the plant, construction period, efficiency of the plant and the cost of fuel, out of service time, operating cost for fixed and variable.

Thirdly is the economic evaluation of the plan. Economic evaluation on investment will be determined to a large extent by how the plants are utilised in the years beyond the planning horizon. The time element is therefore fundamental in the long term planning period. Time value of money is reflected through interest payment, opportunities for investment and also discount rates used.

Fourthly is the reliability criteria. The design of the plan must cater for the frequency of breakdown, variation in demand, variation in hydro condition, scheduled maintenance and delays in projects. the capacity planning is the schedule of power plants addition yielding the optimum benefits while satisfying the forecasted demand within certain supply margin and considering certain foreseeable constraints. The reliability criteria has been discussed in the research methodology.

Fifthly are the constraints. As much as the LCP have determined the capacity planning for the system there are constraints which are not accounted for in the simulation. This includes manpower, environmental, siting of the capacity and other infrastructure and availability.

characteristic, many of the decisions must be of a long term nature. An example is a generating plant decision must be able to handle the availability of fuel type selected based on a certain level of material price. Many instances have occurred in which the fuel price fluctuates and this has tremendous impact on the operating cost. This challenge remain true until today as technology in capacity addition for power sector does not vary tremendously. As an example a boiler economic life span is 25 years and a gas turbine at 20 years.

Demand for high capital - Capital intensiveness

The electric utility business has been known as the most capital intensive of all industries. A typical project cost is at RM3,000 per Megawatt(MW). Earlier publications and findings indicated that the industry requires something in the order of four dollars of investment for every dollar of revenue (Males, 1985). This implies that decision involving capital investments are more difficult to change or reverse. Even so when good operating decisions such as improvement of efficiency during the life of the plant has little impact to offset the effects of bad investment decisions. This is largely because capital is such a large fraction of the total cost.

Public scrutiny

In a regulated industry the decision on capacity planning and plant addition cannot be made only in the boardroom of the utility or power producer but it is subjected to explicitly or implicitly to public review. In Malaysia today many of the decisions must be reviewed and approved by the utility ministry or other regulators. This is viewed as overseeing the interest of the public.

Moreover when the regulating bodies have their own objectives with regards to the plans and may markedly differ from those of the utility management.

TNB would require approval from regulatory bodies but even if it is not required these decision are implicitly still subjected to later investigation in matters relating to tariff hearing or public investigation by the press. This therefore request for a certain degree of logic in the decision making process of fulfilling public and the company requirement. In other words in need to be unimpeachable and clear.

Difficulty in changing the Decisions made

From the first three arguments it is clear that decisions are hard to change due to the long term nature of these decisions, demand for high capital and need for approval by regulators. But the main idea that a decision once made take a particularly long time to reverse needs to be stressed. This can be compared with a manufacturing company needing to lower price due to public outcry. As such the manufacturing company can easily reduces the price, reduce production level or cost of production or increasing marketing campaign. A utility can also do the same but only after a long and protracted hearing. Because of the long term decisions, contracts are written for a long period of time maybe as long as the life of the plant. An example is the fuel gas contract and power purchase agreements (TNB 1994, 1995).

Public service obligation

It has been traditionally thought that a utility must be prepared to meet the need of its customers whether or not it seems advantageous for the utility to do so. There seem to be an implicit if not explicit understanding that electricity prices would be set to cover the cost incurred by implementing these decisions. This contradicts very much from the competitive environment in which a firm can decide not to enter a market or not to meet a prospective need of consumers. Hence until today in the Malaysian scenario, price is one aspect which will normally be influenced by the public.

Unequal risk-reward

The risk-reward relationship in the regulated utility industry for the owners or investors is not symmetric. The decision to lower cost may not bring proportional additional return in profitability to the owners. On the other hand if a decision turns out badly and increased cost, these added costs may have to be paid from profits of the firm. This again contradicts from what has been a traditional view of the utility business a cost plus enterprise in which consumers would bear the major elements of the cost consequences of the decision making. Today, this no longer seems true.

The above six points indicates the complications peculiar to the utility sector which provides a challenge to operate successfully. These are the issues that have to be addressed by the decision makers in the electric utilities.

How to improve decision making

There are four rules that were thought of in improving decision making and derived from the six characteristics of the utility industry. These rules are based on findings by various researchers on this subject that can be seen as related to the local scene in TNB.

To evaluate from the view of different stakeholders

In every decision, different parties have different interest in the decision outcome. Because of the public nature of the decision and the nonsymmetry of the decision in the utility business, analysing the decision from each stakeholders point of view is important.

Normally there are three principles stakeholders namely the customers, the owners and the investors and the nation as a whole. Unfortunately the interest are never the same in the short run and not even in the long run. An example is in the selection of fuel type. A customer wishes for a fuel that will result to the cheapest electricity. This can be interpreted as not requiring any other expansion plan for generation. However this short term decision may result in higher cost in the long term. The owners on the other hand, while desiring to minimise cost of electricity over the long run also wishes to minimise the risk. The utility may also wish to do a less capital intensive project which depends on more expensive fuel, as the case for gas turbines using alternative fuel of distillate. In deciding this, the **first rule** is to investigate the decision as it affect each class of stakeholders.

Risk-reward

As mention earlier, the decision making in a utility is different because of its unequal risk-reward which exist for each of its stakeholder. An example is that a customer risk-reward indicates a preference for high reserve margins and low or no outages. The nation on the other hand indicates the value of excess capacity rather than dependence on imported or scarce fuel. However, the owners risk reward curve indication is a total opposite. Therefore the analyst of the scenario must not only look at the decision from the perspective of the stakeholder only but also at the effects of varying outcomes relatives to benefit or cost to each stakeholder. This brings us to the **second rule**, to analyse decisions under various possible outcomes caused by significant uncertain future events.

