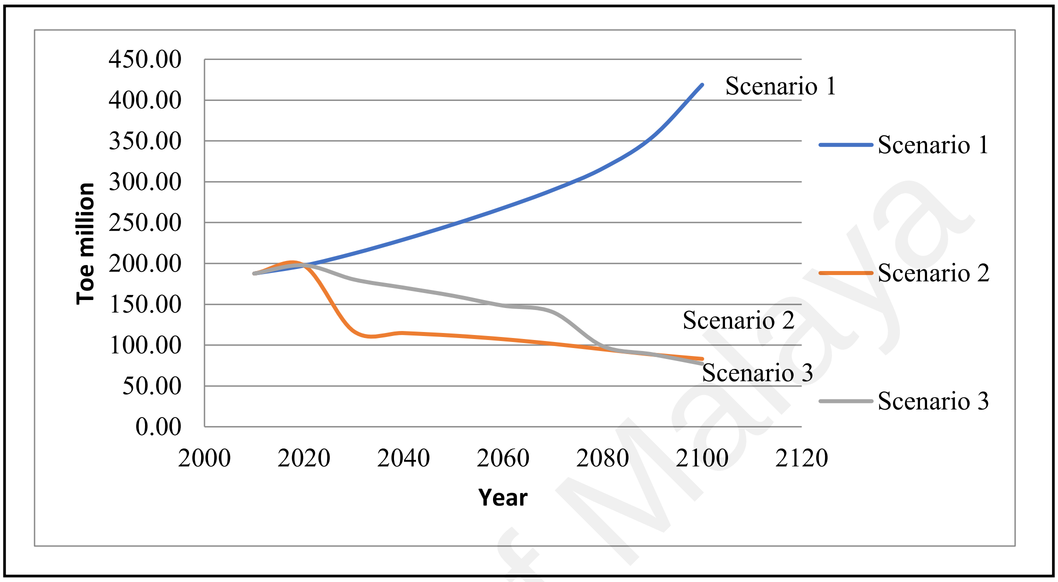

Figure 4.1: Carbon emissions, Three scenarios

Source: Authors' simulations

To comprehend better from the second beside third scenarios presented above, the significant components of carbon discharge decrease activities below several marginality situations need a valuation. Figures 4.2, 4.3 and 4.4 present all the sub-components of carbon emission decrease activities considered here.

This includes features like "marginal damage cost, marginal abatement cost, and marginal control rate" aimed at all the stated three scenarios for the period from the year 2010 to the year 2100. The elasticity of marginal utility of consumption along with "pure rate of social time preference, discount factor, capital stock, and investment projections" are also estimated here to capture the pertinent and actual longstanding forecasts. The marginality results show alterations in relative costs tendencies throughout the year 2010 to the year 2100.

Figure 4.2 demonstrations "marginal climate damage cost" of stated three situations which are starting from the year 2010 to the year 2100, and this is projected using studying the temperature besides "carbon concentration cap".

Any "Marginal climate damage" cost shows at which level, of climate action becomes sophisticated and thus extra costs are sustained, then in the second scenario because of the added costs, which will have to be accepted in order to reduce of damages happening from Climate Change from the year 2020 to the year 2100.

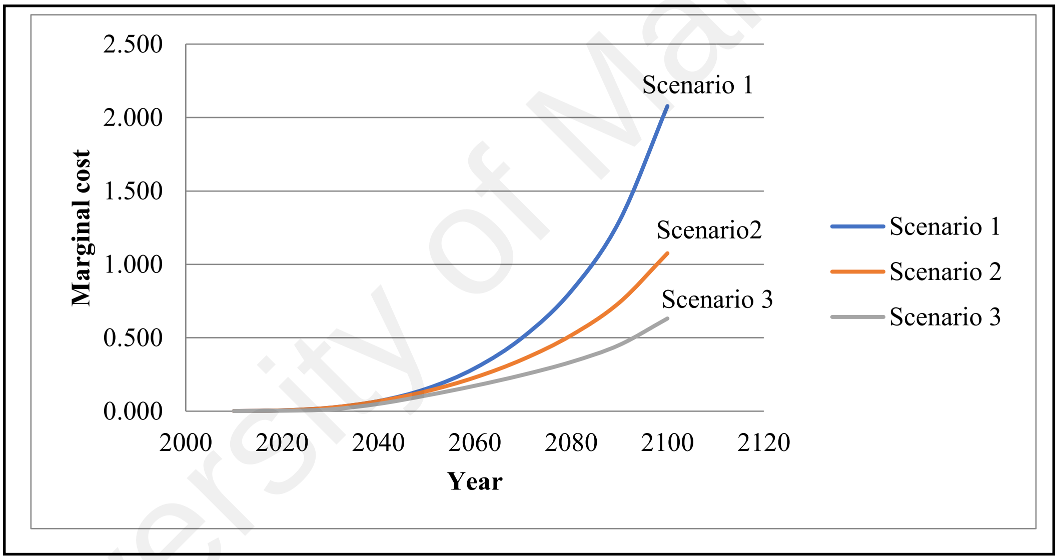

Figure 4.2: Marginal Cost of Climate Damage, Three Scenarios

Source: Authors' simulations.

The costs in scenario two increase quicker than scenario three after 2050 to almost gets double by 2100. In scenario 1, Marginal climate damage cost is highest and it is shadowed by scenario two besides scenario 3 for the period starting from the year 2010 to the year 2100.

The real climatic damage cost will amount to RM14,257 million for scenario 1, which will fall sharply to RM 3,789 million in scenario 2 and RM 1,407 million aimed at scenario 3. Consequently, the "marginal damage cost approximations" indicate that the third scenario is further economically sustainable than the "second scenario", particularly after the year 2050 forwards.

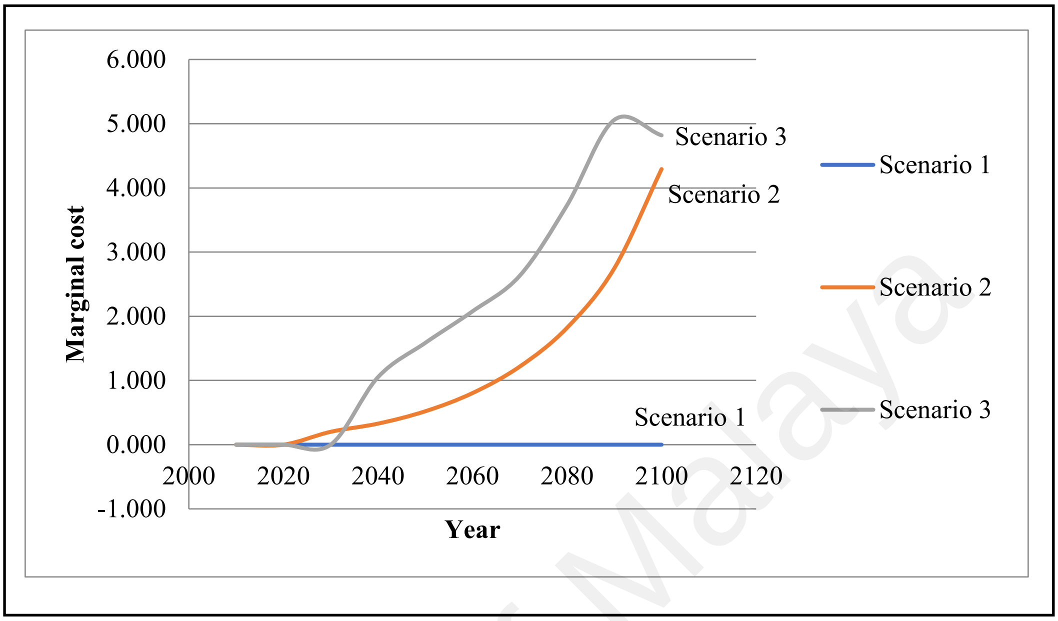

Figure 4.3: Marginal Abatement Costs, Three Scenarios

Source: Authors' simulations.

Figure 4.3 display the "marginal abatement cost" for the three given scenarios. The forecasts in scenario 2, formulated over the "emissions intensity" dropping by almost 45 % within year 2030.

It is done with the assumption that Malaysia will use the latest greening knowhow with suitable preferences targeted at emission control with adequate Climate Change financing for the first 35% reduction in emissions, and capacity building support from the developed nations for the remaining 10% (UNFCCC, 2015). The results obtained from the analysis designate marginal abatement costs besides relative consequences for scenario two besides scenario three starting from the year 2010 up to the year 2100.

Marginal abatement cost calculated here, using the ASEAN RICE model from the year 2020 to the year 2025 and year 2100 under scenarios 2 and 3 is almost alike. However, the results seem to be quite diverse for the period of the year 2035 to the year 2090. It demonstrates that abatement cost for scenario 2 is comparatively diffident and there are moderately few upsurges in propensity relations associated with scenario 3.

Thus, the "marginal abatement costs" of "scenario 2" show the best result. Here marginal abatement cost destined for scenario 1, 2 and three will be Zero, MYR.11.93 million and MYR. 20.95 million correspondingly. The total abatement costs[37]for scenario 1, scenario 2 and scenario three will then be Zero, MYR. 14,350.6 million, and MYR. 14,644.7 million respectively.

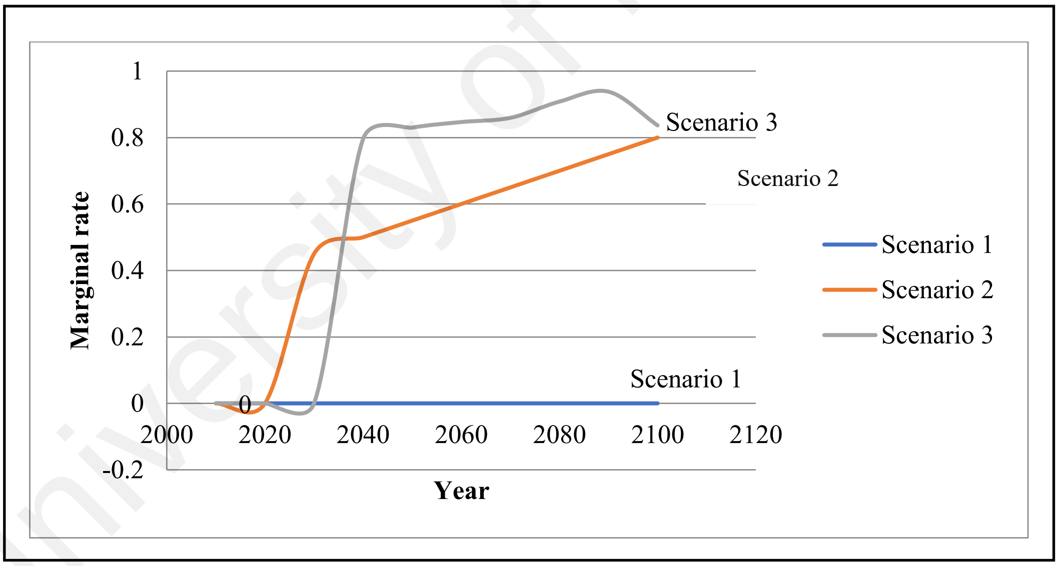

Figure 4.4: Marginal Control Rates, Three Scenarios

Source: Author's' simulations.

Figure 4.4 above offers the "marginal control rate" plotted from the year 2010 to the year 2100 considering all the three scenarios stated earlier. The results show the same "marginal control rates" for both scenario two and scenario three throughout the year 2010 to the year 2100. However, the "marginal control rates" deviate with a period,

[37] Total abatement cost is derived by multiplying the marginal abatement cost with cumulative damage measured in toes.

particularly from the year 2025 onward till the year 2095. So, the "control rates in scenario 3" seem to be increasing a bit higher than "control rates" for scenario two for the year 2020 to the year 2035.

Although, the "control rates" for scenario three seems to rise faster than in scenario two from the year 2035 to the year 2095. Notably, under the COP21 suggestion, the proposed carbon emissions will gradually start to fall and at a faster speed starting from the year 2035 to attain the pledge made to UNFCCC by Malaysia.

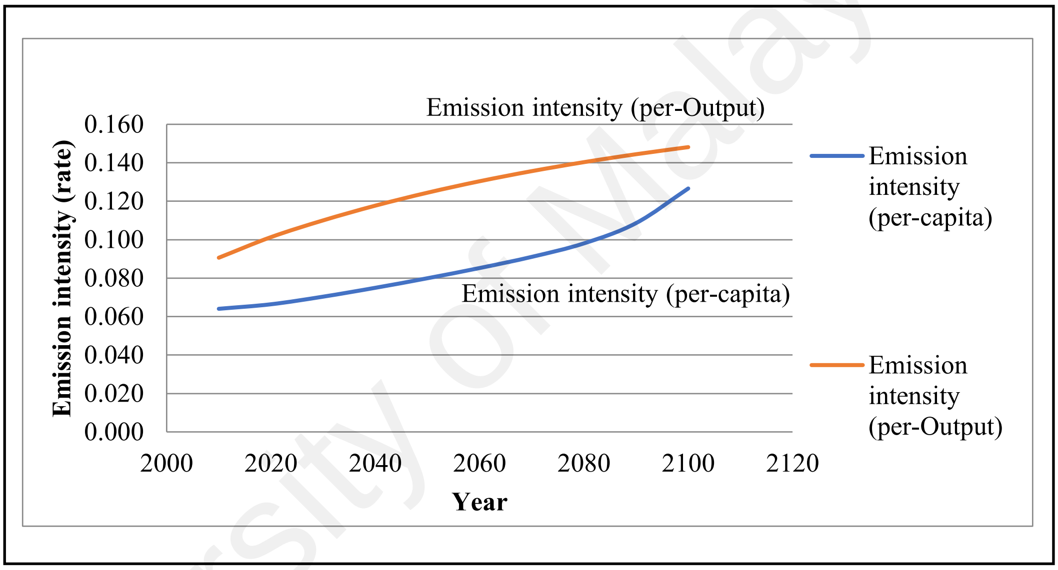

Figure 4.5: Emission intensity, Scenario 1

Source: Authors' simulations.

However, the emission scenarios cannot alone designate the best selections, and hereafter, we examine a different kind of emission intensities besides marginal cost reductions in the next segments.

Figures 4.5, 4.6 and 4.7 offers emission intensities under scenarios provided, like scenario 1, 2 and 3, correspondingly. Here all are appraised on the foundation of per-capita besides per-output estimations for the epoch starting from the year 2010 to the year 2100.

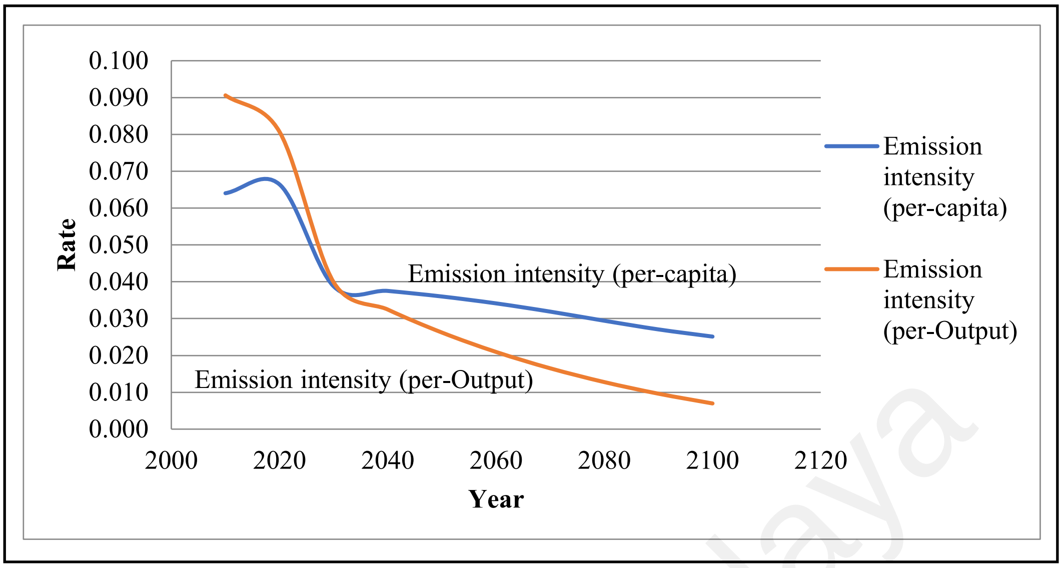

Figure 4.6: Emission intensity, Scenario 2

Source: Authors' simulations

The "Carbon intensity per-output" here is quite higher than per-capita consideration. The findings indicate a declining percentage with time in mutual scenarios for per-capita besides the per-output basis for scenario 2.

Also, "emission intensities per-output" show an additional collapse if it is compared with emission concentrations per-capita scenarios, mainly from the year 2030 onward when Malaysia finishes with the implementation of its INDC pledge to UNFCCC until the year 2100.

Under scenario 3, the graph for "emission intensity per-output" drops quicker than "emission intensity per-capita." Such answers call into query, about "Malaysia's INDC commitment to the UNFCCC" given that, dimensions used here are taken on a "per-capita basis" relatively than a "per-output basis."

This research also measured the "Climate control" possibilities employing "emission intensities" happening in the regional economy besides preventing absorption of GHG's by COP 21 emission reduction strategies, directed at averting climate harm during the long run with deliberate "climate control" measured as an optimal condition.

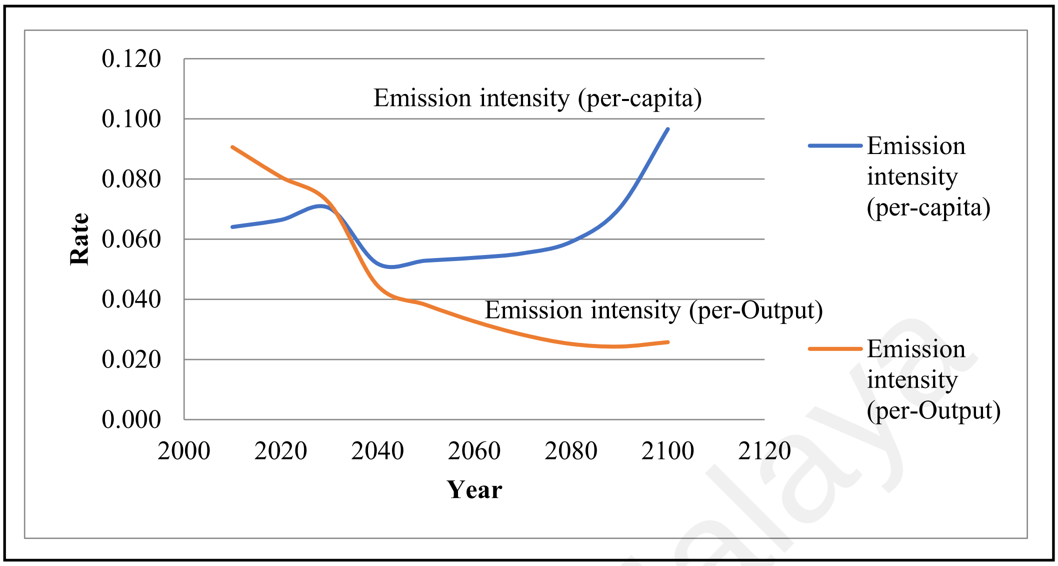

Figure 4.7: Emission Intensity, Scenario 3

Source: Authors' simulations.

The results using the emission intensity option and limiting the concentration of GHGs are obtainable in Figures 4.8 and 4.9 below. The results from the ASEAN-RICE model simulations display "emission concentration" remains predictable toward increase by maximum of 899 ppm for scenario 1, 850 ppm in scenario 2, besides 851ppm in scenario 3.

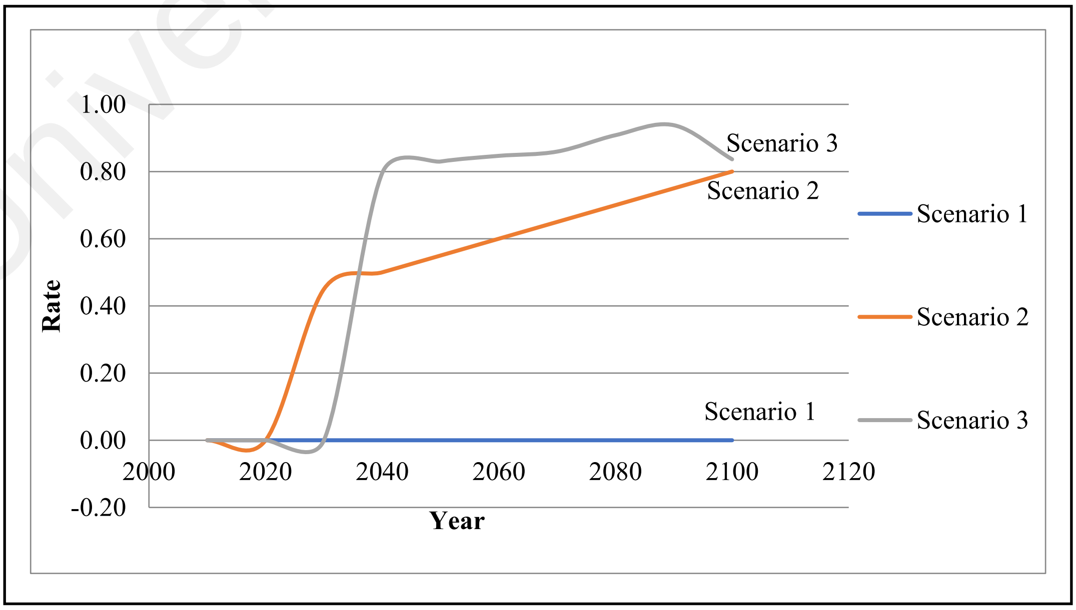

Figure 4.8: Emission Control Intensity, Three Scenarios

Source: Authors' simulations.

For scenario 2, “carbon concentration” is forecast to upsurge to an extreme level of 390 ppm in the year 2020, 677 pm in the year 2050 and 1087ppm in the year 2100, 390ppm in the year 2020, 677ppm in the year 2050 and 881.29 ppm by the year 2100.

The findings specify resemblances in controlling emissions by the end of 2100. Though, yearly controlling rates for the period starting from year 2035 to until the year 2080 are stronger within scenario three compared to that of the result of scenario 2.

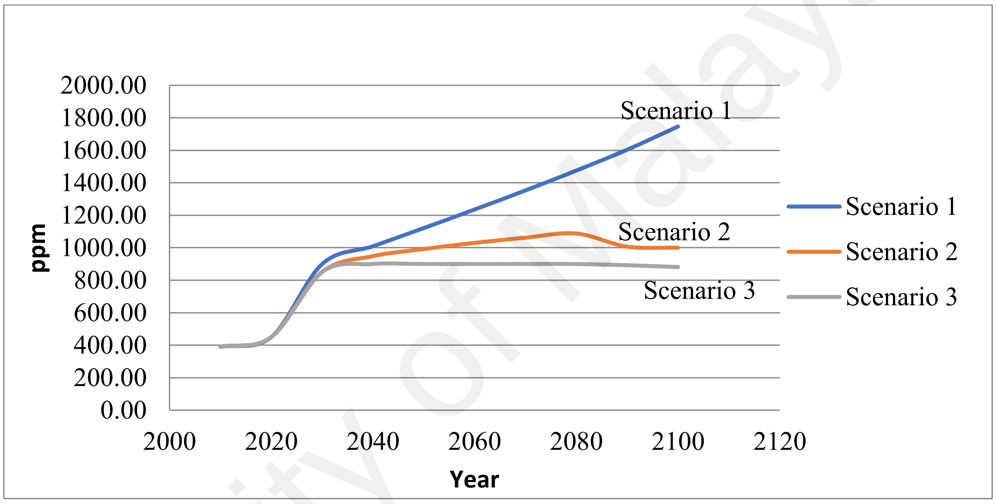

Figure 4.9 Emission Control Rates (Ppm), Three Scenarios

Source: Authors’ simulations.

Generally, scenario two besides scenario three mutually offers plummeting forecast trend for GHG’s releases over period. Still, here are “variances for concentration” and “pace of emission fluxes”, so the “abatement costs” amid the two core scenarios.

Significant differences between, two scenarios categorize that, Scenario 3 considered here is the most excellent available option when the importance is more focused on dipping emission intensity, but Scenario 2, shows the importance of the analysis is more on to ensuring fewer abatement costs.

Subsequently, as the core objective of our research is to minimize emission intensity efforts, so we must take necessary steps to raise the expansion of backstop technology, within the specially selected sector as a long-term mitigation option which would unavoidably increase the necessary abatement costs.

4.8 Summary

This chapter following the first research objective (RO1) presented in Chapter 1 of the thesis, which includes the plan to examine Malaysia's climate mitigation scenarios over the period from the year 2010 to the year 2100. It was tested, based on the existing strategies including "no intervention scenario or BAU Scenario" and two proposals-based mitigation action scenario that has been accessible in recent climate policy dialogues; namely, INDC submitted for Malaysia's, which was defer to UNFCCC. That proposal includes options for no interventions till 2030, and after 2030, both prearranged and severe climate control interference proposal to block worldwide increase of temperature within 1.5°C and also maintains “carbon concentration” near an extreme of 650 ppm since 1990 equal.

Cumulative damage resulting from of climatic change during the period of the year 2010 to the year 2100 was estimated to be amount to 2,722 mtoe under the contemporary climate rule or Scenario 1; 1,203 mtoe following Scenario 2, besides 699 mtoe under Scenario 3. On the other hand, increasing carbon concentration during the period, year 2010 to year 2100 was estimated to be amount to 11,912 ppm under the present climatic regime, which may decrease to 9,714 ppm and 8,592 ppm correspondingly following scenarios 2 and 3 correspondingly. Since, “total cost for abatement" in scenario 2 is MYR.14,350.6 million, which, seems fairly near to that of scenario 3 of MYR.14,644.7 million, but it is an undeniable fact that the third scenario suggestion is the greatest among the three options we considered for this objective.

These results are not only significant to outline Malaysia's Climate Change mitigation roadmap, but they also suggest a set of actions to be undertaken for other regional nations, who are looking forward to conducting the identical. The results augment our present knowledge for "(a) formulating the long-standing national Climate Change mitigation policies for Malaysia itself, in particular, and (b) persevering the anticipating openings in our perceptions for the impact, (with costs) of dissimilar climate regulator selections. While, final target group for this research is considered as the policymakers of Malaysia mainly, so an extensive assortment of research societies in addition organizations linked with Climate Change training in this regional area are expected to benefit from this analysis due to the fundamental considerations and trends of this scientific outcomes.

CHAPTER 5

CLIMATE SCENARIO PROJECTIONS FOR ASEAN 2060

5.1 Introduction

This chapter is second analytical chapter of this research study that attempts to analyze climate mitigation impact over the ASEAN member nations. It also introduces their respective "Intended Nationally Determined Contribution (INDC)" submitted to UNFCCC according to IPCC (2014b) following "Paris Accord" and "Marrakech Proclamation" (COP 22).

For analysis part of this chapter we use dynamic, non-linear and computable general equilibrium model by also considering the "Input-Output tables of 2010". We did so to estimate the mitigation significances of Climate Change following the INDC framework (optimal scenario) and the Business as Usual (BAU) scenario. This thesis chapter starts with the notation that, according to IPCC (2014b) Climate Change is a grave hazard for forthcoming well-being of civilization.

To accomplish the targets of significant reductions of CO_2 emissions, target obligatory for emissions of regional greenhouse gas (GHG). So, altering the regional consumption outline for selected ASEAN nations are progressively recognized as noteworthy support for encountering the global challenge for mitigation of Climate Change. The IPCC (2014) report for mitigation, states that individual human behaviour, as well as specific lifestyle pattern, and also certain cultural practices have substantial stimulus on the usage of energy category besides emissions. Moreover, according to IPCC (2014) report by steadying or else dropping usage, it is promising to confirm transitioning towards an allocation-based economy and accepting behavioural changes that may have a superior perspective for mitigation

The core aim of this chapter is to assess Climate Change and its impact on economic growth using the three alternate scenarios for “no-action” besides “the combined INDCs submitted by the ASEAN nation governments to the UNFCCC.” With the “Regional Integrated (ASEAN RICE)” model aimed at climate beside economy, we assess the efficacy of ASEAN member nations INDC’s to alleviate “Climate Change impacts” without reducing the growth rates for economic development. We begin with an explanation of the essential concepts, debates, and the state of the environment among the countries studied. We introduce the material and methods used before examining the results.

