



**Asia-Pacific
Economic Cooperation**

PEER REVIEW ON ENERGY EFFICIENCY IN BRUNEI DARUSSALAM

Final Report

19 November 2013

Endorsed by the APEC Energy Working Group

TABLE OF CONTENTS

Table of Contents	ii
Preface	iv
Executive Summary	v
Recommendations	vii
PART I: BACKGROUND INFORMATION	1
1. Statistics, Forecasts and Trends in Energy Consumption	2
1.1 Brunei Darussalam’s Energy Situation in 2012	2
1.2 Trends in Energy Supply	3
1.3 Trends in Energy Consumption	4
2. Energy Efficiency Institutions, Policies and Major Programs	9
2.1. Institutional Framework	9
2.1.1 The Energy Department, Prime Minister’s Office	9
2.1.2 Department of Electrical Services	10
2.1.3 Other Related Agencies	11
2.2. Brunei Darussalam Energy White Paper	12
3. Energy Efficiency and Conservation Roadmap	13
3.1 Roadmap for Power Sector	13
3.2 Roadmap for Transportation Sector	13
3.3 - Roadmap for Industrial Sector	14
3.4 - Roadmap for Residential and Commercial Sectors	16
4. Major Programs for the Promotion and Implementation of Energy Efficiency	19
PART II: PREE REVIEW TEAM REPORT	22
1. Institutional Context	23
1.1 Achievements and Challenges	23
1.2 Recommendations	24
2. Energy Efficiency Goals, Targets and Strategy	25
2.1 Achievements and Challenges	25
2.2 Recommendations	30
3. Energy Data Collection and Monitoring	33
3.1 Achievements and Challenges	33
3.2 Recommendations	34
4. Policy Measures – Residential, Commercial, Government and Industrial Sectors	38
4.1 Overall Demand Sector Initiatives	38
4.1.1 Achievements and Challenges	38
4.1.2 Recommendations	43
4.2 Energy Management System Initiative	45
4.2.1 Achievements and challenges	45
4.2.2 Recommendations	46

4.3	EEC Building Code Initiatives	47
4.3.1	Achievements and Challenges	47
4.3.2	Recommendations	47
4.4	Industrial Sector Initiatives	49
4.4.1	Achievements and Challenges	49
4.4.2	Recommendations	51
5.	Policy Measures – Transport Sector	52
5.1	Achievements and Challenges	52
5.2	Recommendations	53
6.	Policy Measures – Electricity Sector	60
6.1	Achievements and Challenges	60
6.2	Recommendations	64
7.	Policy Measures – Appliances and Equipment	67
7.1	Achievements and Challenges	67
7.2	Recommendations	73
	Appendix A: Peer Review Team Members	75
	Appendix B: Organisations and Officials Consulted	76

PREFACE

According to the guidelines for the APEC Peer Review on Energy Efficiency (PREE), the objectives of the PREE as endorsed by APEC Leaders at their 2007 meeting are to:

- Share information on energy efficiency performance as well as on policies and measures for improving energy efficiency
- Provide opportunities for learning from the experiences of other economies and for broadening the network among energy efficiency policy experts
- Explore how energy efficiency goals on an overall and /or sectoral basis and action plans could be effectively formulated in each economy under review, taking into account the range of possible strategies that could be used, according to the circumstance of each economy
- Monitor progress attaining energy efficiency goals on an overall and/or sectoral basis and implementing action plans, if such goal and action plans have been already formulated at the time of the review
- Provide recommendation for voluntary implementation on how implementation of action plans could be improved with a view to achieving energy efficiency goals

Two activities are undertaken as part of the PREE:

- a) **Peer Review** of volunteer member economies
- b) The **Compendium of Energy Efficiency Policies** of APEC member economies based on either the APEC voluntary PREE or energy efficiency aspects of the IEA Energy Policy Review.

Brunei Darussalam volunteered to undertake a Peer Review on Energy Efficiency (PREE) and this was the tenth PREE exercise for an APEC Economy. This report presents the results of a peer review of energy efficiency policies conducted in Brunei Darussalam. The primary accountability for each peer review is shared by the economy being reviewed and the Review Team.

The peer review in Brunei Darussalam was conducted by a PREE Review Team of nine experts (see Appendix A) who visited Brunei Darussalam from 11-15 June 2013.

During the visit, the PREE Review Team held comprehensive discussions on energy efficiency with representative and experts from government ministries and agencies, consultants and research institutions (see Appendix B). The Review Team wishes to thank all the presenters and those who participated in the discussions, especially the representatives of the Brunei Darussalam Energy Department, Prime Minister's Office who organized the event.

EXECUTIVE SUMMARY

Brunei Darussalam is one of the few economies in the APEC region that is self-sufficient when it comes to energy. The economy is blessed with an abundance of oil and gas resources. With the small population, total overall energy consumption constitutes a small share of its energy production and the economy is able to export the bulk of its resources to generate revenue. Its current GDP per capita is one of the highest in the region. Based on APERC's projections in the *APEC Energy Demand and Supply Outlook 5th Edition*, Brunei Darussalam is likely to remain an energy exporter beyond the year 2035. The economy's wealth from the oil and gas industry is generously shared with its citizen in various forms; ranging from absence of tax on income; free education (up to university level and overseas scholarships); reduced prices for staple food (sugar and rice), housing, medical and health care services; as well as subsidised energy and utility prices (petrol products, electricity, water).

For most APEC economies, especially economies with limited energy resources, expensive energy imports are a powerful motivator for energy efficiency and conservation (EEC) measures. Given the wealth and secure energy situation of this economy, the PREE Review Team was curious as to why Brunei Darussalam was motivated to undertake a Peer Review on Energy Efficiency; after all, motivation is a fundamental criterion in ensuring that EEC implementation is successful and sustainable for the long term. The government officials interviewed during the visit were very clear and passionate about this subject. Several reasons were cited, ranging from the recognition that the oil and gas resources on which Brunei Darussalam has built its wealth upon may not last forever; the extremely high energy consumption per capita especially when compared to other economies in the region; the benefits of saved energy for export; the social and environmental costs of energy wastage; and the unsustainably high energy subsidies.

With these motivations in mind, Brunei Darussalam has decided to implement a number of EEC initiatives in pursuit of its energy savings goal. In an effort to first understand the consumer habits in the economy, in 2010, the Centre for Strategic and Policy Studies of Brunei Darussalam engaged a consultant to conduct a comprehensive study on EEC that critically evaluates energy consumption across all major sectors and identifies measures and recommends appropriate policy options to achieve high energy efficiency in each of these sectors. Eight key policy options were identified, namely **appliance standards, labelling, building regulation, energy management, fuel economy regulation, electricity tariff reform, financial incentives and awareness-raising**.

By the time of the PREE Review Team's visit in June 2013, the electricity tariff reform policy option has already been successfully implemented since January 2012 while the awareness-raising policy option is now a continuous, on-going process under the responsibility of the Energy Department, Prime Minister's Office (EDPMO) and the Ministry of Education. As for the other key policy options, Brunei Darussalam is currently conducting in-depth evaluation for each option to design the most appropriate method of implementation that best suits the economy's circumstances (i.e. institutional capacity, legislative and regulatory frameworks, private and public sector costs and savings, social impact and feasibility, timeframes).

The PREE Review Team highly commends and appreciates Brunei Darussalam's positive attitude and endeavours in planning innovative EEC measures and incentives that suits the economy's unique situation. At the same time, the PREE Review Team strongly believes that these EEC measures and initiatives should be integrated into an overarching national EEC strategy with well-defined, sector-specific targets and clear implementation plans. This will enable the economy to prioritise resources allocation and designate responsibilities for EEC program implementation, monitoring and evaluation.

From the institutional context, while EDPMO and other government agencies have been tasked with implementing specific EEC measures in concert with other stakeholders it is important that there is

strong leadership and coordination at the ministerial level to oversee the overall planning and effective implementation of EEC programs in order to ensure national targets can be achieved. To this end the National Energy Efficiency & Conservation Committee (NEECC) was established in 2011 and is co-chaired by the Minister for Energy, Minister of Development and Minister of Communication.

The PREE Review Team also believes that the EEC data collection and monitoring should be a priority for Brunei Darussalam as a first step towards providing real and useful information on energy usage. This is vital in the initial design process of appropriate EEC programs and policies. In the future, information on energy consumption will enable EDPMO to monitor progress and modify EEC initiatives accordingly.

Under the current energy pricing mechanism, motivating the people of Brunei Darussalam to voluntarily apply EEC measures is admittedly a challenge as the usual market incentives are not the main driving force in this economy. Therefore, PREE Review Team strongly recommends that Brunei Darussalam initiate a detailed market research to identify the EEC messages and incentives that would be most likely to appeal to different consumer groups, and customize communication strategies accordingly. Additionally, other novel EEC approaches that the PREE Review Team believes would be suitable for implementation in Brunei Darussalam have been included in this report. Two examples of innovative approaches are the Opower Home Energy Reports that applies a social incentive approach to electricity billing and the demand-responsive transport model to replace the traditional fixed-route public transport model.

At the same time, it is essential that certain policy options are backed up by the necessary legislative measures to ensure compliance. Specifically, the appliances and equipment minimum energy performance standards and labelling, EEC Building Codes and fuel economy regulations are policy options that require legislative and regulatory measures in order to ensure a minimum standard is achieved across the board. Legislative measures are also necessary in establishing the EEC-related institutions and financial frameworks proposed in this report, otherwise, the EEC institutions proposed may not have sufficient authority to carry out its EEC mandate.

The PREE Review Team is concerned that implementation of EEC policy actions may be hampered by the shortage of qualified EEC practitioners and experts in the economy as EEC has only recently been made a priority area in Brunei Darussalam. The PREE Review Team proposes that Brunei Darussalam conduct accelerated capacity building workshops on EEC data collection and management, EEC compliance, energy facility management, energy auditing and energy financing to quickly overcome this shortage.

On the other hand, the PREE Review Team was favourably impressed with the many initiatives that Brunei Darussalam has implemented to EEC awareness for the general public, especially the School Energy Clubs and designated Energy Day.

In summary, Brunei Darussalam has already identified the key policy options that should be implemented in order to achieve the economy's goal of 45% reduction in energy intensity by 2035 (using 2005 levels as the base line). The PREE Review Team agrees that these policy options are essential and will likely result in vast reductions in energy consumption, especially for the major consuming sectors. The recommendations made in this report are tailored towards aligning policy options under a unified framework and sharing best practices and innovative approaches from around the world, while concurrently identifying and addressing issues that may hinder EEC implementation in the economy. Brunei Darussalam has great potential to become one of the most efficient economies in APEC, and it is hoped that the recommendations in this report will help the economy to realize this potential and achieve its EEC goals.

RECOMMENDATIONS

Institutional Context

Recommendation 1: The National Energy Efficiency & Conservation Committee (NEECC) should oversee not only the implementation but also the planning of prioritized energy efficiency and conservation (EEC) plan of actions. This committee should be overseen by the Prime Minister.

Recommendation 2: The Government of Brunei Darussalam should enact necessary legislative measures to promote EEC. In addition, a comprehensive EEC Law should be considered in order to systematize necessary legislative measures.

Recommendation 3: The Government of Brunei Darussalam should establish the proposed innovative financing program, Brunei Energy Efficiency Fund (BEEF), in order to facilitate EEC projects in the private sector.

Recommendation 4: The Government of Brunei Darussalam should consider implementing gradual energy pricing reforms which draws on successful approaches used in other countries.

Energy Efficiency Goals, Targets and Strategy

Recommendation 5: Identify appropriate incentives to further enhance EEC measures.

Recommendation 6: Establish a national energy efficiency sub-target which measures energy efficiency improvement in the economy and ensures that it has a significant role in achieving the energy intensity target.

Recommendation 7: Apply a clear implementation plan (roadmap) to accelerate appropriate technologies to meet or exceed Brunei Darussalam's EEC targets. This plan should be announced to the public as a national agenda.

Energy Data Collection and Monitoring

Recommendation 8: Define a structured energy efficiency data collection framework and ensure regular implementation.

Recommendation 9: Introduce a data evaluation, monitoring and verification (EMV) protocol to ensure energy efficiency data is credible and accurate.

Recommendation 10: Publish energy efficiency indicators monitoring reports periodically to evaluate progress and encourage continuing efforts in energy efficiency improvements.

Recommendation 11: Establish a Brunei Energy Data Management Centre (BEDMC) that reports directly to the Minister of Energy.

Policy Measures – Residence, Commercial, Government and Industrial Sectors

Recommendation 12: Brunei Darussalam should conduct a detailed market research to identify which EEC messages would appeal the most to different consumer groups.

Recommendation 13: School Energy Clubs should be enhanced by developing an energy efficiency curriculum to reach all students in all levels of education.

Recommendation 14: An energy conservation and promotion fund (ECPF) should be established to be used for funding the EEC promotion program such as partial subsidies for EEC project investment, rebate, labelling, capacity building and demonstration programs, research and development grants, etc.

Recommendation 15: An Energy Conservation Centre Brunei (ECCB) should be legally established.

Recommendation 16: To demonstrate the effectiveness of energy management systems, a number of government, commercial and industrial facilities should be selected to participate in an energy management pilot program in line with ISO 50001 criteria. This can be further supplemented with detailed guidelines for establishing and implementing energy management systems, which could be distributed to the target organizations.

Recommendation 17: Brunei Darussalam should develop an energy management law adopting appropriate parts of the ISO 50001: 2011 Energy Management System, particular emphasis should be given to energy management system training.

Recommendation 18: In support of the energy management law, a sufficient number of qualified external auditors should be trained to conduct monitoring and verification exercises to ensure compliance.

Recommendation 19: Appropriate incentives should be designed to motivate facility managers and operators, particularly those in government-owned facilities, to apply EEC improvements that minimize operation costs.

Recommendation 20: The proposed EEC Building Code should include a strong foundation for EEC elements (along with existing fire, safety, construction and health) and be a unified document that clearly defines the jurisdiction of all agencies.

Recommendation 21: EEC Building Code should include passive or partial-passive cooling and lighting design, and construction using low thermal mass and insulated materials for new residential, government and commercial buildings. In doing so, cooperation with a research centre, such as the Energy Research Group of Universiti Brunei Darussalam (UBD), is highly recommended.

Recommendation 22: EDPMO should develop a compliance enforcement program to be effective once the EEC Building Code comes into force.

Recommendation 23: Build local capacity for addressing the EEC elements of the Building Code.

Recommendation 24: Energy efficiency improvement in the oil and gas industry should be focused on heat recovery, and this should be also applied for any new oil and gas plant designs.

Recommendation 25: Consider replacing small gas turbines with new gas engine sets for power generation in oil and gas industries.

Recommendation 26: Conduct a study on the efficiency of the gas transmission line, to check whether there might be gas leakage along the gas pipe line. Then, identify and implement energy efficiency measures that could reduce gas wastage.

Policy Measures – Transport Sector

Recommendation 27: Continue developing a database of fuel efficiency of light vehicles in the Brunei Darussalam fleet to be the basis on which vehicle fuel efficiency policies and initiatives, including consumer information, can be designed and monitored.

Recommendation 28: Provide consumer information on vehicle fuel consumption through the implementation of a vehicle labelling programme and energy efficient driver behaviour.

Recommendation 29: Incorporate fuel efficiency into new driver education and driver licensing.

Recommendation 30: Set CO₂ emissions based vehicle acquisition or taxation policies which encourage both fuel efficient vehicles and lower carbon fuel vehicles, such as gas vehicles, electric vehicles and plug-in hybrids.

Recommendation 31: Continue to periodically survey daily vehicle usage patterns (range of trip distances, range of daily driving distances and trip purpose) to increase understanding of travel patterns to assist in the design of future policies and initiatives.

Recommendation 32: Investigate information technology based, demand responsive transit models which may be more suitable to Brunei Darussalam's population size and urban density than traditional fixed-route public transport and better meet customers' needs.

Recommendation 33: Encourage greater coordination between the infrastructure functions of the Ministry of Development and the transport functions of the Ministry of Communications.

Policy Measures – Electricity Sector

Recommendation 34: The Department of Electrical Services (DES) should develop a roadmap to improve overall power systems efficiency.

Recommendation 35: DES should work closely with the Ministry of Finance to ensure that a well structured finance plan is put in place to provide the capitalization needed to finance the roadmap.

Recommendation 36: DES should implement ISO 50001 in all of its power generating stations.

Recommendation 37: Continue to implement progressively increasing tariffs over a specified long-term schedule, similar to what is currently being practiced in Japan and California.

Recommendation 38: Consider using other innovative tariffs such as "time of use (TOU) tariffs" to encourage consumers to increase their use of energy efficiency and lower overall system consumption.

Recommendation 39: Install smart meters for enhancing both demand side and supply side operations and programs.

Recommendation 40: Accelerate efforts to implement demand-side measures such as those being implemented for air conditioning units, chillers and lighting and consider Building Management Systems (BMS) for the commercial sector.

Recommendation 41: Consider implementing an energy efficiency (and water saving) program for drinking water and waste water treatment facilities.

Recommendation 42: As part of the efforts to supply electricity to the eco-tourism Temburong area, conduct a feasibility study that applies intensive energy efficiency measures integrating small-scale renewable energy supply (keeping the diesel generation facility as a back-up if needed).

Policy Measures – Appliances and Equipment

Recommendation 43: The EDPMO and BNERI should accelerate the development of the National Standard and Labelling Regulation, in order to achieve a more rapid transformation of the energy efficiency market in Brunei Darussalam.

Recommendation 44: Benchmark Brunei Darussalam's standards to established international or other regional standards.

Recommendation 45: Enforcement of the set standards should be a priority. Therefore, plan resources to ensure that stringency is maintained and enforcement is carried out.

Recommendation 46: Allow a grace period for sellers to sell out their existing inventory of inefficient products and limit their ability to import such products prior to the standards' effective date.

Recommendation 47: Develop a product label that is easily identifiable by consumers and uses a simple rating system.

PART I: BACKGROUND INFORMATION

The background information contained in this report has been contributed by Brunei Darussalam. This information is intended to provide some context to the recommendations of the PREE Review Team. The first section discusses the trends in Brunei Darussalam's energy consumption. The second section provides information on Brunei Darussalam's energy efficiency institutions, current policies and objectives and energy efficiency programs.

1. STATISTICS, FORECASTS AND TRENDS IN ENERGY CONSUMPTION

1.1 BRUNEI DARUSSALAM'S ENERGY SITUATION IN 2012

Brunei Darussalam enjoys a high standard of living with a GDP per capita of BND 52,315, which is among the highest in the region; thanks to the oil & gas sector that contributes about 67.6% of the BND 20.5 Billion Brunei Darussalam's GDP (in 2011). Oil & gas sector also constitutes about 95.6% of the BND 15.6 Billion total export and also about 91.4% of the Government's revenue. The oil & gas sector has for a long time been the determining factor for Brunei Darussalam's economy and is expected to remain the dominant contributor to the economy's revenue and source of energy in the foreseeable future.