Long run consequences

Most of the decisions will be long run in nature, inflexible and the degree of uncertainty over that long period. Therefore the decision must be robust under most eventualities. Flexibility may require adopting technologies and ability for the power plant to switch to alternative fuel as an example. This is in so far incorporated in TNB existing coal and gas stations. Since every stakeholder can imagine unlimited future, the problem arises to limit the analyses to a manageable set of eventualities while examining the future adequately enough to provide protection against risk of unknown and unlikely catastrophic events.

This brings to the **third rule** of assuring all reasonable uncertainties have been analysed and will certainly include unlikely but catastrophic eventualities.

Public review

This is similar to the review by regulators or ministry. Hence decision must be reviewed not only from stakeholder groups but also subgroups such as customers with lower income, politicians, groups with special interest on the environment and those who focus on the economic expansion of the area such as state development. Therefore TNB must seek approval of the customer-base that are being served. After identifying these external requirements for decision review, the internal requirement would be to convince the senior management as well as the Board on the issues at hand. This approach has been in practice in TNB.

The **fourth rule** is therefore for managers to assure that decisions can be supported during public scrutiny and that decisions are well documented for the contingency of public retrospective review.

It can be seen that in this complex and uncertain environment to which utilities exist, there is no hope of identifying the single right decision. At best the utility will avoid wrong decision. this is normally termed as the rational view of the

decision making.

The least cost plan - An Empirical example on static analysis approach

An example of the least cost plan is the requirement of about 5,000MW of capacity in the national system from year 2000 to year 2005. From this requirement the model may have chosen basically coal power plants as the cheapest option for capacity addition. A static analysis has been conducted to investigate the benefit-cost and Internal Rate of Return for the option based on TNB data. This can be referred in Appendix 3. Appendix 3 provides the output of levelised cost and benefit-cost ratio base on the input of a coal plant, capital cost and operations cost. It can be summarised as follows:

	Discount rate 10%		**Discount rate 12.5%**	
Loading	CF 70%	CF 80%	CF 70%	CF 80%
BC ratio	1.14	1.31	0.93	1.07
levelised cost cents/kWh	6.96	6.89	6.93	6.86

CF = Capacity factor; BC = Benefit-Cost

The above results showed that the decision on the viability of the project is dependent on the loading of the plant and also the discount rate used. Naturally loading the plant at the higher capacity factor with a lower discount rate will make the project most attractive. But TNB cost of capital presently is higher than 10%, and from the above, case it showed that in order for the capacity addition to be cost effective, the capacity factor have to remain high. However, these are not the only factors affecting the analysis. The average tariff would also have an impact to the project, but by not increasing the tariff is a conservative approach in the analysis. Planners can also investigate the impact to the capacity addition by varying the input data.

Hence as highlighted earlier, planning for a capital intensive industry requires realistic and high degree of confidence on the input used.

The model can go a step further by incorporating details such as finance charges, taxes or even project financing decision. However, this will perhaps be another separate study recommended for the future.

The LCP essentially provides a deterministic solution. The issues arising from this method are the ability of this plan to withstand sudden changes, for example the increase in capital cost to incorporate equipment to mitigate excessive emissions, procurement of sites and even associated transmission cost due to location of the units. In other words there is almost complete exclusion of consumer reaction from the planning process. Hence because of these 'defects' there is a need to look at a new approach.

The new approache need to consider the roles of national economy, energy sector variation such as fuel choices, commercial and non commercial, amount and type of project financing and constraints, pricing policy, regulatory body, the market for power consumption and technology. From these criterias, the expected output are the companies financial position short and longer term as a result of a decision on a capacity plan. The impact of catastrophic changes to the LCP is required and this will result to multiple objective solution rather than a single objective solution.

The purpose of a scenario planning can be discussed and argued. The many reasons includes but not restricted to the following. Firstly, it will be consider and build into development plan a degree of flexibility. This means that a least cost scenario may look at the lowest cost for expansion within a certain reliability criteria (as Appendix 1). However this planning method have not considered variation in financing the projects, changes in electricity pricing and changes in Government policy on fuel or capital intensive projects.

Secondly, the plan produced will determine the market and pricing and not vice versa. TNB can consider meeting a certain market segment only for example only 70% of the demand and realise the financial terms rather than the national economic terms as been practiced.

Thirdly scenario planning is for entrepreneural type of planning and able to make optimal use for private sector of the electricity industry.

Fourthly, scenario planning can assess the effectof market competition, imprived efficiency of existing plant, regulatory changes and consequences.

The least cost plan which is described in the appendices have the following issues to consider with respect to the WASPIII.

Firstly the demand forecast. In any planning it is necessary to identify the demand forecast for the service or product. Uncertainties will include either too high or too low an estimate. Underestimating may create difficulties as service dates for new facilities are seldom advanced, whilst overestimating may result to excess generating equipment and imposing unnecessarily higher cost to TNB.

Secondly is the technology option. This comprises of the capital cost of

CHAPTER 4

RESEARCH RESULTS AND ANALYSIS

Decision making in the utility generation planning

Historically to make decision in capacity addition for the utility in Malaysia is relatively easy as the market then were in an uncompetitive environment. But even at that time the decision is already complicated. Moreover, the consequences of bad decisions in the utility industry is costly although rarely resulted in bankruptcy.

This research also looks at some of the peculiarities of the utility business that creates difficult conditions for decision making. Although the problems highlighted here also exist in other industries, but in the utility industry, there are at least six problems or rather challenges which have important roles. These are discussed as follows.

Long term decision

In the utility industry, planting up will involve economic life span of 25 to 50 years. It is traumatic to imagine a plant partially completed having to be changed due to cost or alternative decision. Because of this long term