5.2 Key Concepts

Before going further into the detail of the discussion, it is relevant to outline the central two critical notions, explicitly, "Climate Change" besides "Development" for this chapter. The term, "Climate Change" according to Sachs (2015) mentions toward a serious degree of alteration in the general weather that may have a remarkable effect on all of human life, economy, besides development. On the other hand, the term "Development" according to Sachs (2015) is a multifaceted notion that poses solid, non-solid besides normative essentials, for approximation purposes. Here we can also outline "Development" at this moment, refers as a cluster of favourable variations for any given nations, in the certain period, specific economic exhibitor, like, “GDP growth, population growth, besides energy consumption.”

The rising of population sources extra demand of energy within any given region and results in higher consumption of energy produced in a given time. Thus, as the least developed and developing nations, according to Sachs (2015), remain categorized with higher birth rates, and face a significant increase for energy demanded as they focus for rapid economic development.

It is also a fact that, the primary clients of energy mostly are industrialised nations. Henceforth, prospects towards attaining development among nations will only increase further demand for energy. Sachs (2015) also point out the fact that, the rising demand for energy made it difficult to reserve or store energy. It is also important to note that we need to shift the bases of energy supply, as of fossil fuels (for example, Coal, Gas, Oil, and Wood), that emits CO_2 besides additional GHGs gasses. We need to shift to non-fossil and renewable energy sources with zero emission, like, Wind power, Solar power, and Hydro Power. Following the IPCC, (2014b) report, if we continue to use fossil fuel and continue emission of CO_2 in the present manner, then the world will reach to the point of no return very quickly and is threatened by worse climatic impacts such as global warming, tsunami, and rising sea level.

According to IPCC (2014b) report, as carbon emission from human actions are considered as the critical components of Climate Change problem, to accomplish the transformation to low carbon economies, it is significant that individuals and groups, communities, all require to alter their current usage and behaviour's practices to confront the change in climate. However, there are many opinions and differences for the signification of climate-friendly regimes, which will necessitate in relations of substantial variations for production beside general consumption process in the long run (IPCC, 2014b). Also, there is no guarantee if such variations need to be incremental, applicable besides appropriate into peoples' present lives (Lorek and Spangenberg, 2009; IPCC, 2009; Jackson, 2011).

When we focus on mitigation efforts of Climate Change, we usually look for consumption patterns, as that need certain kind of shifting the possessions of people obtaining towards substitutes by inferior climate impacts (Lorek & Spangenberg, 2014) and decontaminating our energy preservation performs (like, putting off the room lights when leaving, or regulating interior temperatures) (Clarke et al., 2014). Though apropos practices, we can ensure and maintain considerable decreases in emissions of CO_2. According to Schanes, Giljum, & Hertwich (2016), it is serious to substitutes to pursue new form of renewable energy and more full chances to decrease emissions.

There are many actions available according to IPCC (2014) that folks can uptake to green society by way of growing quantity of know-hows trade by low-carbon lifestyles. In order to modify behaviors of human properly, initially this is significant to stipulate certain target behaviors (Darnton and Horne, 2013). As of the perspective of household's, there are diverse behaviour patterns to spread the goals of low carbon policy. This kind of reductions according to Darnton and Horne, (2013) may be comprehended by abating the thermostat, fitting “double glaze” otherwise “solid window”, and good lining within the buildings, as well as fitting such gadgets in every new building. Local Individuals according to IPCC (2014b) can also set up “Solar panels” over their house roof tops to fulfil their daily requirements of energy. According to IPCC (2014b), different types of Individual and organizational behave differently for their energy demand, following their contexts and features. In dissimilarities with the idea of the “Limits to Growth” initiated through “Club of Rome” (Meadows et al., 1972) and following (Penayatou, 1998; Sachs, 2015) the alternatives we have is the fact that, there is no need to sacrifice economic growth for Climate Change. (Stern, 2007; Nordhaus, 2008).

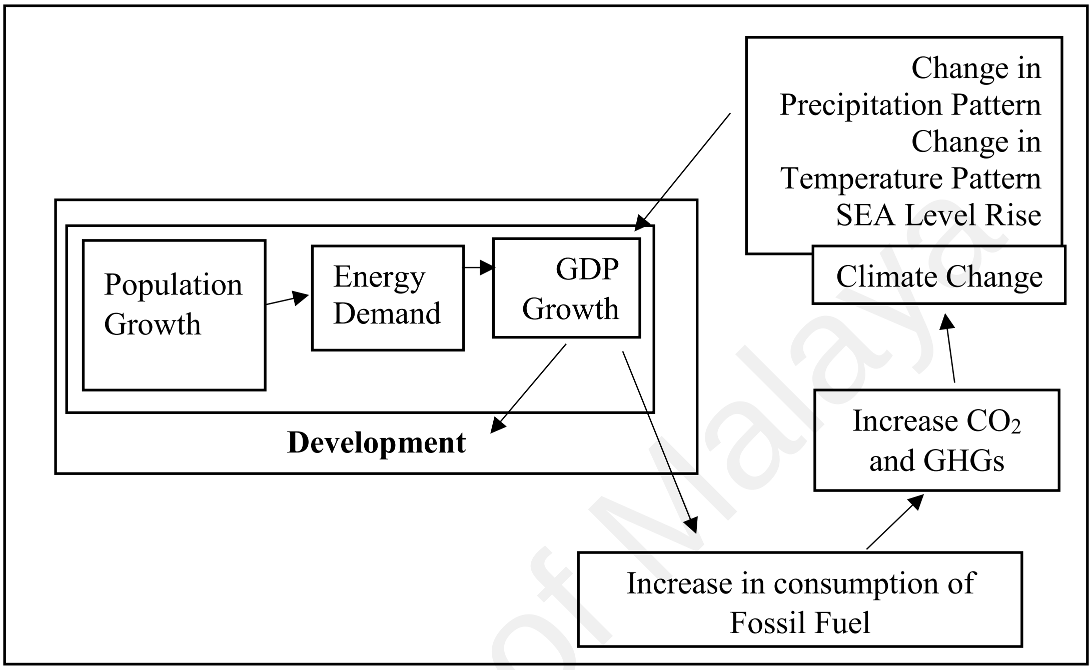

Figure 5.1: Population, Development, and Energy Demand Nexus
Source: Plotted by author

To attenuate the impacts of Climate Change and to confirm that national performers in related sectors perform a vital part in this progression. All the ASEAN nation, including 192 states from the world promised to submit “Intended Nationally Determined Contributions” (INDC) to UNFCCC during COP 21 (2015) following “Paris Agreement”, that wanted to minimize the rise of worldwide temperature by 1.5°C within following century from the base year of 2005 (UNFCCC, 2016).

The actions necessary for mitigation of Climate Change limited in the INDCs are focused to attain the long-term targets set by the Paris Agreement, which was prolonged till the year 2050, for the ASEAN nations focusing the “Marrakech Declaration”. INDC’s submitted from the ASEAN member nations in 2016 to UNFCCC are provided with in the following table:

Table 5. 1: INDC's Submission for ASEAN member nations

Sl	Country Name	Country Code	Submission Date
1	Indonesia	IDN	9/24/2015
2	Brunei Darussalam	BRN	12/1/2015
3	Lao PDR	LAO	10/1/2015
4	Malaysia	MYS	1/18/2016
5	Myanmar	MMR	9/28/2015
6	Cambodia	KHM	9/30/2015
7	Singapore	SGP	7/3/2015
8	Vietnam	VNM	9/30/2015
9	Thailand	THA	10/1/2015
10	Philippines	PHL	10/1/2015

Source: UNFCCC (2016)

From the above discussion, it is visible that the United Nations Framework Convention for Climate Change (UNFCCC) by "Conference of Parties (COP)" wanted to attain extreme courses for inversing Climate Change impacts. During COP21 (2015) at Paris, the scientist community was trying to halt temperature increase at 1.5°C globally within next century. However, the year 2030 remained initially set as the deadline fixed during the COP21(2015) conference to complete this target. This was later revised and reformed to be attained by the year 2050 at the COP22 (2016) that took place in Marrakesh in 2016 (UNFCCC,2016). ASEAN member nations likewise others also submitted their INDCs with detailed set initiatives to decrease carbon discharges. For Malaysia in particular, it needs to reduce in total emission of CO_2 by 45% within the year 2050, of which the first 35% of the target reduction of emission of CO_2 attained by their efforts and capacity. The attainment of the remaining 10 %, depends on the fact that only if they get green technology support from developed nations. Thus, this chapter of the thesis tries to appraise the efficiency of ASEAN member nations INDCs in plummeting climate damage for them besides their significances on long term economic development.

5.3 Environmental debate

Initial acknowledgment of hazards linked to Climate Change arose as of the ideas, while the prominent economists of the world disagreed over adverse effect from faster population growth and their excessive demand on scarce resources (Malthus, 1798; Ehrlich, 1968), It hypothesized that, population. is growing too fast, to be supported by the earth's scarce resources and may not sustain long term growth. The "Club of Rome" conferring to Meadows et al., (1972) used a model to conduct a simulated analysis by computer run and that initiatives prove that there are certain limits for every kind of development, This actually cautioned certain republics to recognize that the world cannot support their over growing population, and so they need to control their population growth rate and hence associated economic development may vary proportionally from country to country.

This argument acquired a more complex ruling in policy formulation level as Kuznet (1955) and Panayotou (1993) familiarized the upturned "U shaped Kuznets curve". This curve explaining in what means any contamination concentration may rise in the early stage of economic expansion and as we all know that; growth only happens from the occurrence of smaller utility for a good environment. Firstly, after a certain level of an environmental threshold is met, material development is accomplished. After that, contamination intensities are expected to decrease once the usefulness of the atmosphere surpasses the value of substantial growth. The importance of a fresh atmosphere is measured to increase progressively as per significant development stands to raise.

Marginal utility from the surrounding atmosphere is estimated to be insignificant during the initial development phases of substantial accumulation, although with certain time it will surpass and extend its utility vacuum with the of significant expansion as the economy continues to produce more. Such arguments are not useful as the world cannot afford to experience nations consecutively changing their attention from pollution reduction to cleaner energy, and smarter green rules for economic progress. Nordhaus (2008) illustrated that novel technological expansions also demonstrate that nations are capable of withstanding high level of economic growth and development even they go for alteration of energy usage generated from fossil fuels to non-fossil-fuels.

Moreover, as the ambiance remains measured as a global common (Hardin, 1968), so all nations will be equally influenced by environmental discharges from any portion of the biosphere, with the effect being strongest as of the neighboring nations. Now, there is undeniable proof that worldwide warming is being happened by a change in climate, and it is frequently linked with human actions for energy production (Stern, 2007; Nordhaus, 2008), although the probable hazards are facing by the planet earth, which goes far outside of human activity. Thus, any sound state strategies have to an emphasis on the following sectorial matters to ease the impacts of Climate Change:

1. Features of developing climate movements
2. Nationwide Mitigation competences
3. Organized Backing
4. Elementary Substructure
5. Inferences for Strategy
6. Inspiring backstop technologies

Societies make sensible policy decisions based on Scientific evidence. Thus, scientific evidence and innovation information's are crucial as a vital component for smart and sustainable development. The science of Climate-change is anticipated to endure to help the societies in making conversant decisions for how to decrease the degree of Climate Change impacts and how to move towards mitigation. CO_2 is one of focal component of GHG's that will captivate heat (infrared radiation) emitted from world surface. As concentrations of these gases increases in the atmosphere, it causes the globe to warm up through trapping additional heats. Actions done by human, particularly the use of fossil fuels from the beginning of the "Industrial Revolutions", for industrial production as well as for individual consumption have augmented atmospheric concentration of CO_2 by almost 40%, by more than half of this upsurge was occurring since 1970.

Subsequently, from the year 1900, universal average temperature of earth surface has augmented by around 0.8 °C (1.4 °F), which have triggered heating up of the seas and an increase in its global levels. A steady deterioration in the sea ice of the arctic, and many other linked effects of environment. A considerable part of this kind of warming in the earth have occurred as a chain reaction, starting from a rise in the global temperature. Stern (2007) and Nordhaus (2008) provided a scientific evidence-based study to claim that the heating occurred throughout this period is mostly an outcome of amplified attention of CO_2 and additional greenhouse gases emitted by a human while perusing development actions in the manufacturing sector. Continuous discharges of these GHG gases in enormous quantity would deteriorate the climate damage, with significant upsurges in "global average surface temperatures" with a harmful effect over systematic weather. Scale beside timing for such climatic variations depend over numerous effects.

However, the so-called "Climate Change" is mostly happening for the whole amount of GHGs emission happening from worldwide human actions. Forecast for any specific long-term periods of climate variations indicates that, such alterations are happening from increase of collective greenhouse gas emissions in the atmosphere, within that specific time period. This is also a long-established claim supported by the climate research from different scientific communities (Nordhaus, 2008). However, the realization of climate and its significances on economic development pace and regional-to-local spatial scales remains insufficient. The magnitudes of both Climate Change and Development have convert areas of active investigation and are summarized in the following table below:

Table 5.2: Change in Climate and Development Significances

CLIMATE CHANGE	DEVELOPMENT
1. Is Real & Happening	1. For nations, Economic growth is usually measured by using GDP growth
2. Its Human Induced	2. High levels of poverty, inequality pre-exists
3. A Problem with Global Common	3. Manufacturing additional energy as demand rises
4. It's not only Environmental but also an Economic Problem.	4. Energy is used in industry, in transport, in houses, and in agriculture.
5. Effects few generations	5. It's a Global process

Source: plotted by Author

The UNFCCC through its annual Chief of Parties (COP) conferences continued to deliberate on actions toward stop global temperature increase by inspiring the partaking governments to control emissions of carbon and minimize carbon concentration as much as possible, that concluded in 192 nations promising to stop rise of temperature to 1.5°C within next century. According to, World Bank (2017) report, Climate Change will take a noteworthy effect on different, regionally divided areas.

So, we have considered selected ASEAN member nations for this research, as they are within the most vulnerable world's regions due to "Climate Change".

We focus on selected ASEAN member nations because a couple of them are still very much defenceless towards the impacts of Climate Variation. "Global Climate Risk Index-2019", presented in COP 24 on Dec 04 at Poland in 2018, positions that among the most affected Top ten Nations of the world, affected by extreme climate events ranging from 1998 – 2017. Among them three nations are from the ASEAN region namely Myanmar ranking in Number Three, the Philippines in number Five and Vietnam in number Nine. On 2018 on the same Index their position was Three (Myanmar), Five (Philippines) and Eight (Vietnam).

So, for few ASEAN nations in order to ensure economic development, we cannot overlook the impacts of Climate Change. To achieve "effective economic growth and development" in ASEAN region, we need to mitigate the influences of Climate Change. As out of 10-member ASEAN forum, the three-member nation is considered as most vulnerable and affected nations from 1998 to 2017 globally for climatic events. This is a serious concern and impediment to Economic progress and development for the ASEAN region. Table 5.3 represents the longstanding "Climate Risk Index (CRI) 2019" that represents all ten member nations that most affected from the year 1998 to the year 2017 (annual averages).

Table 5.3: The Long-Term Climate Risk Index (CRI): the ten nations most affected from 1998 to 2017 (annual averages)

CRI (100) 1998-2017 (1997-2016)	Country	CRI Score	Death Toll	Deaths per 100 000 inhabitants	Total losses in million US$ PPP	Losses per unit GDP in %	Number of e (total 1998-2
1 (100)	Puerto Rico	7.83	150.05	4.061	5.033.16	4.204	25
2 (1)	Honduras	13.00	302.45	4.215	556.56	1.846	66
3 (3)	**Myanmar**	13.17	7048.85	14.392	1275.96	0.661	47
4 (2)	Haiti	15.17	281.30	2.921	418.21	2.642	77
5 (5)	**Philippines**	19.67	867.40	0.971	2932.15	0.576	307
6 (4)	Nicaragua	20.33	163.60	2.945	223.25	1.009	45
7 (6)	Bangladesh	26.67	635.50	0.433	2403.84	0.064	190
8(7)	Pakistan	30.17	512.40	0.315	3826.03	0.567	145
9(8)	**Vietnam**	31.67	296.40	0.350	2064.74	0.516	220
10 (44)	Dominica	33.00	3.35	4.718	132.59	21.205	8

Source: https://germanwatch.org/en/16046

https://unfccc.int/event/germanwatch-global-climate-risk-index-2019

5.4 Materials and Methods

For measuring the long-term effects, of Climate Variation, here as before, we use a dynamic and dual multi-disciplinary ASEAN-RICE model[38]This prototype helps us to unite, evaluate and deploy cost-effective economic, environment, earth science, and environmental ideas.[39] This double multi-disciplinary framework is a "non-linear, quantifiable model" grounded over "Empirical Regional Downscaling Dynamic Integrated framework of Climate and the Economy". This specific "RICE model" described here how uses of climatic features, like "Climate Change, carbon cycle, climatic damage, and carbon emissions," which actually impact overall regional economic development. It also focuses over the "endogenous variables" like "population, capital stock, output, fossil fuel stock, and the pace of technological change" in order to appraise the effect of INDC's, from all "ASEAN" member nations.[40]

The "exogenous variable" used in for the "ASEAN RICE" model is actually "policy thrusts", that presumed "top-down approach". Quantifiable components that used here are actually the worth of products besides services, by means of exposures that are insignificant then contemporary values. The ASEAN RICE model used here also account for sustainable economic growth through seeing ASEAN development with forthcoming vision, venture the capital, level of consumption, besides technological development in contrast to linked effects and exposures of climate change.

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[39] This specific model is executed by deploying a "mathematical optimization focus" through using "geometric, algebraic modeling system (GAMS) programming".

[40] "Technological change" is seen here as a exogenous component for study. The deploying "CGE modeling" actually makes these limitations unavoidable. So, we attempt to introduce the "backstop technologies" which are linked to greening of the economies. Here, the "Abatement costs" are deliberated, to understand "impact of consumption per capital", which may be static by nature.

Forecasts for GHGs emission trailed endorsements on forthcoming targets are accessible from “Fourth Assessment Report” by IPCC (2007) and the replacement of fossil-based fuel through non-fossil based renewable energy for reducing the emissions of CO_2 by deploying backstop know-hows. Emissions which are not-industrial besides non-carbon particulates that are measured in the damage estimate as per suggested in both 3rd and 4th Assessment Reports from IPCC (2007, 2001). The particulars of our study resources and methods used are accessible in the appendix.[41]

The measurements of climate variations utilized in this research were accepted for every of the ASEAN member nations, while “climatic data” is collected from “European Commission (EU, 2015 JRC/PBL, EDGAR)”. Struggle towards attaining climatic data from one source was considered to confirm that the data we used here for this research is collected reliably and also for the specific time periods. The conditions and estimate deployed in this research follows the model made by Nordhaus (2008) meticulously, with an experimental downscaling process to perceive exchanges amid “global warming, Climate Change and damage to the economies (see Appendix 1)”. Economizing the adoption dimensions signify a range of rational climate consequences from the year 2010 to the year 2060, as they are endogenous. The accepted “top-down modeling” method begins with variations at the global phase with a focus on specific nations then how they are managing climatic enterprises and addressing it in the research through disaggregation by means of distinct national data. Emphases on the ASEAN member nations, considering the explanation of an extensive range of probable climate consequences through shifting as of the global to the regional scales besides level. The accepted methods are deployed by assessing a wide-range of dataset to forecast the “annual-cycle” of practical (a) temperatures besides (b) large-scale effects of circulation. Two key instruments we used to analyze these data and then to forecast

[41] The full description of the model equations and procedures are presented in the Appendix 1-3.

here are “General Algebraic Modelling System (GAMS)” besides “Syntax Programming (SP)”. GAMS in addition SP, both were use here towards explain “non-linear in addition mixed-integer difficulties” for developing “ASEAN-RICE” economy-based mathematical climate modes. This research starts by means of originally considering the effects of temperature founded at “business as usual” settings aimed at ASEAN member nations to forecast future setups of climate arrangement until year2060 with the hypothesis that no extra interference will happen in the climate management.

In Scenarios two, which supports interferences essential to implement the INDC’s by the individual ASEAN nations regimes. The “discount rate” is 1.45% for ASEAN nations is considered for translating the “future costs into present values”. “Discount rate” is assessed here for present and future goods into “Ringgit Malaysia (MYR)” as a “real discount rate through net inflation”. This research use “inflation rate of 3% annually” for ASEAN nations, and is collected from “ASEAN Secretariat (2015)”. Lastly, the “cost of carbon emissions” is calculated by pricing it following the “social cost of carbon”, that signifies “present value of extra monetary harm” in the forthcoming from extra releases of CO_2.

5.5 Sources of Data

For this analysis, two kinds of data were deployed. The first set of data is for the ASEAN macro-economic assessment for nature, which is accomplished from “ASEAN Secretariat (2015)”. The second dataset is accomplished from Meteorological division of Malaysia (MMD) and is based on climate parameters (MMD, 2009; NAHRIM, 2006). All “large-scale predictor” of “ASEAN climate data” was occupied from the

"European Commission (EU, 2015 JRC/PBL, and EDGAR)". The temperature differences of ASEAN nations were derived as of "historical EU records" for forecast changes within significant rule of differences through "concentrations of GHGs (280-927 ppm)". Yet, some adjustments are made, to data collected here to attain the study scope beside to apprehend long-term effect as of year 2010 to year 2060. End year 2060 was preferred instead of year 2110, by following the revised amendments of "Paris accord". Such kind of numerous possessions are expected to change with time in the following few decades.

5.6 Results and Discussion

Dynamic climate model deployed for this research is identified as ASEAN RICE model. This specific model is used to measure the effect of Climate variation of ASEAN member nations over the next 50 years ranging from year 2010 to year 2060. It will maintain close inter-generational neutrality for resource distribution in addition to "rate of return of capital" for calibration for long-term approximations. "Cost of technology" here is grounded over "marginal clearing rates" (negligible harm stands equivalent to the marginal cost aimed at dropping the "last unit of carbon emissions") from year 2010 to year 2060. Table 5.2 and Figure 5.2, both represent the estimated "contemporary emissions for ASEAN" member nations using "elasticity of the marginal utility of consumption" by considering pure rate of "social time preference" of 1.45% annually. While such Scenarios were built on "ASEAN INDC's" that used "substitution of carbon-intensive energy with backstop technologies", as the business as usual quantity Scenarios bids no replacement.

Table 5. 4: BAU and Optimal scenarios, for ASEAN, 2010-2060

Year	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Industrial Emissions BAU (bT CO_2 per year)	2	3	5	8	12	18	25	35	44	59	68
Industrial Emissions Optimal (bT CO_2 per year)	1.832655	3.103922	5.11151	7.813809	11.7839	9.552256	13.68514	19.09013	23.59509	31.31012	31.99
Atmospheric concentration of carbon BAU (ppm)	390	314	304	287	301	287	310	294	326	305	351
Atmospheric concentration of carbon Optimal (ppm)	390	314	304	287	300	287	304	287	314	291	329
Atmospheric Temperature BAU (deg C above preindustrial)	0.80	0.79	0.76	0.71	0.69	0.66	0.67	0.66	0.70	0.71	0.79
Atmospheric Temperature Optimal (deg C above preindustrial)	0.80	0.79	0.76	0.71	0.69	0.66	0.66	0.64	0.66	0.65	0.71
Climate Damages BAU (fraction of gross output)	0.014	0.024	0.038	0.056	0.085	0.119	0.184	0.256	0.413	0.580	0.977
Climate Damages Optimal (fraction of gross output)	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Consumption Per Capita BAU (thousand RM per year)	7.5	9.8	13.0	17.4	23.3	31.0	40.9	53.4	69.0	88.5	112.3
Consumption Per Capita Optimal (thousand RM per year)	7.5	9.8	13.1	17.5	23.4	31.1	40.9	53.7	69.5	90.0	114.5
"Carbon Price BAU (RM per t CO2)"	1.121536	0	2.37847	0.147835	5.226192	1.040485	11.19901	3.729649	23.07531	10.70182	45.83958
"Carbon Price Optimal (RM per t CO2)"	0	0	0	0	0	230.4167	224.6563	219.0399	258.1614	251.7074	245.4147
Emissions Control Rate BAU (total)	0.00	0.00	0.01	0.00	0.02	0.01	0.04	0.03	0.09	0.07	0.16
Emissions Control Rate Optimal (total)	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.45	0.50	0.50	0.50
"The social cost of carbon BAU, RM"	15.92	13.23	36.41	42.84	90.11	55.21	224.11	188.62	552.80	571.02	1349.95
"The social cost of carbon Optimal, RM"	15.92	13.23	36.41	42.84	90.11	14.44	20.14	21.02	25.38	19.98	15.25
Interest Rate BAU (Real Rate of Return, RM)	0.095	0.103	0.105	0.104	0.102	0.099	0.097	0.093	0.091	0.088	0.086
Interest Rate Optimal (Real Rate of Return, RM) XX	0.095	0.131	0.085	0.094	0.095	0.098	0.097	0.094	0.092	0.089	0.087
Abatement Cost (BAU)	0	0	0	0	0	0	0	0	0	0	0
Abatement (OPT)	0.00	0.00	0.00	0.00	0.00	0.64	0.90	1.22	2.18	2.81	3.56

Source: Computed by the author using the ASEAN-RICE Mode

Based on the forecasts, under the BAU Scenario industrial emission will upsurge from 1.83 bt CO_2per year in the year 2010 to 11.78 bt CO_2per year in the year 2030, 25.00 bt CO_2 per years in the year 2040 till it reaches 68.00 bT CO_2 per year in the year 2060 after which, it will be relatively stable. Under the optimal Scenario, ASEAN as a whole region will experience an upsurge initially from 1.83 bTCO2 per year in the year 2010 and to 11.78 bT CO_2 per year in the year 2030.

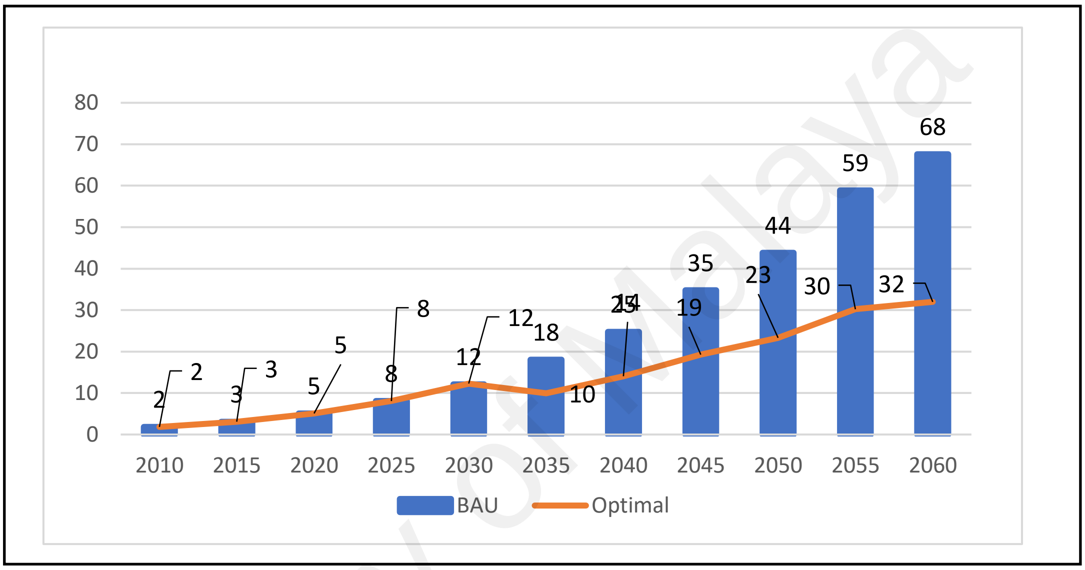

Figure 5.2: Industrial Emission Projections, ASEAN, 2010-60, (bT CO2/Year)

Source: Plotted by author

Still, industrial emissions will decrease then to 9.55 bT CO_2 in the year 2035 before it starts to rise again to 13.69 bT CO_2 per year in the year 2040 and to conclude rises up to 31.99 bT CO_2 per year in the year 2060. Under the optimal Scenario considered for this research objective (RO2), industrial emissions will fall significantly by 53.0% eventually in the year 2060. The forecasts also designate that the atmospheric attentiveness of carbon following “BAU Scenario (PPM)” will decrease from 390 PPM within the year 2010 to 287 PPM in the year 2035 and year 2045 before it starts increasing to 351 PPM in the year 2060 (Figure:5.3). “Carbon concentration” following “Optimal scenarios” trails outline of “BAU scenarios” since the year 2010 until the year 2045 recording 390 PPM in the year 2010, and 287 PPM in the year 2035 and year 2045. Yet, “Carbon concentration” afterward solitary increases to 329 PPM within the year 2060 under the optimal Scenario. Effect of the INDC's over "carbon concentration" may be measured as "marginal unit" because this is a bit lesser then "BAU Scenarios", by about 6.3% less for the year 2060.