Total final energy consumption in Brunei Darussalam is around 2.5 ton of oil equivalents (toe) per capita (2012). For production of electricity, 99% of the generation mix comes from natural gas and the other 0.999% is coming from oil (diesel) and 0.001% from solar energy. Most of the power plants in Brunei Darussalam are still using single cycle gas turbines, which have low efficiency. The single cycle gas turbines burn more fossil fuel and emit more carbon dioxide to the atmosphere. In 2012, an average of 39% of the electricity generated goes to residential sector, 27% to commercial sector, government sector takes an average of 18% and the remaining 16% is supplied to the oil & gas industrial sector (Figure 1).

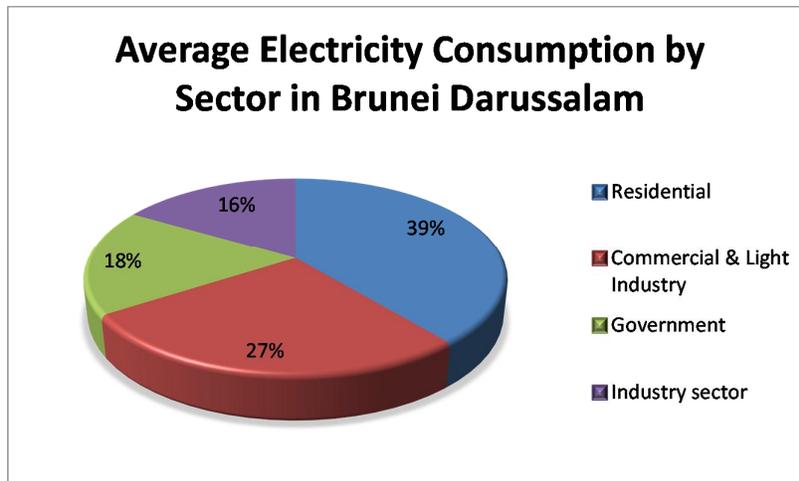


Figure 1 – Average Electricity Consumption by Sector in Brunei Darussalam for 2012

Air conditioning is the leading consumption of electricity. Air conditioner accounted for almost 60% of electricity consumption in a building. This is prevalent in almost all homes, government buildings and commercial buildings in Brunei Darussalam. With the relatively low electricity tariff, the population have enjoyed cheap and relatively high usage of air conditioning to create “cool” environment in both home and office.

Transportation sector is the third largest spender in fuel expenditure, accounted B\$ 521 Million or 25% of total energy expenditure in Brunei Darussalam (2010). Meanwhile excessive fuel is burnt given that the average efficiency of motor transport in Brunei Darussalam is only 10%. The number of in-use private and commercial is estimated at 200,000 vehicles travelling on 2,775 km of paved roads (2010). This makes Brunei Darussalam one of the highest in the world as far as car ownership is concerned, equivalent to more than 2 vehicles per licensed driver.

1.2 TRENDS IN ENERGY SUPPLY

Brunei Darussalam is well endowed with conventional energy resources such as oil and gas and renewable energy sources such as solar energy may also have some potential.

In 2012, the total primary energy supply of Brunei Darussalam was 3,425 kilotonnes of oil equivalent (ktoe) as shown in Table 1. Natural gas and oil accounted for most of the supply whereas natural gas represents about 77.9% and the rest was from oil (22%) and solar -photovoltaic (>1%).

Table 1: Brunei Darussalam Energy Supply and Consumption for 2012

	2012
Primary Energy Supply (ktoe)	
Indigenous Production	20,201
Net imports and other	-17032
Total PES	3,425
Coal	0
Oil	756
Gas	2,669
Other	0.14
Final energy consumption (ktoe)	
Industry	250
Transport	452
Other sectors	310
Total FEC	1,012
Coal	0
Oil	666
Gas	26
Electricity and other	320
Power Generation (GWh)	
Total	3,930
Thermal	3,929
Hydro	0
Nuclear	0
Other	1.2

Brunei Darussalam's domestic oil production occurs both offshore and onshore. The Brunei Darussalam's oil and gas production in 2012 was 20,201 ktoe, a decline of 2.95% from 2011, where crude oil /condensate and petroleum products production was around 8,616 ktoe and 17 ktoe respectively. Natural gas production and other (solar) production were around 11,568 ktoe and 0.14 ktoe respectively.

Historically, Brunei Darussalam is the net exporter of oil and natural gas. The crude oil and condensate export was around 151 thousand barrels per day. Net oil and gas exports account for more than 80% of Brunei Darussalam's production. The main export destinations were the ASEAN countries, South Korea, India, Australia, New Zealand, Japan, China, and USA. The majority of natural gas was exported as liquefied natural gas (LNG) to Japan and the rest to South Korea.

On the other hand, Brunei Darussalam also imported 379 ktoe of energy, primarily in the form of motor gasoline, diesel, Jet A-1, bitumen and lubricant.

1.3 TRENDS IN ENERGY CONSUMPTION

The final energy consumption in 2012 was around 1,012 ktoe, whereas petroleum products contributed the largest share around 666 ktoe (65.8%), electricity 320 ktoe (31.6%) and the rest was natural gas at around 26 ktoe (2.6%). The total final energy consumption in 2012 increased slightly around 6.5% compared to 2011. Figure 2 shows Brunei Darussalam’s final energy consumption.

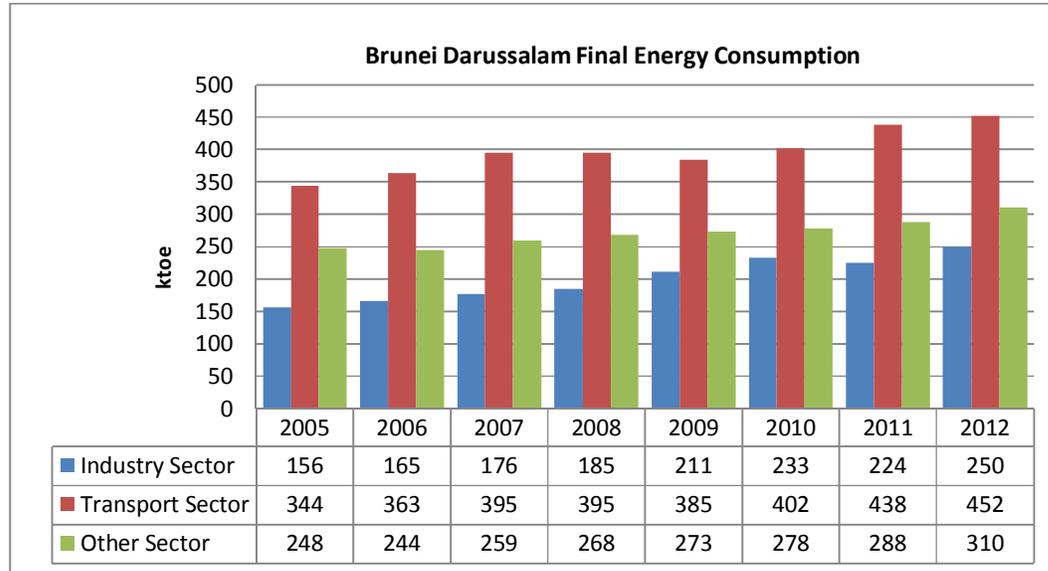


Figure 2 – Brunei Darussalam’s Historical Final Energy Consumption

Energy Consumption by sector

Historically, the shares of the three main sectors still remain unchanged. In 2012, the transportation sector was the largest final energy end user at 452 ktoe, or 44.7% of total final energy consumption, followed by the commercial and residential sector at 310 ktoe, or 30.6% and the industrial sector at 250 ktoe, or 24.7%.

a) Residential and Commercial Sectors:

The residential and commercial sector is the second largest energy consumer in the country. In the year 2012, this sector consumed 310 ktoe of energy. Residential & commercial sectors accounted for an average of 48% and 25% respectively in terms of electricity consumption for the past 5 years. In the past few years, significant efforts have been implemented towards saving energy in the residential and commercial sectors. Measures include applying “smart” tariffs in the residential sector which was launched on the 1st January 2012 and using high-energy efficiency technologies in buildings. Technologies like air-conditioners with ‘inverter’ technology, chillers, lighting equipment (i.e., compact fluorescent lamps, LEDs) and lighting system controls, automatic control equipment occupancy sensor and photo sensor unit at the offices to control brightness, penetration of solar water heaters and “Smart” power meters at the main switchboard to continuously monitor consumption are used by leading green energy organizations. According to a preliminary study, promoting these energy conservation initiatives in residential sector could result in up to 50% reduction in energy from Business-As-Usual (BAU) case in 2035 with three quarters of this contribution from high efficiency air conditioners and 7% from high efficiency lamps. Similar measures in commercial buildings could result in up to 44% reduction in energy from BAU case in 2035 with half of the total contribution from high efficiency air conditioners and a quarter of the total contribution from high efficiency chillers.

b) Transport Sector:

Gasoline cars and diesel cars account for 52% and 27% (or collectively 79%) of energy consumption in this sector respectively. Energy saving measures that have been implemented include promoting technologies, like the optimized gear box, the use of hybrid cars, electric vehicles and fuel efficient vehicle (FEV) to the public and evaluation of imposing the EU equivalent standards of fuel economy by 2025 for all the new vehicles (i.e. 21.3 km/l). This could result in about 40% lower energy needs than the BAU scenario by 2035. In collaboration with Ministry of Communication (MoC), the EDPMO will also evaluate how to improve the public transportation system (by adding capacity, optimizing routes and upgrading infrastructure) and the potential use of hybrid or electric vehicles for public transportation. Furthermore, EDPMO and MoC will seek to promote behavioral levers such as planning destination routes upfront and car-pooling to minimize the number of vehicles on the road.

c) Industrial sector:

The industrial sector accounts for 250 ktoe of energy, approximately one quarter of the total final energy consumption. By practicing energy efficiency, the industrial sector could not only optimize energy usage and abate CO₂ emission, but also reduce operational costs. In Brunei Darussalam, industrial sector is dominated by oil and gas industry which account for an average of 10% in terms of energy consumption for the past 5 years. In the oil & gas industry, the CO₂ emissions mostly come from the combustion of fossil fuel from auto-producer power plant facilities. Various initiatives have been undertaken in the oil & gas industry sector by the local operators to improve their operational efficiencies and reduce greenhouse gas emission. There has been a steady decrease of greenhouse gas emissions over time especially from 1998 onwards. The main contribution to the reduction of greenhouse gas emissions has primarily been from the reduction in venting and flaring emissions through rationalization projects and improvements in operational efficiencies in producing oil & gas fields. With significant reductions having been achieved in venting and flaring emissions, fuel gas (for gas compression and power generation) becomes the main contributor to greenhouse gas emissions in the order of about 50%. Efforts are now focused on energy efficiency of compression and auto-producer power plant facilities. The opportunities identified include upgrading or replacement of aged and inefficient equipment (e.g. compressors and control systems) in improving operational reliability and efficiency.

Energy Price and Subsidies

a) Fuel Prices

Brunei Darussalam’s fuel prices are fixed and set as follows:-

Table 2: Fixed Fuel Prices

Fuel Type	Cost
Premium Ron 97	B\$0.53 cents/litre
Regular Ron 95	B\$0.36 cents/litre
Diesel	B\$0.31 cents/litre

b) Electricity Tariff

Brunei Darussalam's current electricity tariffs are structured as follows:-

Table 3: Residential Electricity Prices

Units	Rates
1 to 600 units	B\$0.01 cents/kWh
601 to 1500 units	B\$0.08 cents/kWh
1501 to 4000 units	B\$0.10 cents/kWh
4001 units above	B\$0.12 cents/kWh

Table 4: Commercial/ Industrial Premises Electricity Prices

Units	Rates
First 10 units	KVA x B\$0.20 cents/kWh
Next 60 units	KVA x B\$0.07 cents/kWh
Next 100 units	KVA x B\$0.06 cents/kWh
Remaining units	KVA x B\$0.05 cents/kWh

The tariff for domestic sector was changed on 1 January 2012 from a regressive to a progressive structure, however the tariff for commercial and industrial premises remain unchanged.

c) Gas Subsidy to DES/BPC

The price of gas delivered to the Department of Electrical Department (DES) and Berakas Power Company (BPC) gas power stations are lower than the market price.

Energy Intensity

In line with other APEC economies, Brunei Darussalam is working towards an ambitious goal of a 45% energy intensity reduction by 2035 (using 2005 as the base year). Historically, there has been a severe irregularity in terms of energy intensity trend in Brunei Darussalam from 2005-2012 primarily as a result of inconsistent trend of both Gross Domestic Product (GDP) and Total Primary Energy Supply (TPES) – see Figures 3 and 4. Presumably, the trend will remain analogous for the next few years due to the development of downstream industry and additional production from offshore blocks which will further increase the energy usage in the region. However, due to the disproportionately higher increase in GDP contribution from the upstream industry, the overall energy intensity will drop to about 215 toe / USD Million GDP. This corresponds to a 45% reduction from 2005 baseline, indicating significant efforts need to be undertaken to help Brunei Darussalam reduce its energy intensity.

Currently, Brunei Darussalam is using TPES/GDP as a reference indicator to calculate energy intensity (EI) reduction in line with the reference indicator being used by APEC member economies. However, this indicator does not seem to be the right tool to measure the amount of reduction for energy

consumption because it has no direct impact on, and is perhaps not solely related to, energy efficiency improvement. In view of this, ASEAN member states (AMSs) are planning to use a reference indicator of TFEC/GDP for ASEAN long-term energy intensity reduction target. Brunei Darussalam is in full support to use TFEC/GDP as a reference indicator to be used on long-term EI reduction target for all AMSs. In the meantime, Brunei Darussalam calculates EI reduction using both reference indicators (TPES/GDP & TFEC/GDP) as shown in Tables 5 and 6.

a) Energy Intensity Reduction (TPES/GDP)

Table 5: The energy intensity reduction for Brunei Darussalam (2005-2012) using reference indicator of TPES/GDP

Years	Real GDP (million US\$)	TPES (ktoe)	Flat EI Target (TOE/US\$Mil GDP)	Actual (TOE/US\$Mil GDP)	Actual (%)
2005	6,864	2,679	390	390	0.0
2006	7,527	2,761	384	367	5.9
2007	7,886	2,743	378	348	10.8
2008	8,219	2,671	372	325	16.7
2009	7,908	2,670	367	338	13.4
2010	8,711	3,237	361	372	4.7
2011	9,725	3,375	355	347	11.0
2012	9,895	3,424	349	346	11.3

Base year

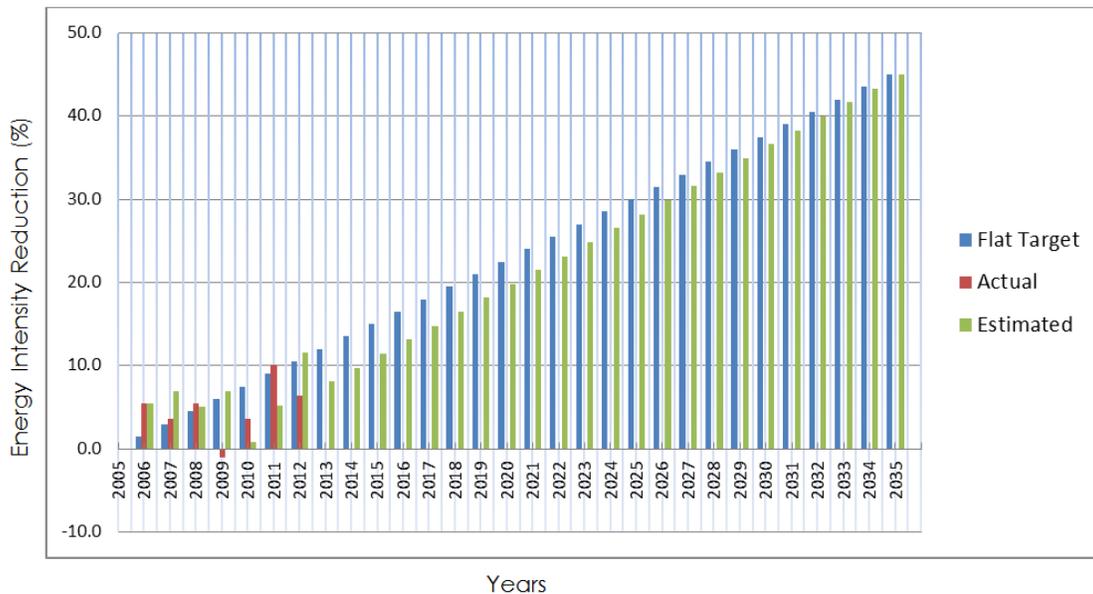


Figure 3 – Energy intensity reduction target for Brunei Darussalam between 2005 – 2035, using reference indicator of TPES/GDP (Actual versus Targets)

b) Energy Intensity Reduction (TFEC/GDP)

Table 6 – The energy intensity reduction for Brunei Darussalam (2005-2012) using reference indicator of TFEC/GDP

Years	Real GDP (million US\$)	TFEC (ktoe)	Flat EI Target (%)	Actual (TOE/US\$Mil GDP)	Actual (%)
2005	6,864	748	0.0	109	0.0
2006	7,527	773	1.5	103	5.5
2007	7,886	830	3.0	105	3.6
2008	8,219	848	4.5	103	5.5
2009	7,908	868	6.0	110	-1
2010	8,711	913	7.5	105	3.6
2011	9,725	950	9.0	98	10.1
2012	9,895	1,012	10.5	102	6.4

Base year

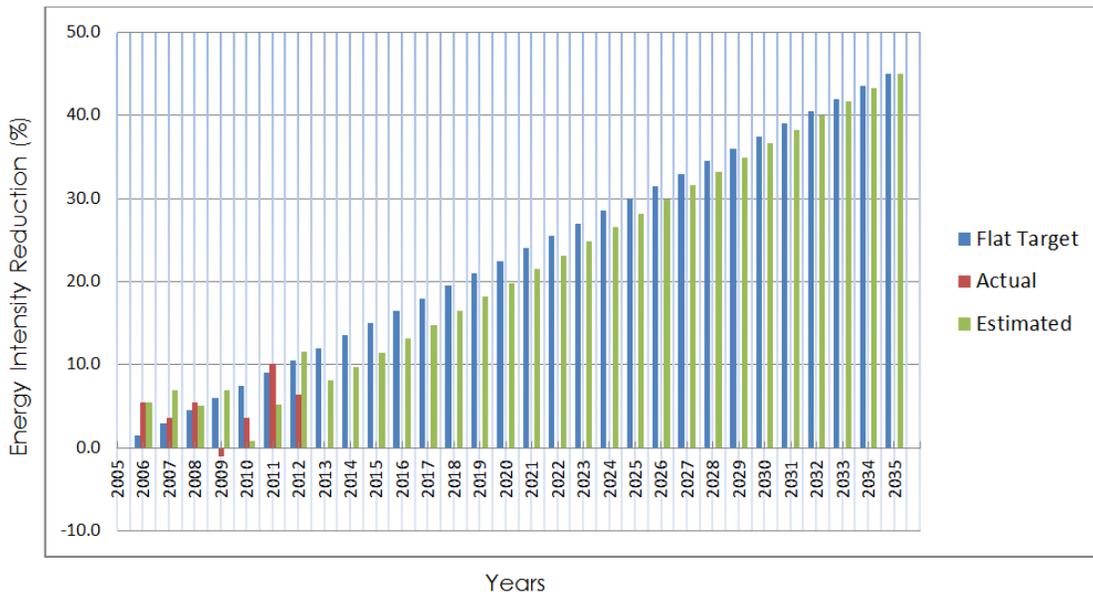


Figure 4 - Energy intensity reduction target for Brunei Darussalam between 2005 – 2035, using reference indicator of TFEC/GDP (Actual versus Targets).

