COST-EFFICIENCY ANALYSIS IN SUPPORT OF THE ENERGY EFFICIENCY STANDARD AND LABEL FOR TV SETS IN MALAYSIA

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ABSTRACT

In Malaysia, the popularization of 24 hours pay-TV, interactive video games, web-TV, VCD and DVD are poised to have a large impact on overall TV energy consumption. Additionally the numbers of TV ownership have also increased tremendously over the past three decades. With the increase of overall TV energy consumption, energy efficiency standard and label is one of the highly effective policies for decreasing electricity consumption in the residential sector. Energy efficiency standard and label for TVs in Malaysia are also capable of reducing electricity bill and contributing towards positive environmental impacts.

In this study there are two methods adopted for proposing a standard, which are statistical analysis and engineering/economic analysis. The statistical analysis is used to fix the standard whereas the engineering/economic analysis is used to examine the potential TV efficiency improvement and cost estimates on the future energy consumption. The energy label adopted in this study is the comparative style which ranks TV sets according to number of stars and displays the energy efficiency index for each unit. In order to justify the proposed standard and label program is an effective policy to be implemented, the potential energy savings, economical benefits and positive environmental impact are investigated.

It has been estimated from this study that the proposed standard and label will save approximately 8,452 GWh of energy which corresponds to bill savings of

approximately RM 1,986,149,662 (US$ 522,670,964) during the standard period of 4 years. Furthermore, the standard and label program will bring a total of CO_2 emission reduction of approximately 4,510,346 tonne, SO_2 reduction of approximately 20,452,192 kg, NO_x reduction of approximately 11,529,027 kg and CO emission reduction of approximately 3,130,478 kg from power generation in this country. The cost-efficiency analysis on the other hand proved that with the current available technology, it is possible to improve TV sets energy consumption to meet the proposed standard.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

NOMENCLATURES

Symbols	Descriptions	Unit
$AEC_{i_{AVG}}$	Average annual energy consumption of TV	(kWh)
$AEC_{i_{MIN}}$	Minimum annual energy consumption of TV	(kWh)
AEC_{SC}	Annual energy consumption of TV on the year survey conducted	(kWh)
AEC_{STD}	Annual energy consumption of TV on the year standard is proposed	(kWh)
AEI	Annual energy efficiency improvement of TV	(%)
ANS_i	Annualized net dollar savings in year i for TV	($)
AS_i	Applicable stock of in year i of TV	
AS_{i-1}	Applicable stock of in year i-1 of TV	
BAU_i	Business as usual energy consumption in year i for TV	(kWh/yr)
BEC_s	Baseline energy consumption for TV	(kWh/yr)
BS_i	Bill savings in year i for TV	($)
c	Constant value	
CCE_s	Cost of conserved energy for TV	($/kWh)
CO_i	Carbon monoxide reduction in year i for TV	(kg)
$CO2_i$	Carbon dioxide reduction in year i for TV	(kg)
CRF	Capital recovery factor	(%)
d	Interest rate per year	(%)
E_i	Energy efficiency index	
$E_{i_{AVG}}$	Average E_i value from the samples collected	
$E_{i_{MIN}}$	TV set with the lowest value of E_i from the	
E_t	Energy consumption of TV in standby mode	(Watts)

E_R	Reference energy consumption	(kWh/yr)
E_0	Energy consumption of TV in on-mode	(Watts)
Em_p^n	Emission p for fuel type n for a unit electricity generation	(kg/kWh)
ER_i	Emission reduction in year i of TV	(kg)
ES_i	Energy saving in year i for TV	(kWh/yr)
IC	Incremental cost of TV	($/kWh)
IE_i	Energy efficiency improvement in year i for TV	(%)
IIC_s	Initial incremental cost of more efficient TV	($/unit)
k	Constant value	
L	Life span of TV	(Year)
LCC_{option}	Life cycle costs of TV with design option	($)
LEC_l	Label energy consumption of appliance a	(kWh/yr)
Na_i	Number of households with TV in year i	
Na_{i-1}	Number of households with TVs in year i-1	
Na_{i-L}	Number of households with TVs in year i-L	
NOX_i	Nitrogen oxide reduction in year i for TV	(kg)
NS_i	Net saving in year i for TV	($)
$OE_{baseline}$	Operating expenses per year of baseline unit TV	($)
OE_{option}	Operating expenses per year of TV with design option (energy costs)	($)
PBP_{option}	Payback period of design option	(year)
PE_i^n	Percentage of electricity generation in year i of fuel type n	(%)
PF_i^n	Fuel price in year i for fuel type n	($)

$PP_{baseline}$	Purchase price of baseline unit TV	($)
PP_{option}	Purchase price of TV with design option	($)
$PV(ANS_i)$	Present value of annualized net saving in year i for TV	($)
PWF	Present worth factor	
r	Discount rate	(%)
S_i	TV saturation level per household in year i	
SEC_s	Standards energy consumption of TV	(kWh/yr)
SEI_s	Standards efficiency improvement for TV	(%)
SF_i	Scaling factor in year i of TV	(%)
Sh_i	Shipment in year i of TV	
$SO2_i$	Sulfur dioxide reduction in year i of TV	(kg)
SSF_i	Shipment survival factor in year i for TV	(%)
STN	Proposed standard	(%)
U_t	Usage hours of TV in standby-ode	(Hour)
U_0	Usage hours of TV in on-ode	(Hour)
UES_i	Unit energy savings in year i for TV	(kWh/yr)
UES_s	Initial unit energy savings in year i for TV	(kWh/yr)
x	Year predicted – year start	
y	Predicted value	
Ydr	Year of discount rate base	
Ypd	Year standard is proposed	
Ysc_s	Year survey is conducted	
Yse_s	Year of standards enacted of TV	
Ysh_i	Year i of shipment of TV	
δ	Step size of the labels	
ΔOE_{option}	$OE_{option} - OE_{baseline}$	($/year)

ΔPP_{option}	$PP_{option} - PP_{baseline}$	($)

Abbreviations

AEC	Annual Energy Consumption
BAU	Business As Usual
CENTREE	Centre for Education and Training in Renewable Energy Efficiency Malaysia
CLASP	Collaborative Labeling and Appliance Standards Programs
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CRT	Cathode Ray Tube
DLP	Digital Light Processing
DPL	Dolby Pro Logic
DVD	Digital Versatile Disk
IEC	International Electro-technical Commission
ISO	International Organization for Standardization
JBEG	Department of Electricity and Gas Supply
JIS	Japan Industrial Standards
LCC	Life Cycle Cost
LCD	Liquid Crystal Display
LCoS	Liquid Crystal on Silicon
MS	Malaysian Standard
NO_x	Nitrogen Oxide
PJTV	Rear Projection TV
RM$	Malaysian Dollar (Ringgit)
SIRIM	Standard and Industrial Research Institute of Malaysia
SLS	Sri Lanka standard

SO_2	Sulfur Dioxide
SS	Singaporean Standard
STD	Standard
TCPHEA	Technical Committee on Performance of Household Electrical Appliances of Malaysia
TV	Television
UHP	Ultra High Performance
VCD	Video Compact Disk
WEB-TV	Web Television

Superscripts

L	Life span of TV
n	Fuel type

Subscripts

baseline	Baseline unit
CRT	Cathode Ray Tube TV
i	In a particular year
l	Year of labels enacted
LCD	Liquid Crystal Display TV
option	Design option
PJTV	Rear Projection TV
PLS	Plasma TV
s	Year of standard enacted
SC	Year survey conducted
t	Standby-mode
0	On-mode