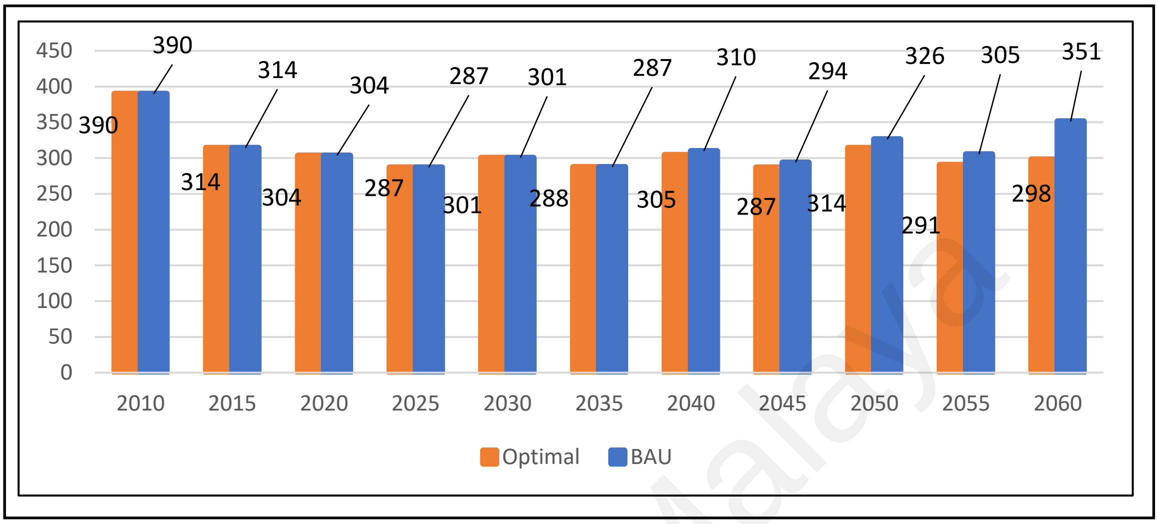

Figure 5.3: Atmospheric concentration of Carbon, ASEAN, 2010-60 (ppm)

Source: Plotted by author

The outcomes also confirm that the increase in "atmospheric temperatures" over Pre-industrial stages drive progressively decrease from 0.80°C for year 2010 by 0.66 °C for the year 2035 before increasing again by 0.79°C in the year 2060 (Figure 5.4). Following the optimal scenario to employ the INDCs ASEAN member nations will experience the similar level of temperature rise until year 2035.

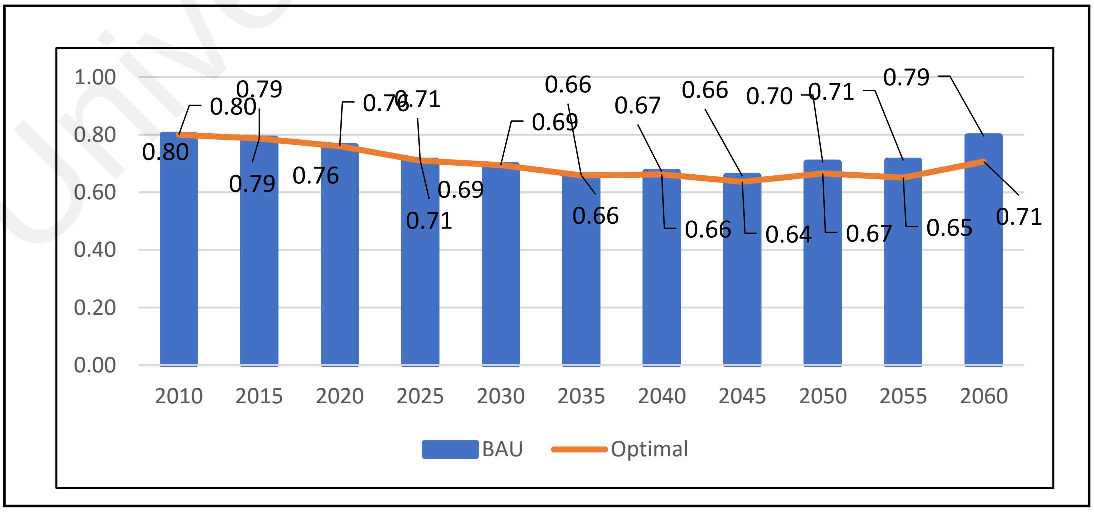

Figure 5.4: Atmospheric Temperatures, ASEAN, 2010-60 **(°C above pre-industrial level)**

Source: Plotted by author

From then, the temperature will rise gradually as considered following the "BAU Scenario" by 0.71°C till year 2060. "Variance in temperature" till year 2060 is not much significant as its valued at 10%, which recommends us to uptake supplementary action plan to decrease the furthermore emissions of CO_2. Cumulative damage of Climate from both "BAU and Optimal scenarios" will continue as the same at MYR.8.0 Billion besides MYR.14.3 Billion correspondingly in the year 2010 and year 2015 as interferences may not have set in (Figure 5.5).

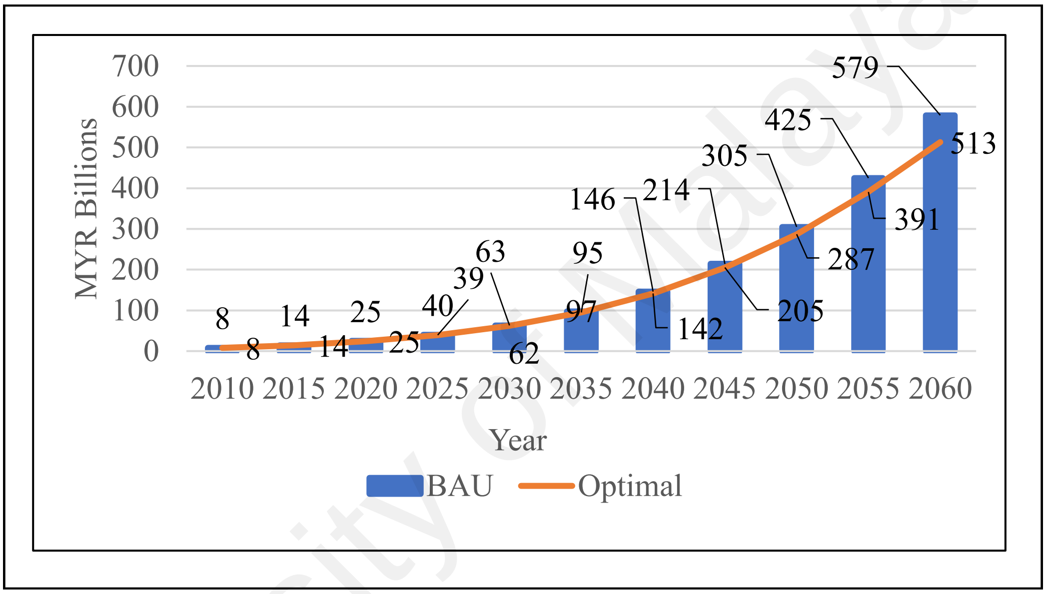

Figure 5.5: Climate Damage, ASEAN, Year 2010-60 (MYR Billions)

Source: Plotted by author

It remains the equivalent at MYR. 24.8 Billion respectively in the year 2020 as the interference period is very small. Cumulative damage from climate aimed at the Optimal scenario will start to act in from year 2025, so the damage from climate will again increase a little slower than "BAU scenario". Following "Optimal scenario", climate damage would rise from MYR. 39.4 Billion for the year 2025 to MYR.513.1 Billion in the year 2060. Following the BAU scenario total climate damage may increase from MYR. 40.0 to MYR. 579.1 Billion. In general, "Optimal scenario" succeeding "execution of INDCs" will decrease the "Climate Damage" by almost 11.4% throughout the period of year 2020 to year 2060.

In spite of the growing shift from the "fossil to non-fossil" based "Energy sources", the "GDP per capita" outlines do not fall or slowdown as per prophesied in "Limits to Growth" argument earlier. Definitely, "GDP per capita of ASEAN" member nations following "BAU and Optimal scenarios" would continue to increase over the period 2010-60 (presented below in Figure 5.6). "GDP per capita" under "optimal scenario" increases a little more than following "BAU scenario". While "GDP per capita" following "BAU scenario" increases as of MYR. 12,985 in the year 2010 to MYR 20,359 in the year 2060, it rises from MYR.12,986 in 2010 to MYR. 20,361 following "Optimal scenario". The peripheral variance in total GDP recommends that, the efforts to "decarbonize the ASEAN" selected nations following the INDC's will not slow down the regular and present GDP growth rates for the members.

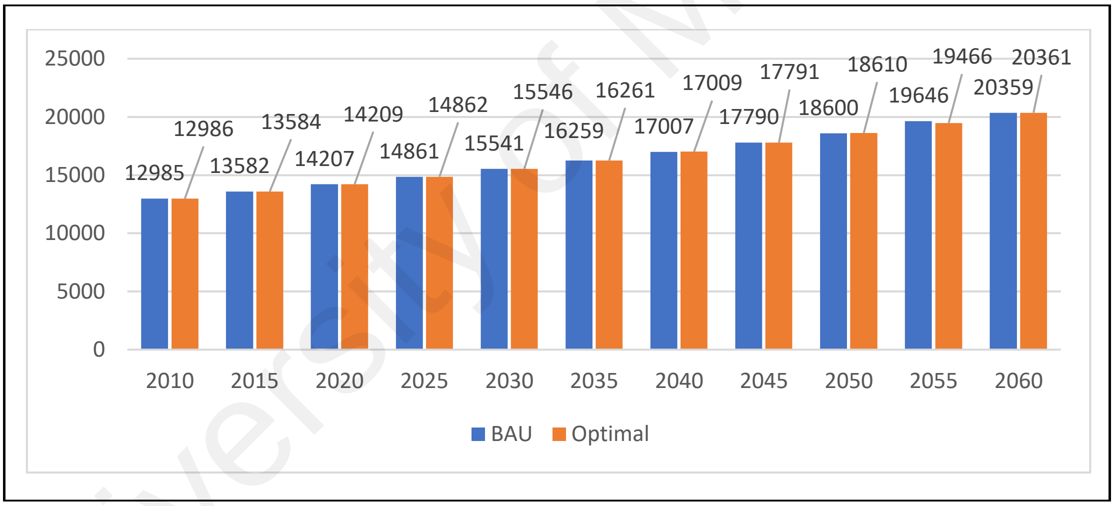

Figure 5. 6: GDP per Capita, ASEAN, 2010-60
Source: Computed by author

Carbon taxes will be a significant policy device that ASEAN nation governments can utilize to change the behaviour of economic agents to decrease the carbon concentration of production besides consumption. Though nations, like Singapore, has already introduced carbon taxes, following BAU Scenario, so the "Carbon price" will increase from almost zero per t CO_2 in year 2010 to MYR 11.2 per t CO_2 in the year 2040, MYR. 23.1 per t CO_2 in the year 2050 and MYR.45.8 per t CO_2 in the year 2060 (Figure 5.7). Though, below the Optimal scenario, the price for carbon would rise as of zero per t CO_2 in 2010 to MYR 224.65 per t CO_2 in year 2040, MYR. 258.2 per t CO_2 in the year 2050 and MYR.245.4 per t CO_2 in the year 2060.

The enormous variance generated in the tax income (81.3%) for time period from year 2060 raised from "Carbon taxes" under "Optimal scenario" might be diverted to sustenance in addition to subsidize conception and outline of backstop know-hows.

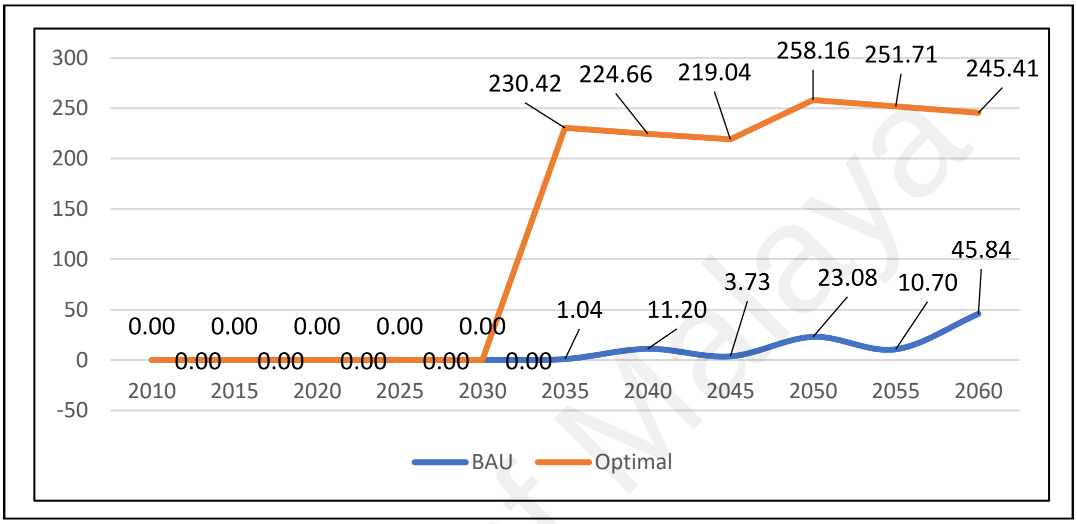

Figure 5.7: Carbon Price, ASEAN, 2010-60 (MYR per t CO_2)

Source: Plotted by author

The results also demonstrate that following "BAU scenario", "total emission control rate" would begin to rise as of almost zero for the year 2010 to MYR 0.01 Billion for the year 2040, MYR 0.08 Billion for the year 2050 and to MYR 0.16 Billion in the year 2060.

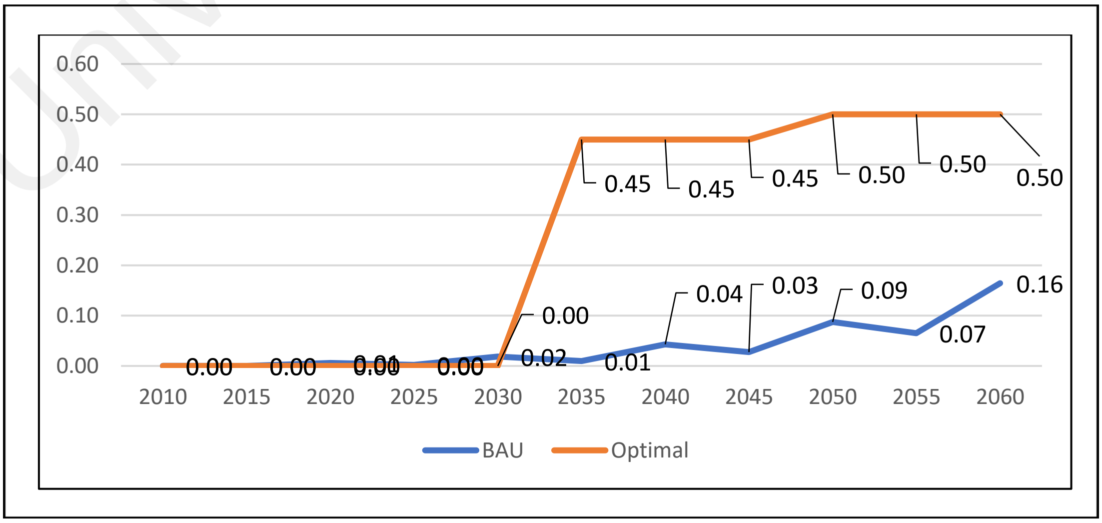

Figure 5.8: Emission Control Rate, ASEAN, 2010-60 (%)

Source: Plotted by author

Below the Optimal scenario, "total emission control rate" will start to upsurge from zero from year 2010 to MYR. 0.45 Billion for the year 2040, MYR 0.50 Billion by the year 2050 then then maintain steady there at MYR0.50 Billion till for the year 2060. "Cost of emission controlling" by the introduction of the INDC's for the "Optimal scenario" would total to 68% of total costs following "BAU scenario" (Figure 5. 8).

The "Social Cost of Carbon (SCC)" following the Optimal scenario for the period of year 2010 to year 2060 would result in rise from MYR 15.9 Billion from the year 2010 towards MYR55.2 Billion in the year 2035, MYR 224.1 Billion in year 2040, MYR 552.8 Billion in year 2050, MYR 571 Billion in year 2055 to increase sharply to MYR 1350.0 Billion in year 2060.

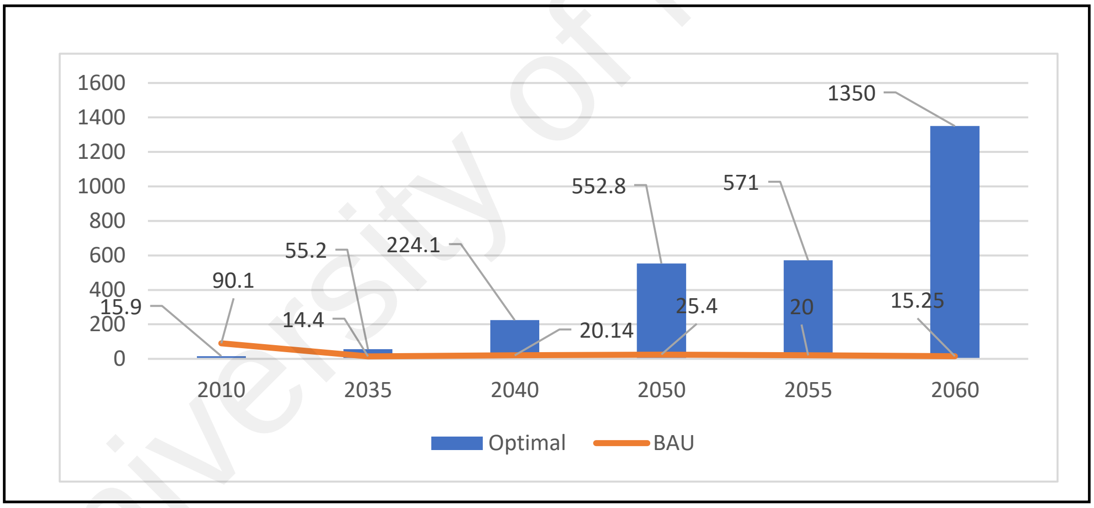

Figure 5.9: Social Cost of Carbon, ASEAN 2010-60 (Billion RM)

Source: Plotted by author

Following the "BAU scenario" , "the social cost of carbon" will increase as of MYR 15.9 billion from the year 2010 to MYR 90.1 billion within year 2030, but will drop from there to MYR 14.4 billion within the year 2035 before rising slowly to MYR20.14 billion in year2040, MYR 21.0 in year 2045, MYR 25.4 Billion in year 2050. Later it will fall again to MYR 20.0 Billion in year 2055 and MYR 15.25 Billion in year 2060.

Following the BAU scenario presented from "Optimal scenario" decreases the SSC sharply following year 2010 to year 2060 (Figure 5.9).

Figure 5.10 in the following page offers the "abatement costs" will be produced following "BAU scenarios" and "Optimal scenarios" throughout the period of year 2010 to year 2060. As, no extra interferences are expected under "BAU Scenario", the costs for abatement remain likely to be zero during the time period considered. However, this increases abruptly afterward the year 2030 following "Optimal scenario".

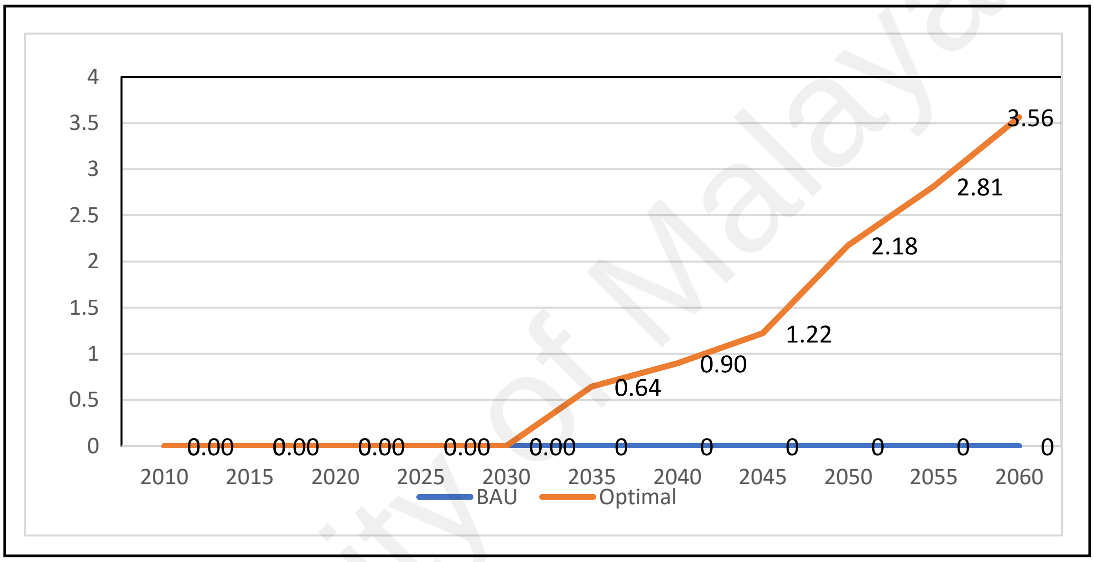

Figure 5.10: Abatement Cost, ASEAN, 2010-60 (Billion RM)

Source: Plotted by author

As the INDCs move in the scenarios of abatement costs, so it will rise to MYR2.18 Billion in the year 2050 and MYR 3.66 Billion RM in the year 2060, that will be funded as of revenue composed from carbon taxes. The results in this chapter demonstrations that it is worth positioning carbon taxes in synchronize through endorsements following Stern (2007) and Nordhaus (2008) to attain the anticipated decrease in level of carbon emissions and in level of concentration of carbon among the ASEAN member nations.

The combined decreases considered regionally, will be practiced by ASEAN as a whole region may have a smaller bearing than INDC plans submitted by "Singapore, Malaysia, and Thailand (Rasiah et al., 2016)". Nevertheless, if we consider that nations that are bordering are porous then results, we find here that they are expected to be further consistent than those other country estimations as those forecasts remained grounded on norms that the bordering nations may instigate alike actions to check Climate variation and warming of the globe.

In that logic, ASEAN member nations will actually be forced by exertions of regions bordering these economies. In spite of aggressive attempts to shift from “fossil to non-fossil fuels”, both China and India need to accelerate their “Greening Policies” to synchronize the decrease of “carbon emissions besides carbon concentration”. The similar spread over to all of the other ASEAN nations is required as environmental effects are a global shared property (Harding, 1968). A proper appreciation of the concept of the “Global common” is also necessary for the developing nations, who will then start to share technical support from one to other. It will help them to ensure that their “National Climate Change Goals” followed by individual states are rapidly synchronized to produce “Optimal results”. Moreover, by backing up the poorer nations with “Greening and Smart technologies”, such as “Flat solar panels”, besides “Windmills”. There must also be a level of “Dissemination of knowledge” for renovating the available “biomass” into renewable energy. Among “ASEAN-6 market economies” we have “Indonesia, Brunei, Malaysia, Philippines, Singapore, and Thailand” which nations are capable to deal “Climate change impacts”. For these nations, use of solar energy is already well accepted and developed. These nations can share such accessible and easy technologies with countries like “Cambodia”, “Lao PDR”, “Myanmar”, “Vietnam” and other neighbouring states, like “Timor Leste” besides “Bangladesh”. Governments also requires to take initiatives to zone- and region-specific areas as “Green zones” so that natural flora and fauna of these sites are conserved and perform as per “Green lung zones”. Significant anxiety also growing due to the encroachment of jungle lands, for cultivating the cash-crops in those large-scale farming projects. In case of Indonesia and Malaysia, vast areas of tropical forest land have been vacant to cultivate oil palm trees.

Finally, the forecasts we made here have not consider the probability of account of accidental events and inventions. Hence, we need to conduct a cautious review of INDCs proposals and projections need to be recorded and after every five years we to recalibrate the assessments we made to take justification of such actual variations and predictions, and to identify the deviations.

5.7 Summary

The results of this study research objective (RO2) shows, the probable damaging effect of Climate Change can be condensed significantly by familiarising certain level on mitigation interventions. Such interventions include, by introducing “carbon tax” to change the behaviour of economic agents in ASEAN member nations to ensure aggressive switch of the core energy dependencies from fossil to non-fossil, renewable-based energy. This idea is also supported by both the two prominent climate researcher and economist, Stern (2007) and Nordhaus (2008).

The concentration of “atmospheric carbon and temperatures” subsequent outline of carbon taxes drive may drop to 329PPM and temperature will fall to 0.71°C respectively while it will only drop to 395PPM and temperature will fall to 0.80°C if prevailing practices are upheld till the year2060.

The “Cumulative climate damage” will first increase to MYR 513 Billion following the optimal scenario related to MYR 579 Billion following the BAU scenario for the year 2060. Whereas the “GDP per capita” following the “BAU scenario” rises from MYR

12,985 with in year 2010 to MYR 20,359 in the year 2060, it gradually rises from MYR 12,986 in year 2010 to MYR 20,361 following the optimal scenario. The Carbon taxes raised by the ASEAN governments with rising of carbon prices much earlier following the optimal scenario to MYR. 245.4 per t CO_2 related to quicker MYR. 45.8 per t CO_2 following the BAU scenario in the year 2060 will help the ASEAN member nations to finance the additional abatement costs of MYR 3.6 Billion following the optimal scenario, which is bigger than the MYR. 2.2 Billion considered under the BAU scenario for the year 2060.

These results depend over slightly stationary modeling in spite of the usage of "non-linear dynamic downscaling methodology" applied. Hence, this is decent to analysis such forecasts to recalibrate "effective mitigation interferences of climate and emission decrease trajectories" accepting justification of change in random features and other necessary evidence after every five years. In light of those positive results, it will be beneficial to establish a "regional ASEAN-wide mitigation policy", which will require effective coordination, and framework for cooperation which are necessary to excite active climate mitigation actions among the distinct affiliate nations.

The optimal scenario results must remain interpreted into strategies on how carbon concentration besides emissions can be condensed proficiently with following INDCs targets, and in order to start a regional policy negotiation that could inspire to accelerate mitigation of climate outside the targets set by the INDCs. There should also be a full-scale collaboration network among the ASEAN member nations, and also among those active Asian nations, which are currently leading the "Greening Initiatives", such as "Japan, China, India, Taiwan, and South Korea". Collaboration through "Europe, Canada, Australia, and New Zealand" may likewise ensure additional benefits for this objective (see ABD, 2013).

CHAPTER 6

LOW CARBON ECONOMY INDEX FOR INDONESIA, MALAYSIA AND THAILAND

6.1 Introduction

Sir David Attenborough the prominent environmentalist from United Kingdom expresses his realizations in COP 24 conference, UNFCCC (2018, 3rd December) at Katowice, Poland following the "public's response" for the "impacts of Climate change" as follow:

> *"Right now, we are facing a human-made disaster of global scale, Our greatest threat in thousands of years, Climate Change. If we do not take action the collapse of our civilizations and the extension of much of the natural world is on the horizon. People have spoken, leader of the world, you must lead. The continuation of our civilizations and the natural world upon which we depend is in your hands".*

This is an important message for the entire globe, and we have to act as soon as we can. When we start to write this chapter, we were more focused on different methods and techniques to find mitigation of Climate Change, and that leads us to a new notion of Low carbon Development.

This chapter efforts to bring the selected ASEAN nations (Malaysia, Indonesia, and Thailand) in the podium of Low carbon Development. Here each country performance is also compared with each other, after the Low Carbon Economy Index (LCEI) is developed from their yearly performance using the ASEAN RICE model till 2060.