2. ENERGY EFFICIENCY INSTITUTIONS, POLICIES AND MAJOR PROGRAMS

2.1. INSTITUTIONAL FRAMEWORK

2.1.1 The Energy Department, Prime Minister's Office (EDPMO)

The EDPMO is under the purview of the Minister of Energy at the Prime Minister's Office co-headed by the Permanent Secretary (Upstream) at the Prime Minister's Office and the Permanent Secretary (Downstream & Power) at the Prime Minister's Office.

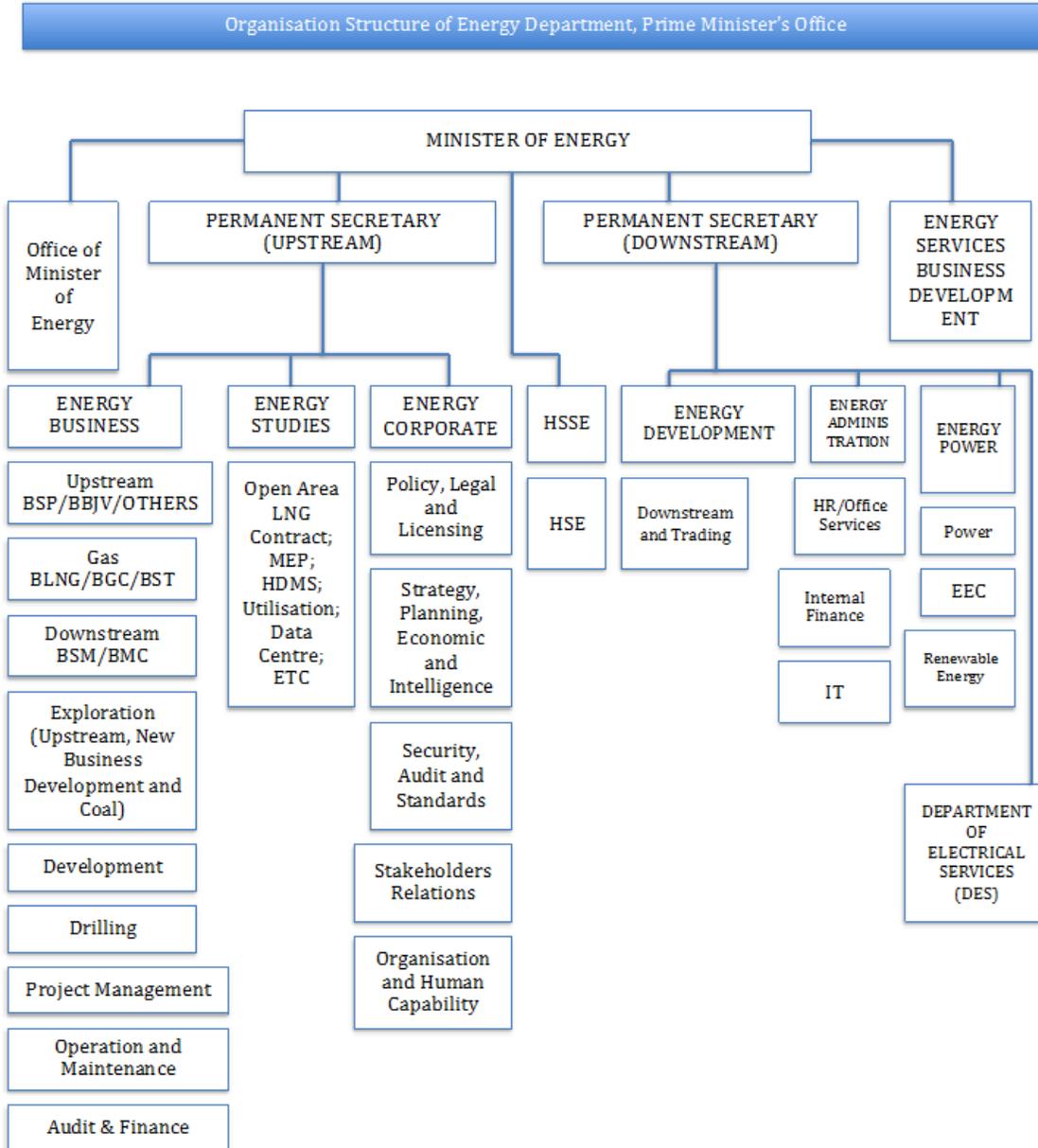


Figure 5 – Organisation Structure of Energy Department, Prime Minister's Office

The Department envisions a “sustainable energy for Brunei prosperity” with a mission to “drive Brunei economy into sustainable future”. Its goals include to strengthen and grow oil and gas upstream and downstream activities, ensure safe, secure, reliable and efficient supply and use of energy, and maximize economic spin-offs from energy industry.

Under the EDPMO, the relevant entities for EEC policy planning and implementation are as follows:-

1) The Energy Efficiency & Conservation Unit

The Energy Efficiency & Conservation (EEC) Unit is entrusted to implement all necessary plans of action which help to reduce energy consumption towards more efficient use of energy nationwide. The unit shall manage all initiatives and projects for the development of energy efficiency & conservation, in particular but not limited to the following:-

- i. Promoting and developing all plans and programs related to energy efficiency & conservation (EEC) nationwide.
- ii. Ensuring the implementation of energy efficiency & conservation (EEC) projects. These are not just limited to the projects planned by the Energy Department itself, but also include all projects being planned by other agencies or organizations including secondary schools through their Energy Clubs.
- iii. Develop and establish energy efficiency & conservation policies and laws and to ensure all agencies, organizations and individuals are fully obliged in implementing those policies and laws.
- iv. Undertake an audit at government and commercial buildings in order to monitor the energy consumption patterns and will make recommendations towards energy efficiency improvements.
- v. Providing advice on matters directly related to Energy Efficiency & Conservation (EEC) to public including school students.

2) National Energy Efficiency & Conservation Committee (NEECC)

A comprehensive approach on EEC initiative taken by the EDPMO is the formation of National Energy Efficiency and Conservation Committee (NEECC) in 2011 at the Ministerial level. This committee, which is co-chaired by the Minister of Energy, Minister of Development and Minister of Communication, is tasked to oversee the implementation of prioritized EEC plan of actions as outlined in the EEC Roadmap. The EEC Roadmap was developed in 2011 from four major sectors namely residential, commercial, transportation & industrial sectors. The NEECC will also be in charge of the execution of projects and coordination with various stakeholders. Moreover, in line with the realization of energy intensity target in the future, the committee will also need to set standards for industries (especially for the new upcoming downstream) on the production process that would comply with the minimum energy consumption policy to ensure the national level of energy intensity can be achieved.

2.1.2 Department of Electrical Services

The Department of Electrical Services (DES) is a government department under the Prime Minister’s Office mandated as a regulator and service provider in the areas of:

- i. The generation of electricity.
- ii. The transmission of electric power.
- iii. The distribution of electricity to the end-users.
- iv. The use of electricity in Brunei Darussalam

The DES also provides technical and essential services to the consumers in the form of:

- i. Controlling the standard of electrical works in buildings;
- ii. Technical advisory services to the end users;
- iii. Installation, operation and maintenance of street lighting.

DES has five power stations; namely Gadong 1A Power Station, Gadong 2 Power Station, Bukit Panggal Combined Cycle Power Plant, SOASSKW Lumut Co-Generation Power Plant and a diesel powered power station at Belingus in the Temburong District. All power stations are strategically located close to the load centres. Lumut Power Station is located in the Belait District, Bukit Panggal Power Station is located in Tutong District and Gadong I & Gadong II Power Stations are located in the Brunei Muara District.

The existing total capacity for electricity generation by DES power stations stands at 442 MW. The DES generation peak load is 313 MW. This accounts for 60% of the total peak load for Brunei Darussalam.

2.1.3 Other Related Agencies

In order to realize the energy intensity target, EDPMO will require coordinated effort from all stakeholders (government and private sectors) who will jointly evaluate legislative measures to promote energy efficiency & conservation. The four (4) important Ministries which are also the core members of NEECC are the Ministry of Development, Ministry of Communication, Ministry of Education and Ministry of Finance.

1) Ministry of Development

Under the Ministry of Development (MoD), there are two Departments that play major roles in achieving nationwide EE&C goals:-

- i. Department of Mechanical and Electrical (DME), Public Works Department
- ii. Authority for Building Control & Construction Industry (ABCI).

The Ministry of Development via ABCI and DME, in collaboration with EDPMO, are responsible for the development of the EEC Building Regulation/Code as outlined in EEC's roadmap with an objective to establish energy efficiency and conservation standards and a regulatory mechanism for buildings in Brunei Darussalam.

Meanwhile, the Department of Environmental, Park & Recreation (DEPR), which is also one of the departments under the Ministry of Development, plays an important role on subjects related to climate change. EDPMO has been working very closely with DEPR towards the reduction of carbon emission from various energy sectors in the country.

2) Ministry of Communications

The Ministry of Communications (MinCom) with the vision of being a 'Service Hub 2004' has a mission for the "provision of a safe, efficient, accessible and secure transport and communication services" or SEAS. Part of the role of the Transportation Section in the Ministry of Communication is to be responsible for managing and administering the land-based transport in the country, both private and public. It enforces the policy and regulations for transport management.

Land Transport Department as one of department under the Ministry of Communication is also responsible for sustainable development of public transport system and promoting widespread usage of modes of transport to ensure public transport service operators provide a more integrated, efficient and safe transport system in the country.

In terms of EEC initiatives in relation to transportation, the EDPMO has been working together with the Ministry of Communication in introducing and promoting the use of hybrid cars, electric

vehicles and Fuel Efficient Vehicle (FEV) in the country. This is again another initiative being undertaken by the EDPMO in collaboration with Ministry of Communication to reduce the energy intensity to 45% via transportation sector as well as to push towards a cleaner, greener and more sustainable transportation system and a better living environment in Brunei Darussalam by 2035.

3) Ministry of Education

Another important initiative being undertaken by the EDPMO (in cooperation with STEP Centre, Ministry of Education) is the establishment of Energy Clubs in schools since 25 May 2009. The objective is to inculcate the culture of energy efficiency and conservation at grassroots level (at schools) so that young people would become EEC ambassadors.

Currently, there are 30 Energy Clubs in Brunei Darussalam. This number is expected to rise as there are several schools that have conveyed their interest to establish Energy Clubs in their schools. Since its establishment, Energy Clubs have conducted quite a number of EEC and renewable projects. Some of these projects were showcased in big, energy-related events nationwide, including Brunei Energy Expo & Energy Week.

4) Ministry of Finance

The Ministry of Finance, in collaboration with EDPMO, plays an important role in introducing effective financial incentives for energy efficient products and technologies. Financial incentives such as tax reductions or perhaps tax exemption are often used for prevailing energy efficient equipment that initially has high costs. This financial support will aid in reducing the cost differences that may be incurred when purchasing more efficient equipment.

Discussion have been going on between EDPMO and relevant departments under the Ministry of Finance to explore several options in setting up an appropriate financial incentive mechanism or framework; i.e, for energy efficient cars such as electric vehicles (EV), hybrid vehicles and EV infrastructure in transportation sector as well as incentives for energy efficient equipment/technologies for example; air-conditioning, lightings, photovoltaic, HP water heaters and solar water heaters in residential and commercial sectors.

Support from the Ministry of Finance in making endorsements and approving financial incentives would be vital for the success of EEC promotion initiatives in Brunei Darussalam.

5) Brunei National Energy Research Institute

The Brunei National Energy Research Institute (BNERI) is a think-tank that provides policy advice to the Government of Brunei Darussalam on energy matters including those of Energy Efficiency and Conservation. BNERI will play an important role in imparting the best EEC policies into Brunei Darussalam's current institutional framework.

2.2. BRUNEI DARUSSALAM ENERGY WHITE PAPER

In order to secure the future of Brunei Darussalam's energy sector, Energy Department in the Prime Minister's Office (EDPMO) has set 3 strategic goals in the Energy White Paper (EWP) to drive the energy sector forward and realize the National Vision:

- Strategic Goal 1 – Strengthen and Grow Oil and Gas Upstream and Downstream Activities
- Strategic Goal 2 – Ensure Safe, Secure, Reliable and Efficient Supply and Use of Energy
- Strategic Goal 3 – Maximise Economic Spin-off from Energy Industry - boost local content and secure high participation of local workforce

More details of the Energy White Paper will be available when it is launched (date to be confirmed).

3. ENERGY EFFICIENCY AND CONSERVATION ROADMAP

3.1 ROADMAP FOR POWER SECTOR

Proposed integration of renewables into the grid sometime in 2020 by implementing feed-in tariff (FIT). New fossil fuel fired power plants does not need to be built in the next 20 years as electricity demand will not grow due to energy savings made in the residential and commercial sectors and the integration of renewables, including the proposed Sarawak inter-connections. Tariff reform is a very effective method to incentivize energy savings in residences and offices and has already been implemented on 1 January 2012.

Category	Market and policy	2010	2020	2030	2035
Renewable	Market impact		Integration of renewables into the grid 		
	Policies to be implemented		RPS or FIT 		
Facility improvement	Market impact	Sarawak Grid Inter-connection I Operational improvement (Improvement of load factor, lowering distribution losses, etc.) Smart grid (preparation for renewables) 			
	Policies to be implemented	Master plan 	Financial assistance for smart grid 		
Tariff reform	Market impact	Smart metering 	Tariff reform 		
	Policies to be implemented	Feasibility study 	Support for tariff reform 		

Figure 6 – Roadmap for Power Sector

3.2 ROADMAP FOR TRANSPORTATION SECTOR

The key measure is to introduce fuel economy labelling to allow fuel efficient vehicle to be sold in Brunei Darussalam. The fuel economy regulation of 39.97 MPG by 2020 and 49.48 MPG can be effectively introduced by 2025. Electric vehicles (EV) were first introduced in Brunei Darussalam in 2011 during the Brunei Energy EXPO 2011 and have since been utilized by the government as a pilot demonstration project. Until now, EVs have not been expanded for registered public use. There is a proposal to study and develop EV charging infrastructure to ease the transition from conventional vehicles to EVs and this will support the target for diffusion for EV by 2022. Additionally, there is also a proposal to consider providing subsidy for EV as part of incentives for both charging station and EVs by 2020. On public transportation, it is proposed to undertake feasibility study as early as 2012, followed by financial assistance for infrastructure. The introduction of public transport is proposed to be implemented by 2018.

Category	Market and Policy	2010	2020	2030	2035
Fuel economy	Market Impact	Fuel economy labeling Only fuel efficient cars can be sold in Brunei			
	Policies to be implemented	Making Fuel Economy Standard	39.97 MPG regulation	49.48 MPG regulation	
Electric vehicles	Market impact	Demonstration Project Diffusion of EVs Installing EV chargers			
	Policies to be implemented	Subsidy for installation of EV Chargers Subsidy for EVs			
Public transportation	Market impact	Introduction of public transportation			
	Policies to be implemented	Feasibility study Financial assistance for infrastructure			

Figure 7 – Roadmap for Transportation Sector

3.3 - ROADMAP FOR INDUSTRIAL SECTOR

On the improvement of equipment efficiency, pilot projects and subsidies can be an effective policy options towards improving energy efficiency by 2035. The dissemination of newly developed technologies is also an important factor in energy efficiency improvement. On recovery of waste energy, the adoption of subsidy schemes is a prospective policy option which can be introduced by 2020. Meanwhile, in a survey for potential for change of energy, a subsidy for installation is again the preferred policy option to be introduced by 2020. On operational improvement, the introduction of energy advisor is an important policy option for Brunei Darussalam by 2020. On structural change of energy management, an introduction of energy managers as well as awareness-raising would be an important policy option at least by 2020.

Category	Appliance	2010	2020	2030	2035	
General	Measures	Improvement of equipment efficiency				
	Policies to be implemented	Pilot project Subsidy	Subsidy	Dissemination of newly developed technology		
	Measures	Recovery of waste energy				
	Policies to be implemented	Develop heat recovery plan for selected industrial area		Subsidy for installation		
	Measures	Survey on potential for change of energy		Change of energy		
	Policies to be implemented	Subsidy for installation				
	Measures	Operation improvement				
	Policies to be implemented	Introduction of energy conservation advisor				
	Measures	Structural change of energy management				
	Policies to be implemented	Introduction of "Energy Manager" into factories		Awareness raising in industries		

Figure 8 – Roadmap for Industrial Sector

3.4 - ROADMAP FOR RESIDENTIAL AND COMMERCIAL SECTORS

In order to improve the energy efficiency of cooling in Brunei Darussalam, it is highly important that the use of energy efficient air conditioners such as inverter air conditioners & inverter chiller should be introduced. Compact fluorescent and LED lamps should also be used and installed in building and houses as early as 2012. Appliances Standard & Labeling would be the preferred policy to be implemented for both cooling system and lamps to prohibit low energy efficiency products from entering the market and hence people would purchase energy efficient products and appliances.