The INDCs revised in COP 22 by all of the ASEAN nations efforts to measure the dependence on non-renewable or fossil fuel-based resources, addresses growing other environmental challenges and recommends the way forward to renewables or other forms of energy for ASEAN nations. Thus, the revised INDCs commitment and its proper implementation can lead the ASEAN nations to attain a "low-carbon, climate-resilient future." According to Batel, Devine-Wright and Tangeland (2013); Rosen and Guenther (2015) for formulating a nation's "Low Carbon" reliant economy is an esteemed way forward because it concurrently generates revenue, investment, besides addressing the "sustainable development" challenge that upsetting our biosphere. This can be considered as an appliance of hope for forthcoming economies that in future will offer a source for imminent low emission and high growth. According to Middlemiss and Parrish (2009) the concept "Low Carbon" is a revolutionary idea to reduce carbon emission and it is growing fast as a clean energy segment of the global economy. According to Ashina, Fujino and Masui (2012) many nations come forward to attain the INDC's, which consists a list of practical climate actions which is undertaken by the particular government before 2050 to reduce its Carbon emission and thus incorporating the "Low Carbon" standing. The INDCs are pathways that state each nation how they would reduce carbon emissions and address Climate Change respectively, become more of a "Low Carbon" nation.

However, framing the LCEI for selected ASEAN nations (Malaysia, Indonesia and Thailand) are significant, because it can help those nations to advantage from a brief and vibrant photograph of the economic standing of the existing economy, which can arrange the foundation of essentials and actions for achieving low carbon energy policy decisions in future. The methodology of LCEI is a tool that enumerates economic involvement by comparing authentic happenings to actual (as opposite to nominal) prospects, as well as the upcoming ambition by expected forthcoming goals, besides current encounters.

According to Richerzhagen and Scholz (2008) the LCEI is a means that can put low carbon-based development into the context of mitigation framework of Climatic impacts that we have considered, as implementable mitigation options. It helps us to identify where the gap is, and how to reach the actual outcomes as expected. It also tells us what needs to be done further to cover up the differences and how we can set the new scope to go out from the challenges for success. This becomes easier for the selected ASEAN nations when Malaysia takes the lead to measures probable indicators, evaluates them effectively and categorises the critical components of Low Carbon Economy, determine its progress and novelties with the index. Here we select a common base year for all the three nations respectively, and then calculate accordingly to formulate LCEI for all the selected ASEAN nations.

To do this more effectively, Malaysia can use the Low Carbon Economy Index (LCEI) developed for the Selected ASEAN Nations by this particular research and follow the rank according to their performances. The initiatives to do the ranking of the selected ASEAN nations from Low Carbon Economy (LCEI) indexes have not yet done by any other research so far in the ASEAN Nations. Thus, this chapter focuses on two objects as follow:

1. Developing the Low carbon economy index for the selected ASEAN nations,
2. Ranking the selected ASEAN nations following Low carbon economy index.

This chapter seeks to formulate the “Low carbon economy index (LCEI)” for the bordering nations Indonesia, Malaysia and Thailand from ASEAN, and to rank these countries using that index. The LCEI was computed using dynamic modeling. While the results bring wide ramifications for the three countries involved, it also serves as a framework for the inclusion of other bordered countries when similar detailed data is available. Following this introduction, the organization of this chapter discusses key issues that justify the formulation of the index before the specific methodology related its construction is introduced under material and methods. The chapter then discusses the results to draw implications for the three countries specifically.

6.2 Significance of CO_2 emission

“CO_2 emissions (metric tons per capita)” refers to releases of CO_2 from those stemming, like from “burning of fossil fuels” besides “manufacture of cement”. They produced carbon dioxide during using of certain “solid, liquid, and gas fuels and gas flaring”. Such emissions are measured by a few organizations like “Carbon Dioxide Information Analysis Center”, “Environmental Sciences Division”, “Oak Ridge National Laboratory”, from the state of Tennessee, United States, who usually regulate this globally. A tentative definition for it looks as follow:

According to IPCC, (2008) CO_2 emissions, are those coming from the burning of fossil fuels and the manufacture of cement annually. They comprise CO_2 formed by consumption of solid, liquid, and gas fuels and gas flaring. CO_2 is known as a naturally stirring gas static by photosynthesis into living substance. It is a by-product of ignition engines that run by fossil fuel and burning Low carbon mass. It is also shaped from industrial processes and other changes in land use. It is a primary anthropogenic greenhouse gas that agonies the Earth's radiative equilibrium. It is also measured as a “reference gas”, against which of the other GHG’s are measure, and quantified. Thus, taking a probable "Global Warming" claim on the shoulder is not easy. However, the "utilization of carbon-based fuels" for energy production since "industrial revolution" which has quickly "augmented concentrations of atmospheric CO_2"," increasing the rate of global warming and causing anthropogenic change" in climate. This is correspondingly a significant source of "Ocean acidification" as it liquifies in water to form carbonic acid. The accumulation of human-made GHG's in the atmosphere interrupts "the earth's radiative equilibrium". This is creating an upsurge in the earth's "surface temperature and to linked effects on weather, sea level increase" also can hamper global cultivation. Discharges of CO_2 happening by "burning oil, coal, and gas" aimed at "energy production usage", also from burning wood, waste materials, besides from manufacturing activities like "Cement production".

The emissions of CO_2 done by a nation is not only an indicator of one GHG's emitted. More comprehensive idea of how a state impacts Climate Change, from gas discharge like "Methane" (CH_4) and "Nitrous oxide" (N_2O) should also be measured. This process is mainly significant for considering "Agricultural economies" like ASEAN member region. Emission intensity of GHGs is representing "average emission rate of a given pollutant" gas considered from a "certain cause relative to the strength of a certain level" of, "specific activity". "Emission intensities" for particular gases are also deployed to compare the "environmental impact of different fuels" used and their results. Correlated terms like "Emission factor" besides "Carbon intensity" remain repeatedly deployed inter changeably.

The ecological impacts of CO_2 are of unique attention. According to Heikkinen et al., (2010) CO_2 actually consist of the maximum share of GHG's causal for "Global warming" besides "Climate Change". Changing other GHG's like "Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6)" to "CO_2 equivalents" made it conceivable to relate them in addition to mitigate total impacts for “Global warming”. “The Kyoto Protocol”, is an “environmental agreement” accepted in year 1997, through several of parties at UNFCCC. This protocol is working towards restricting emissions of CO_2 internationally.

6.2.1 Limitations and Exceptions:

The Carbon Dioxide Information Analysis Center (CDIAC), located at the U.S. Department of Energy, actually computes “Annual anthropogenic emissions from data on fossil fuel consumption” as of “United Nations Statistics Division's World Energy Data Set” and report on “world cement manufacturing” from “U.S. Department of Interior's Geological Survey, (USGS-2011)”. According to Heikkinen et al., (2010) such approximations for “global carbon dioxide emissions” are possibly precise within 10 % on average (“as calculated from, the global average fuel chemistry and use”), “country-based estimates” may have larger error possibilities. Propensities expected from a “consistent time series” incline to be more precise than individual values. Every year USGS also recalculates the time series from year 1949, with updated findings besides alteration initiatives. Approximations to eliminate fuels supplied to ships and aircraft in worldwide use because of exertion of allocating fuels amid the profiting nations.

6.2.2 Statistical Notions:

Emissions of Carbon dioxide, mainly a by-product from production process and usage of energy, explains the largest share of greenhouse gases. It is also linked with global warming issues. According to scientists from IPCC (2007) “anthropogenic CO_2 emissions” primarily from fossil fuel used in the combustion engine and cement manufacturing creates the maximum pollution.

In case of the combustion engine, it is surprising that different fossil fuels release various amounts of carbon dioxide for the same level of energy usage: for example, oil release about 50% more carbon dioxide than natural gas, and coal discharge about twice as much carbon dioxide. Cement manufacturing discharge about half a metric ton of carbon dioxide for every metric ton of cement manufactured. Data for CO_2 emissions measures include considering gases from the burning of fossil fuels and cement produced but excludes all the emissions resulting from the land use, for example, deforestation.

In order to fully take advantage of this developing regional "Low Carbon Economy alliance", it is proposed that a transparent and standardized methodology can be developed to capture the overall sentiment of each participant nation's Low Carbon Economy and eventually to be used as a comparative tool to identify trends, patterns, and synergies between national Low Carbon economies. This is similar conceptually to stock indices around the world, e.g., the Dow Jones Industrial Index and the FTSE Kuala Lumpur Composite Index, which provide a snapshot of overall sentiment of equity investment in their respective nations. Whereas the stock market indices utilize market capitalization of selected public listed companies as a proxy for investor sentiment, a proposed Low Carbon Economy Index (LCEI)[42]will use common economic indicators to measure economic sense. This study will contextualize the current national outcome and contribution, real current achievement, future aspiration with forecasts to the future national targets, contemporary challenges and critical priorities using

[3] “Low Carbon Economy Index” is the useful tool to measure and track of “performance level” that can changes compared to the “business-as-usual trajectory” to an entire “Low Carbon economy” over time.

benchmarking "Low Carbon Economy Contribution Indicators" for formulating the national Low Carbon Economy plan.

Correctly, this findings can be applied to (i) Evaluate actual present achievement against probable accomplishments (based on actual economic conditions); (ii) Relate performance of an exact year in disparity with performance in last years and as share of a general tendency; (iii) Relate sentimentality besides economic activity in Low Carbon Economy sector with comparison by additional national based industries; besides (iv) Relate commercial actions within Malaysian Low Carbon Economy comparing with other Low Carbon based nations.

6.3 Using Low Carbon Economy Indicators

To formulate this Low Carbon Economy Index (LCEI), this study has developed specific Low Carbon Economy indicators[43]for the first time for Malaysia and also for the ASEAN region. It also measured the capacity of Low Carbon Economy and its achievement besides developments as a way forward. For apprehension a photograph of the complete Low Carbon Economy,[44]we have selected four sub-indices in this study as (i) Carbon Price (ii) "Emission Control Rate" (iii) "Social Cost of Carbon (SCC)" besides (iv) Parts per million (Carbon Concentration in the atmosphere.

The impact of Low Carbon Economy is growing universal, and so is the anxiety about world-wide Climate variation and other sustainability matters. This mitigation actions in request for renewable and Low carbon-based goods and services are attracting Low

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[4] The broad framework of indicators assessed as by Input and Output indicators and those can be considered parameters.

[5] Thus, here the measurement of BI classifies the critical drivers of Bioeconomy to observe the progress and innovations to assess the Bioeconomy drivers.

Carbon Economy and Low carbon-based investors. Low carbon medical, industry, diet, food, fibres, fuel substitute, chemicals, and renewable energy remain as main essentials of global Low Carbon Economy, and this is newly a topic of intensive consideration from decision-makers, academics and public representatives for sciences of biophysical and social scope "(Wesseler, J., Spielman, D.J., & Demont, M. 2010)."

In administering the strategy and policy aimed at Low Carbon Economy, the dimension of indicators can measure, quantify and classify the critical elements of Low Carbon Economy development and originality. These can guess the achievement complete quantifiable standards and can transform as norms for evolving as "strategic reference". Number of pointers, mostly used for policy-based results and input, and it often offers an experimental orientation argument for evaluating users of Low Carbon Economy, whether our standing of Low Carbon Economy is on precise pathway or need slight modifications. To be efficiently implemented, all plans, activities, sharing of resources besides strategies or community strategy entail the establishment of a consistent goal, through visible advancement of pointers and periodic evaluation for alterations to the pointers and the evaluating the user of "Low Carbon Economy". Also, the execution of effective plan and deed aimed at the sustainable progress of "Low Carbon Economy" mostly rest on the position and integration of appointment by the numerous participants, agencies and clubs that are intricate within "Low Carbon Economy" at diverse levels within national economy, e.g. resident level, state level besides national stages.

Aarvik, (1985)[45] in his speech mentions about Albert Einstein, who comment on using Nuclear power as, "it is a new way of thinking, that is required for humankind is to survive." This is also applicable for the spread of the Low Carbon development ideology besides necessary actions. (Low-carbon Singapore website, 2010). The right

[45] "Presentation Speech" by Egil Aarvik, Chairman of the Norwegian Nobel Committee, on the occasion of the award of "the Nobel Peace Prize for 1985", Oslo, December 10, 1985.

directions according to Burck (2013) are quantifiable complete by the usage of pointers which evaluate and categorize the critical components of Low Carbon Economy growth mainly over time (e.g., from the short to long run). Pointers considered here according to Cadiz (2013) would combine capabilities, establishment, amendment of activities to “technological progress chain” besides their modification for exploiting strategies, for “action, conversions, regulatory, requirements, strategies”, to attained.

Notably, Low Carbon Economy pointers evaluate numerous features of progress, accomplishment, efficiency, productivity, effectiveness, downtrend and ambiguity in the “Low Carbon Economy”. This aims to put into the context of three general policy questions on how to “(a) evaluate the impacts of the Low Carbon Economy, (b) monitor the progression of the Low Carbon Economy, and (c) calculate the prospects for a sustainable Low Carbon Economy.”

As the year 2020 is closing, the attainment of INDC targets turn out to be more vital to confirm continuousness of the achievements and drive of the economic development, definitely in terms of progress of a new 2020 post-policy agenda. Post-2020, a pre-set tactic essential be put in place to build on certain fundamentals established by regional council like ASEAN, taking into interpretation the on-going advancement of technology, extended infrastructure system, and superior economic competence. The Low Carbon Economy Index could offer the essential perceptions for this, not just in the setting of Malaysia's national Low Carbon Economy, but it can, and should, also be adapted for to evaluate the ASEAN member nations real actions for INDC’s progress and achievement as well.

Therefore, this is important to discovery an arrangement which is inclusive and adequate to accurately monitor the progress of Low Carbon Economy for the selected ASEAN member nations. If the assessment, nursing, and valuation scheme is efficiently precise but deficient in detail, then Low Carbon Economy accomplishment cannot be contented, and the expansion of the Low Carbon Economy may not be charted for work. So, it is critical to narrow down the range of indicators, and to focus on those that are readily computable and accessible and may establish a sufficiently wide-ranging effect of the Low Carbon Economy.

This will accelerate investigation and empower rapid besides through policy activities in addition to approaches. Within comprehensive agenda of pointers in framework for policy enquiries, it is a necessity for categorizing essential "indicators" bestowing for (i) Input Indicators, also (ii) Output Indicators. The "Input Indicators" are the significant aspects of approach as classified like (i) Carbon Price (ii) "Emission Control Rate" (iii) "Social Cost of Carbon (SCC)" besides (iv) Parts per million (Carbon Concentration in the atmosphere.

The amount of (a) "technology-transfer to the new carbon -invention", (b) "direct size of low-carbon innovation workers as percentage of science and technology workforce", (c) "revenues or sales of low carbon-related products, and services", (d) "new balance of low carbon innovation outputs, new low carbon innovative and joint ventures, and number of low carbon -innovation firms", besides (e) "the new low carbon innovation from the R&D spending". This is not so easy to overcome the shortage and to create a sustainable market potential" for Low Carbon Economy, in the long-run is also challenging. So, the exact distribution of investments and an intensive direction is essential collected with speeding up programme in correct segments aimed at useful value accumulation (Figure 6.1) together in the short in addition to long-term.

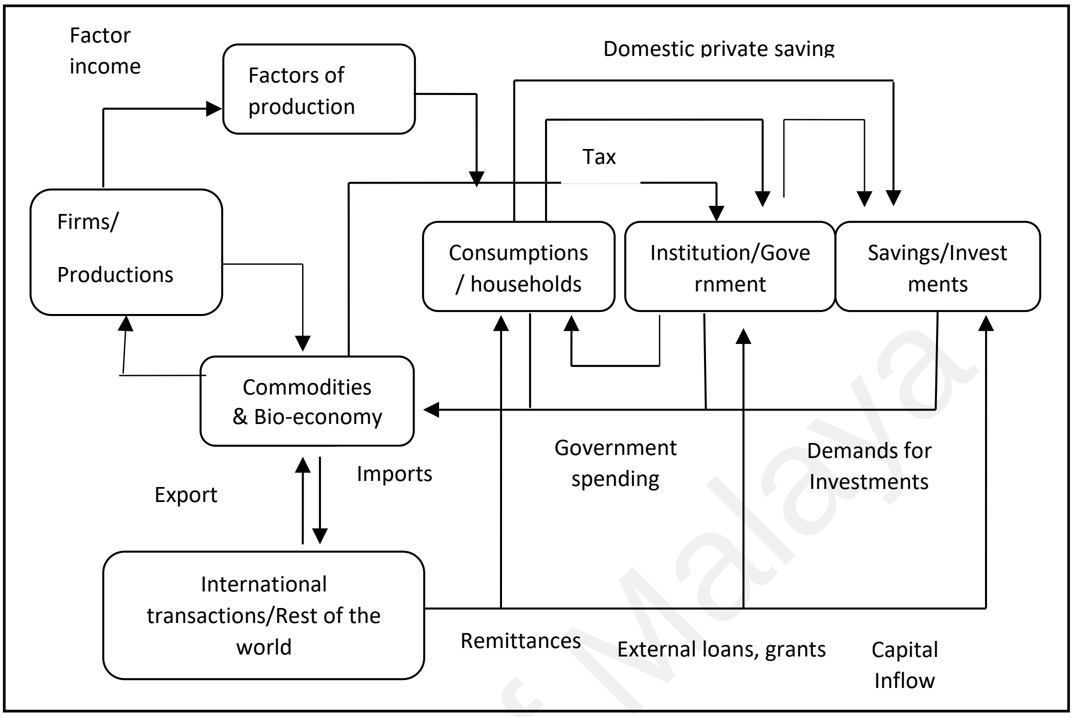

Figure 6.1: Circular flow map for Selected ASEAN Nations economies

Source: Diagram plotted by author

Input pointers for fuel the expansion of Low Carbon Economy measurable inside the economy as a value chain by (a) new innovative sub sectors in addition (b) new low carbon-based marketplaces by means of green invention. Added detailed categories of input pointers encompass the following:

a) A share of low carbon-based essentials that is part of Low Carbon Economy in terms of "GDP, engagement, and turnover"

b) A percentage of green innovation and progresses that is part of the Low Carbon Economy in terms of higher living standards, and health effects

c) A percentage of low carbon cosmeceuticals, betterment, besides pharma nutrition advances that is part of the Low Carbon Economy in terms of health properties

d) A proportion of "R&D innovation" that is part of Low Carbon Economy in terms of "GDP engagement, revenue, and copyrights reported."

e) The percentage of the “low carbon-based industry” which is part of the “Low Carbon Economy” in terms of “GDP, employment, and turnover”

f) A percentage of “Non-Renewable” in “Low Carbon Economy” in terms of “GDP, employment, and turnover”

g) The percentage of “foreign supply usage” in “Low carbon-based production” in terms of “total GDP, employment”.

h) The percentage of “low carbon-based joint ventures” in terms of “GDP, employment, and turnover”.

i) The percentage of “low carbon innovation firms” and in terms of “GDP, employment, and turnover”.

j) The percentage of “Low Carbon Economy input” in terms of “national GDP”.

On the contrary, “output indicators” are outcomes of the “input indicators” composed with state features approach from an outcome of “(a) amount of shared product development, (b)number of projects approved, (c) number of multi-disciplinary study and (d) development packages maintained.” Besides, the output pointers made an assessment to estimate the pointers to monitor (for assessment) actual extension and related progress of Low Carbon Economy over period (annually). These are primarily articulated by:

1. The actual input of Low Carbon Economy to total GDP between the present then last financial year

2. The actual employment contribution in the whole Low Carbon Economy and its segments and its input to the Low Carbon Economy only associated to full engagement and income among the current and last financial year

3. The actual involvement and production of Low carbon-based products between existing then last financial year

4. The actual involvement and means use of the Low Carbon Economy between the current and last financial year

5. The actual ingesting of Low Carbon Economy products between the current and last financial year

6. The actual turnover of Low Carbon Economy between the current in addition to last financial year

7. The actual accomplishments then its portion Low carbon-based combined ventures in terms of “GDP, employment, and turnover” between fiscal performance of current and last year

8. The physical portion amount for Low carbon-innovation firms, actual accomplishments, also the aforementioned attainments within relationships of “GDP and turnover” amid current then last financial year,

9. Total Low Carbon Economy input in terms of national GDP amongst the current and last financial year.

6.4 Materials and Methods

To measure the several enumerated impacts, for Malaysian Low Carbon Economy in a combined manner, this research has measured the progress of the ‘Low Carbon Economy Index’ (LCEI)[46]. LCEI is one of the standardized ways of positioning a valuable numerical grade (e.g., placed on selected year) for a total renewable marketplace in addition to its sectoral input in addition to performance over time. It attains this through generating suitable estimations and procedures for and uniting five specific designated pointers: “Revenue, Investment, R&D Spending, Job income Creation, and Intellectual Property”. Significantly, this similarly calculates an “annual adjusted predictable baseline of impact” for each of constraints that are deployed as per

[46]BI provides a useful scale of achievements over time against 100 points in the base year.

an annual assessment for evaluating authentic act for precise parameters or else the Index in total.

The reference point used in the “dynamic computable general equilibrium (DCGE)[47]Model” is recognized ensuing of “applied general equilibrium framework” (“Robinson, Yunez-Naude, Hinojosa-Ojeda, Lewis and Devarjan 1999; Relnert, and Roland-Holst 1997; Robinson, 1989,1990; Sadoulet and Janvry 1995”). The Biometric Index (BI) contemplates a non-linear quantifiable study that usages secondary data as of collected from diverse institutions of Malaysia, mostly comprises “Biotech Corp, Department of Statistics (DOS), Economic Planning Unit (EPU), Household Income and Expenditure Survey (HIES) and Labor Force Survey (LFS)”. Entire data used here are meant for scheming the LCEI beside “Social Accounting Matrix (SAM)” to be used by the Malaysian economy to complete a baseline study in addition to do estimate for future.

6.4.1 Structure of model

This study assumed that ASEAN selected nations comprise a (comparatively) trivial exposed economy. Generally, ASEAN is a value patron region. Accordingly, the price for import is assumed as an exogenously occupied for prototypical usage. Low Carbon Economy is paying to “National growth” with an individual segment and appraised as of SAM. The “Export claim function” is measured as sloping downward following to scope of ASEAN RICE model. National prices for imports and exports are determined by international values, besides “exchange rate, and import tariff or export subsidy” which can create a difference. The price scheme of any model remains ironic, mainly

[47] The general equilibrium framework has been selected for this study as because it can easily incorporate represent comprehensively to see the bio-economy: vision 2020 and beyond by each sectoral scope of policy changes and responses.

because of expected excellence variances amid commodities of diverse origins in addition destinations ("exports, imports, and domestic outputs used domestically").

6.4.2 Data sources

This research usages the "cross-section data" for entire Low Carbon Economy sectors collected from "National economy which was collected from new Input-Output (I-O) table, SAM-2015, Biotech Corporation, EPU, HIES, LFS and industrial classification prepared by Department of Statistics, Malaysia".

The data that used for this research includes primarily are "Low Carbon Economy Shares (BS) for the national economy, Intermediate Inputs (II), Final Goods and Services (FGS), Domestic Production (DP), Total National Demand (TND), Total Supply (TS), Export and Import (E&I), labor and capital and indirect taxes (DOS, 2005, 2010; DOS, 2013a & b; MDP, 2006 & 2010)".

Table 6.1: INDC based CO_2 Emission Reduction Targets till 2050 for the Selected ASEAN Nations.

Sl	Country	Emission Reduction (Unconditional) (per unit of GDP)	Emission Reduction (Conditional) (per unit GDP)	Reference Year (BAU)	Target Year
1	Malaysia	35%	45%	2015	2050
2	Indonesia	29%	41%	2010	2050
3	Thailand	20%	25%	2005	2050
Combine Average target		28%	37%	2010	2050

Source: http://environment.asean.org/awgcc/

According to Energy Institute (2009) report and following Ekholm, Soimakallio, Moltmann, Höhne, Syri and Savolainen (2010) the SAM for this analysis requires supplementary data succeeding on Low Carbon Economy mission, vision, government expenditure and investment for "Low Carbon Economy, sectoral shares, total factor payments and shares, total household income (e.g. by BI category), total government receipts (including intergovernmental transactions), institutional income distribution, and transfer payments both to households and to production sectors". This is similarly shared through "the national accounts", "Malaysian Household Income and Expenditure Survey (HIES)" data inside a reliable framework aimed at expenses besides investments outlines. So, we begin our data analysis by considering what these ASEAN member nations have promised, to achieve within 2050 in COP22.

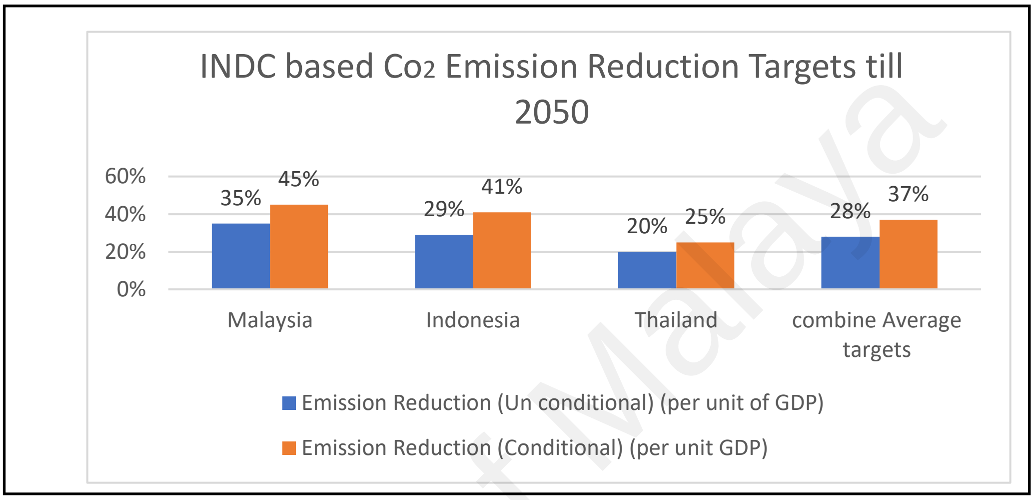

Figure 6.2: CO_2 Emission Reduction Targets till 2050 for selected ASEAN Nations

Source: Graph plotted by author

From their INDC submitted promise, we can develop an average minimum target for them. The data is presented below with graphs for proper conception. The following data collected on 11/14/2018, from World Development Indicators Database for the ASEA member Nations and processed further:

i. CO_2 emissions (kt) for ASEAN Nations 1998-2014

ii. CO_2 emission (metric ton per capital) for ASEAN Nations 2000-2014

iii. "CO_2 intensity (kg per kg of oil equivalent energy use)"

Table 6.2: “CO_2 emissions (kt)” for ASEAN Nations 1998-2014

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Cambodia	1950.844	1895.839	1976.513	2251.538	2207.534	2379.883	2445.889	2775.919	2999.606	3465.315	3898.021	4653.423	5012.789	5207.14	5456.496	5603.176	6684.941
Brunei Darussalam	5269.479	3909.022	4712.095	4506.743	4378.398	4591.084	4998.121	5005.455	4862.442	8415.765	9119.829	7862.048	8203.079	9695.548	9666.212	7803.376	9108.828
Lao PDR	685.729	927.751	938.752	872.746	1151.438	1100.1	1393.46	1404.461	1551.141	909.416	946.086	1257.781	1639.149	1624.481	1697.821	1576.81	1954.511
Malaysia	114186.7	107934.5	125734.1	135620.3	133742.8	158256.7	163826.9	174486.9	167702.9	184816.8	204031.9	198876.1	218476.2	220405	218707.2	236510.5	242821.4
Myanmar	8078.401	8969.482	10087.92	8723.793	9207.837	9845.895	12434.8	11598.72	12849.17	12874.84	9801.891	10230.93	12515.47	14297.63	11070.67	12860.17	21631.63
Indonesia	214200.5	241989	263418.9	294907.5	306737.2	316792.1	337635.4	341991.8	345119.7	375544.8	416560.2	446409.6	428760.3	603665.2	637078.9	490226.6	464176.2
Philippines	69240.29	69159.62	73307	71051.79	71337.82	71425.83	74066.07	74832.47	67692.82	72170.23	78858.84	77568.05	84869.05	85496.11	91205.62	98128.92	105653.6
Singapore	48617.09	50069.22	49005.79	49541.17	47230.96	31132.83	28474.26	30359.09	30799.13	19926.48	36134.62	55932.75	55643.06	45221.44	36372.97	55676.06	56372.79
Thailand	164347.6	176126	181270.8	194600.4	208322.3	224574.4	243188.1	247467.5	252047.6	252447.3	252443.6	267603	281926.3	278318	296598	300088.9	316212.7
Vietnam	47513.32	47693	53644.54	61139.89	70806.1	78767.16	90549.23	98143.59	102745.7	104872.5	117993.1	128634.7	142738	152169.5	142220.9	147230.1	166910.8

Source: Data from the database: World Development Indicators, Last Updated: 11/14/2018

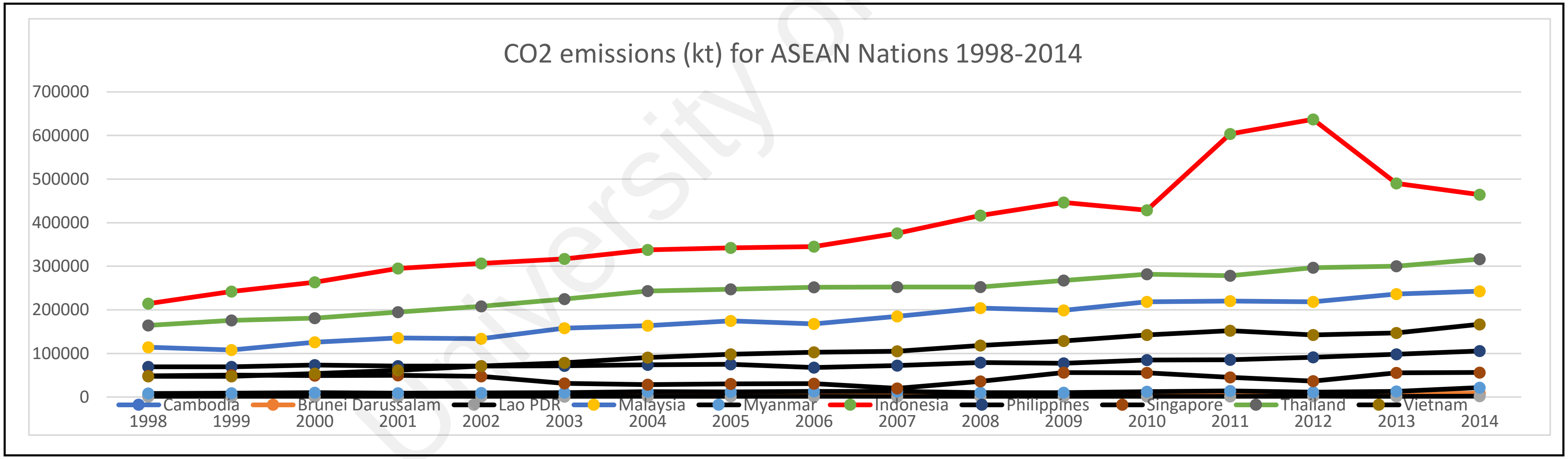

Figure 6.3: CO_2 emissions (kt) for ASEAN Nations 1998-2014

Source: Graph plotted by author

Table 6.3: CO_2 emissions (kt) for Selected ASEAN Nations 1998-2014

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Malaysia	114186.7	107934.5	125734.1	135620.3	133742.8	158256.7	163826.9	174486.9	167702.9	184816.8	204031.9	198876.1	218476.2	220405	218707.2	236510.5	242821.4
Indonesia	214200.5	241989	263418.9	294907.5	306737.2	316792.1	337635.4	341991.8	345119.7	375544.8	416560.2	446409.6	428760.3	603665.2	637078.9	490226.6	464176.2
Thailand	164347.6	176126	181270.8	194600.4	208322.3	224574.4	243188.1	247467.5	252047.6	252447.3	252443.6	267603	281926.3	278318	296598	300088.9	316212.7

Source: Data from the database: World Development Indicators, Last Updated: 11/14/2018

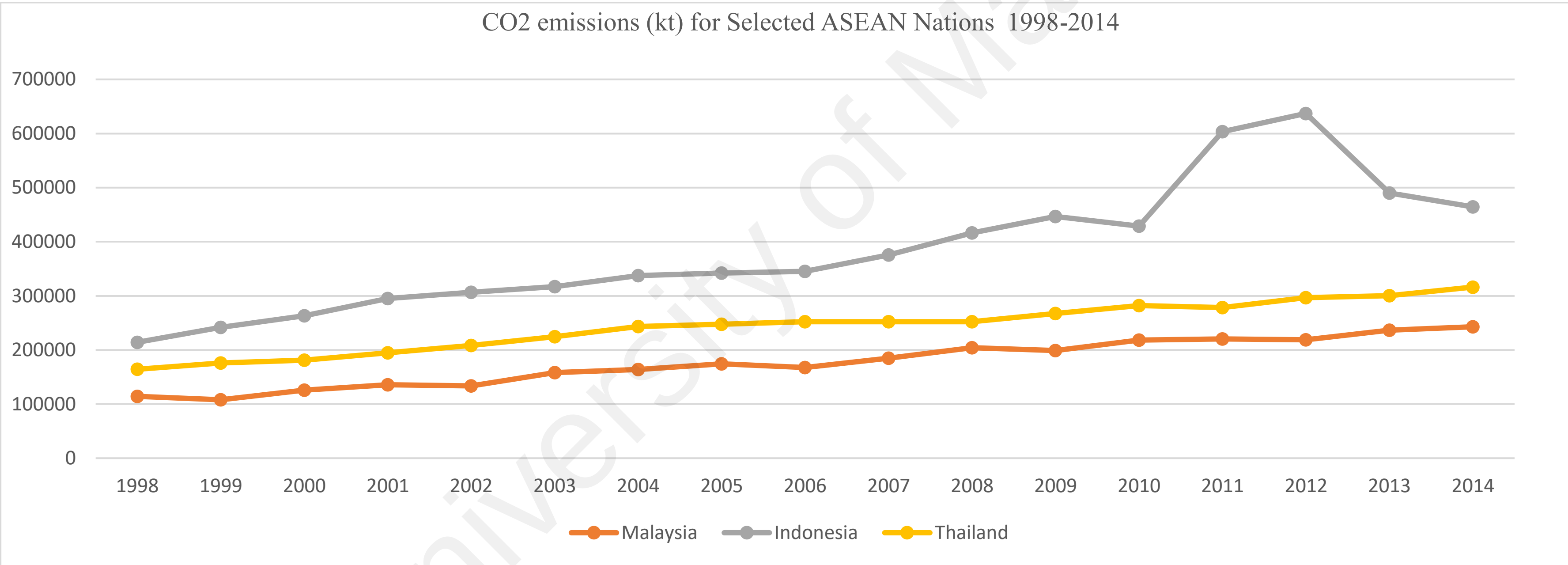

Figure 6.4: CO_2 emissions (kt) for selected ASEAN Nations 1998-2014

Source: Graph plotted by author

Table 6.4: CO_2 emission (metric ton per capital) for ASEAN Nations 2000-2014

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brunei	14.14	13.25	12.62	12.99	13.90	13.71	13.13	22.45	24.05	20.49	21.11	24.61	24.18	19.23	22.12
Indonesia	1.25	1.37	1.41	1.44	1.51	1.51	1.50	1.61	1.76	1.87	1.77	2.46	2.56	1.95	1.82
Cambodia	0.16	0.18	0.17	0.19	0.19	0.21	0.22	0.25	0.28	0.33	0.35	0.36	0.37	0.37	0.44
Lao PDR	0.18	0.16	0.21	0.20	0.25	0.24	0.27	0.15	0.16	0.20	0.26	0.26	0.26	0.24	0.30
Myanmar	0.22	0.19	0.20	0.21	0.26	0.24	0.26	0.26	0.20	0.21	0.25	0.28	0.22	0.25	0.42
Malaysia	5.42	5.72	5.53	6.41	6.51	6.80	6.41	6.94	7.53	7.20	7.77	7.70	7.50	7.96	8.03
Philippines	0.94	0.89	0.88	0.86	0.87	0.87	0.77	0.81	0.87	0.84	0.91	0.90	0.94	1.00	1.06
Singapore	12.17	11.97	11.31	7.57	6.83	7.12	7.00	4.34	7.47	11.21	10.96	8.72	6.85	10.31	10.31
Thailand	2.88	3.06	3.25	3.48	3.74	3.78	3.83	3.81	3.79	4.00	4.19	4.12	4.37	4.40	4.62
Vietnam	0.67	0.75	0.86	0.95	1.08	1.16	1.21	1.22	1.36	1.47	1.61	1.70	1.57	1.61	1.80

Source: Data from the database: World Development Indicators, Last Updated: 11/14/2018

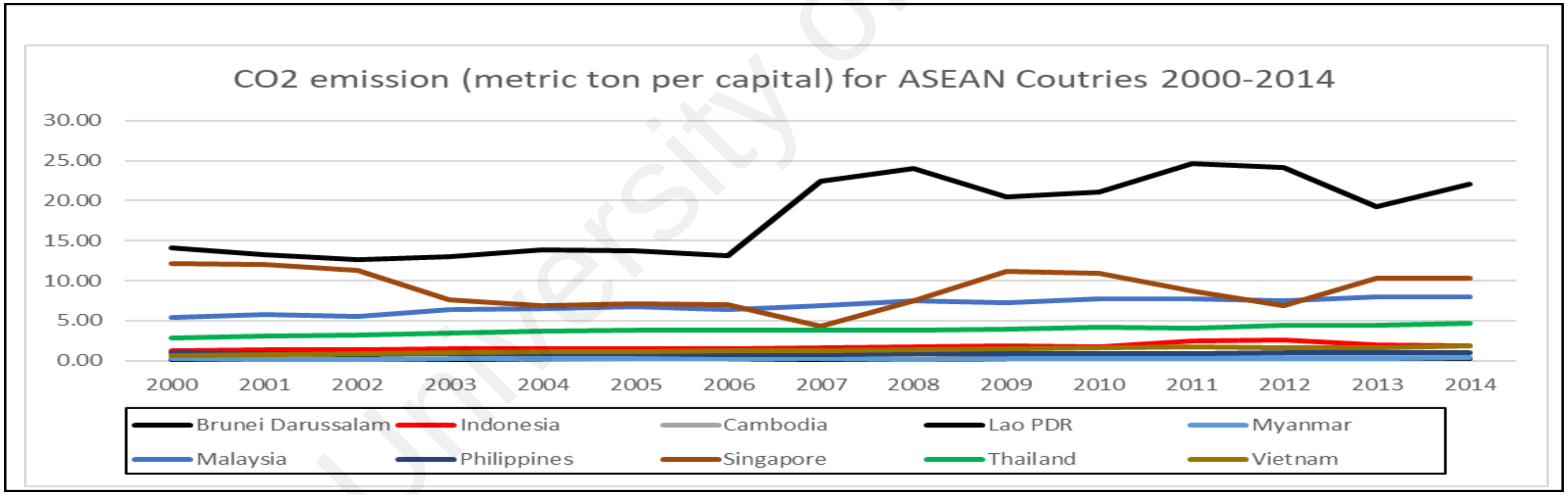

Figure: 6.5: CO_2 emission (metric ton per capital) for ASEAN Nations 2000-2014.

Source: Graph plotted by author

Table 6.5: CO_2 emission (metric ton per capital) for Selected ASEAN Nations 2000-2014

Country Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Indonesia	1.245242	1.374818	1.410234	1.436404	1.509898	1.508481	1.501577	1.611855	1.763895	1.865165	1.767908	2.456845	2.55975	1.945094	1.819363
Malaysia	5.422937	5.722641	5.526835	6.410086	6.507753	6.800116	6.414692	6.941256	7.525778	7.20425	7.771555	7.697016	7.497559	7.961514	8.032992
Thailand	2.879233	3.062483	3.251319	3.47881	3.741227	3.782434	3.829104	3.813656	3.793534	4.001129	4.194782	4.121389	4.371765	4.403808	4.62186

Source: Data from the database: World Development Indicators, Last Updated: 11/14/2018

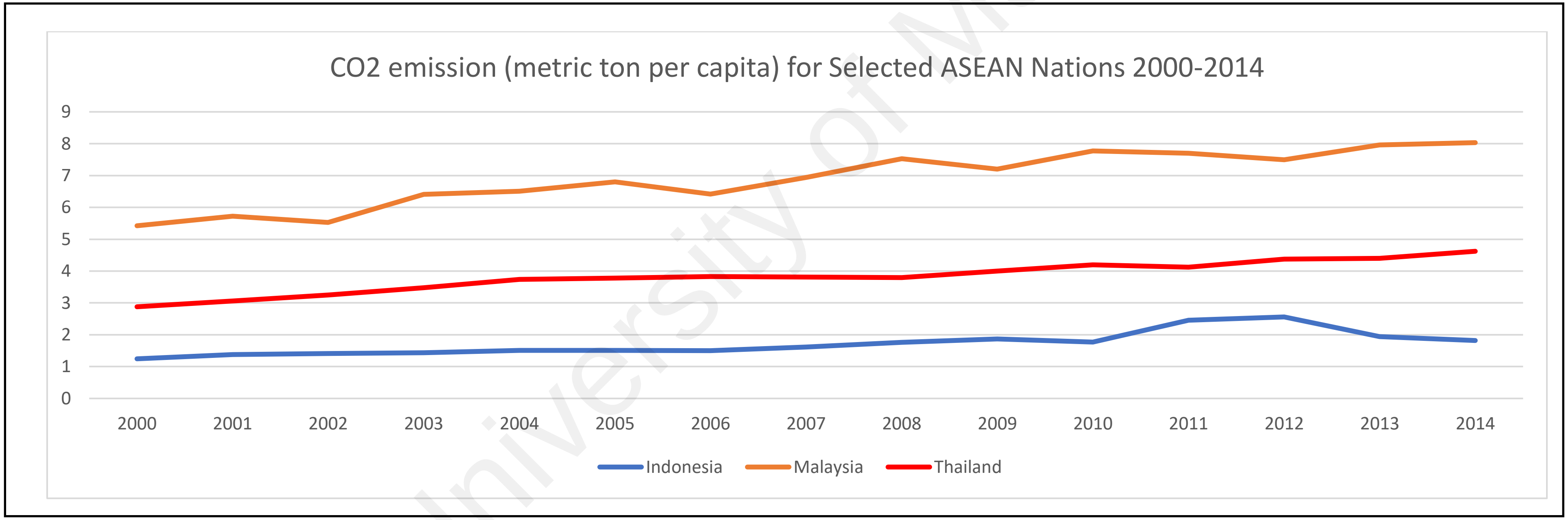

Figure: 6.6: CO_2 emission (metric ton per capital) for Selected ASEAN Nations 2000-2014

Source: Graph plotted by author

Table 6.6 "CO_2 intensity (kg per kg of oil equivalent energy use)" for ASEAN Nations 1998-2013

Country /year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cambodia	0.57	0.55	0.58	0.66	0.55	0.58	0.72	0.81	0.87	1.00	1.12	0.92	0.95	0.94	0.94	0.94
Brunei Darussalam	2.27	1.65	1.98	2.04	2.03	1.83	2.18	2.26	1.54	2.61	2.57	2.58	2.53	2.50	2.52	2.57
Malaysia	2.70	2.52	2.57	2.67	2.54	2.81	2.70	2.65	2.54	2.55	2.70	2.77	2.98	2.88	2.81	2.69
Myanmar	0.65	0.72	0.79	0.70	0.71	0.70	0.84	0.78	0.85	0.82	0.65	0.71	0.89	1.00	0.71	0.77
Indonesia	1.56	1.69	1.69	1.85	1.86	1.91	1.91	1.90	1.88	2.05	2.23	2.21	2.02	2.95	3.01	2.25
Philippine	1.84	1.79	1.83	1.86	1.84	1.84	1.91	1.93	1.76	1.87	1.97	2.03	2.10	2.10	2.11	2.19
Singapore	2.44	2.76	2.63	2.33	2.23	1.22	0.93	1.41	1.33	0.93	1.47	2.63	2.19	1.72	1.40	2.11
Thailand	2.49	2.49	2.51	2.62	2.53	2.52	2.53	2.50	2.50	2.40	2.34	2.48	2.39	2.36	2.35	2.21
Vietnam	1.79	1.75	1.87	2.00	2.12	2.24	2.32	2.38	2.43	2.31	2.43	2.42	2.42	2.58	2.37	2.46

Source: Data from the database: World Development Indicators, Last Updated: 11/14/2018

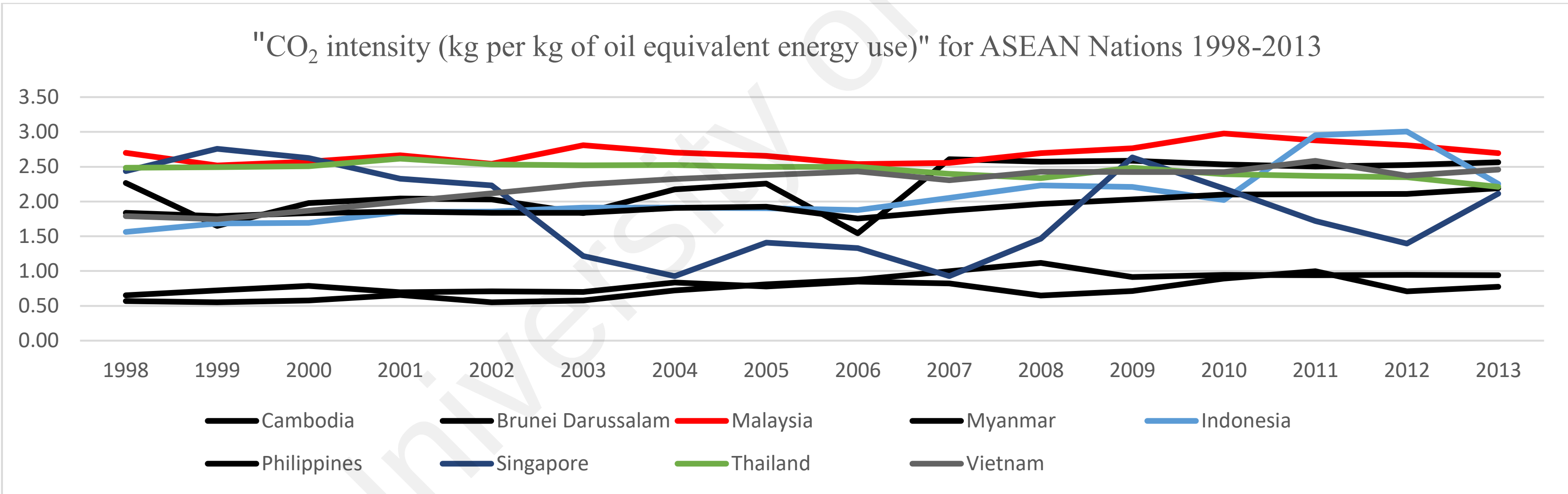

Fig 6.7: "CO_2 intensity (kg per kg of oil equivalent energy use)" for ASEAN Nations 1998-2013.

Source: Graph plotted by author

Table 6.7: CO_2 intensity (kg per kg of oil equivalent energy use) for ASEAN Nations 1998-2013

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Malaysia	2.70	2.52	2.57	2.67	2.54	2.81	2.70	2.65	2.54	2.55	2.70	2.77	2.98	2.88	2.81	2.69
Indonesia	1.56	1.69	1.69	1.85	1.86	1.91	1.91	1.90	1.88	2.05	2.23	2.21	2.02	2.95	3.01	2.25
Thailand	2.49	2.49	2.51	2.62	2.53	2.52	2.53	2.50	2.50	2.40	2.34	2.48	2.39	2.36	2.35	2.21

Source: Data from the database: World Development Indicators, Last Updated: 11/14/2018

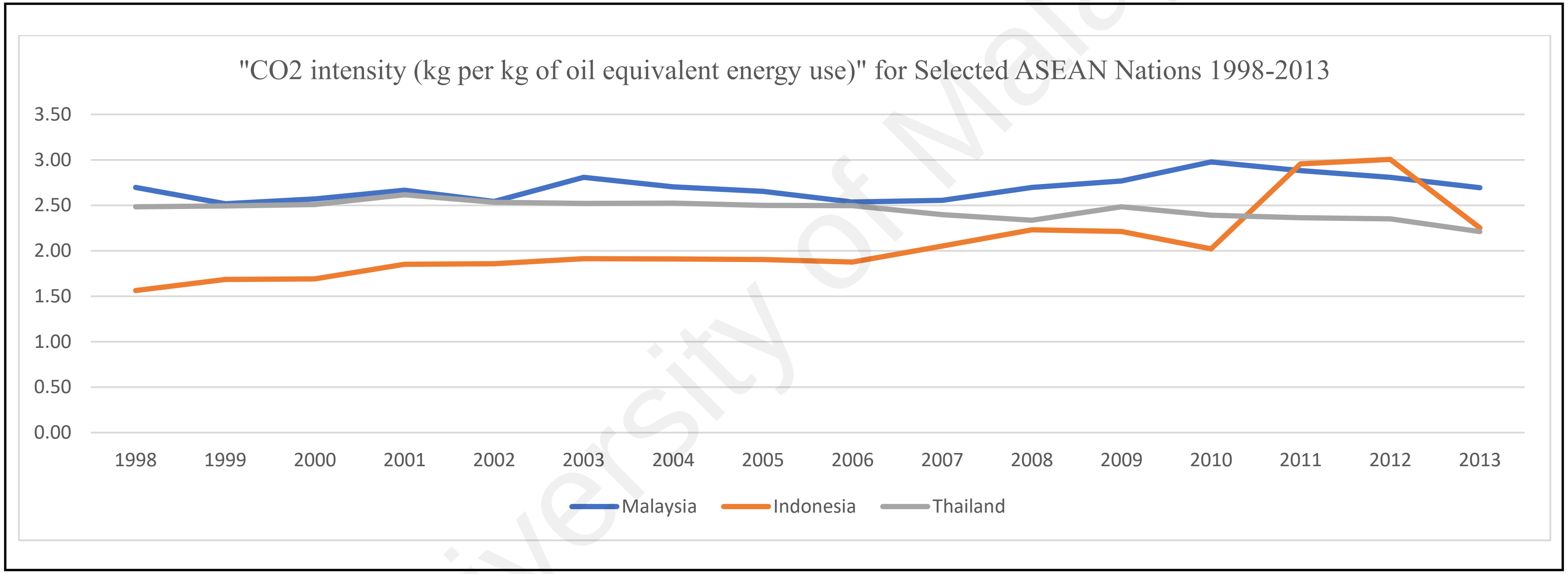

Figure: 6.8: “CO_2 intensity (kg per kg of oil equivalent energy use)” for selected ASEAN Nations 1998-2013.

Source: Graph plotted by author

6.4.3 Analytic Techniques

This study utilizes quite a few instrumental methods for data analysis. To grow a standard database by “Input-Output (I-O) table with SAM framework”, this research uses “Cross-entropy method” towards apprise and stable the SAM for the year 2005 and downscale it till year 2015 as organised by “DOS and Economic Planning Unit (EPU) of Malaysia”.

Key apparatus aimed at this investigation to attain the goal is the “General Algebraic Modelling System (GAMS)” in addition “Syntax Programming (SP)." Both the “GAMS and SP” are deployed towards resolve “non-nonlinear and mixed-integer problems” and make Malaysian economy-wide mathematical models to develop. The device for data analysis proceeds for eight steps as follow:

1. First step of this process is to define mediators (“producers, consumers, state”) and marketplaces,
2. Second step of this process is to establish the data aimed at a mainframe database,
3. Third step of this process is the market information system advancement,
4. Fourth step of this process is to set a subjective standard worth,
5. Fifth step of this process is the practical procedures of supply besides demand to established,
6. Sixth step of this process is the adjustment of the model,
7. Seventh step of this process is the procedure with the analysis of dynamic properties, besides
8. Eighth step of this process is to calculate the index properties.

This study also reflects the “circular flow map of Malaysia” which captures all Low Carbon Economy transmissions and contacts amid sectors besides organizations.

Inventive actions including Low Carbon Economy partaking and venture efforts from economic factor of marketplaces, besides transitional inputs as of commodity markets, then practice these to yield belongings and amenities. Imports and commodity marketplaces counterpart these to households, the administration, and stockholders. The domestic and administration acquisitions of supplies offer in the income's makers want to endure the manufacture process. Extra formal broadcasts, like "taxes and savings", safeguard the "circular flow of incomes" is measured as closed. Significantly, all revenue and spending flows are accounted for, besides there are no outflows from the arrangement.

In the study modeling, the administration gets handover expenses from "the rest of the world (e.g., in the form of foreign grants and development assistance)". This is also added to all of the diverse tax incomes to normalise "total government revenues". Government practices the incomes to pay for "regular consumption spending and remains the handovers to households". The difference between "total revenues" and "total expenditures" results to the national economy with the Low Carbon Economy is total fiscal contributions. Data on the government economic records were drawn from "public-sector accounts" available through EPU (2010).

Following the "ex-post accounting identity", the "gross capital formation", is considered changes recorded in total variation of stocks or inventories. The variance between "total domestic savings" and "aggregate investment demand" is "total capital inflows from abroad" in the "current account balance". Data on the "current account (or rest of the world)" is strained from the "national balance of payments", which is available by "Department of Statistics Malaysia (*National Accounts*; retrieved from www.statistics.gov.my)". Finally, Low Carbon Economy related data has been mostly occupied as of Biotech Corp ("Malaysian Non-Renewable Corporation, 2005-2014").

6.4.4 Calibrating the ASEAN RICE model

The method of calibration is completed to estimate, "associated coefficient parameters" to find specific target level of "Low carbon-outcomes". The parameters used for determining the "Low Carbon Economy Index (LCEI)" are measured on the basis of the "current contribution" and achievement over base involvement and accomplishment. The "base contribution" is then accustomed over time to apprehension the actual results following on the "national actual growth rate" fundamentally followed by "national interest rates, general level of consumer confidence, local asset prices, real national wages, local exchange rate, local commodity prices, the investment levels in infrastructure, investment on human capital, investment for development of green energy expertise and risk rate for political instability as a pre-set proxy in the dynamic CGE modelling system". The "I-O tables" original used here is reformed in to 15 sectors to encounter Low Carbon Economy aims. This study comprises of four recognised mediators, two primary factor manufactures, and the rest of the world (ROW). Total 15 sectors were accumulated from "Malaysian Input-Output table- 2005" and later updated till 2010 with the specific contributions of Low Carbon Economy aids. Here four are the core sectors that represents the ASEAN economy and the remaining 11 are the sub sectors of the core sectors.

The "parameter and elasticity" standards (for example, the CES, the CET etc.) that are working in the study model also measured cautiously as it is vital to evaluate the influence of numerous BI properties. Malaysian "Balanced and updated Social Accounting Matrix (SAM)" for the years 2005 and 2010 have been used as "data for standardisation". The model equation for this index is written in the "General Algebraic

Modelling System (GAMS)" language to estimate the solving parameters with non-linear programming. There are numerous "economic blocks (e.g., economic components/parts)" that are measured to quantify the BI which are also provided in appendix C of this thesis.

6.5 Results and Discussion

The results are presented in the above from Table 6.8 through Table 6.17. The outcomes are conferred in relations of Low Carbon Economy setting besides its connected national effects following on Low Carbon Economy's definite progress and input over specified time.

6.5.1 Carbon Price

Table 6.8 presents the carbon price for the ASEAN nations with forecasted rise due to the carbon tax and government restrictions. For the chapter objective we have initially forecast, the change of Carbon Price from 2010 to 2060 with a 5-year interval to observe the BAU and Optimal scenario for the Carbon pricing in ASEAN Nations. The following table result shows gradual growth in carbon price until 2030.

Table 6.8: Carbon Price BAU and Optimal scenario for ASEAN Nations

Year	'10	'15	'20	'25	'30	'35	'40	'45	'50	'55	'60
Carbon Price BAU	1	1.04	1.07	1.03	2.34	2.32	4.86	4.86	9.42	9.35	16.35
Carbon Price OPTIMAL	1	1.04	1.07	1.03	3.51	3.48	7.30	7.30	14.13	14.03	24.53

Source: Computed by author, (Note: 2010= '10)

However, as after 2030, the INCD conditions need to be implemented by the signatory ASEAN nations, so there will be a surcharge or additional fees, or Carbon tax, imposed. This will gradually upsurge the price of carbon commodities, and so as a policy response the customers either have to pay a higher price or will have to switch to other available non-fossil and renewable energy sources.