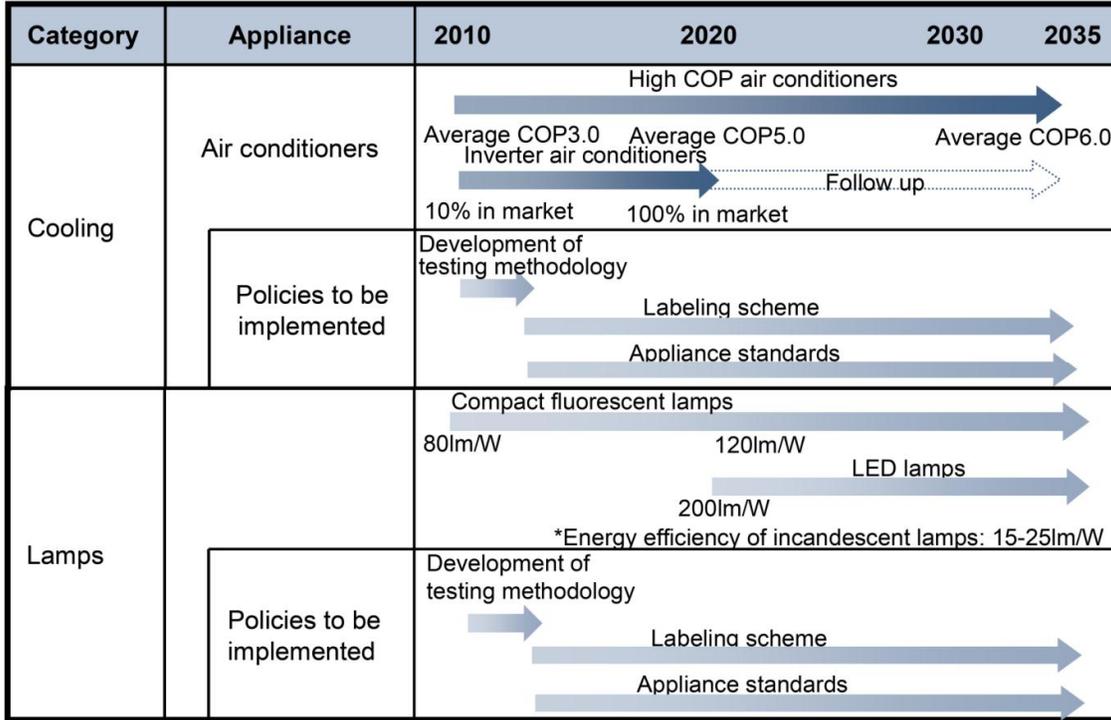


Figure 8 – Roadmap for Residential and Commercial Sectors

In order to realize these initiatives as discussed above, a number of legislative measures are under consideration by the EDPMO, Ministry of Communications, Ministry of Development, Ministry of Education and Ministry of Finance. From a comprehensive study undertaken by a consultant firm in 2011, 8 key policies have been identified to be implemented in order to effectively support all EEC initiatives to be undertaken. Those 8 key policies are summarized as follow:-

Policy 1 - Appliance Standards

- Implementation of appliance standards.
- Prioritizing implementation of high energy efficiency air conditioners, chillers and lamps.
- Setting up a minimum energy efficiency target.
- Designing the types of metrics (i.e., efficiency standards such as rating scale) to be adopted for each appliances.

Policy 2 - Labeling

In order to reduce the energy consumption of appliances, it is crucial to raise public awareness of energy conservation. A labeling scheme is regarded to be one of the most important measures to raise awareness and provide information to the public regarding the energy efficiency of products. The main objectives of labeling schemes are described as follows:

- Introduce energy labeling for consumer to compare the energy efficiency of products and information on reducing energy cost.
- Inform end users of the importance of energy conservation and to raise awareness.
- Inform end users that energy efficient products can reduce energy costs dramatically and that initial costs will eventually be returned through energy savings.

The objective of producing policy 1 & 2 (the National Standard & Labeling Regulation) are to halt the importation of the non-efficient electrical appliances & products (air conditioning & lightings) into the country and concurrently to educate and encourage people to opt to a more energy-efficient electrical appliances & products.

Policy 3 – Building Regulation

It is highly effective to develop energy efficiency regulations for buildings so as to improve the energy efficiency of buildings in Brunei Darussalam. It is crucial to establish Brunei Darussalam's specific building regulations according to its climate with the following criteria:

- Standards to reduce solar heat gains.
- Standards for insulation.
- Standards for air leakage.
- Temperature setting.

Policy 4 – Energy Management

- Implementing the energy management process that is compatible with international standards such as ISO 50001.
- Installing equipment such as Building Automation Systems (BAS), Controllers (i.e. demand controllers) and Building Energy Management Systems (BEMS).

Policy 5 – Fuel Economy Regulation

- Adopting EU equivalent fuel economy regulations by setting a target at 39.97 MPG (Mile Per Gallon) (17.2 km/l) by 2020 (EU 2016 target equivalent) and at 49.48 MPG (21.3 km/l) by 2025 (EU 2020 target equivalent).
- Electric, hybrid and Fuel Efficient Vehicles should also be utilized.

Policy 6 – Electricity Tariff Reform

- Continue to implement progressively increasing tariffs, similar to what is currently being practiced in Japan and California.

- Conducting a survey to understand the optimum tariff schedule through understanding the relationships between household income and electricity usage.
- Installing smart meters to allow more flexible tariff mechanism.

Policy 7 – Financial Incentives

- Introducing the appropriate incentives for energy efficient cars such as electric vehicles (EV), hybrid vehicles and EV infrastructure in transportation sectors.
- Introducing appropriate energy efficient equipments/technologies incentives for example; air-conditioning, lightings, photovoltaic, HP water heaters and solar water heaters in residential and commercial buildings.

Policy 8 – Awareness Raising

- Setting up EEC curriculum in national education system to increase awareness.
- Introducing yearly awards to incentivize people and corporation to practice energy management.
- Conducting Energy Expo, Roadshows, Workshops and seminars for general public to demonstrate the potential for EEC.
- Educate young generation through the establishment of Energy Club in schools.

4. MAJOR PROGRAMS FOR THE PROMOTION AND IMPLEMENTATION OF ENERGY EFFICIENCY

- a) Early last year, His Majesty the Sultan and Yang Di-Pertuan of Negara Brunei Darussalam has consented for the review of the electricity tariff structure in the residential sector which has taken into effect on the 1st January 2012. It is followed by the replacement of post-paid to pre-paid meters as the first steps toward encouraging energy savings amongst the public. The main objective of the **introduction of the new electricity tariff** is to correct the old tariff, which suit today's environment. In the old structure, those who consumed less were charged at a higher rate and were paying more on average per kWh compared to those who consumed more. The new tariff structure moves to being progressive from regressive. Up to a certain level, example for a consumption of 2000 kwh/month, consumers will be paying the same or less than what they are paying before (with the old tariff).

- b) Improving our overall existing power generation efficiency to greater than 45% by 2020 by replacing simple cycle power plant with more efficient combined-cycle or co-generation plant and by having a structured maintenance programme in place. Two major projects have been initiated at two of the major power plants in the country – the Lumut Co-Gen which will have an overall efficiency of greater than 60 per cent through the application of combined heat and power integration or Co-Generation. The other project at Bukit Panggal power plant has already reached an efficiency of about 47% using "Combined Cycle" concept. This is a significant difference compared to the efficiency level of other existing generators using the "Simple Cycle" concept which is only around 26%.

- c) On legislation, Energy Department in collaboration with Brunei National Energy Research Institute (BNERI) is currently developing a **National Standard and Labeling regulation** for electrical appliances which are the air-conditioner and lightings. This is a follow-up from the work which has been developed by a consultant firm on standard appliances and labeling scheme which was completed end of last year. The objective of producing the National Standard & Labeling Regulation is to halt the importation of the non-efficient electrical appliances & products (air conditioning & lightings) into the country and concurrently to educate and encourage people to opt to a more energy-efficient electrical appliances & products. The air-conditioner accounted for almost 60% of electricity consumption in a building. This is prevalent in almost all homes, government buildings and commercial buildings in Brunei Darussalam. Hence, with the later implementation of this regulation, it is hoped that consumers will have a better understanding on which product has a better efficiency rate to be purchased and hence will reduce the energy consumption nationwide.

- d) Energy Department is also currently working with a consultant firm to develop **Energy Efficiency and Conservation Program in Brunei Darussalam**. The objective of the project is to pursue the development of Energy Efficiency and Conservation Program for government and commercial buildings in the country. In addition, the Energy Department is also preparing a paper for the establishment of the Energy Manager for all buildings belong to government ministries in Brunei Darussalam. The Energy Manager is responsible for assessing how, when and why energy use in buildings through energy audit or review. All Energy Managers will undergo training and courses for certification to be an accredited Energy Manager from the ASEAN Energy Manager Accreditation Scheme (AEMAS).

- e) Energy Department in collaboration with the Ministry of Development via the Authority for Building Control and Construction Industry (ABCi) and the Department of Mechanical and Electrical (DME) is also currently in the process of developing the **EEC Building Code** with an objective to establish energy efficiency and conservation standards and a regulatory mechanism for buildings in Brunei Darussalam. Joint working committee has been established between Energy Department and Ministry Development to facilitate the formulation of EEC Building Code through consultant service as well as to recommend the best option in terms of EEC Building Code frameworks and contents.

- f) On transportation sector, Energy Department is currently working together with the Ministry of Communication to **introduce utilization of hybrid cars and electric vehicles** in the country. This is again another initiative being undertaken by the Energy Department towards green environment.

- g) Another important initiative being undertaken by the Energy Department in corporation with STEP Centre, Ministry of Education is the establishment of **Energy Clubs** in schools on the 25th May 2009. The objective is to inculcate the culture of energy efficiency and conservation at grassroots level (at schools) so that young people would become EEC ambassadors.

- h) Energy Department will continuously conducting the **awareness raising programmes** to all community level by organizing Energy Week, Energy Expo and roadshows, workshops and seminars on capacity building and also educate younger generation through the establishment of Energy Clubs in schools. EDPMO is also from time to time conducting a seminar on energy savings to newly appointed government officers and staff, organized by the Institute for Public Service Institute, Prime Minister's Office. The seminar on energy saving is also planned to be extended to rural communities so that they will be given equal opportunity to learn EEC.

- i) Another significant project which will be undertaken by the Energy Department is the replacement of the existing High Pressure Sodium Vapour (HSPV) **street lighting** to low wattage and better light intensity lighting. The benefit of the project would be a saving of approximately USD134 million over a period of 11 years. The government is currently in the high level discussion with one potential company for project kick-off.

- j) While efforts are made to increase efficiency in electricity usage, Energy Department has also taken steps and will continue to put emphasis on the **introduction of alternative and renewable energy** into the energy mix for Brunei Darussalam. In 2011, Brunei Darussalam has commissioned its first photovoltaic solar power plant, that is, the Tenaga Suria Brunei (TSB), in Seria. At 1.2 MW it is supplying power to about 200 homes. It is small but an important first step in the development of renewable energy sources. In addition to solar power, the Energy Department in co-operation with Brunei Economic Development Board (BEDB), Economic Planning & Development Department (JPKE) and the Department of Environment, Park & Recreation (DEPR) is also looking at the possibility of having a Waste-to-Energy facility at Sungai Paku, Seria. This facility would be able generating up to 25 MW of power. The Government has an aspiration to generate at least 10% (50 MW) of the total

power generation from new and renewable resources. With the continuous drive to use energy efficiently and with the introduction of renewable energy, it will eventually help to reduce the consumption of natural gas which can either be exported or use as a feedstock to downstream industries, creating thousands of employment opportunities for the people of Brunei Darussalam while ensuring environmental and economic development sustainability.

Figure 9 is showing the EEC’s legislative measures that will be developed and implemented in Brunei Darussalam. The implementations of a set of policy measures are very important to comprehend Brunei Darussalam’s EEC roadmap. Three measures are to be implemented into the residential and commercial sectors which include; an appliance standard & labeling under the responsibility of EDPMO and building regulation under the responsibility of the Ministry of Development. Meanwhile, measure to be implemented into the industrial sector is the energy management i.e. energy management building and energy monitoring which is again EDPMO as responsible agency. As for the transportation sector the fuel economy regulation is an effective energy savings measure under the responsibility of Ministry of Communication and EDPMO is responsible agency on tariff reforms under power sector which can potentially contribute to savings in electricity consumption. Sector-wide measures include subsidies and tax implementations are again under the responsibility of EDPMO alongside awareness raising initiatives such as education and events which are under the responsibility of Ministry of Education.

Sector	Measure	Responsible division
Residential/Commercial	<ul style="list-style-type: none"> ■ Appliance standards ■ Labeling 	EDPMO
	<ul style="list-style-type: none"> ■ Building regulation 	Ministry of development
Industrial	<ul style="list-style-type: none"> ■ Energy management <ul style="list-style-type: none"> • Energy management building • Energy monitoring 	EDPMO
Transportation	<ul style="list-style-type: none"> ■ Fuel economy regulation 	Ministry of communications
Power	<ul style="list-style-type: none"> ■ Electricity tariff reform 	EDPMO
Sector wide	<ul style="list-style-type: none"> ■ Financial incentives 	EDPMO
	<ul style="list-style-type: none"> ■ Awareness raising 	Ministry of education

Figure 9 - Legislative Measures: Set of policy recommendation & contribution from other government agencies.

PART II: PREE REVIEW TEAM REPORT

This part of the report presents the PREE Review Team's conclusions and recommendation about energy efficiency policies and programs in Brunei Darussalam.

1. INSTITUTIONAL CONTEXT

1.1 ACHIEVEMENTS AND CHALLENGES

A discussion on Brunei Darussalam's energy efficiency institutional context should be prefaced with some review on the energy situation in the economy. It should be recognized that Brunei Darussalam enjoys a high GDP per capita that is among the highest in the region due to the economy's abundant oil and natural gas resources. This has enabled Brunei Darussalam to implement a very generous energy pricing mechanism for its citizens. Unfortunately, this generous energy pricing mechanism, made possible by the abundance of indigenous fossil fuel resources, are the reason for the substantial barriers to energy efficiency in the economy. This may not be sustainable in the long-run as reserves begin to deplete. On the other hand, prioritizing energy efficiency initiatives will benefit the economy in the long-run as these initiatives will free up more oil and natural gas for exports that will increase or prolong national revenue.

As International Monetary Fund (IMF) stated in its report published in 2013, *Energy Subsidy Reform: Lessons and Implications*¹, "energy subsidies are pervasive" in the world and is not limited in Brunei Darussalam, and "energy subsidies have wide-ranging economic consequences". However, the level of energy subsidies in Brunei Darussalam is relatively high in the APEC region, especially for petroleum products. According to the IMF report, Brunei Darussalam's pre-tax subsidy² for petroleum products is the second highest after Indonesia in terms of per cent of GDP. The role of the pre-tax subsidy for petroleum products in encouraging excessive energy consumption is readily apparent in Brunei Darussalam's rapid motorization.

One of the results of this energy pricing mechanism is Brunei Darussalam's large consumption of fossil fuels; the economy currently ranks fourth in the world for Greenhouse Gas (GHG) emission on per capita basis. This fact also became a driver for Brunei Darussalam to promote energy efficiency initiatives more rigorously.

As for achievements in the Institutional Context, the Energy Efficiency & Conservation (EEC) Unit was established under the Energy Department, Prime Minister's Office (EDPMO). The EEC Unit takes the lead in coordination among government agencies related to energy efficiency and conservation (EEC) in implementing EEC measures including the National Standards and Labelling initiative, the EEC Building Code initiative, the Electricity Tariff Reforms and EEC Awareness Raising.

In addition, a National Energy Efficiency & Conservation Committee (NEECC), co-chaired by the Minister of Energy, Minister of Development and Minister of Communication, was established in 2011. The committee is in charge of the execution and coordination with various EEC stakeholders (government agencies, industries and individuals). Mainly, the committee is tasked to oversee the implementation of prioritized EEC plan of actions and ensure the national level of energy intensity can be achieved. However, prioritized EEC plan may need to be revised to cope with rapidly changing energy and economic situations in Brunei Darussalam. In order to facilitate timely and speedy revisions of prioritized EEC plan, NEECC should oversee not only the implementation, but also the planning, of prioritized EEC plan. For the same purpose, this committee should be overseen by the Prime Minister in order to avoid possible discord among co-chairing three Ministers. In Brunei Darussalam's legislation, relevant government agencies have already initiated joint evaluation of legislative measures to promote EEC, such as the National Standard and Labelling regulation and the

¹ Available at <http://www.imf.org/external/np/pp/eng/2013/012813.pdf>

² The IMF report defines two components for consumer subsidies, a *pre-tax subsidy* (if the price paid by firms and households is below supply and distribution costs) and a *tax subsidy* (if taxes are below their efficient level).

EEC Building Code (see Chapter 4 and 7 for more detailed information). On top of each legislative measure, it is important to create the necessary legal framework that will allow EEC laws to be effective.

Along with government institutions and legislation, financial Incentives are also a part of the institutional basis for energy efficiency initiatives. While EEC projects by government agencies can be financed by the government budget, with the inexpensive energy prices, there will be no incentives for private entities to pursue EEC measures. The most serious challenge is to obtain the Ministry of Finance's approval for the proposed innovative "Brunei Energy Efficiency Fund (BEEF)". BEEF is expected to facilitate EEC projects by incentivizing private financial institutions and also reducing expenditures by the Ministry of Finance. In addition to BEEF, other financial instruments can be further developed for energy efficiency projects, which will be discussed in Chapter 4 on the policy measures for residential, commercial, government and industrial sectors.

1.2 RECOMMENDATIONS

Recommendation 1: *NEECC should oversee not only the implementation but also the planning of prioritized EEC plan of actions. This committee should be overseen by the Prime Minister.*

Recommendation 2: *The Government of Brunei Darussalam should enact necessary legislative measures to promote EEC. In addition, a comprehensive EEC Law should be considered in order to systematize necessary legislative measures.*

Recommendation 3: *The Government of Brunei Darussalam should establish the proposed innovative financing program, Brunei Energy Efficiency Fund (BEEF), in order to facilitate EEC projects in the private sector.*

Recommendation 4: *The Government of Brunei Darussalam should consider implementing gradual energy pricing reforms which draws on successful approaches used in other countries.*

Example: The IMF *Energy Subsidy Reform: Lessons and Implications* report contains a section on "Lessons Learned from Experience" based on case studies of successful and unsuccessful reform exercises by economies around the world.

Other case studies and recommendations are also available at the Global Subsidies Initiatives Website³; including a series of *Citizen Guides to Energy Subsidies* by economy to engage public interest on energy subsidies and reform measures.

³ Available at <http://www.iisd.org/gsi/>

2. ENERGY EFFICIENCY GOALS, TARGETS AND STRATEGY

2.1 ACHIEVEMENTS AND CHALLENGES

Brunei Darussalam attaches great importance to energy efficiency. In line with other APEC economies, the economy is working towards an ambitious goal of a 45% energy intensity decline by 2035 (using 2005 as the base year) while identifying energy efficiency improvement and renewable energy development as major approaches to realize this goal. Many coordinated efforts from all the stakeholders (government agencies, industries and individuals) have been conducted or in the process of being conducted.

As described in the draft *Energy White Paper of Brunei Darussalam*, “Ensure Safe, Secure, Reliable and Efficient Supply and Use of Energy” is now prioritized as one of the three national energy strategic goals⁴. This has been laid down as an essential basis for improving energy efficiency and promoting energy conservation in Brunei Darussalam towards 2035.