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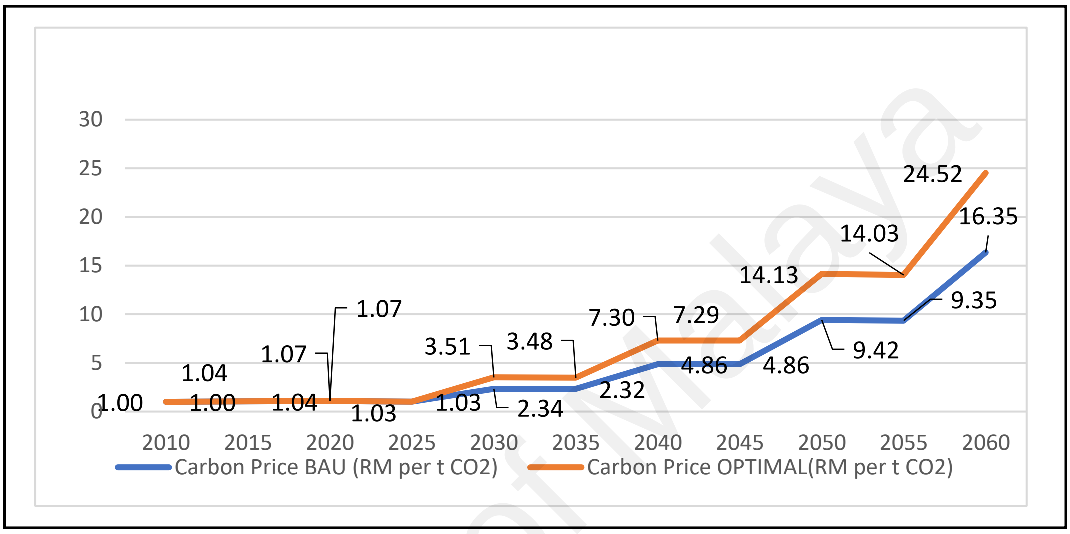

Figure 6.9: Carbon price BAU and Optimal for ASEAN Nations from 2010-60.

Source: Computed by author

The customers being reasonable, will look for the alternative options, which are more sustainable and easier to pay, and will choose so. Plotting the Data in the Graph, it was evident, that the price of carbon is gradually rising from the year 2010 to year 2030.

This is really happening as common peoples are becoming more aware about the Climate Change facts by the works of literature from Nordhaus (2008, 2014, 2018) and Stern (2007). Now governments of various ASEAN nations are formulating new policies to set up carbon tax accordingly.

6.5.2 Emissions Control Rate

Table 6.9 presented below represents the Emission Control Rate for the ASEAN nations with forecasted rise due to the carbon tax and government restrictions. For the third objective of the thesis, we have primarily predicted, the emission control rate with two scenarios.

They are, namely the "BAU scenario" and the "Optimal scenario" as from 2010 to 2060 with a 5-year interval. This was done to see the change pattern in Emission control Rate for different scenarios in ASEAN Nations. The finding shows continuous growth for Emission control rate till year 2030. However, as after year 2030, the INDC properties need to be implemented in the ASEAN nations, so there may be a surcharge or additional fees, or "Carbon tax", imposed on use of Carbon Thus, we are hopeful that the rules of the market will transform, and will be sustainable for the future.

Table 6.9: Emissions Control Rate BAU and Optimal scenario for ASEAN Nations

Year	'10	'15	'20	'25	'30	'35	'40	'45	'50	'55	'60
Emissions Control Rate BAU	0	0	0	0	0	0	0	0	0	0	0
Emissions Control Rate Optimal	0.02025	0.021886	0.023451	0.025128	0.026925	0.02885	0.030914	0.031465	0.044382	0.038221	0.051485

Source: Computed by author, Note: 2010= '10

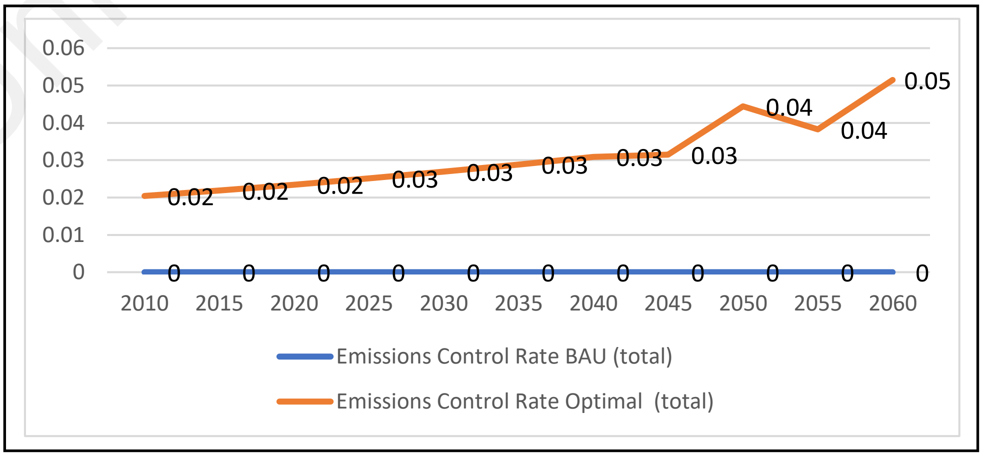

Figure 6.10: Emissions Control Rate BAU and Optimal for ASEAN Nations from 2010 to 2060

Source: Computed by author

This will slowly increase the emission control rate, and so the customers who are paying tax for using carbon-based energy, will try to switch to other non-fossil and renewable energy sources. Being reasonable, we assume that customers will always choose the most sustainable and cheaper options. So, it is vital for renewable technology to get their price low in the consumer market for penetration and single unit use.

After plotting the forecasted Data in Graph 6.11, it was quite noticeable, that the Emissions Control Rate is static in the BAU Scenario, but the opposite in Optimal scenario. It seems to rise gradually from the beginning of year 2010 to year 2030. This rise, as we assume was due to public awareness, and participation of the commons. But, after year 2030, as Industrial emission control measures are positioned following the INDC targets, so the emission starts to reduces within year 2045, and after a sharp rise in year 2050, it falls back in year 2055. From the literature from Nordhaus (2014) and Stern (2007), it was one of the targets of INDCs to increase the emission control rate in an optimal scenario. After 2055, the emission control rate will gradually grow back.

6.5.3 Social Cost of Carbon

The "Social cost of carbon" is referred a quantity of the economic damage results from those influences, articulated as the "dollar value of the total damages from emitting one ton of carbon dioxide into the atmosphere". The contemporary essential estimation of the "social cost of carbon" is crudely US $40 or RM 160 (assuming, 1 $ = 4RM) per ton. For this objective, here we compare the BAU and the Optimal scenario.

As we focus on attaining a low carbon economy index, so the optimal scenario of the SCC must fall below significantly, then that of the BAU.

Table 6.10: Social Cost of Carbon (SCC) BAU and Optimal for ASEAN Nations

Year	10	15	20	25	30	35	40	45	50	55	60
The social cost of carbon, BAU, RM	0.48	0.68	1.06	2.02	2.33	3.31	4.86	5.86	9.41	10.35	15.93
The social cost of carbon, Optimal RM	0.48	0.68	1.06	2.02	1.86	1.74	1.79	1.82	2.30	2.65	2.79

Source: Computed by author, Note: 2010= '10

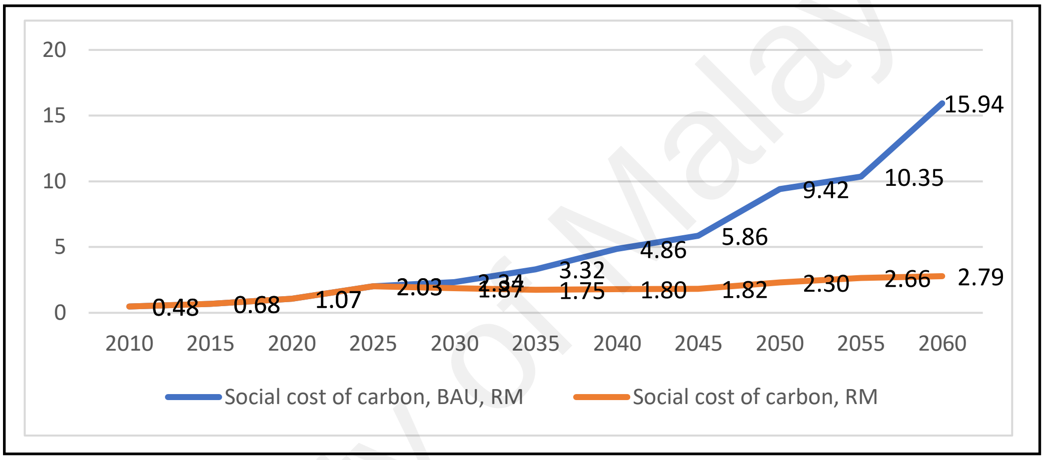

Figure 6.11: Social Cost of Carbon (SCC) BAU and Optimal for ASEAN Nations from 2010 to 2060

Source: Computed by author

6.5.4 Parts Per Million (PPM)

Table 6.11 presented below illustrates the parts per million BAU and Optimal Scenario for the ASEAN nations with forecasted rise as the overall carbon emissions are significantly rising.

For this objective of our research we have forecasted, the PPM with the BAU and Optimal scenarios from year 2010 to year 2060 with a 5-year interval to see the change patterns in different nations for ppm million scenario in ASEAN Nations. The result shows continuous growth for PPM until year 2030.

Table 6.11: Parts per Million (PPM) BAU and Optimal scenario for ASEAN

Year	10	15	20	25	30	35	40	45	50	55	60
ppm BAU	389.86	409.35	413.2507	417.1493	421.0479	424.9465	428.8451	432.7437	436.6423	440.5408	448.338
ppm OPTIMAL	389.85	409.35	413.25	417.14	417.53	417.92	418.31	418.70	419.09	419.48	419.48

Source: Computed by author, Note: 2010= ‘10

However, as after year 2030, the INCD conditions need to be implemented in those nations there will be a surcharge or additional fees, or “Carbon tax”, imposed. This will progressively rise the market retail price of carbon, and so the customers, being a rational economic being will try to switch to other non-fossil or renewable energy sources.

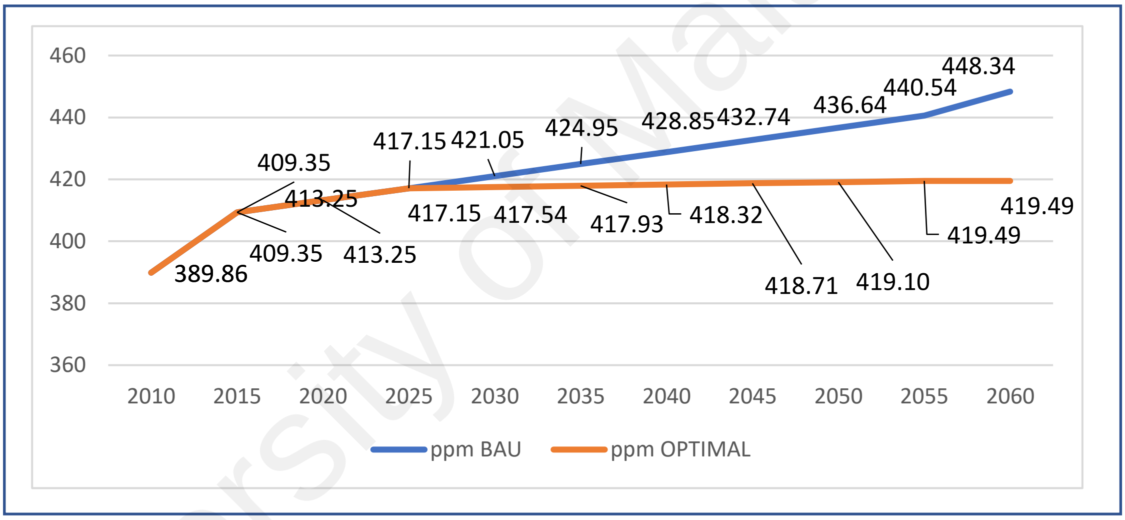

Figure 6.12: Parts per million (PPM) BAU and Optimal scenario for ASEAN Nations from year 2010 to year 2060

Source: Computed by author

6.5.5 Low Carbon Economy Index (LECI)

Low Carbon Economy Index (LECI) is a new index for Malaysia and Indonesia. It is a 100 points-built Index using the base year 2005. The BI here in the base year indicates (e.g., equation 5) that the current contribution of the total Low Carbon Economy over base influence is 100.Thus, the existing involvement and attainment of Low carbon-based properties and amenities produced within the national economy that regulates the BI growth are equivalent over the base contribution, and accomplishment of Low carbon-based products and amenities provided[48]. The consequence of Low Carbon Economy Index (LCEI) is separated into the 5 sub-indices to observe the sub-indicator accomplishments, outlines, and tendencies from the base year 2005 to year 2014. Table 6.12 presents the total Low Carbon Index for the all ASEAN member nations, and it can be utilized to assess the Low carbon situation and improvement in Carbon mitigation from a regional perspective.

Table 6.12: Low Carbon Economy Index (LCEI) Optimal Scenario for ASEAN member Nation

Year	'10	'15	'20	'25	'30	'35	'40	'45	'50	'55	'60
Low carbon index	1	1	1	1	1.11	1.35	1.65	1.83	2.30	2.15	2.94

Source: Computed by the author, Note: 20[10= '10

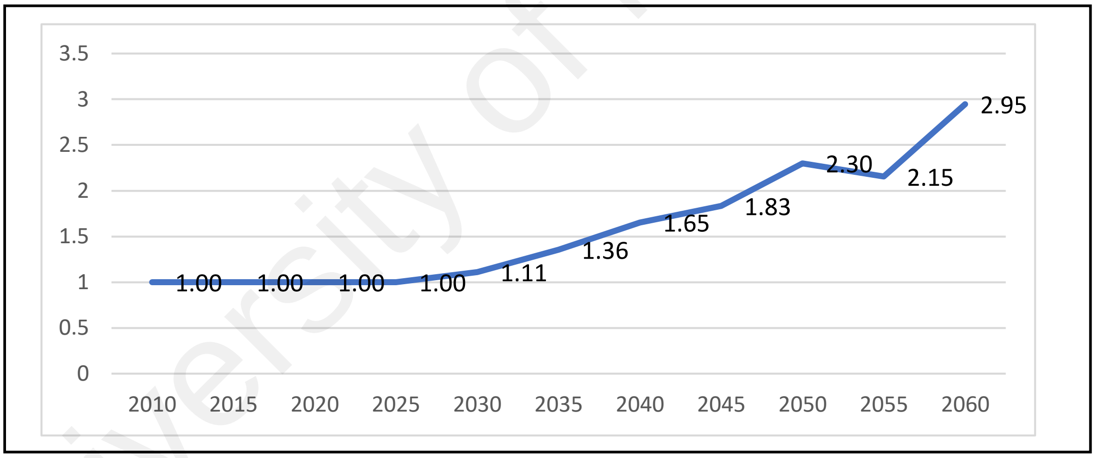

Figure: 6.13: Low Carbon Economy index (LCI) for ASEAN Nations until 2060.

Source: Computed by author

6.5.6 Optimal of PPM, ECR, and SCC

As we presented the Data in the following table, we can visualize and compare all the three variables, namely the Parts per million (PPM), Emission Control rate (ECR) and Social Cost of Carbon (SCC) comparison for ASEAN Nations from 2010 to 2060

[48] Two parts estimate the Bioeconomy Index (BI). The first part is considered from 2005 to 2014 based on actual position and the second part is considered from 2015 to 2022 based on simulation and forecast.

Table 6.13: Parts per million (PPM) Emission Control rate (ECR) and Social Cost of Carbon (SCC) comparison for ASEAN Nations from 2010 to 2060

Year	10	15	20	25	30	35	40	45	50	55	60
ppm - Sub index	1	1	1	1	1.09	1.02	1.02	1.03	1.04	1.05	1.06
Emissions Control Rate (total) -Sub index	1	1	1	1	1.07	1.15	1.23	1.25	1.76	1.52	2.04
The social cost of carbon, RM - Sub index	1	1	1	1	1.25	1.90	2.70	3.21	4.09	3.89	5.72

Remarks: 2030= used as INDC option and action (onward), 1.00 = no option optimized,1.11 = 11 point (not percent) from baseline, 1.36 = 36 point from baseline and so on over time (until 2060)

Source: Computed by author, Note: 2010= '10

It shows an upsurge turn reflects that the selected ASEAN nations are moving in the right direction, but more is needed to upgrade our regional position and Mitigation success. They need to develop our low carbon strategies in such a way that we can maintain and excel the prediction pathways to enhance the growth trend.

The graph at Figure 6.15 presents a good sign for ASEAN nations, as it soars upward with all these variables, it proves that it is getting better for the whole region to attain the higher Low carbon standing more quickly and easily.

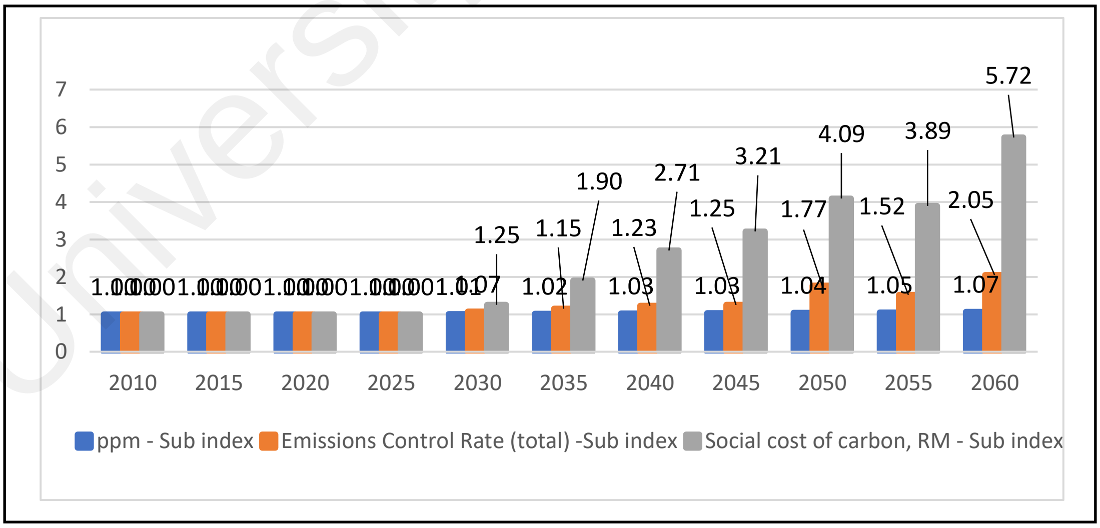

Figure 6.14: Visual Comparison Parts per million (PPM) Emission Control rate (ECR) and Social Cost of Carbon (SCC) for ASEAN Nations from 2010 to 2060 with forecasted values

Source: Computed by author

We make the comparison till 2060 as the present INDC targets are according to Marrakesh Proclamation and ranges till 2050. If there are any revised targets in COP 23, i can quickly adjust and recalibrate. If we run the components for the Selected ASEAN Nations to determine, which country is performing how in the

Table 6.14: Emissions Control Rate (total) for the selected ASEAN nations till 2060

Year	10	15	20	25	30	35	40	45	50	55	60
Emissions Control Rate/Year											
Emissions Control Rate (total)BAU**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions Control Rate (total) Optimal	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05

Source: Computed by author, Note: 2010= '10

emission control situation among the selected nation? Here let us clear one thing first that emission control rate is intended for CO_2 emission control, as it is one of the main components responsible for Climate Change.

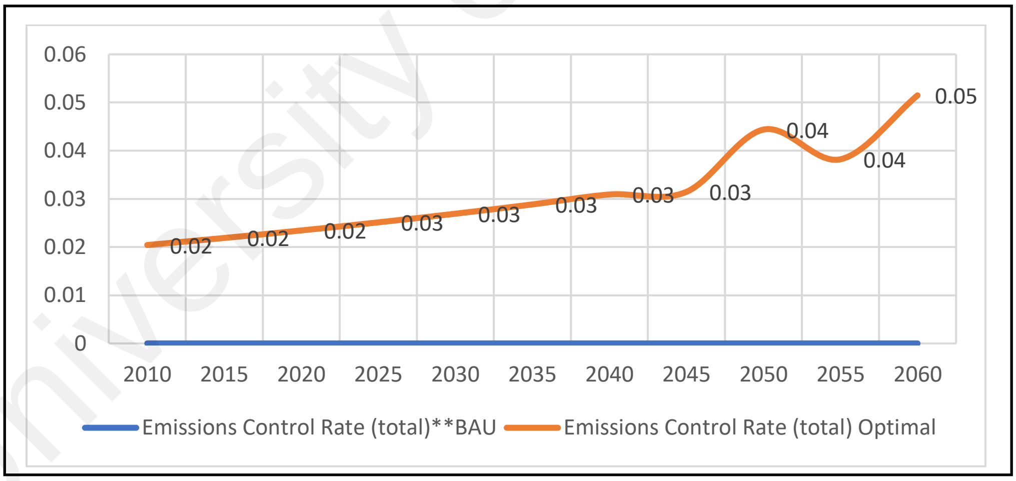

Fig 6.15: Emissions Control Rate for the selected ASEAN Nations until 2060

Source: Computed by author

The data presented in the graph shows two scenarios, the blue line representing the Business as usual (BAU) Scenario, and the Red line shows the optimal scenario. The Data shows the selected nations already have taken some actions to control emission, and so the optimal scenario is an uprising.

Table 6.15: Social Cost of Carbon (SCC) for the selected ASEAN Nations from 2010 till 2060

Year	10	15	20	25	30	35	40	45	50	55	60
The social cost of carbon, RM BAU	0.48	0.68	1.07	2.03	2.34	3.32	4.86	5.86	9.42	10.35	15.94
The social cost of carbon, RM Optimal	0.48	0.68	1.07	2.03	1.87	1.75	1.80	1.82	2.30	2.66	2.79

Source: Computed by the author, Note: 2010= '10

This graph demonstrates two scenarios, and the first scenario is if I do not take any measure or BAU Scenario and the other is the efforts of the respective governments to control the Emission combinedly through the mitigation policy. As the carbon tax will be forced after 2030 in the ASEAN member nations, the "Social cost of carbon" will increase sharply in the Selected ASEAN Nations until 2060. If only we can plot the data in a graph, then we can show that for Social Cost of Carbon (SCC) for the selected ASEAN Nations will be gradually rising till 2060, which indicates that the future for carbon-based energy will be costly.

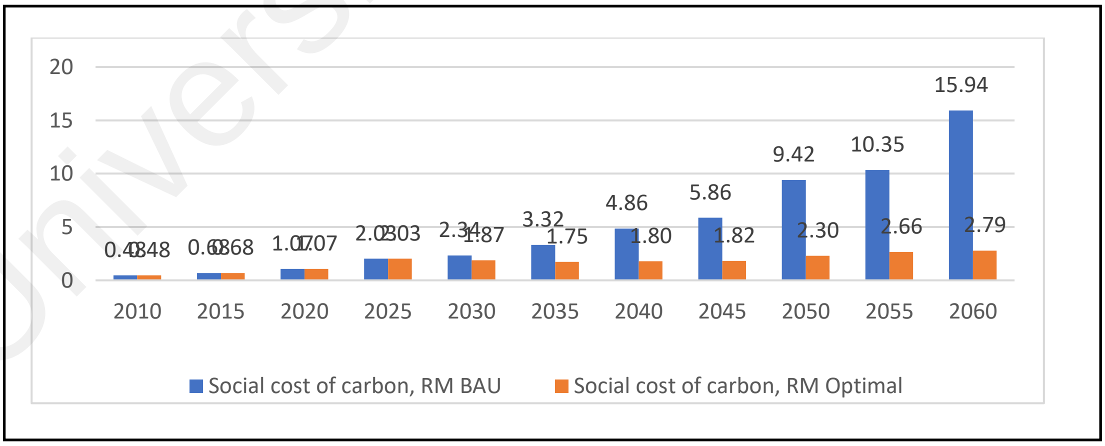

Figure 6.16: Social Cost of Carbon for the selected ASEAN Nations till 2060.

Source: Computed by author

This graph demonstrates two scenarios, and the first scenario is if the selected ASEAN nations do not take any measure or BAU Scenario and the other is the efforts of the respective governments to control the Emission combinly through the mitigation policy.

As the carbon tax will stand imposed after 2030 for the ASEAN member nations, the "Social cost of carbon" will also rise abruptly for the selected ASEAN Nations until 2060.

Table 6.16: Parts per Million (PPM) for the selected ASEAN Nations until 2060

PPM/Year	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
ppm BAU	389.86	409.35	413.25	417.15	421.05	424.95	428.85	432.74	436.64	440.54	448.34
ppm OPTIMAL	389.86	409.35	413.25	417.15	417.54	417.93	418.32	418.71	419.10	419.49	419.49

Source: Computed by the author, (Note: 2010= '10)

This graph presented here demonstrates two scenarios, the first scenario is if the nations do not take any measure, and let things go as usual. This is also known as the BAU Scenario and the other is the efforts of the respective governments to control the Emission combinly through the mitigation policy.

As the carbon tax will be imposed after year 2030 in the ASEAN member nations, the "Social cost of carbon" will rise sharply in the Selected ASEAN Nations until year 2060. As the selected ASEAN nations agreed that from 2030, the climate Change mitigation apparatus like carbon tax and other green initiatives will be fully functional and implemented so, year 2030 is significant for this analysis.

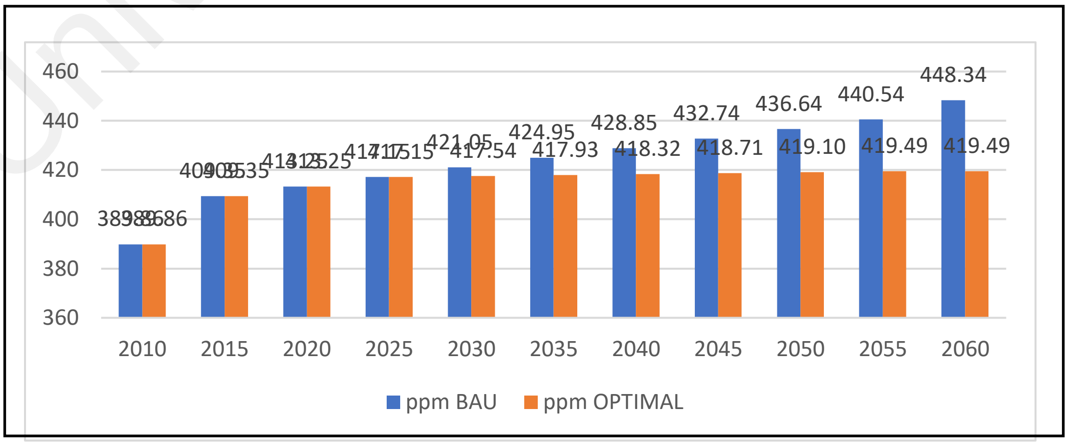

Figure 6.17: Parts per Million (PPM) for the selected ASEAN Nations until 2060.

Source: Computed by author

The table 6.17 below presents the Low Carbon Economy Index (LCEI) for the three selected nations namely Indonesia, Malaysia and Thailand generated by using ASEAN RICE model. Table 6.17 presents the LCEI for the selected ASEAN Nations from 2010 to 2060, where by score Malaysia is ranked as the first position for Low Carbon Economy Index (LCEI) among the three selected ASEAN Nations, Thailand is in the 2nd place, and Indonesia is in the last position till 2060 consequently.