In 2011, a comprehensive study on energy efficiency, entitled *Brunei Energy Efficiency and Conservation Study: Roadmap Formulation and Policy Advice*, was published. The study was commissioned by the Brunei Darussalam government to investigate various possible pathways from major sectors (residential, commercial, power, transportation, and industrial) to realize its energy efficiency goals. Based on the results of this study, several energy efficiency and conservation (EEC) measures have been identified to ensure that the national level of energy intensity can be achieved. These are summarized in the table below.

Table 2-1: EEC Measures to Achieve Brunei Darussalam’s National Level of Energy Intensity

Sector	Measures
Residential and Commercial Sectors	<ul style="list-style-type: none">• Applying “smart” tariffs• Promote use of high-energy efficiency technologies in buildings. Proposed technologies include energy efficient air-conditioners, chillers, lighting equipment (i.e., compact fluorescent lamps, LEDs) and lighting system controls, automatic control equipment occupancy sensor and photo sensor unit at the offices to control brightness, penetration of solar water heaters and “Smart” power meters at the main switchboard to continuously monitor consumption.
Transport Sector	<ul style="list-style-type: none">• Promoting technologies, like the optimized gearbox, the use of hybrid cars, electric vehicles and fuel-efficient vehicle (FEV) to the public and evaluation of imposing the EU equivalent standards of fuel economy by 2025 for all the new vehicles (i.e. 21.3 km/l).• Evaluate how to improve the public transportation system (by adding capacity, optimizing routes and upgrading infrastructure) and the potential use of hybrid or electric vehicles for public transportation.• Promote behavioural levers such as planning destination routes upfront and car-pooling to minimize the number of vehicles on the road.

⁴ The other two national energy strategic goals from the draft *Energy White Paper of Brunei Darussalam* are “Strengthen and Grow Oil and Gas Upstream and Downstream Activities” and “Maximize Economic Spin-off from the Oil and Gas Industry”.

Power Sector	<ul style="list-style-type: none"> • Increase efficiency in the power generation from 23% to 45% by implementing energy-saving technologies – the combined cycle turbine, reducing partial load operation and transmission and distribution losses, mandating an energy efficiency target for any new power plant, installing smart meters (i.e. dynamic pricing based on energy consumption). • Evaluating feasibility of altering tariff structure to promote desired consumption behaviour. • Integration of renewable energy to meet the demands on power in Brunei Darussalam and reduce gas consumption.
Industrial Sector	<ul style="list-style-type: none"> • In Brunei Darussalam, fuel gas is the main contributor to greenhouse gas emissions. Efforts are now focused on improving energy efficiency and reliability of compression and auto-producer power plant facilities. Opportunities identified include upgrading or replacement of aged and inefficient equipment (e.g. compressors and control systems).

Prior to 1998, the main contribution to greenhouse gas emission comes from the combustion of fossil fuel from auto-producer power plant facilities. It is encouraging that with the various initiatives undertaken in the oil and gas industry sector by the local operators, there has been a steady decrease of greenhouse gas emissions over time especially from 1998 onwards. This was achieved mainly through rationalization projects and improvements in operational efficiencies in producing oil and gas fields which resulted in reduction in venting and flaring emissions.

It should also be noted that energy intensity in Brunei Darussalam has shown some fluctuations since 2005. However, largely due to economic improvements, overall energy intensity in 2012 is lower than the base year of 2005 by more than 10% (mainly as a result of increase in oil and natural gas export in recent years), which is in line with the expected pace of progress towards achieving its energy intensity decline target by 2035.

Brunei Darussalam has identified 8 key policies to be implemented in order to effectively support all EEC Measures identified in Table 2-1, these policies are summarized in the next table.

Table 2-2: Implementation of Key EEC Policies

Policy	Rationale	Implementation
Policy 1: Appliance Standards	The objective is to halt the importation of the non-efficient electrical appliances & products (air conditioning and lightings) into the country and concurrently to educate and encourage people to opt to a more energy-efficient electrical appliances and products.	<ul style="list-style-type: none"> • Implementation of appliance standards. • Prioritizing implementation of high energy efficiency air conditioners, chillers and lamps. • Setting up a minimum energy efficiency target. • Designing the types of metrics (i.e., efficiency standards such as rating scale) to be adopted for each appliance.

<p>Policy 2 - Labelling</p>	<p>In order to reduce the energy consumption of appliances, it is crucial to raise public awareness of energy conservation.</p> <p>A labelling scheme is regarded to be one of the most important measures to raise awareness and provide information to the public regarding the energy efficiency of products.</p> <p>At the same time, like the appliance standards, labelling schemes will halt importation of non-efficient appliances and products into the country and concurrently to educate and encourage people to opt to a more energy-efficient electrical appliances and products.</p>	<ul style="list-style-type: none"> • Introduce energy labelling for consumer to compare the energy efficiency of products and information on reducing energy cost. • Inform end users of the importance of energy conservation and to raise awareness. • Inform end users that energy efficient products can reduce energy costs dramatically and that initial costs will eventually be returned through energy savings.
<p>Policy 3 - Building Regulation</p>	<p>It is highly effective to develop energy efficiency regulations for buildings so as to improve the energy efficiency of buildings in Brunei Darussalam.</p> <p>With its hot climate, Brunei Darussalam requires high cooling loads throughout the year so it is crucial to establish Brunei Darussalam's building regulations according to its specific requirements.</p>	<p>Criteria to be included in Brunei Darussalam's building regulations:</p> <ul style="list-style-type: none"> - Standards to reduce solar heat gains. - Standards for insulation. - Standards for air leakage. - Temperature setting.
<p>Policy 4 - Energy Management</p>	<p>The use of energy management is a fundamental approach to promoting EEC in companies, governmental organizations, schools etc. When EEC is promoted properly, it is essential that the actual status of energy consumption is known, and that an appropriate plan and selection of measures is employed.</p> <p>An energy management provides such an appropriate base for EEC. Generally, energy management is implemented by a PDCA (Plan, Do, Check, Act) cycle.</p>	<ul style="list-style-type: none"> • Implementing the energy management process that is compatible with international standards such as ISO 50001. • Installing equipment such as Building Automation Systems (BAS), Controllers (i.e. demand controllers) and Building Energy Management Systems (BEMS).

<p>Policy 5 – Fuel Economy Regulation</p>	<p>There are currently no policies to regulate fuel economy and CO₂ emissions in Brunei Darussalam. However, the introduction of such policies will make it possible to achieve energy conservation within the transportation sector.</p>	<ul style="list-style-type: none"> • Adopting EU equivalent fuel economy regulations by setting a target at 39.97 MPG (Mile per Gallon) (17.2 km/l) by 2020 (EU 2016 target equivalent) and at 49.48 MPG (21.3 km/l) by 2025 (EU 2020 target equivalent). • Electric, hybrid and fuel-efficient vehicles should also be utilized.
<p>Policy 6 – Electricity Tariff Reform</p>	<p>A reform of Brunei Darussalam’s tariff mechanism will offer the opportunity to create and provide incentives for Bruneians to use energy more efficiently.</p>	<ul style="list-style-type: none"> • Continue to implement progressively increasing tariffs, similar to what is currently being practiced in Japan and California. • Conducting a survey to understand the optimum tariff schedule through understanding the relationships between household income and electricity usage. • Installing smart meters to allow more flexible tariff mechanism.
<p>Policy 7 – Financial Incentives</p>	<p>Financial measures such as tax reductions and subsidies are often used for the prevailing energy efficient equipment that has a higher price than existing standard products.</p>	<ul style="list-style-type: none"> • Introducing the appropriate incentives for energy efficient cars such as electric vehicles (EV), hybrid vehicles and EV infrastructure in transportation sectors. • Introducing appropriate energy efficient equipment/technologies incentives for example; air-conditioning, lightings, photovoltaic, HP water heaters and solar water heaters in residential and commercial buildings.
<p>Policy 8 – Awareness Raising</p>	<p>In order to maximize the effectiveness of energy saving measures, it is very important that each person in Brunei Darussalam understands the importance of energy savings. Even if energy efficient equipment is installed, individuals need to be made aware of how to use the equipment effectively, to its full potential. Therefore awareness-raising is the key to a successful EEC.</p>	<ul style="list-style-type: none"> • Setting up EEC curriculum in national education system to increase awareness. • Introducing annual awards to incentivize people and corporation to practice energy management. • Conducting Energy Expo, Roadshows, Workshops and seminars for general public to demonstrate the potential for EEC. • Educate young generation through the established Energy Clubs in schools.

Figure 2-1 shows the detailed information of EEC potential and its clear benefit to Brunei Darussalam. Under BAU scenario, energy consumption is projected to increase by 89% from 2009 to 2035, which is equivalent to 1,389 thousand toe increase. However under EEC scenario, a potential of 63% reduction from BAU, which is equivalent to 1,863 thousand toe, would be achieved by 2035 primarily from a reduction of fossil fuel supply for inland energy use via four major sectors, namely commercial, residential, transportation and industrial sectors. This will allow Brunei Darussalam to export more oil and natural gas. The overall benefit of this EEC scheme is calculated to be around BND 523 million per year by 2035, with additional investments of around BND 255 million per year in achieving and maintaining the EEC scheme.

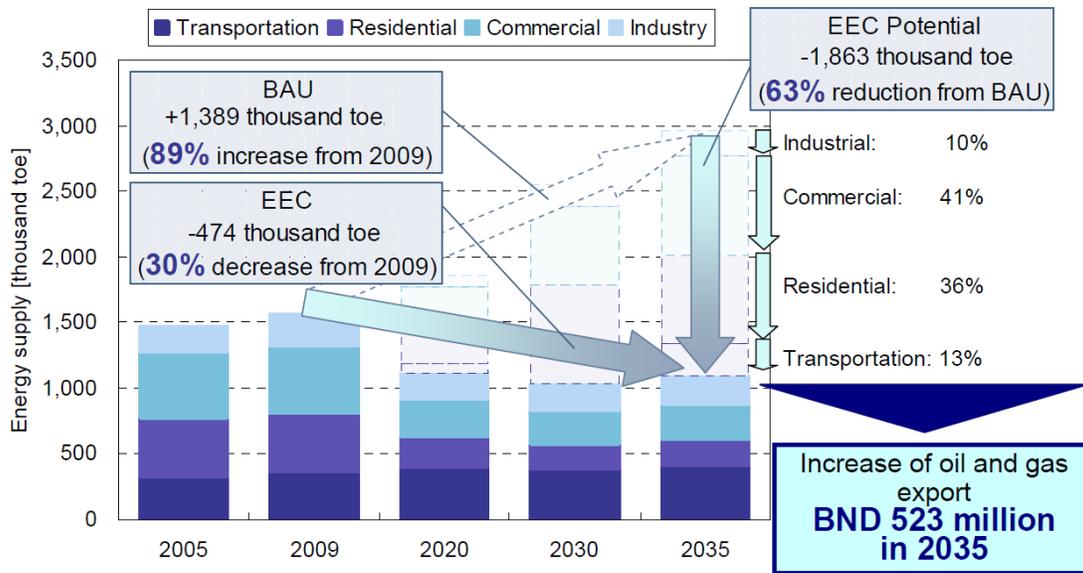


Figure 2-1: Overall Brunei Darussalam EEC Potentials and Benefits⁵

Most APEC economies are facing the twin challenges of limited domestic energy resources and expensive energy prices. These challenges are less urgent in Brunei Darussalam; as a result, there are less financial incentives to implement EEC measures. Therefore, finding the correct, alternative incentives for consumers to engage in EEC actions is a particular challenge in Brunei Darussalam.

Presently, the oil and gas sector contributes more than 60% of the total national GDP in Brunei Darussalam. Fluctuations in price for oil and natural gas at international market (export price) will result in fluctuations in Brunei Darussalam's GDP, which will in turn influence energy intensity. In order to realize Brunei Darussalam's 2035 energy intensity reduction target, more detailed analysis in defining energy efficiency indicators will be required to reflect EEC efforts. Considering their importance of energy activities in Brunei Darussalam, clear energy efficiency indicators serving as disaggregated goals for energy efficiency improvement are especially required for power generation sector, commercial sector, residential sector, transportation sector and industrial sector. Moreover, identification and implementation of pragmatic countermeasures in these key sectors is another challenge for Brunei Darussalam towards realizing its energy intensity reduction target.

⁵ Mitsubishi Research Institute (2011), *Brunei Energy Efficiency and Conservation Study: Roadmap Formulation and Policy Advice*.

2.2 RECOMMENDATIONS

Recommendation 5: *Identify appropriate incentives to further enhance EEC measures.*

One possible incentive can be based on the fact that “oil and natural gas conserved through EEC initiatives can expand export (hence achieve more GDP) at current level of oil and natural gas production” as this fits well with the interest of sustainable development by keeping more reserves of oil and natural gas for longer-term utilization.

Most efficiency programs apply financial incentives (rebates, discounts, financing or other forms of subsidies) for the purchase or installation of specific energy efficiency measure. It is also possible to apply non-financial incentives to encourage energy efficient behaviour. For instance, implementing energy efficiency measures can create a barrier known as the “hassle factor” where consumers do not have the time or expertise to work through all the steps required in the process.

Two non-financial incentives that can help mitigate this problem are the information services and technical services incentives. Information services like brochures and training can help educate consumers on basic EEC information such as how to determine how efficient their homes/businesses are, what their EEC options might be and how to evaluate these EEC options. Technical support and assistance can help customers to reduce the hassles of implementation, thus increasing installation rates⁶. Brunei Darussalam may also consider using social incentives as in the following example.

Example: Social incentives can also be a good motivator for energy behaviour at the consumer level. A US company, Opower, provides consumers with a Home Energy Reports that delivers information about household energy usage, tips that lead to quick energy savings and info-graphics showing the household energy use in comparison with similar households in their neighbourhood.

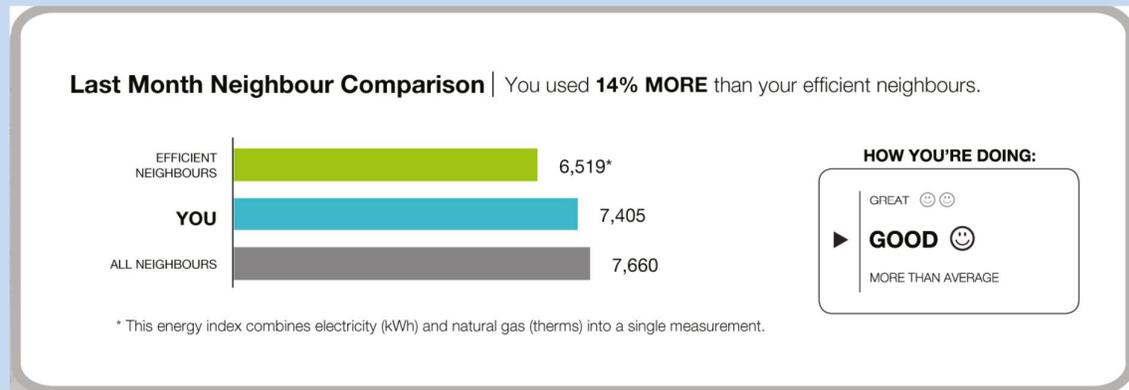


Figure 2-2: Energy Use Comparison in the Opower Monthly Home Energy Report⁷

According to a Business Week Report, one million households received these monthly Home Energy Reports in 2009, and customers in the program have reduced annual energy usage by an average of 2.8%, or the equivalent of 280 kilowatt-hours per year⁸.

⁶ Adapted from US Environmental Protection Agency (2010), *Customer Incentives for Energy Efficiency Through Program Offerings*, http://www.epa.gov/cleanenergy/documents/suca/program_incentives.pdf

⁷ UK Cabinet Office (2011), *Behaviour Change and Energy Use*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48123/2135-behaviour-change-and-energy-use.pdf

⁸ Bloomberg Business Week (2009), *Energy Use: Neighbor vs. Neighbor*, http://www.businessweek.com/innovate/content/nov2009/id2009115_475766.htm

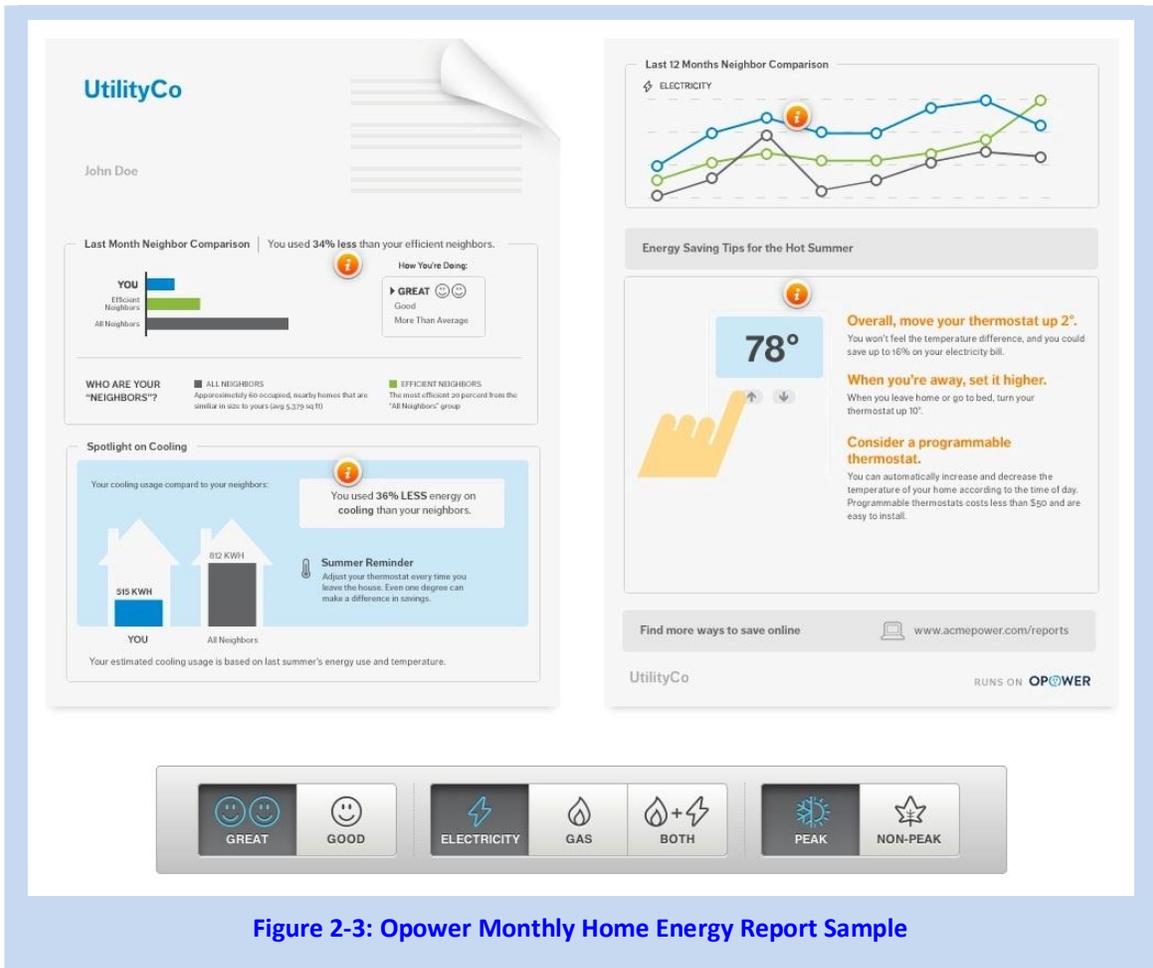


Figure 2-3: Opower Monthly Home Energy Report Sample

Recommendation 6: Establish a national energy efficiency sub-target which measures energy efficiency improvement in the economy and ensures that it has a significant role in achieving the energy intensity target.

Additionally, the PREE Review Team strongly believes that there should be targets developed for each sector that is in line with the national energy efficiency sub-target. Setting individual sectoral targets will allow Brunei Darussalam to focus and tailor policies and programs specific to each sector, determine if the national energy efficiency sub-target is being met, and understand where more aggressive measures are needed.

At the same time, the PREE Review Team noted that this might be a long process due to unavailability of baseline data and collecting data for this purpose may need a few years. During this process, there may be a need for capacity building in data decomposition.

Example: Indonesia, Korea, New Zealand, Peru, the Philippines, Chinese Taipei, Thailand and the United States have specific sectoral goals that are in line with the overall national energy efficiency target⁹.

⁹ APERC (2012), *Summary Table for Compendium of Energy Efficiency Policies of APEC Economies*, http://aperc.iecei.or.jp/file/2012/12/28/Summary_2011.pdf

Recommendation 7: *Apply a clear implementation plan (roadmap) to accelerate appropriate technologies to meet or exceed Brunei Darussalam's EEC targets. This plan should be announced to the public as a national agenda.*

Technological advancement is a key instrument to improving energy efficiency in Brunei Darussalam. The PREE Review Team recommends that Brunei Darussalam establish an appropriate technology roadmap by considering the existing research findings, including inter alia, the energy efficiency reports by the Mitsubishi Research Institute, International Energy Agency (IEA) and APEC. These should be adopted by Brunei Darussalam to encourage rapid uptake of energy efficiency technologies.

3. ENERGY DATA COLLECTION AND MONITORING

3.1 ACHIEVEMENTS AND CHALLENGES

Brunei Darussalam already has a framework in place for collecting, compiling and analysing energy data related to the production and overall consumption of oil, natural gas, petroleum products and electricity. The department responsible for this task is the Strategy, Planning, Economic and Intelligence (SPEI) unit of the Energy Corporate Division under the Energy Department. The Energy Department is under the Prime Minister’s Office. The SPEI unit is also responsible for handling data requests from all government agencies and third parties, some of which are shown in Figure 3-1, and includes many international organizations like the Asia Pacific Economic Cooperation (APEC), United Nations (UN) and the International Energy Agency (IEA) as well as reputable publications like the Oil and Gas Journal.

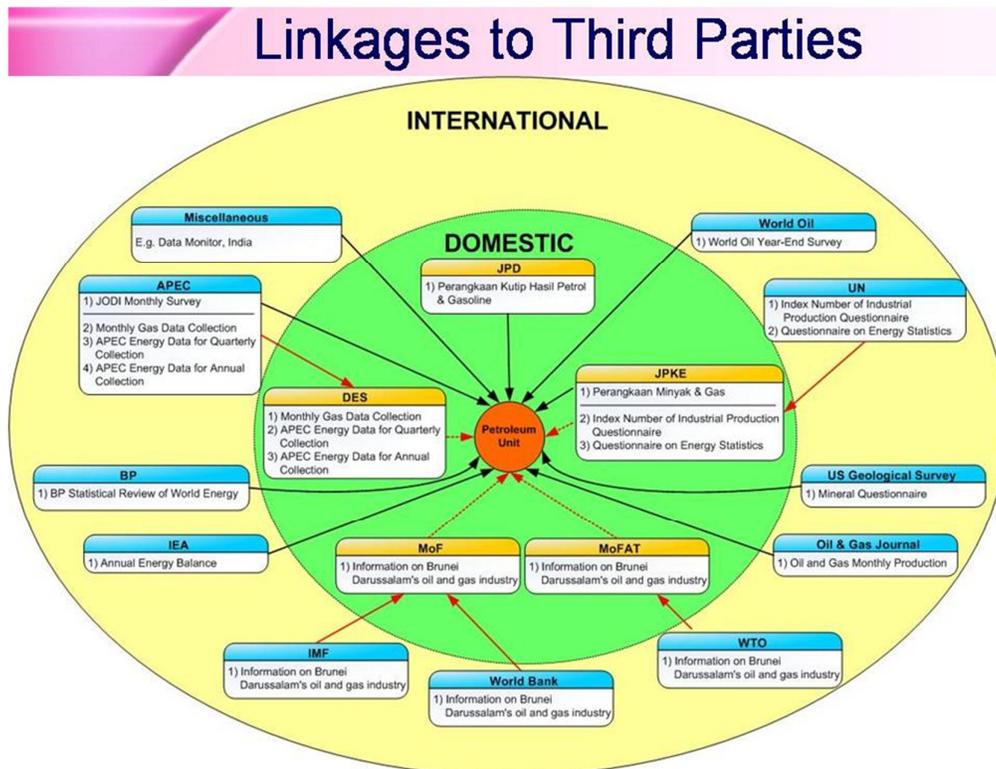


Figure 3-1: SPEI Linkages to Third Parties

Usually, the SPEI Unit collects data on a monthly basis. Oil and gas data are provided by oil and gas operating companies/stakeholders including Brunei National Petroleum Company Private Limited (PetroleumBRUNEI), Brunei Shell Petroleum (BSP), Brunei LNG Sdn. Bhd. (BLNG) and Brunei Shell Marketing (BSM). Electricity data is sourced from the Department of Electricity Services (DES). Data reporting follows the format for the JODI and APEC questionnaires, if the requests differ from these formats, the data will be re-calculated and adjusted accordingly.

It is worthwhile to note that SPEI Unit has excellent cooperation and relationship with the stakeholders providing energy data, thus enabling the unit to easily request and access available data and provide timely reports as required.

Brunei Darussalam’s current energy data collection framework has not been designed to collect data for energy efficiency analysis at sectoral level. In 2010, Brunei Darussalam contracted a consultant to

conduct an Energy Efficiency and Conservation (EEC) Study. Under this study, energy consumption for major sectors were estimated based on statistical data obtained from interviews with 23 organizations, including governmental organizations, and questionnaire surveys with 100 households. This is a commendable achievement as it gave a good indication of the current energy supply and consumption structure in Brunei Darussalam and enabled the formulation of an EEC roadmap that is in line with the Wawasan Brunei 2035. However, this was a one-off study, and more consistent collection and analysis of disaggregated energy end-use data will be required in order to continually measure and improve energy efficiency initiatives in the economy.

3.2 RECOMMENDATIONS

Recommendation 8: *Define a structured energy efficiency data collection framework and ensure regular implementation.*

Data collection is an important component for any EEC initiative as this will provide a good basis for understanding energy use in different sectors of the economy which is essential to help policy makers decide on effective strategies policy instruments to improve energy efficiency.

As part of this proposed framework:

1. A set of quantifiable energy efficiency indicators should first be developed, in line with Brunei Darussalam's energy efficiency targets. Examples of useful energy efficiency indicators are energy intensities by sector and sub-sector (kWh/BND or toe/BND), specific energy consumption by physical units (kWh/appliance, litre/100 km, toe/employee).
2. Data requirements should be defined in accordance with the energy efficiency indicators.
3. Relevant stakeholders/agencies responsible for providing the data should be identified.
4. Based on the identified requirement, a clear and concise data reporting procedure may be developed to standardise and simplify the data collection process.
5. Report submission by stakeholders/agencies must be made a mandatory, periodic exercise with appropriate penalties for non-compliance.

Example: The IEA has conducted a workshop on Energy Efficiency Indicators that covers how to develop and utilize energy efficiency indicators to support energy efficiency initiatives¹⁰. A detailed guideline for Russia was also produced in 2011¹¹.

Information available in both the workshop materials and the report should serve as a useful example for Brunei Darussalam on the how to develop its own set of energy efficiency indicators, the stakeholders that should be involved and the reporting procedures that can be implemented.

¹⁰ International Energy Agency (2012), *Energy Efficiency Indicators Workshop*
<http://www.iea.org/workshop/energyefficiencyindicatorsworkshop-6-70612.html>

¹¹ International Energy Agency (2011), *Development of Energy Efficiency Indicators in Russia*,
http://www.iea.org/publications/freepublications/publication/Russia_En_Eff_Ind.pdf

Recommendation 9: *Introduce a data evaluation, monitoring and verification (EMV) protocol to ensure energy efficiency data is credible and accurate.*

A well-designed EMV protocol will help Brunei Darussalam to:

- Accurately measure energy savings achieved and evaluate effectiveness of policy instruments; this enables policy makers to adjust policy instruments to become efficient and effective.
- Ensure the credibility of reports on outcomes for energy efficiency investments, thus increasing investor confidence in energy efficiency projects which in turn will enhance the chances of more energy efficient projects of being financed.
- Highlight public co-benefits of energy efficiency initiatives, including improved community health, reduced environmental degradation and increased employment.

Therefore, Brunei Darussalam should strongly consider introducing a data EMV protocol in conjunction with the energy efficiency data collection framework.

Example: Guidelines from Ecofys Netherlands¹² and Efficiency Valuation Organization (EVO)¹³ may be useful starting points for Brunei Darussalam.

Recommendation 10: *Publish energy efficiency indicators monitoring reports periodically to evaluate progress and encourage continuing efforts in energy efficiency improvements.*

Periodic dissemination of monitoring reports will enable stakeholders to consistently evaluate the progress and success of EEC improvements, thus elevating the level of confidence and commitment and garnering support for further energy efficiency initiatives, particularly for initiatives that require funding. Dissemination may be done either monthly or quarterly through printed publications or online. Sharing the reports with the general public is strongly recommended to encourage widespread public participation in EEC initiatives.

Example: Several APEC Economies are already publishing their energy use statistics online, including New Zealand¹⁴ and Thailand¹⁵. Another excellent example is Brunei Darussalam's own Public Works Department's Green Building Initiatives Website¹⁶. The website allows users to analyse monthly data on energy consumption at selected government buildings before and after the adaptation of Green Building Initiatives.

¹² Ecofys (2006), *Guidelines for the Monitoring, Evaluation and Design of Energy Efficiency Policies*, <http://www.aid-ee.org/documents/000Guidelinesforthemonitoringevaluationanddesign.PDF>

¹³ Efficiency Valuation Organization (2013), *International Performance Measurement and Verification Protocol (IPMVP)*, http://www.evo-world.org/index.php?option=com_content&view=article&id=272&Itemid=397&lang=en

¹⁴ New Zealand Energy Efficiency Conservation Agency, *Energy End-Use Database*, <http://enduse.eeca.govt.nz/default.aspx>

¹⁵ Thailand Energy Policy and Planning Office, *Energy Statistics*, <http://www.eppo.go.th/info/>

¹⁶ Brunei Darussalam Public Works Department, *Green Building Initiatives Website*, <http://www.pwd.gov.bn/dme/Default.aspx?ObjectId=AS-C02>

Recommendation 11: *Establish a Brunei Energy Data Management Centre (BEDMC) that reports directly to the Minister of Energy.*

The introduction of this centre is based on the need to ensure a strong focus on data collection and analysis in order to monitor progress towards EEC improvement goals. The introduction of a single organisation or authority will help to streamline and simplify data collection and EMV efforts.

Examples of Energy Data Management Centres in other APEC economies:

- In the United States, the US Energy Information Administration (EIA) is the statistical and analytical agency within the US Department of Energy that collects, analyses and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment.
- In Indonesia, the Centre for Data and Information (PUSDATIN) under the Secretary General of the Ministry for Energy and Mineral Resources is responsible for Indonesia's centralised and coordinated energy data and information collation, storage and dissemination.

Brunei Darussalam may establish this proposed BEDMC either:

1. As an entity under the Brunei National Research Institute (BNERI) that reports directly to the Minister for Energy.
2. As a new department directly under the Ministry of Energy. Enhancing the functions of the SPEI Unit would be a practical step if Brunei Darussalam decides to pursue this option. Under the current organizational framework, the SPEI unit resides under Permanent Secretary (Upstream) (please refer to Figure 3-2). To create independence, the new BEDMC should be relocated to a new position directly under the Minister of Energy.

The PREE Review Team strongly suggests that the proposed BEDMC should have the following characteristics:

- The BEDMC should be all-inclusive but with separate units that compiles data on hydrocarbons, electricity sector, oil and gas downstream sector and energy use for different demand sub-sectors.
- Capacity building workshops should be held to train both the officers in this centre and agencies providing data to ensure high quality data.
- Data reporting must be a periodic, mandatory exercise.

Organisation Structure of Energy Department, Prime Minister's Office

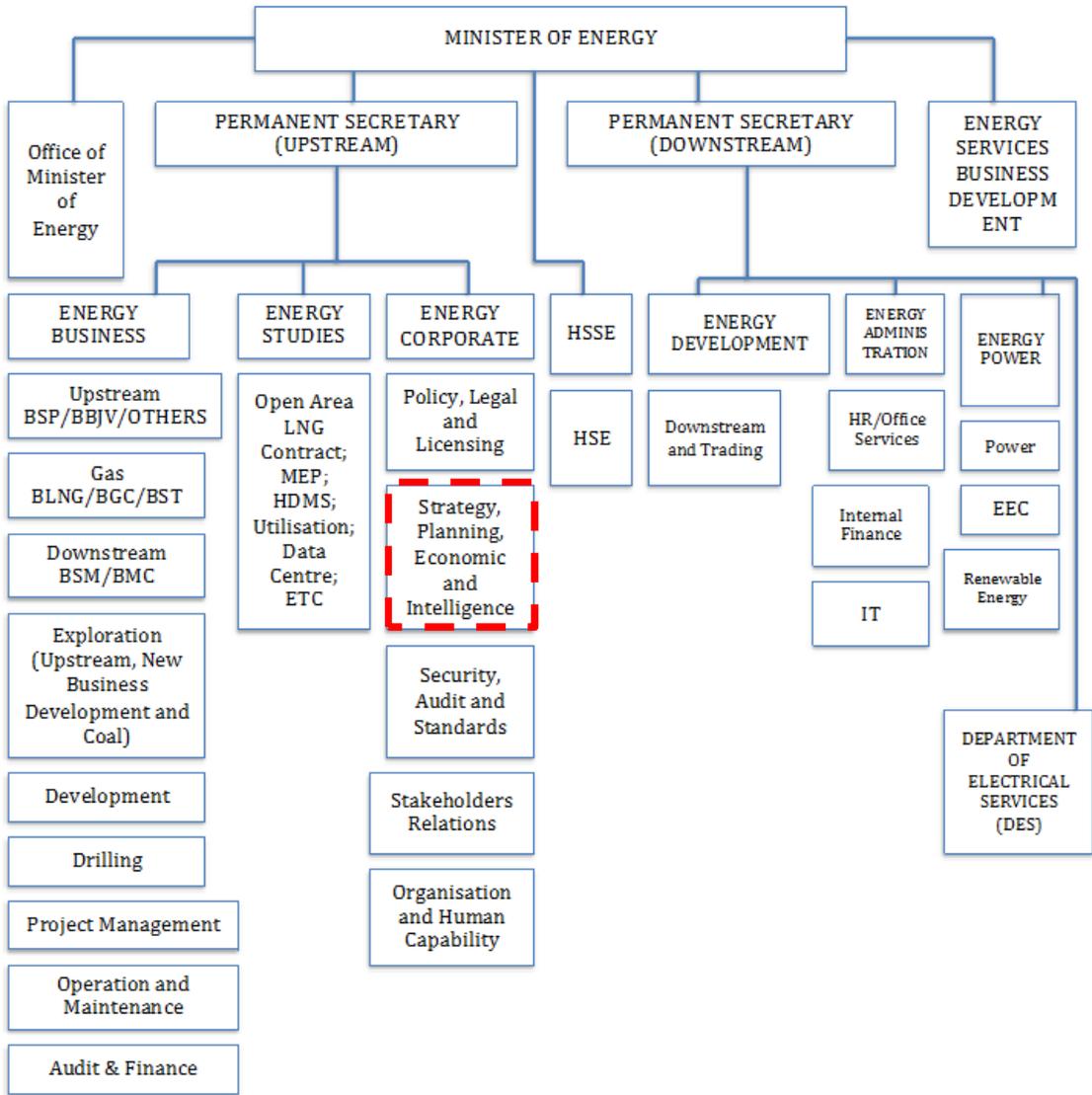


Figure 3-2: The Current EDPMO Organizational Chart

4. POLICY MEASURES – RESIDENTIAL, COMMERCIAL, GOVERNMENT AND INDUSTRIAL SECTORS

4.1 OVERALL DEMAND SECTOR INITIATIVES

4.1.1 Achievements and Challenges

A number of energy efficiency improvement measures for residential, commercial, government and industrial sectors have been formulated by Energy Department, Prime Minister's Office (EDPMO) in conjunction with other stakeholders, including other government agencies, industries and individuals. These include applying smart (pre-paid) meter and new tariffs and using high-energy efficiency technologies in buildings. Technologies like energy efficient air-conditioners, chillers, lighting equipment (i.e., compact fluorescent lamps, LEDs) and lighting system controls, automatic control equipment occupancy sensor and photo sensor unit at the offices to control brightness, penetration of solar water heaters and "Smart" power meters at the main switchboard to continuously monitor consumption are used by leading green energy organizations.

In addition, several energy efficiency and conservation (EEC) related studies and activities have also been conducted in the economy as follows:

- A study on energy efficiency financing models has been commissioned by EDPMO and undertaken by Sustainable Development Capital Limited. From the PREE expert team observations, the proposed models relies more on external financing rather than internal financing.
- A feasibility study on a standards and labelling scheme was commissioned by EDPMO and undertaken by the Mitsubishi Research Institute (MRI). The final report, titled *Brunei Energy Efficiency and Conservation Study: Roadmap Formulation and Policy Advice*, was published at the end of 2011. This study also included the results from a survey of energy end-users to clarify how much energy is consumed by each major sector, and in what way. The major sectors covered are the power sector, transport sector, industrial sector, residential sector and commercial sector¹⁷.
- EDPMO in collaboration with Brunei National Energy Research Institute (BNERI) is currently in the process of developing a National Standards and Labelling Regulation and associated implementation documents.
- An online website has been developed by the Public Works Department that publishes the energy consumption and performance of several government buildings monthly since 2011¹⁸.
- Energy Club for Schools has been established since 2009. The objective is to generate awareness of energy conservation at the grassroots level, and engage students to be ambassadors for energy saving awareness. By the end of May 2013, 30 Energy Clubs would have been established.
- Review and restructure of the electricity tariff in the residential sector have been made and the new electricity tariff structure has been in effect since 1 January 2012. The new tariff structure shifted from regressive to progressive rate.
- The Public Service Institute regularly organises 'Energy Savings Seminars' for government officials to disseminate energy savings culture in offices. This year, the 'Energy Saving Seminars'

¹⁷ The Mitsubishi Research Institute (MRI) report is quoted extensively throughout this chapter.