Table 6.17: Low Carbon Economy Index (LCEI) for the selected ASEAN Nations until 2060

(optimality) Year	10	15	20	25	30	35	40	45	50	55	60	Rank
Low Carbon Economy Index	1	1	1	1	1.11	1.35	1.65	1.83	2.30	2.15	2.95	
Indonesia (SECTORAL)					0.49	0.60	0.73	0.81	1.02	0.95	1.31	**3**
Malaysia (SECTORAL)					1.82	2.22	2.71	3.00	3.77	3.53	4.83	**1**
Thailand (SECTORAL)					1.01	1.24	1.51	1.67	2.10	1.97	2.69	**2**

Source: Computed by author (Note: 2010= '10)

As we present the data of Table 6.17, in a graph and later generate Fig 6.19 using it. The figure illustrates four distinctive lines, representing Low Carbon Economy Index (LCEI) for the three selected ASEAN Nations till 2060, where Malaysia is ranked as first with the green line for Low Carbon Economy Index (LCEI) among the three

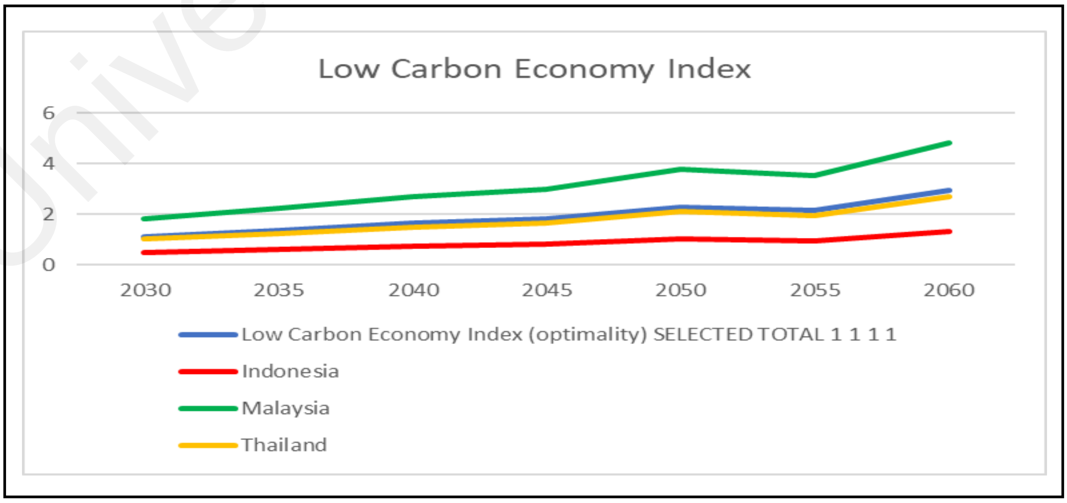

Figure 6. 18: Low Carbon Economy Index (LCEI) for the selected ASEAN Nations until 2060

Source: Computed by author

selected ASEAN Nations till 2060, Thailand is following Malaysia in the 2nd place with the orange line, and Indonesia is in the third position with the red colour for the Low Carbon Economy Index (LCEI) till 2060.

This graph indicates here that, among the three selected ASEAN nations, if they want to work on mitigation actions, then both Thailand and Indonesia need to uptake aggressive climate mitigation targeting certain specific sectors. The blue line in the graph is the average score of the three nations till 2060. That is the minimum target for all the three nations, and Malaysia is maintaining a constant lead above the average Low Carbon Economy Index (LCEI) for the selected ASEAN Nations till 2060 and can lead the other two nations to prepare adequately and efficiently.

6.6 Summary

Malaysia is now fragment of this global movement and has recently given urgency in generating a sustainable resource-based process for the country's forthcoming economic progress. The Malaysian government approved non-renewable fuel usage reduction and, more recently, Low Carbon economy is considered as one of the key strategic drivers to lift the nation's progress by the acceptance of sustainable industrial procedures, new innovations in healthcare and agronomic efficiency. So, Malaysia can act as a leader for the selected ASEAN nations initially to formulate a 'strategic master-plan' to improve and prove that it is possible to enhance the competitiveness and achievement of INDC Promises to contribute toward sustained development of the selected part of the ASEAN regions.

The analysis was completed in this chapter suggest, to develop a strategic plan for the Low Carbon Economy of ASEAN nations for going forward until 2060. Within the construction of BI estimate, this study reflects the measurement and merging of five pointers to evaluate general and sectoral BI as key drivers: “Revenue, Investment, R&D Spending, Job income Creation, and Intellectual Property”. The measurement of BI also includes a number of the constructions of Low Carbon Economy and valuation by a quantifiable standard and criteria by DCGE approach to produce a yearly accustomed reference point (baseline) as a tool to compare actual attainments in the future. The BI outlines the growth towards the national set targets dimension from year 2005 to year 2014 and then used the scenarios till 2022 to comprehend the openings and projections and enable inclusive assessment every year to guide the forthcoming nationwide Low Carbon Economy progress schedules.

The BI delivers an orientation point as a fact for evaluating the available drivers of “Low Carbon Economy” to perceive whether as a fording economy are we going towards a right path beside accurate means successively in the nationwide economic system. It is expected that with the progress of the Low Carbon Economy Input Index, policymakers thus can take benefit of the growing possibility and amount of data available as well as the growing computing capabilities afforded by technology. The ASEAN RICE model was organized as a tool to evaluate the rank of the Low Carbon Economy for the selected in a quick, consistent and comprehensive manner to enable targeted and ASEAN Nations among the ASEAN region for timely formulating mitigation policy and strategy to deal with Climate Change.

Low Carbon Economy Index (LCEI) for the three selected ASEAN Nations till 2060, ranked Malaysia, Thailand, and Indonesia in the First, Second and Third place according to the forecasted Low Carbon Economy Index (LCEI) till 2060. To catch up with Malaysia both Thailand and Indonesia need aggressive low carbon transformation from present energy use to mitigate climatic impacts.

Going onward, we anticipate to see this procedure to be further utilized to compare Low Carbon Economy impacts across all ASEAN member nations, and even it can be deployed to measure the future low carbon development opportunity for other sectors or potential industries, as this measurement techniques will help us to identify and will provide even greater sectorial insights and foundations for formulating efficient national as well as regional , and international low carbon based economic policy.

CHAPTER 7

CONCLUSION

7.1 Introduction

To summarize this total research, we want to quote from the speech of Sir David Attenborough who voiced in COP 24 conference, UNFCCC (2018, 3rd December) at Katowice, Poland following the public's response for the impacts of Climate change as follow:

> *"The Paris agreement proved, together we can make real change happen. But our time is running out. We need to act now. Leaders of the world, you must lead. The continuation of our civilisations and the natural world upon which we depend, is in your hands"*

This final chapter draws conclusions from the findings of the study. The thesis initially adapted the CGE based Model of Nordhaus'(2008) AD-DICE model, which is a global climate model. We modified the model to best fit for the ASEAN regional climate settings and adjusted the mitigation focus for selected ASEAN nations, i.e., thus downscale and developed the "ASEAN RICE" Model.

However, attempts to draw lessons for policy will require consensus on the price level necessary; the clarity and stability of political willingness and signals; and our desire to mitigate into a low carbon economy. These elements can provide practical guides for shifting from high to low carbon scenarios, but there is much more to policy, including the operation of trading, and other market failures.

The answer of this research depends on three critical questions that ASEAN nations need to sort, which largely relates to prices and price structures. These include the price level of renewable energy likely to be necessary; the political will and signals to promote renewable energy; and income and benefit distribution process to move to a Low Carbon economy.

In this concluding chapter we present the synthesis of the study, draw implications for theory and policy, and establish future directions for new studies in the field. The rest of this chapter is structured as follow: Section 7.2 provides the synthesis of the thesis, 7.3 outline contribution of the study for mitigating Climate Change impacts for Malaysia and the Selected ASEAN Nations. Section 7.4 prescribes the implication for theory realised from this research. Section 7.5 of this study discusses the implication for policy, it provides policy recommendations for certain sectors, based on the finding of this research study. The end part of this chapter, in section 7.6 we discuss the future direction which upholds suggestions for future research.

7.2 Synthesis of the Study

Climate Change is a human-induced global common problem, and it is happening. To confront it, the Association of Southeast Asian Nation (ASEAN) members need to act as a regional component, as global impacts and actions of Climatic events are sometimes not so much visible. In this thesis we seeks to evaluate the effects of Climate Change incidents on ASEAN members as a whole, and also on the basis of selected ASEAN nations by looking at different scenario-based projections by using a Computable General Equilibrium (CGE)-based regional model, viz., the ASEAN Regional Integrated model of Climate and the Economy (ASEAN-RICE).

Hence, the first objective of this thesis is the formulation of a non-linear CGE based "ASEAN-RICE" model to assess climate mitigation impact under Malaysia's INDCs submitted to the UNFCCC at COP 21. The second objective was to analyze the impacts of climate mitigation on the ASEAN under the INDC of all ASEAN member nations submitted to UNFCCC at COP 22. The third objective was to estimate the Low Carbon Economy Index (LECI) for the three selected ASEAN member nations as Malaysia, Indonesia, besides Thailand.

The LCEI estimations for Malaysia, Indonesia besides Thailand placed Malaysia first followed by Thailand and Indonesia. The results suggest that Indonesia will have to introduce aggressive Climate Change mitigation strategies to catch up with Malaysia. Overall, this thesis established through CGE modeling the best Climate Change mitigation scenario that if followed will effectively check global warming facing ASEAN economies in general, and Malaysia in particular**.**

The methodology used for all three research objectives (ROs) was Non-linear dynamic computable general equilibrium modeling. The input-output table 2015was deployed to estimate climate mitigation consequences under the INDC framework (optimal scenario) and the business as usual (BAU) scenario if existing practices are sustained. In the Malaysian case, an additional national plan scenario was encompassed. The period 2010-2110 was designated for the first objective besides 2010-2060 is selected for the second and third objectives.

For the Malaysian instance, climate damage over the period 2010-2110 will fall from 2,722mtoe following the BAU scenario to 1,203mtoe following the national plan scenario and 699mtoe following the UNFCCC's INDC scenario. Carbon concentration which will reduce from 11,912ppm following the BAU scenario to 9,714ppm under the national plan scenario and 8,592ppm under UNFCCC's INDC scenario. Since the abatement costs of the latter two are almost the same, the UNFCCC's INDC based scenario is the best option for the ASEAN member nations to mitigate the climate change impacts for the long run. In the ASEAN as a whole case, the outcomes designate that atmospheric concentration of carbon and temperatures following UNFCCC's INDCs scenario, will fall to 329ppm and 0.71°C respectively within year 2060, whereas under the BAU scenario it will be 395ppm and 0.80°C respectively in year 2060. Cumulative climate damage under BAU and optimal scenarios will rise to MYR 579 Billion following the previous compared to MYR 513 Billion following the last in year 2060. The decrease in emissions of carbon is ensured while the GDP growth is not compromised.

These findings as we said earlier, was derived by using non-linear dynamic downscaling procedure. Henceforth, it will be efficient and ethical to reassess these forecasts in order to re-calibrate interventions for the climate mitigation and reducing pathways for CO_2 discharge that need proper justification of change in arbitrary factors after every five years. Considering the positive results, this research can be useful to form a regional mitigation policy for the selected ASEAN member nations. This research can also be useful to coordination and determine the level and pattern of cooperation for a framework to arouse climate mitigation amid the individual associates.

According to World Bank (2010) and ADB (2013) report, the challenges for managing the impacts of Climate Change will be particularly severe for developing nations in the ASEAN region. To ignore such a challenging climate situation would merely make for bad investments. Mitigation of Climatic impacts according to world bank report suggests (WB, 2017) must be an inbuilt component of development. At the same time, development itself must be very leading in mitigating, as it encourages economic diversification and a more flexible workforce, both of the options reduce vulnerability. It also needs to generate the income necessary for robust investment and such a move will foster greater technical knowledge. In short, development with low carbon emission option is the most crucial form of mitigation that is gaining acceptability among the developing nations.

To decrease the impacts of change in Climate for all ASEAN nations is a challenging task, but it is not impossible also. According to this research results, the nations within ASEAN, including Malaysia and few others, who were interested in achieving that, need to prepare their economies under a unified regional body, with a strong vision to reduce the carbon dependence and thus strengthening the resilience to the effects of Climate Change in future. This is an account for the efficient and pecuniary management of economic investment and growth from the perspective of both mitigation of Climate Change and low carbon development. What we will do over the next 50 years to mitigate the impact of climate change will actually determine the fate of all life on the planet.

For dealing with such a global crisis like Climate Change, the Leadership and political role will play a very substantial role, as mutual understandings and trade-offs are necessary to formulate and accept an effective regional deal. Collaboration might involve, and be assisted by, agreement on other matters such as trade balance, health benefits, and financial stability. Furthermore, according to a recent ADB report (2013), the procedure of articulating a more comprehensive framework of the regional deal may lay the foundations for future regional cooperation on broader concerns. Here, the broader framework refers that such kind of local deal cannot be left only to environment ministries, they are of course an important component, but all of the essential ministries must be involved and committed in an equal manner, and the deal must be in the hands of the heads of government. According to ESCAP (2010), ADB (2013) report only if regional leaders give this issue serious attention and priority, then it is possible to formulate an effective deal which reflects the magnitude of the risks and the scale of action required. So, the selected ASEAN nations need to plan carefully for their low carbon future, as the costs of achieving low-carbon growth will be entirely relative to the risks we try to avoid for future.

Moreover, as the fourth Industrial revolution begins in this century, I anticipate that with technological progress, it is possible that various new technologies and opportunities will be exposed along the way that is likely to make renewable energy costs much lower than what all anticipate. A more secure, stable, actively growing world with a safe, natural environment and with less poverty is possible, but only if the regional leaders act together as a united region and follows effective economic and social policies. The big question of this south Asian regional policies must answer the three basic economic questions as follow:

1. What should we prioritize to aim for the future?
2. How do we attain our desired targets? and
3. What will it cost us individually and regionally?

According to IPCC (2014, 2018) report, the regional cooperation is measured as a prevailing force in the regional economy for Sustainable trade and technology collaboration, as well as transboundary agreements related to water, energy, transport, etc. So, there is a growing interest to formulate and use regional cooperation as a means of achieving the INDC mitigation objectives and transforming our local carbon dependency as well. A regional perspective (where the regions are mostly defined geographically, with further assortment related to economic proximity) recognizes differences in the opportunities and barriers for mitigation and low carbon transformations, opportunities for combined action on mitigation and shared vulnerabilities, and assesses what regional cooperation can and has already achieved in terms of mitigating the impacts of climate variations. Regional cooperation can provide a competitive advantage linkage between regional and national/subnational action on Climate Change and can also complement and implement in national, regional and global low carbon initiative to ensure improved low carbon transformations.

According to Stern (2009), the actions a regional organization like ASEAN can undertake in the coming thirty to fifty years. Through joint investments, the generation and use of energy and electric power, the way they will organize the national and regional transport system, and even the handling of mangrove forests. It will help them to determine whether or not those selected nations are readily capable of managing the hazards of Climate Change effectively and efficiently. More new technologies to generate power that uses low-carbon or no carbon and less waste will be central to an effective response. The activities required to shift into a sustainable and low carbon pathway with long-term planning for certain key sectors, many of the critical investments, such as low carbon-based power plants and buildings, infrastructures have a lifespan of many decades.

Stern (2015) in his book "Why are we waiting?" warned us that, to mitigate the risks and costs resulting from Climate incidents effectively, what we need is to act really quick. As the impacts of Climate Change are complex, and sometimes they are difficult to link up the effects to the cause and usually goes beyond only an economic analysis. So, fumbling to act by identified trajectories of change can be costly in the future. The selected nations need to plan specific, potential low carbon pathways for local execution through cooperation and performance consequently. As the thesis follows the same argument, in Chapter Four, of the thesis, we have analytically proved that which mitigation option and climate pathway is best, which path Malaysia need to follow.

In Chapter Five, of the thesis methodically, using ASEAN RICE model, we have demonstrated that which mitigation option and climate pathway ASEAN nations need to follow. With the least abatement cost and at Chapter Six, we have established the Low Carbon Economy Index (LECI), for ASEAN region, and also for three selected nations, namely Malaysia, Indonesia, and Thailand with cooperative based ranking. It is a critical index that helps to measure the progress of Low carbon emission for a nation, and reflect a systematically achieved pathway for Climate Change mitigation.

Here we distinctly measure the low carbon transformation preparedness of the three selected ASEAN nations namely Malaysia, Indonesia and Thailand (The three-border sharing and almost strictly same level of economic performance) Low Carbon index and ranked them according to their present carbon usage. This will help Malaysia and the other two selected nations to tune and rectify they're on ongoing low carbon initiatives to become more efficient. This LCEI can be considered as a basis for a Low carbon development trial case by ASEAN as a regional platform for the selected nations.

All the chapter 4, 5 and 6 cover the scientific and practical part of the analysis, but stumbles for issues like "Political stability" and "leadership understanding" which may or may not change overnight, and are subject to millions of assumptions. The actions and position taken by the present US government leading by President Donald Trump on the Climate Change issue is a catastrophic example of such occurrence. On June 1, 2017[49], United States President Donald Trump announced that the U.S. would cease all participation in the 2015 Paris Agreement on Climate Change mitigation. Trump stated that "The Paris accord will undermine (the U.S.) economy," and "puts (the U.S.) us at a permanent disadvantage.[50]"

[49], *Paris climate deal: Trump announces the US will withdraw". BBC News. June 1, 2017. Retrieved June 1, 2017.*

[50] *Chakraborty, Barnini (June 1, 2017). "Paris Agreement on climate change: the US withdraws as Trump calls it 'unfair.'" Fox News.*

This is, in reality, an awful effect, which is more substantial than the Climate Change impact itself. It is like denying the common global aspects of Climate Change, individually and thus attempt to do whatever you want to do. Someone (least developed and climate vulnerable nations) has to pay for such reckless denial of scientific facts and undertaking reverse actions in the future.

While scripting the general recommendation for this research, I attempt to reminisce Stern's (2015) direction to develop a pathway for Climate Change mitigation process that contemplates and consider it from all the three aspects of social realism, such as Scientific & practical, Ethical & Political view. Although I am optimistic that ASEAN nations will not get any egocentric leader similar to President Donald Trump, nothing is impossible, and no one knows what our future holds.

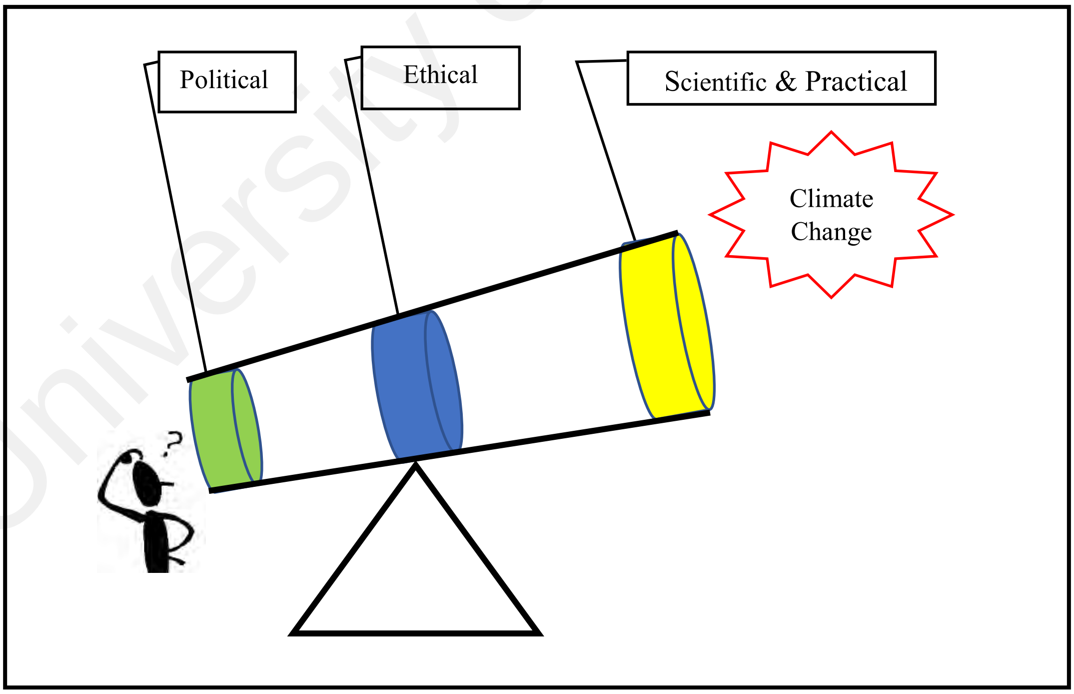

Figure 7.1: The three views for mitigation thought of Climate Change

Source: Developed by author

So, it is best to change the legal bindings formally as quickly as possible, because time is an essential factor here. Two more critical aspects also needed for practical and profound low carbon mitigation comprises of "Financial support" and "Technical know-how". These two are essential for initial start-up and spread of Backstop or Renewable technology in the selected regions. Such technology will help the designated ASEAN nations to alter their dependency from Fossil fuel to renewable energy sources rapidly.

Thus, it is certain that, the pace of development for these selected ASEAN nations will not be compromised and can ensure effective mitigation of Climate Change impacts. According to World Bank policy research talk, (World Bank, 2014)[51] The world's present level of greenhouse gas emissions embraces significant threats to environmental sustainability and economic development. The expected growth in worldwide temperatures and additional alterations, if such variances are not adequately managed, then they can posture serious harm to complex ecosystems, and result in happenings of dangerous natural events, besides even create massive health impacts. A Significant level of reduction in global emissions is compulsory to mitigate such risks, but to achieve that these ASEAN nations need universal as well as regional treaty on implementation of few costly changes in energy in addition to few other related sectors.

In a Policy Research Talk of World Bank[52], At 2014, Michael Toman, the research manager of the World Bank's research department deliberated for the challenge of mitigating the impacts of Climate variations, as illustrated in few of the latest scientific and economic indication on this issue. He categorized the job of mitigating impacts of global Climate Change as a very “Wicked problem.” In his opinion, "Climate Change is an issue that presents great complexity of scientific and economic nature, some have profound and long uncertainties, with profound ethical issues, and even lack agreement

[51] NB: (The Policy Research Talks are a monthly event held by the research department to foster a dialogue between World Bank researchers and operational colleagues.)

[52] World bank 2014, The Policy Research Talks Source: http://www.worldbank.org/en/news/feature/2014/09/30/a-wicked-problem-controlling-global-climate-change.

on what the problem is." He also added that "Economists will always think about the trade-offs involved. Ecologists will point out to us about the idea that we are moving towards a road of no return. In our opinion, "both views are true." and the important enquiry is, how do we resolve these two considerations together at the same stretch?"

In chapter two, we shared that Yuan et al., (2011) point out that, there are six distinctive stages for low carbon-based development. Except Singapore, most of the ASEAN nations are still at initial phase of "Low Carbon Economic Development". So, Low Carbon Indexing and ranking of the selected Nations will be the initial step to measure and to move deeper into real low carbon efforts.

In the Chapter 4 of this thesis, to address the First research objective of this thesis, the results of this study demonstrate that, the likely damaging effect of Climate Change besides global warming for the ASEAN region can be reduced and managed significantly by familiarising mitigative interventions through carbon taxes to transform the conduct of economic agents in Malaysia to switch the future energy sources from fossil to non-fossil, renewable energy , which is also supported and recommended by Stern(2006) and Nordhaus (2008) in their own research.

According to the analysis of Chapter 4, following COP 21 recommendation the cumulative damage of climatic change over the period 2010-2100 will amount to 2,722 mtoe under the present climate regime (scenario 1); 1,203 mtoe under scenario 2, and 699 mtoe under scenario 3. On the other hand, increasing carbon concentration over the period, 2010-2100 will amount to 11,912 ppm under the present climatic regime, which will fall to 9,714 ppm and 8,592 ppm respectively under scenarios 2 and 3 respectively. Since the total abatement costs for scenario 2 of MYR14,350.6 million, is close to that of scenario 3 of MYR14,644.7 million, so the third proposal is the best for Malaysia. These findings from research objective of this research are very similar and close to global forecast suggested my IPCC (2014b, 2018) and ADB (2013)

The results are not only essential to define Malaysia's Climate Change mitigation roadmap, but they also offer lessons for other ASEAN nations in the region who are looking forward to organizing the same. The findings enhance current knowledge on (a) setting up a long-term national Climate Change mitigation policy for Malaysia, (b) plugging gaps in our understanding of the climatic impacts in Malaysia, (including costs) of the different climate mitigation options. Although the ultimate target group considered in this study is principally Malaysian policymakers, a wide range of research communities and organizations of member nations related to Climate Change studies of ASEAN region are expected to benefit due to the nature of the scientific analysis results.

Chapter 5 deals with the second research objective of this thesis, where this research sought to examine the all ASEAN nations proposed climate mitigation scenarios known as INDC's. Over the period from 2010 to 2050, following the existing no intervention scenario and two proposals that have been obtainable in recent climate policy dialogues, namely at COP 22. Malaysia's INDC was revised and submitted to UNFCCC with subsequently no interventions till 2030, and from 2030, the planned climate control intervention proposal to cap global temperature rise to 1.5°C and carbon concentration to a maximum of 650ppm from the 1990 level.

Chapter 6 of the thesis deals with the third objective of the thesis, which is to develop a Low Carbon Index (LCI), and the rank the selected ASEAN nations by that LCI. This is a demanding task, as it is a very new concept gaining popularity among climate researchers. If we follow our First and Second objective for the ASEAN region, these nations are getting ready for the economic transition into a low economy country. As these nations are at the initial level, it is critical to measure their preparedness for low carbon initiative as a region and to rank them individually. As we want to plot in advance from the stages and level of Low carbon development of the Selected ASEAN nations, where the selected ASEAN nations are and where they want to move on in this proposed low carbon development phases.

In light of the constructive outcomes, it will be really valuable, to establish a regional Climate change mitigation policy for the selected ASEAN-member nations. The optimal scenario results are interpreted here in to guidelines on how emission of carbon and its concentration could be reduced efficiently by implementing the INDCs, and to activate a policy dialogue that could motivate to quicken climate mitigation beyond the targets set in the INDCs.

Multilateral collaboration among the ASEAN member nations, can also be initiated for active pursuing greening initiatives, we need to negotiate with nations like "Japan, China, India, Taiwan, and South Korea" for such initiatives. According to ABB (2013) collaboration with Australia, Canada, Europe and New Zealand, can also help ASEAN nations further to attain mitigation of climate impacts promptly. Thus, if we want to see the overall findings of this research at a glance, we need to develop a summarised table as follow, which one presents here the significant results, research contribution and policy implication from this specific study:

Table 7.1: Findings of the Study at a Glance

Chapters	Name	Expected Contents
Chapter 1	**Research Gap**	In this chapter we have identified the core research problem and impacts of Climate Change on the ASEAN region, From the Literature review done in Chapter 2. Here we have identified the following research gaps necessary for this research: 1. ASEAN regions do not have any CGE based Mitigation focused model so far, I use this research to build by an ASEAN Regional Integrated Climate and Economy Model (ASEAN-RICE Model) and use it to measure the scenario-based long-term (100 years) Climate Change projection for Malaysia and best mitigation option following COP 21 INDC agreement. 2. To use the newly formulate ASEAN- RISE model to project for Climate Change mitigation of all ASEAN member nations for next 50 year considering INDC Proposal presented at COP 22 and to calculate the Abatement cost by using ASEAN RICE model. 3. To use the ASEAN RICE model to develop the Low Carbon Index (LCI) for the selected ASEAN nations (Malaysia, Indonesia, and Thailand) and also for all of the ASEAN nations for the period ranging from 2010 to 2060. This Index was developed in the past only for Indonesia by PriceHouseCopers. However, it has never been done so far for Malaysia and Thailand, along with All of the ASEAN member nations so far.

Chapters	Name	Expected Contents
2	**Research Objectives (ROs)**	The Research objectives for this research include the following: 1. To develop a scenario-based long-term (100 years) Climate Change projection for Malaysia and best mitigation option following COP 21 INDC agreement. 2. To project for Climate Change mitigation of ASEAN nations for 50 years considering the INDC Proposal of COP 22 and calculate the Abatement cost by using an ASEAN Regional Integrated climate and economy Model (ASEAN RICE model) 3. To develop the Low Carbon Index (LCI) for the selected ASEAN nations (Malaysia, Indonesia, and Thailand) and also for all of the ASEAN nations for the period ranging from 2010 to 2060.
	Research Questions (RQs)	The research questions (RQs) for this analysis can be as follow: 4. What is the Climate Change effect for the Malaysian economy, by using ASEAN- RICE model can we forecast (100 years) best Climate Change mitigation scenario is for Malaysia with COP 21 INDC proposal? Which scenario is the best for Malaysia and why? 5. What will be the long-term (50 years) Climate Change BAU Scenario and INDC based mitigation Scenario and abatement cost for the ASEAN nations following (COP22) Marakccash proclamation? Which Scenario is the best for ASEAN nations? 6. How to develop the Low Carbon Index (LCI) for the selected ASEAN nations and rank them (Malaysia, Indonesia, and Thailand) and also for all of the ASEAN nations for the next 60 years ranging from 2010 to 2060?