¹⁸ Brunei Darussalam Public Works Department, *Green Building Initiatives Website*, <http://www.pwd.gov.bn/dme/Default.aspx?ObjectId=AS-C02>

will be extended to schools and rural communities to further promote the awareness on EEC to the general public.

- 24th May has been designated as ‘Energy Day’ for Brunei Darussalam since 2007 to foster the culture of energy saving and efficiency. Each year, various events are organised in conjunction with this day, including mass prayers, presentation of EEC awards, distribution of car stickers bearing tips on saving energy, energy forums and expos as well as energy camps and competitions for school children.
- In 2010, EDPMO introduced the Energy Efficiency and Conservation Initiatives Awards with categories for the education sector, government sector, commercial sector and industry sector.

Based on Brunei Darussalam’s national energy balance from 2008 to 2012, electricity accounts for about 56-60% of the final energy consumption for residential, commercial, government and industrial sector. At present, Brunei Darussalam does not monitor or collect electricity consumption statistics from each economic sector or sub-sectors, instead energy consumption data is aggregated as either under Industry Sector or Other Sector (As in Table 4-1). On the other hand, according to the MRI’s Report, for 2009, electricity accounted for 82% and 92% of energy consumption in residential and commercial sectors respectively (p. 78), and 27% of industrial sector energy consumption (p. 63). For both residential and commercial sectors, air-conditioners accounted for the bulk of electricity use.

Table 4-1: Annual electricity consumption by sector in Brunei Darussalam¹⁹

Year	Industry Sector (GWh)	Other Sector (GWh)
2003	602	2134
2004	584	2494
2005	546	2419
2006	541	2338
2007	556	2493
2008	546	2599
2009	562	2681
2010	593	2734
2011	551	2838
2012	613	3112

While statistical information on household electricity consumption is not yet available at present, the number can be derived based on the MRI report findings and available Brunei Darussalam statistic reports. From Table 4-1, total electricity consumed in 2011 was 3,389 GWh. Based on the MRI report; it can be assumed that 48% of this total was consumption by the residential sector, which is 1,627 GWh. From the Brunei Darussalam *Population and Housing Consensus 2011*, there were a total of 68,208 households in the economy that same year. Therefore, the average household electricity consumption can be estimated at 23,849kWh/year or 1,987kWh/month, which is considerably high; almost triple that of Singapore²⁰. It is likely that the low electricity tariffs works as a disincentive in this economy. Most households are probably not aware of how to rationally and efficiently use electricity as there are currently no financial incentives to do so.

¹⁹ Statistics from EDPMO’s *PREE Background Report for Brunei Darussalam*

²⁰ The Energy Market Authority’s *Singapore Energy Statistics 2012* reported that in 2011, the average monthly household electricity sales for private housing was 784 kWh/month. This is more than double of the public housing monthly average of 369 kWh/month.

In fact, referring to the next table on the ASEAN Electricity Tariffs, Brunei Darussalam’s electricity price is ranked as the lowest among ASEAN economies at BND 0.06/kWh; half of the next lowest economies (Lao PDR, Thailand and the Philippines) and almost one-tenth of the highest ranked economy, Myanmar.

Table 4-2: Average ASEAN Electricity Tariff²¹

	Countries	Brunei Cents/kWh
1	Myanmar	50
2	Singapore	27
3	Cambodia	23
4	Indonesia	19
5	Malaysia	18
6	Vietnam	13
7	Lao PDR	12
8	Thailand	12
9	Philippine	12
10	Brunei Darussalam	6

Therefore, while the PREE expert team applauds Brunei Darussalam’s efforts to implement new tariffs that are progressive and still protects the welfare of low-income households, it is still important to acknowledge that the low electricity prices may encourage wasteful energy use.

From the presentation on New Electricity Tariffs during the PREE expert team visit, the majority of consumers (79%) are unaffected by the tariff change. It is possible that the 12.4% reduction in 2011 electricity consumption achievement may not be due to the tariff reform, but rather mainly the application of pre-paid meters.

kWh	Old Tariff	New Tariff
600	\$36.00	\$6.00
1500	\$90.00	\$78.00
1600	\$96.00	\$86.00
2000	\$120.00	\$118.00
2050	\$123.00	\$123.00
3000	\$180.00	\$218.00
4000	\$240.00	\$318.00
4800	\$288.00	\$414.00

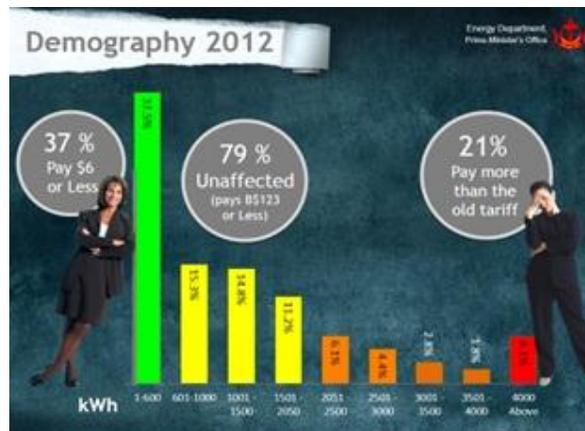


Figure 4-1: Impact of New Electricity Tariff

Given the high average household electricity consumption, especially when compared to other economies of similar size and, climate conditions, there are many opportunities for applying energy efficiency measures for the residential and commercial sectors.

Based on the MRI report, under Business-as-usual (BAU) scenario, energy consumption in 2035 has been projected to increase by 1,389 kTOE, or 89% from the baseline year 2009. But under EEC

²¹ Adapted by EDPMO from *Electrical Tariff in ASEAN Member Economies*, <http://talkenergy.files.wordpress.com/2011/02/asean-electricity-tariff-2011.pdf>

scenario, the energy consumption in 2035 would be reduced by 474 kTOE, or 30% from the year 2009, resulting in an energy saving potential of 1,863 kTOE, or 63% reduction from the BAU scenario in 2035. The leading energy saving potentials would be in the commercial and residential sectors, 41% and 36%, followed by transportation and industrial sectors, 13% and 10% from the BAU scenario respectively.

If these EEC improvements can be achieved in all of the major consuming sectors, then the fossil fuel supply for inland energy use can be significantly reduced. This will allow for more oil and gas exports which would translate to increased revenue for Brunei Darussalam, estimated to be around BND 523 million in 2035; after taking into account the investments required for achieving and maintaining the EEC measures.

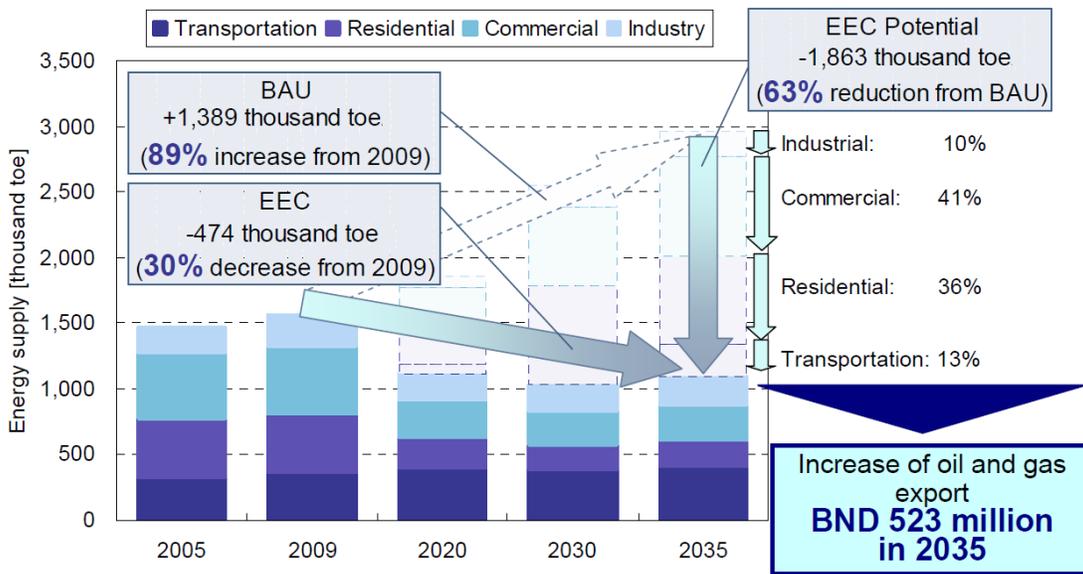


Figure 4-2: Overall EEC Potential and Benefit for Brunei Darussalam

From Figure 4-2, it is evident that the residential and commercial sectors have by far the largest EEC potential, and as electricity is the main fuel in these sectors, most of the potential will be from electricity savings. More detailed analysis of energy saving potential by each sector is as illustrated in the figures below.

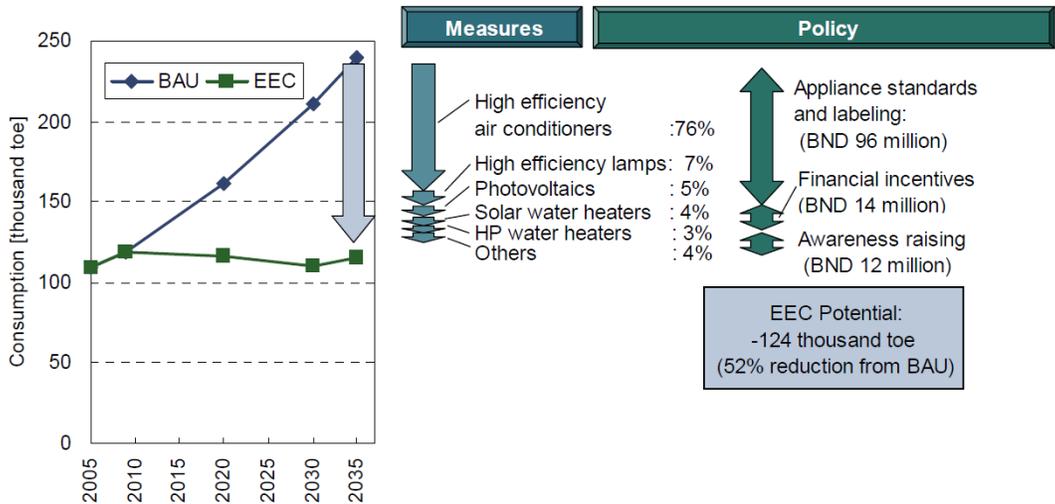


Figure 4-3: EEC Measures for Reducing Energy Consumption in Residential Sector in Brunei Darussalam

It was estimated that for the residential sector, there would be up to 52% overall reduction in energy consumption from BAU scenario in 2035. Most of this savings is contributed to the diffusion of more efficient appliances and equipment, particularly air-conditioners (76%) and lamps (7%), under the upcoming National Standards and Labelling Regulations.

For the commercial sector, up to 44% overall reduction in energy consumption from BAU scenario in 2035 is expected. As space cooling is a major use of energy for this sector, the bulk of savings is expected to come from the increased penetration of high efficiency air-conditioners and chillers.

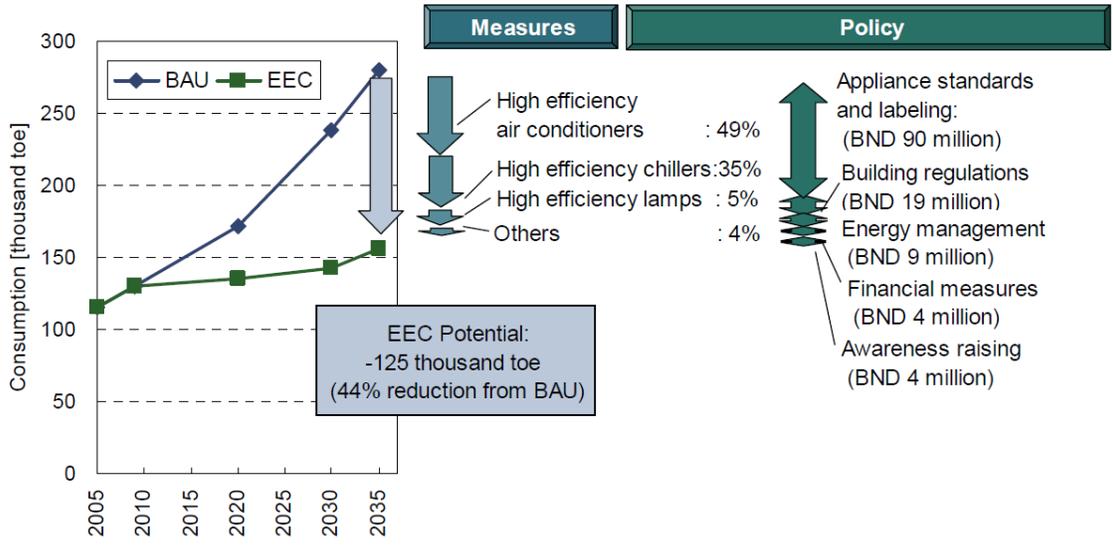


Figure 4-4: EEC Measures for Reducing Energy Consumption in Commercial Sector

The PREE Review team foresees that realizing these EEC potentials will be a major challenge for Brunei Darussalam, given the comparatively low electricity prices, the lack of historical base for

promoting energy efficiency, and the lack of awareness among consumers as to the benefits of being energy efficient or what steps the consumer can take to become more energy efficient.

4.1.2 Recommendations

Recommendation 12: *Brunei Darussalam should conduct a detailed market research to identify which EEC messages would appeal the most to different consumer groups.*

It is clear that with its comparatively low electricity prices, market mechanism is not a good driver for energy efficiency initiatives in Brunei Darussalam. Instead new and innovative methods should be designed to better impart the EEC message to all segments of the population. This is where market research comes in, this exercise will help Brunei Darussalam to identify the values and motivators of each population segment, and how to successfully market EEC initiatives and instil EEC behaviour.

Examples of EEC Market Research Reports:

- A report by the California Institute of Energy and Environment (CIEE)²² evaluates how market segmentation can be applied to utility demand-side management programs to achieve energy reducing goals. In this report, residential consumers are segmented demographically (e.g. age, family size, income level, education level, etc.), and geographically. Businesses are segmented by similar end-use technologies, ownership patterns, economic characteristics and other associated behaviours. Energy efficiency programs and strategies are then crafted to address segment-specific problems. For example, hotels are segmented under the hospitality sector, and a useful program that addresses specific need is to provide direct installation of sensors that regulate air-conditioning in vacant rooms. Further examples on identifying and strategizing for different market segments are provided in the report.
- The World Energy Council's publication *Innovative Communication Campaign Packages in Energy Efficiency*²³ highly recommends that EEC campaigns be based on market segmentation which allows better focus, use of tailored instruments and more efficient use of resources. The publication details several case studies on targeted EEC campaigns worldwide. For instance, Cuba's Energy Revolution and Chile's Good Energy Initiatives campaigns specifically addressed schoolchildren. Identifying target groups also enables campaigners to choose the best communication channels for reaching its target groups, while television and radio are still the most common medium, new social media like Facebook, Twitter and YouTube are also becoming more popular.

Recommendation 13: *School Energy Clubs should be enhanced by developing an energy efficiency curriculum to reach all students in all levels of education.*

In addition, posters, pamphlet, stickers of guidance for rational and efficient use of electricity at home, school, office, and commercial buildings should be published and distributed to the public as an EEC campaign, along with advertisement via TV and newspaper.

As before, market research will enhance understanding of Brunei Darussalam's market segments, enabling more effective planning of EEC campaign materials, communication channels and messages.

²² California Institute of Energy and Environment (2008), *Market Segmentation and Energy Efficiency Program Design*, http://www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/pdfs/market_seg.pdf

²³ World Energy Council (2010), *Innovative Communication Campaign Packages on Energy Efficiency*, http://www.worldenergy.org/documents/ee_case_study_communication.pdf

Therefore, such market research should be conducted regularly. Monitoring and evaluation of such a program should be conducted to get a feedback participation assessment.

Example: As Islam is the official religion in Brunei Darussalam, one way to reach the Muslim segment of the population is to collaborate with religious authorities to help spread the EEC message. The *Muslim Green Guide to Reducing Climate Change*²⁴ booklet is a good example of Islamic-related energy saving guidelines.

Recommendation 14: *An energy conservation and promotion fund (ECPF) should be established to be used for funding the EEC promotion program such as partial subsidies for EEC project investment, rebate, labelling, capacity building and demonstration programs, research and development grants, etc.*

The purpose of the ECPF is to fund energy conservation and energy efficiency activities initiated by the government. ECPF might be collected from any sources where appropriate and it is important to investigate the most practical and suitable way to provide for this ECPF fund. Possible methods include direct funding by the Ministry of Finance, levies from oil and gas export revenues and levies from energy users. The pros and cons of these funding methods must be explored fully to ensure sustainability of the fund.

Example: Thailand and Malaysia both apply a small levy on their energy prices to fund energy efficiency and renewable energy projects. In the case of Malaysia, a 1% levy is applied to consumers whose electricity usage exceeds 300kWh/month for the Renewable Energy Fund²⁵. In the case of Thailand, this levy comes from the sale of specified fuels like gasoline, diesel, fuel oil, and kerosene²⁶. This method is both sustainable and has the co-benefit of raising awareness and encouraging rational use of energy.

ECPF should be legally established under the jurisdiction of a committee that can legally protect the fund from being used for other purposes than EEC activities. The ECPF covers a much bigger scope compared to the BEEF revolving fund discussed in earlier section. BEEF can be partially funded from the ECPF, and be administered by local financial institutions under the supervision of the government. The purpose of BEEF would be to specifically finance EEC development projects proposed by the private sector.

Example: In Thailand, two types of fund are available, the EE Revolving Fund and ESCO Fund. Both are initially allocated from the ECPF.