Chapters	Name	Expected Contents
Chapter 4	**Results and Discussions for Research Objective 1**	1. This chapter deliberates to measure the capacity of only Malaysia as an individual nation, to achieve the promises it made by INDC submitted in COP 21. 2. Here we used CGE based ASEAN RICE Model to analyze climate data collected from GTAP 9 database for three different scenarios as, Scenario I or BAU and Scenario2 and Scenario 3 respectively. 3. Here Scenario 3 follows the mitigation option that Malaysia promised to attain within the next 100 years by implementing INDC. The scenario I or BAU refers to a situation where no action or intervention is considered to curtail the impacts of Climate Change. 4. Scenario2 used moderate intervention to diminish the effects of Climate Change. 5. In this analysis, Scenario 3 seems to be most viable for Malaysia to attain the promised INDC targets fully and to ensure low carbon development. 6. Thus, from this chapter, it is established that "it is possible for Malaysia to attain its INDC promises if they do not delay and act from the present day according to the INDC Promises.
Chapter 5	**Results and Discussions for Research Objective 2**	1. This chapter contemplates the revised target set for the all ASEAN nations in COP 22, starting from the year 2010 until the year 2060, which is a period of the next 50 years. 2. This 50 year was definite after a long scientific debate by top scientists of the globe in COP 22. 3. This chapter seeks to scrutinize that if the accepted targets in COP22 are beneficial and can bring significant transition for ASEAN nations to achieve the promises made in the INDCs and move forward “Low carbon economy."

		4. For this chapter analysis, we used the ASEAN RICE Model, and it is a CGE based model. 5. Here I try to identify which Scenario, among the considered Scenarios, is the best one considering cost and green technology access for all the ASEAN nations. 6. This chapter considers the effect of Climate Change over specific key macroeconomic indicators like private consumption, trade balance and GDP growth rate to a general equilibrium framework to determine which Scenario uses the lowest carbon and cost. 7. Then we select that one Scenario which maximizes the effectiveness and efficiency for overall mitigation option for the ASEAN nations.
Chapter 6	**Results and Discussions for Research Objective 3**	1. The CGE based ASEAN RICE model was used to run microsimulation using Selected ASEAN member country data to develop Low Carbon Economy Index (LCEI) from 2010 to till 2060 for Malaysia, Indonesia, and Thailand, this index helps us to get a bird's eye view for low carbon development. 2. This is a unique contribution of this thesis to develop the LCEI for the three selected ASEAN nations. 3. Here, we also develop LCEI for the whole of the ASEAN to determine where the whole region is heading in Climate Change mitigation efforts. 4. This focused analysis helps us to identify more precise sectorial input necessary to attain the effective low carbon economic progress.

Source: Formulated by the researcher

Table 7.2: Research Contribution at a Glance

Research Contribution	1. New Model Design	a. Modified the RICE model to developed ASEAN- RISE Model, it is a unique contribution of this research.
	2. Climate scenario forecast for Malaysia and ASEAN	a. Climate forecast for Malaysia following COP 21 pledged INDC b. Climate forecast for ASEAN nations following COP 22 pledged INDC c. Forecast the Low carbon Economy Index for all ASEAN Nations and also for selected ASEAN member nations (Malaysia, Indonesia, and Thailand) till 2060
	3. New Index formulation	a. The Low carbon Economy Index for all ASEAN Nations and also for selected ASEAN nations (Malaysia, Indonesia, and Thailand). This index has not yet been developed for Malaysia, Thailand, and ASEAN as a whole, and thus it is a unique contribution of the research.

Source: Formulated by the researcher

Table 7.3: implication for Policy at a Glance

Policy Implication	1. Theoretical Implication	1. Demonstrated that Climate Change mitigation is possible for the selected ASEAN nations if we follow the theory of "Low Carbon Development." 2. "Theory of transition" is supported by conversion from the traditional energy source, like using fossil fuel or combustion engine, and shift to renewables and clean energy options like Soler power and other low-cost options for mitigating the impacts of Climate Change in the ASEAN region
	2. Practical Implication	This section focusses on practical implementation of selected ASEAN nations (Malaysia, Indonesia, Thailand) that need transformation for mitigation: 1. Energy generation 2. Industry and municipalities 3. Transportation 4. Buildings 5. Infrastructure, spatial planning 6. Agriculture, forestry and other land uses 7. Demand reduction

Source: Formulated by the researcher

7.3 Contributions of the Study

As a mitigation option, many scientific research findings approved that, we need to implement sustainable means to reduce CO_2 emissions as soon as possible. Assessment done in this thesis, specifically in chapter four, and five demonstrate that prompt implementation of selective mitigation actions are the best options. They are also economically viable for the ASEAN Nations to deal with the hard and complex human-induced Climate Change issues. The benefit of such mitigation actions suggested by IPCC (2014b, 2018) and INDC proposals[53] are consistent with this research study findings, and thus we have a strong suggestion to change our general conduct for Energy production and consumption from fossil base to non-fossil, low carbon base renewable sources.

Here we need to focus on efforts from regional climatic and economic governing agencies to evaluate combinly the economic valuation of impacts. We need to sort out the significant features that can function in the ground, to mitigate climatic influences and ensure low carbon transformations. It is also recognized that the selected Nations already have a certain level of climate impact mitigation by renewable and backstop technology implementation.

The first impact comes from the "Investment" issue. During the initial phase, of renewable or backstop technology implementation, significant financing is necessary for those nations and designated methods to utilize regionally. They have to ensure that the spread of mitigation practices can be consistent and equal proportionately among the region. The primary results of this research show, and confirms potential opportunities for achieving the IPCC targets is significantly high for the ASEAN region, only if the selected nations can ensure a substantial level of achievement of the

[53] Source: https://www4.unfccc.int/sites/submissions/INDC/Submission%20Pages/submissions.aspx

mitigation targets. This Indicate that the solution of the Climate Change problem is still within available range for the selected ASEAN nations. What they need to do is to, stop paperwork, negotiations or to talk, and to start implementing concrete actions immediately.

For the ASEAN region, it is essential to instigate (as a prototype case) actions on a pilot basis for low carbon regional climate mitigation deed with political support for the selected ASEAN Nations, (Malaysia, Indonesia, and Thailand) and if others become interested, then allow them to join and assist them in participating under the low carbon mitigation initiative

The contributions of the research include the followings:

1. Formulation of the ASEAN RICE model that can be used for further analysis for other ASEAN nations.
2. Long term prediction of Climatic forecast following INDC of COP 21 with Abatement cost assessment and pointing out the best alternative Scenario for Malaysia.
3. Long term prediction of Climatic forecast following INDC[54] of COP 22 with Abatement cost assessment and to identify the best alternative Scenario for all ASEAN Nations, it can be useful if they want to do the ASEAN regional Climate Change mitigation plan.
4. Developing the Low Carbon Index (LCI) for the ASEAN nations and ranking the selected nations (Malaysia, Indonesia, and Thailand) to enhance their role for further mitigative climatic incidents as an experimental hub.

From the theoretical perspective, the main novelty of the thesis lies in the ASEAN RICE model construction to investigate regional Climate scenario to answer the question," How fast do the selected nations need to act as a Region for Climate

[54] Source : https://www4.unfccc.int/sites/submissions/INDC/Submission%20Pages/submissions.aspx

Change crisis?" According to Johan Rockström, who told (on 18 January 2018) in World Economic Forum 2018, opening session: “As a general rule of thumb, staying below 2°C above pre-industrial levels means halving emissions of greenhouse gases every decade if we want a high probability of success”.

We know this as an exponential pathway the Global Carbon Law, inspired by Moore's Law in the IT industry – the observation that computers double in speed about every two years. From a practical perspective, the rationale is not as simple as we think. This is because within the next three decades, the Fourth Industrial Revolution, driven by artificial intelligence, machine learning and the Internet of Things, will transform everyone’s lives on earth. The direction for this transformation is yet undecided. The ASEAN Nations need to ensure this revolution is regulated towards a prosperous and resilient zero-carbon future. Rapid innovation cycles provide the tech sector stays on its phenomenal and exponential Moore’s Law trajectory.

This is what all the selected ASEAN nations need for the Global Carbon Law. For this, the industries need a regional roadmap to coordinate as a sector to deliver on these low carbon-based innovation cycles. The CEO of Apple, Mr. Steve Jobs at a conference in 2011[55] said,

> "We are here to put a dent in the universe. Otherwise, why else even be here?".

Like Steve Job’s, we attempted to determine what actions are necessary to mitigate the problem of Climate Change for selected ASEAN nations, these efforts are like trying to put a dent on our world to overhaul the problem. This is only possible by the practical and meaningful mitigation of Climate Change. The world needs nothing less to recover and go forward. From a practical standpoint, this study of mine also

[55] Source: https://www.macworld.com/article/1162827/steve-jobs-making-a-dent-in-the-universe.html

contributed to the understanding of effective mitigation policies for CO_2 emission reductions and looks forward to a smooth transition of the selected ASEAN nations towards a Low carbon economy.

7.4 Implications for Theory

In chapter two of this thesis; the Literature review part, I have presented the research work of the prominent economist of the world like Stern (2006) and Nordhaus (2008). There, although it seems that both of them agreed on the mitigation issue that the selected ASEAN nations can maintain the present level of economic growth. With proper environmental condition, only if they can reduce the emission of only one of the prime GHGs, specifically the CO_2 or carbon emission. Multiple study report from reputed development and research organizations as well as research institutes like IPCC, ADB, World Bank also conducted research to find the solution for excess demand for energy by household and manufacturing firms. They also approve with the findings of the Stern (2006) review and Nordhaus (2008) interpretation of mitigation option for such problem. In this research following the INCDs prescribe the selected ASEAN nations our analysis also suggests that these nations (ASEAN) need to undertake the INDC promised actions to maintain the present growth, while cutting carbon emissions. They need to act quickly and do not have much time to hesitate to act. If they delay or take too long time to act, then our future generations will face the severe consequences.

According to my review of literature, for any given developing nations policy fabricators, "economic growth" and "poverty reduction" were the key components to consider. However, mitigation planning of Climate Change may offer those nations the chance to revisit development approaches from a completely different and novel perspective. The reflections of considerations for change happening in climate can help us to set new urgency on few social possibilities. This may include energy competence, use of the renewable form of energy, and sustainable policies for land-use, an argument about the impact of Climate Change with other environmental problems.

The theory of low carbon development with its six stages are discussed in detail at the literature review of this thesis. This helps us to identify best ways to confirm the resilience of ASEAN regional ecosystem and spread low-cost green technology more effectively. It will be successful, if it can be implemented ensuring the regional focus for attaining green energy efficiency, enforcing regional development, reducing CO_2 emission and upholding the regional balance of ecology. "Theory of transition" is another theory that we discussed in the conceptual framework of this research, which is critical for implication at the policy level. This theory also supports the necessary conversion from the traditional energy source, like from fossil fuel-based combustion engine to the renewables and clean energy options. For example, Solar power and others that are now affordable and available for mitigating the effects of Climate Change in the ASEAN region. Achieving such social transformation towards Regional Mitigation of Climate Change will require time and profound commitment from selected ASEAN nations (Malaysia, Indonesia, and Thailand) to accept the followings actions:

1. To alter their (Malaysia, Indonesia, and Thailand) individual and collective energy generation and using pattern. The need to change their travel habits and consumption pattern also.

2. To invest, purchase and spend (Malaysia, Indonesia, and Thailand) more in Renewable Energy in a sustainable and low carbon manner.

3. To issue consent from authorities (Malaysia, Indonesia, and Thailand), for changes in the building codes and landscapes where we live and work. We need change in the markets in which we participate, for services and products, that we either buy or sell.

4. To pay for many aspects of the transition (Malaysia, Indonesia, and Thailand) through their bills & taxes.

IPCC (2014a, 2014b, and 2014c) published a three-part detailed report which actually focus and describe in details about various ways to limit or reverse the detrimental impacts from greenhouse-gas emissions. The need for international and regional cooperation and especially setting up a price on carbon and financing green technology are central to this report, and it also highlights the importance of direct actions at every level. Numerous of those propositions presented in IPCC (2014b, 2014c) report are "attainable" by state as well as by local communities or regional authorities, businesses and individuals of the selected ASEAN member nations (e.g. Malaysia, Indonesia, and Thailand).

This research considers different sectors of the economy, using the ASEAN RICE Model and outlining the likely options for reducing greenhouse gas emissions by attaining greater engine efficiency, or condensed the use of fossil fuels by other means. The selected ASEAN nations (Malaysia, Indonesia, and Thailand) now need to form a regional carbon fund with a 3 to a 5-year period, where funds will be accrued from the harmonized carbon tax on a trial and error basis. Sad, but the reality is, none of the ASEAN nations introduce the "Carbon Tax" in their monetary system. The ASEAN region need to act fast and made it implementable. The 50th anniversary of ASEAN was held in 2017. So, ASEAN is a mature regional economic body, like the European Union. It can now work alone as an accepted platform, to set up inbuilt components for a harmonized carbon tax. The fund generated from this tax can be used to subsidize the selected ASEAN nations abatement technology cost. The sooner they start to organize and function for "Carbon Tax" is the better for all the nations involved.

From the chapter four, five and six of this thesis's, it seems that now the selected ASEAN Nations need to find a reliable way to include the backstop and renewable technologies (renewable energy sources) in their daily energy formation system. It will help them to curtail their CO_2 emission, and thus help them to mitigate the impacts of Climate Change effectively. Actually, mitigation is an economical option that is subject to transfer of technology and also smooth financing for such technology. These two components seem to be the supporting blocks of successful Mitigation in the long run.

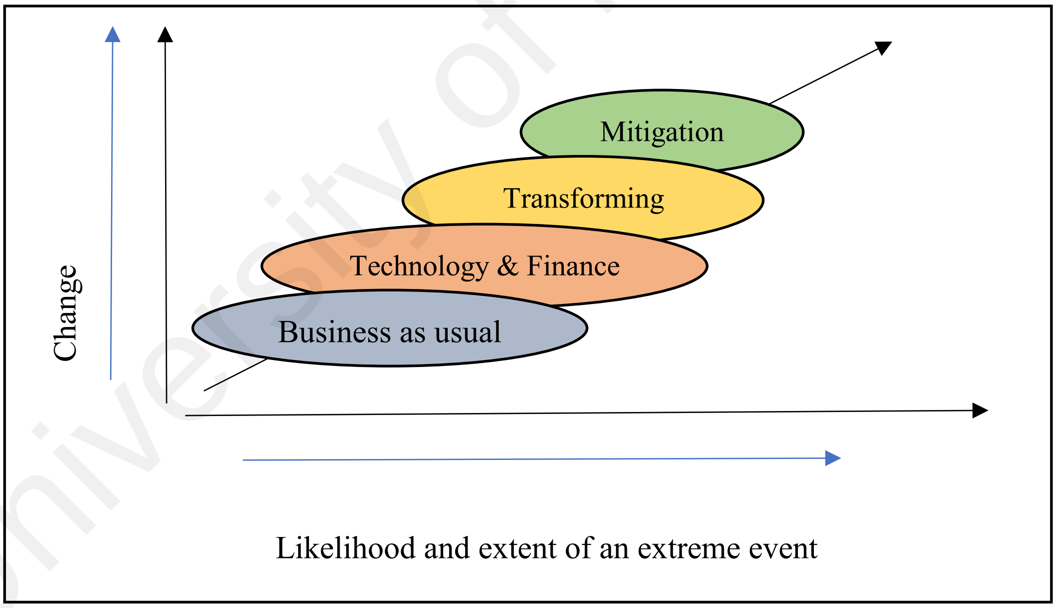

Figure: 7.2: Technology and finance, and transforming as components of mitigation

Source: Figure composed by the author

To attain this within year 2050 as proposed by all ASEAN INDCs, the nations have to stress on restructuring their activities of some specific sectors as a single, unified region These nations also need to ensure such transformation are focused into low carbon dependent technology. If the selected ASEAN nations can do this, up to a certain predetermined level for some specific sectors of their economy, only then effective mitigation of Climate Change is ensured.

If the selected ASEAN nations can go for full-scale regional integration for low carbon-based development, only then the total regional integration of Climate Change mitigation becomes more manageable among all the selected nations (Malaysia, Indonesia, Thailand). Afterward, they can lead other members and can generate synergic effects for the whole region to reduce carbon dependency more effectively.

7.5 Implications for Policy

The Global Climate Risk index presented in Cop 24· On Dec 04 at Poland in 2018, illustrates that among the most affected Top ten nations of the world, by extreme climate events ranging from 1998 – 2017, three nations are from the ASEAN region they are namely Myanmar ranking in Number three, the Philippines in number Five and Vietnam in number Nine. So, to gain Economic development for the ASEAN region, we cannot overlook the severe impacts of Climate Change incidents on these member nations.

To ensure active economic growth in the ASEAN region, we need to alleviate the effects of Climate Change. There is no problem with nations having different combinations of Regional policies, but there are two critical requirements as follow:

First, the overall level of the regional ambition should be robust, trustworthy and equitable.

Second, providing a robust Regional role for trading schemes is essential to allow Regional trade in greenhouse gas reduction, which in the long run will improve Regional Low Carbon efficiency and provide incentives for developing nations to join in international action pathway. Such 'carbon flows' will be considered as a key element in the 'glue' that holds the local deal together.

The particular specific sectors of the selected ASEAN nations (Malaysia, Indonesia, Thailand) that need transformation for mitigation are listed and discussed below in detail:

7.5.1 Energy generation: Plummeting emissions of Carbon for generation of electricity for selected ASEAN Nations (Malaysia, Indonesia and Thailand) is a big challenge, but not impossible. As this is one of the most cost-effective ways to reduce the impacts of Climate Change. It is a scientifically proven fact, that Decarbonization is possible more quickly in the electricity generation process than changing in industrial productivity, in structures and transportation sectors also. In the mainstream of low-stabilization situations, the portion of low-carbon based electricity supply may rises from the current percentage of approximately 30% to 80% by the year 2050.

Despite the political ambiguity, wind and other renewables have sustained to produce quickly, and per-kilowatt prices of "Green Electricity" thus are dropping to close range with fossil fuels. Nation play a vital role in the growing and spread of renewable energy option like wind and solar . Over the next 20 years, annual investments in renewables, nuclear and electricity generation with carbon capture and storage are projected to rise multi folds, while those for fossil-fuel based electrical generation capacity will decline a lot. (IPCC, 2014) So, that's why Malaysia is trying to develop its renewable Energy resource as its fifth fuel option. Renewables have a new beginning from 2012, and except hydropower, it is getting significant acceptance. The selected ASEAN nations (Malaysia, Indonesia or Thailand) can work together in promoting this fuel option in this region.

7.5.2 Industry and municipalities: All sizes of Businesses can decrease emissions of carbon by small shifts and changes like the use of more efficient motors and eradicating air and steam leaks. When new offices are made the sharing of infrastructure and utilization of waste heat will decrease energy losses substantially. The chief barriers to increased industrial effectiveness are the “initial investment costs” and “lack of information”. "Information programs are a prevalent approach for promoting energy efficiency, followed by economic instruments, regulatory approaches, and voluntary actions." In 2010, for the ASEAN region, according to an Asian development bank report (ADB, 2017), industrial uses accounted for 28% of global energy consumption and produced 13 gigatons of CO_2. While emissions are projected to increase between 50% and 150% by 2050, the sector's energy intensity could be reduced by 25% from the current level through the wide-scale adoption of currently available renewable technologies.

7.5.3 Transportation: emissions of Carbon and other GHG’s from Transportation can be reduced by formulating and implementing effective mitigational policy. With economic growth and the economy becomes stronger transport mix of solar and electric vehicles combination can contribute significantly to attain the mitigation level at regional, national and local levels for the ASEAN Nations. Such strategies can also help to reduce travel demand, By 2050, new electric based mass-transit infrastructure and urban redevelopment have the probability to cut final energy demand 40% below the baseline, an improvement over that reported in the IPCC's Fourth Assessment Report on Climate Change. “Projected energy efficiency and vehicle performance improvements range from 30% to 50% in 2030 relative to 2010 depending on transport mode and vehicle type.” In particular, bus and other rapid transit like LRT, MRT has relatively low infrastructure costs and can be employed much quickly. “Integrated urban planning, transit-oriented development, more compact urban form that supports bicycling and walking can all lead to modal shifts as can, in the longer term, urban redevelopment and investments in new smart and green infrastructure such as high-speed electric rail systems that reduce short-haul air travel demand.” Such changes have the potential to cut transport emissions GHG by significant amount, and help to fulfil the INDC targets quickly

7.5.4 Buildings: During 2010 the construction sector was responsible for almost 32% of total energy consumption use and emits almost 8.8 gigatons of direct and indirect CO_2 In the baseline scenarios, according to IPCC (2014b, 2014c) report by mid-century this sector's energy demand is projected to be double and its CO_2 emissions will rise to 50% to 150%. The standards of Green-building are the most cost-effective ways to reduce such emissions. Some developed nations have contributed to stabilization in total demand for energy in buildings.

Noticeably consolidation of these codes, and adopting them in our future jurisdictions, and diffusion them to more building and appliance types, will be a crucial feature in the attainment of the climate goals. Retrofits of existing buildings can reduce energy use by 50% to 90%. The recent progress in performance and costs make deficient energy construction and retrofits economically attractive, sometimes even at net negative costs, and can ensure mitigation of global warming.

7.5.5 Infrastructure, spatial planning: The majority of upcoming urban development is likely to happen at smarter green metropolises, only within developing nations. Actual strategies for mitigation include jointly accepted policies, with discovering high residential and employment densities, ensure supreme diversity and integration of land uses, growing accessibility and investment in public transport and other demand management measures.

According to ADB (2013) report the infrastructure, spatial planning, and energy consumption are strictly interlinked; so, the most significant risk is our "locking in" to infrastructure and settlement patterns that need high levels of energy use and thus includes emissions of high levels of greenhouse gas. Once such infrastructures are made, future emissions are much more difficult to prevent or offset. As the world's population is growing and getting rapidly urbanized, but it results in serious damages in ecosystems and even leads to higher greenhouse-gas emissions. Trends in declining population densities and continued economic and population growth, urban landcover is projected to expand by 56% to 310% between 2000 and 2030."

The nearly six-fold difference between the extreme rise in economic and population growth shows the assortment of potential results and highpoints the standing of mitigation actions as soon as possible.

7.5.6 Agriculture, forestry and other land use: "The most cost-effective mitigation options in forestry are afforestation include "sustainable forest management" and "reducing deforestation," with large differences in their relative importance across regions[56].

In agriculture, according to ADB (2013) report the most cost-effective mitigation options included: cropland management, grazing land management, and restoration of organic soils." The land uses the account for the equivalent of 10 to 12 gigatons of CO_2 per year, approximately 25% of anthropogenic emissions. These primarily result from massive deforestation, agriculture, and livestock. With a reduction in deforestation, increasing restoration of forests and the widespread adoption of sustainable cropland and grazing management techniques, it is possible that this sector could become a net CO_2 sink before 2100.

7.5.7 Demand reduction: Because demand happens at the individual consumption level, emissions can be considerably dropped through changes in personal consumption patterns. These include Energy conservation culture like driving less, switching to higher efficiency cars, using mass transit, buying longer lasting products and reducing food waste. Some options including monetary and non-monetary incentives as well as information measures may facilitate behavioural changes in the selected ASEAN nations can help in cutting energy demand through conservation is crucial not only because it reduces consumption, but also because it increases long-term flexibility among chosen regions. The reductions in energy demand in selected ASEAN nations are an essential element of cost-effective mitigation strategies, provide more flexibility for reducing carbon concentration in the energy supply sector, hedge against related supply-side risks, avoid lock into carbon-intensive infrastructures. Many of the above approaches have "co-benefits," as the IPCC report (IPCC, 2018) point out, such

[56] Mostly known as "carbon sink."

mitigation scenarios show progresses in terms of the sufficiency of resources to meet national energy demand as well as the resilience of energy supply, resulting in energy systems that are less weak to price volatility and supply disruptions.

Other advantages contain reduced ecosystem influences and pollution, improved human health by the increase in cycling and walking, and even amplified worker productivity and employment gains that result from building-related mitigation options. When monetized, these and other co-benefits can exceed energy cost savings and potentially even climate benefits. As because many of the suggested actions are already happening in a different place at the regional and municipal levels, coordination is essential, mainly when working with state authorities.

We all can determine 'what needs to be done,' but we also believe the fact that People, being a rational economic being, make decent choices if they are properly informed and asked. So, to mitigate time impacts of Climate Change for the ASEAN selected member nations, we need to implement the following as soon as possible including:

1. A complete shift to low carbon electricity, mostly renewable with a period of 10-30 years. A dramatic rise in usage of electric and hybrid vehicles and other steps to cut the carbon emissions from road transport.

2. Smarter and more flexible management of present Energy demand, including new energy storages, to enable higher and efficient penetration of renewables in buildings and Industrial production.

3. We need to Decarbonisation of ASEAN Region heat by ensuring new build developments achieve their full low carbon potential and contribute effectively to a smarter energy system. From their own INDC promises, we can consider an average minimum target for them.

4. Huge reductions in energy demand in buildings and the equipment and processes within them So far but we have already done the easy bits for ASEAN including:

a. we must accept the challenge individually as a nation and also as a regional body, that by 2030 at least 25% of total power generated in the selected ASEAN nations (Malaysia, Indonesia, and Thailand) must originate from renewables like wind and solar Energy. We need to expand the solar Energy options in these selected ASEA nations (for different reasons) just as costs of Solar Panels are falling sharply with amplified efficiency.

b. Domestic cavities and lofts insulated (more or less) and boiler, solar panels efficiencies and effectiveness need to upgrade, and we are into more complex building design and structural work, that makes building greener, stronger, reliable and smart.

c. ‘Easy win' upgrades for efficiency standards for buildings, vehicle, appliance, and lighting, it is a genuine concern that, there is a push back from incumbents and arguments about additional costs for new structures and technology.

d. Electric Vehicles and hybrid vehicles are used by many people who believe in environmental policies, what we need is to sort out charging infrastructures like the new design and implementation of charging stations for such vehicles and regimes for resilience, system optimization, and fairness.

7.6 Future Directions

Like every other research, this research also has few future directions to follow, as follows:

1. The ASEAN RICE Model depends on many economic assumptions and climatic parameters, so change in one assumption, or parameter can affect the results of the models. So, in future, we need to focus on the use of as minimum assumptions possible.

2. The ASEAN RICE Model can be used for the total ASEAN region. For other regions, we just need to modify the model according to the specific regional climatic parameters.
3. The initial scenario for Objective 1 was completed following COP 21, so it was estimated for 100 years. Later as the Marakccash proclamation in COP22 targets were available till 2050; so, then we estimated the model for 50 years ranging from 2010 to 2060. This indicated that, this model can consider different period with new INDC proposals in future. This research depends on long term time series climatic data is challenging to collect and access. The results of this research depend on static model although we use dynamic non-linear methodology for downscaling. So, this will be effective to review our projections after every two to five years to re-calibrate the interferences and emission reduction trajectories we consider for climate mitigation

4. The model developed and used in this research is generally an ASEAN region focused model known as ASEAN-RICE model, which can only be used for any ASEAN region nations just, to stimulate climate mitigation policy formulation among the individual members.

This analysis is conducted to develop mitigation policy for the selected ASEAN Nations following COP 21 and COP22 (2016) INDC proposed by the specific ASEAN nations at UNFCCC. Thus, the findings are based on the INDC Proposals, and seems to be really close of the proposal findings. So, we recommend the following of this study can be used for further study:

1. **Continuous research & Learning:** This research needs a constant update and recording to climatic incidents to enrich the overall learning and linking different low carbon-based mitigation practices for any selected part of the community or entire ASEAN region.
2. **Careful monitoring:** This research needs continuous, careful tracking of specific climatic parameter which is essential for further analysis and to confirm the reduction of carbon emission
3. **Risk management:** We need to develop the management system of risk resulting from climatic incidents and the carbon produced from energy production.
4. **Need review and recalibration after every five years**: This will be practical and decent to review these forecasts after every two to five year to re-calibrate the interventions and emission reduction trajectories that we deploy for climate mitigation taking account of change in random factors and other extraneous information within every five years.

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