- The EEC Revolving Fund provides a line of credit to local financial institutes or banks to provide low interest rates to developers of EEC and some types of renewable energy projects. The participating banks manages the loans, thereby minimizing government involvement in the financing process, but reports to the government authority²⁷ on project progress, thus ensuring real energy savings. This program has successfully helped to build local banks' understanding

²⁴ Islamic Foundation for Ecology and Environmental Sciences (2008), *Muslim Green Guide to Reducing Climate Change*, <http://fathi.co.uk/booklet.pdf>

²⁵ Sustainable Energy Development Authority Malaysia (2011), *1% levy for electricity users from next month*, <http://www.seda.gov.my>

²⁶ Center for Clean Air Policy (CCAP), *Revolving and Esco Funds for Renewable Energy and Energy Efficiency Finance: Thailand*, http://ccap.org/assets/CCAP-Booklet_Thailand.pdf

²⁷ In this case, the Thailand Ministry of Energy's Department of Alternative Energy Development and Efficiency (DEDE).

and capacity to finance EEC projects on their own, therefore enabling Thailand to begin phasing out the EEC Revolving Fund since 2011²⁸.

- The ESCO Fund was established as a source of revenue capital for energy services companies to jointly invest with private investors through various channels; namely equity investment, ESCO venture capital, equipment leasing, carbon credit trading, technical assistance and credit guarantee facilities²⁹. The fund is managed by government appointed, non-profit foundations. Projects are monitored during development, construction and operation

Recommendation 15: *An Energy Conservation Centre Brunei (ECCB) should be legally established.*

ECCB should take the lead role in implementing national EEC programs and should build its internal capacity to be able to effectively promote and incentivize EEC initiatives, standards and labelling, local capacity building and demonstration programs, etc.

Examples of Energy Conservation Centres in APEC Economies:

- The Energy Conservation Center, Japan (ECCJ) was established under the Japanese Energy Conservation Act, with a mandate to promote energy conservation through economic sectors in Japan, including control of energy management in commercial and industrial sectors to be compliance with the law. ECCJ has received a strong support from private sector, particularly industries since their inception, and partial support from the government in term of project basis.
- The Energy Conservation Center of Thailand (ECCT), on the other hand, was established as a joint government and private sector project under the cabinet approval. ECCT's mandate is to promote energy efficiency and conservation programs and provide energy efficiency advisory services to both government and private sectors. ECCT received an initial financial support from the government for their first five years of operation with a commitment to be self-reliant after that period, by generating their own income from providing energy solutions services. The government still provides partial support to ECCT, on project basis.

4.2 ENERGY MANAGEMENT SYSTEM INITIATIVE

4.2.1 Achievements and challenges

Brunei Darussalam is considering adopting an energy management system that is compatible with the ISO 50001. This system is to be implemented in commercial, government and industrial sectors. Building owners will be encouraged to introduce management systems that include equipment to monitor energy consumption such as the Building Automation Systems (BAS), Controllers (i.e. demand controllers) and Building Energy Management Systems (BEMS). The MRI report has also recommended the adoption of an energy manager scheme to monitor energy consumption and develop EEC plans and activities.

EDPMO, in collaboration with a consultant firm, is currently developing an Energy Efficiency and Conservation Program for government and commercial buildings. At the same time, EDPMO is also preparing a paper for the establishment of the Energy Manager for all buildings belonging to government ministries in Brunei Darussalam in line with the MRI recommendations. All Energy

²⁸ Same as CCAP.

²⁹ APERC (2010), *Peer Review on Energy Efficiency in Thailand*, http://aperc.ieei.or.jp/file/2010/9/26/PREE20100414_Thailand.pdf

Managers will be required to undergo training and courses for certification to be an accredited Energy Managers from the ASEAN Energy Manager Accreditation Scheme (AEMAS).

The PREE expert team found that energy savings is not usually designated as a critical part of productivity in Brunei Darussalam. Furthermore, there are no incentives for managers or operators to improve energy efficiency; even if applied energy savings help to lower operating cost for the business or facility, this usually does not translate to any additional benefit for the managers or operators.

The PREE expert team also believes that the ISO 50001 may be too complex for full-scale adoption by Brunei Darussalam. One concern is that there may not be sufficient numbers of technical persons in each organization to meet the requirements of implementing the energy management system.

4.2.2 Recommendations

Recommendation 16: *To demonstrate the effectiveness of energy management systems, a number of government, commercial and industrial facilities should be selected to participate in an energy management pilot program in line with ISO 50001 criteria. This can be further supplemented with detailed guidelines for establishing and implementing energy management systems, which could be distributed to the target organizations.*

Recommendation 17: *Brunei Darussalam should develop an energy management law adopting appropriate parts of the ISO 50001: 2011 Energy Management System, particular emphasis should be given to energy management system training.*

Example: In Thailand, the Energy Minister issued a Ministerial Regulation governing Energy Management in designated buildings and factories under the Energy Conservation and Promotion Act. The Ministerial Regulation defines standards, criteria, and methodology for energy management system (compatible with ISO 50001) to be implemented by designated facilities. Designated factory and buildings may adopt the full ISO 50001 voluntarily as one of their operation standards, mostly with the view towards enhancing their business competitiveness.

Recommendation 18: *In support of the energy management law, a sufficient number of qualified external auditors should be trained to conduct monitoring and verification exercises to ensure compliance.*

Intensive training programs with expert facilitators should be provided to accelerate this capacity building process.

Recommendation 19: *Appropriate incentives should be designed to motivate facility managers and operators, particularly those in government-owned facilities, to apply EEC improvements that minimize operation costs.*

Acknowledging EEC success can take many forms ranging from formal written commendations and certificates, plaques presented at award ceremonies, bonuses and salary increases³⁰.

³⁰ US Environmental Protection Agency, *Teaming up to Save Energy*, http://www.energystar.gov/ia/business/guidelines/continuous_improvement/Teaming_Up_To_Save_Energy.pdf

4.3 EEC BUILDING CODE INITIATIVES

4.3.1 Achievements and Challenges

The first building guideline and standards in Brunei Darussalam, the Piawai Brunei Darussalam 12 or PBD 12 – Building Guidelines and Requirements, was issued in 1994, and contains only building guidelines and standards for development purposes (earthwork and building construction). This was later revised in 2008 to take into account additional requirements from the Ministry of Health and the Brunei Fire and Rescue Department, but does not include energy efficiency requirements.

EDPMO in collaboration with the Ministry of Development (MOD) via the Authority for Building Control and Construction Industry (ABCi) and the Department of Mechanical and Electrical (DME) are in the process of developing the EEC Building Code with the objective to establish an EEC standards and a regulatory mechanism for buildings in Brunei Darussalam. Currently, the joint working committee with officials from EDPMO and MOD are working with a consultant service to identify the best options formulating the EEC Building Code framework and contents.

Based on the discussions during the visit, the PREE expert team has recognized several barriers that may hinder this EEC Building Code formulation process:

- Insufficient indigenous human resources to develop and implement the EEC Building Codes.
- The EEC Building Code should include guidelines on maximizing EEC potential through passive solar design and building orientation. However, according to EDPMO and MOD, the tools and data to determine solar and wind profiles, solar heat gain and building orientation are currently unavailable in Brunei Darussalam.
- Jurisdiction among the government agencies responsible has not been clearly defined.
- Compliance and enforcement issues have not been adequately addressed yet.

In addition to collaborating with EDPMO on the EEC Building Code formulation, the Public Works Department (PWD) under MOD has also begun its own EEC initiatives. This includes awareness raising programs within the ministry and department buildings such as the temperature setting (at 22-23°C), No-Lift Sundays and Rainwater Harvesting Pilot Project.

PWD is also conducting the Green Buildings Initiatives program for government buildings. Under this initiative, energy audits are conducted to detect excessive consumption or wastage, and potential EEC measures are identified. The effectiveness of these measures is monitored periodically and the actual energy consumption for each building audited is published online each month on the PWD website. Since 2011, nine buildings have been audited, and each building has shown reductions in energy consumption following the implementation of EEC measures.

According to Dr Rohaniyati Salleh's presentation during the PREE meetings, MOD has developed a Green Building Roadmap that will eventually lead to a National Green Building Certification Scheme for Brunei Darussalam. This roadmap adopts Singapore Building and Construction Authority's (BCA) Green Mark Scheme and will be applied for new and existing buildings. The implementation is still in early stages; and the PWD is currently reviewing current maintenance practices and collecting data for the benchmarking of existing buildings.

4.3.2 Recommendations

Recommendation 20: *The proposed EEC Building Code should include a strong foundation for EEC elements (along with existing fire, safety, construction and health) and be a unified document that clearly defines the jurisdiction of all agencies.*

Mandate of each agency involved could be defined in the main body of the code, but details of their specific requirements may be elaborated in separate documents that can be updated at different times, such as standards, guidelines, directives or annexes.

Example: The New Zealand Building Code sets out performance standards that must be met by all new buildings, and covers aspects such as structural stability, fire safety, access, moisture control, durability, services and facilities. Building consent is issued only if the building plans and specifications comply with the Building Code. However, detailed information on building materials, design or construction are not provided in the Building Code, instead, this information is provided in the Compliance Documents, which is under the purview of the Ministry of Business, Innovation and Employment³¹.

EDPMO should be given the responsibility of reviewing and implementing the EEC elements of the Building Code every three years.

Recommendation 21: *EEC Building Code should include passive or partial-passive cooling and lighting design, and construction using low thermal mass and insulated materials for new residential, government and commercial buildings. In doing so, cooperation with a research centre, such as the Energy Research Group of Universiti Brunei Darussalam (UBD), is highly recommended.*

UBD is already working on EEC research projects for local content. One of the projects is on developing a database for local conditions (climate, building size and occupancy, building materials) for a standard energy efficiency/renewable energy building simulation software which will later enable users to model the building energy use under local Brunei Darussalam conditions. Collaborating with UBD researchers will be beneficial for both EDPMO and UBD.

To further support the implementation of EEC elements in the code, EDPMO may also consider:

- Conducting demonstrations for housing developers on integrating and constructing EEC design elements like passive cooling and lighting.
- Setting up a building material testing laboratory, preferably at UBD to build local expertise in this field.
- Offering financial and tax incentives for both housing developers and consumers.

Recommendation 22: *EDPMO should develop a compliance enforcement program to be effective once the EEC Building Code comes into force.*

The compliance enforcement program should include:

1. The design of the proposed building should meet the mandatory code requirements before receiving a building permit. Also, designated officials have to be given access during and after construction in order to verify compliance with the code.
2. Efficient methods for verifying compliance such as through site surveys, audits, submission of building plans and software tools³².

³¹ New Zealand Ministry of Business, Innovation and Employment, *About the Building Code*, <http://www.dbh.govt.nz/bcr-about-the-building-code>

³² The US Department of Energy lists several software and web tools that can clarify compliance with energy codes and standards that simplify the process of verification. The list is available at <http://www.energycodes.gov/compliance>

3. Penalties for non-compliance; for instance civil fines and fees for minor infractions, revoking/suspension of license/certification or criminal prosecutions for major non-compliance.

Example: The European Union has innovative examples of strategies for code enforcement including professional architect certification that can be revoked if a building is found to be out of compliance with the code. Denmark uses a two-stage compliance process – first providing permission to build based on code compliance of the building design and second, providing permission for occupancy based on the construction meeting the design requirements. Sweden requires a follow-up report two years AFTER construction to verify the predicted performance of each building.

Recommendation 23: *Build local capacity for addressing the EEC elements of the Building Code.*

Capacity building should be provided for all stakeholders at all stages of building construction; ranging from regulators (ministry officers responsible for building and maintaining the EEC Building Code), housing developers (including architects, engineers, contractors, project managers, etc.), compliance inspectors (local officers with the authority to issue building and occupancy permits) and building owners themselves. This can be done through training seminars, workshops, demonstrations and pilot projects.

4.4 INDUSTRIAL SECTOR INITIATIVES

4.4.1 Achievements and Challenges

In Brunei Darussalam's oil and gas industry, carbon dioxide emission mostly comes from the combustion of fossil fuel from auto-producer power plant facilities. Various initiatives have been undertaken by the local operators to improve their operation efficiencies and reduce greenhouse gas emission. There has been a steady decrease of greenhouse gas emissions over time especially from 1998 onwards. The main contribution to the reduction of greenhouse gas emissions has primarily been the reduction in venting and flaring emissions through rationalization projects and improvements in operational efficiencies in producing oil and gas fields. With significant reductions having been achieved in venting and flaring emissions, fuel gas (for gas compression and power generation) becomes the main contributor to greenhouse gas emissions in the order of about 50%. Efforts are now focused on energy efficiency of compression and auto-producer power plant facilities. The opportunities identified include upgrading or replacement of aged and inefficient equipment (e.g. compressors and control systems) in improving operational reliability and efficiency.

Based on Brunei Darussalam's background report, fuel gas in industrial plants is not used optimally. Typically, there is a tremendous heat loss with temperature over 500 ° C in gas production process, particularly in the gas compression system, which could be converted to mechanical power for electricity generation, or for additional gas compression, or as a heat source for heating and cooling processes.

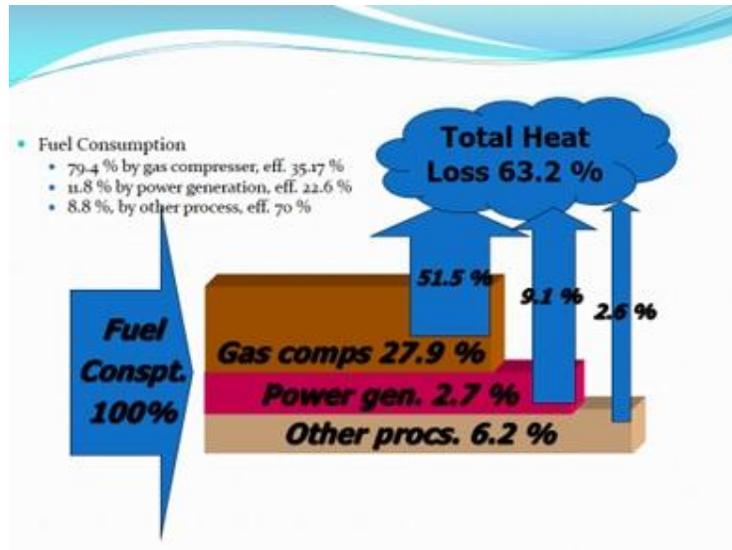


Figure 4-5: Typical energy utilization at an offshore gas production plant

If waste heat is utilized for power generation, then this would reduce the amount of gas burned for electricity production. In the case of offshore gas producers, waste heat can be utilized to generate steam and drive an additional steam gas compressor to produce more volumes of gas. The latter method may be the more attractive measure since both energy efficiency and productivity improves.

Example: A pre-feasibility study in an offshore gas production platform in the gulf of Thailand revealed that the waste heat from operating the existing gas compressors, 22 MW x 3 units, could be converted into 18 MW of mechanical power.

From this 18 MW of power, 6 MW is used in steam turbine generators to generate electricity, which is sufficient to meet the electricity demand of the whole plant. The rest, 12 MW, is utilized in a new steam gas compressor to produce additional gas volume for raising revenue.

Alternatively, the 18 MW mechanical power may be used solely to drive a new 18 MW steam gas compressor to generate more gas.

Brunei Darussalam estimates that it is possible for the industrial sector to achieve 23% reduction in energy from Business-As-Usual (BAU) case in 2035 by improving equipment efficiency and operational processes, implementing waste heat recovery, switching energy sources, and introducing energy management system. To support the implementation of these measures, it is likely that an investment of BND 37 million will be required.

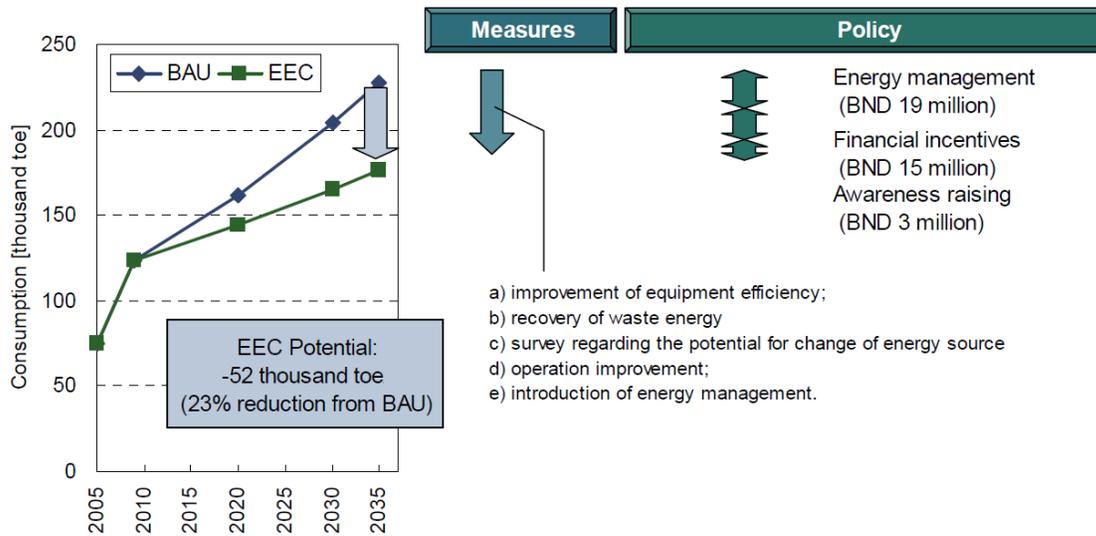


Figure 4-6: EEC Measures for Reducing Energy Consumption in Industrial Sector

4.4.2 Recommendations

Recommendation 24: *Energy efficiency improvement in the oil and gas industry should be focused on heat recovery, and this should be also applied for any new oil and gas plant designs.*

Feasibility study on whether it is converted into electricity or steam for powering steam gas compressor or used as a heat source for heating and cooling processes, should be conducted, taking into account technical barriers such as space availability, loading capacity, installation, extension or building a new platform etc., (in case of offshore gas production).

Recommendation 25: *Consider replacing small gas turbines with new gas engine sets for power generation in oil and gas industries.*

This option should be considered whenever there is a need to overhaul existing gas turbines. Replacement with new gas engines of equivalent size may or may not be cheaper, but operation costs will be lower as gas engines have higher efficiencies than gas turbines, especially when running at partial load.

Example: A case study on replacing 3MW x 4 units of gas turbines with gas engine sets of the same size and units at an offshore gas production platform in the gulf of Thailand revealed that the project could reduce fuel gas consumption by up to 40%.

Recommendation 26: *Conduct a study on the efficiency of the gas transmission line, to check whether there might be gas leakage along the gas pipe line. Then, identify and implement energy efficiency measures that could reduce gas wastage.*

5. POLICY MEASURES – TRANSPORT SECTOR

5.1 ACHIEVEMENTS AND CHALLENGES

Transport is the largest energy end use sector in Brunei Darussalam, accounting for around half of all energy used by consumers, as shown in Figure 5-1³³. This proportion is very high by international comparison. The vast majority (97%) of transport energy is used for road transport.

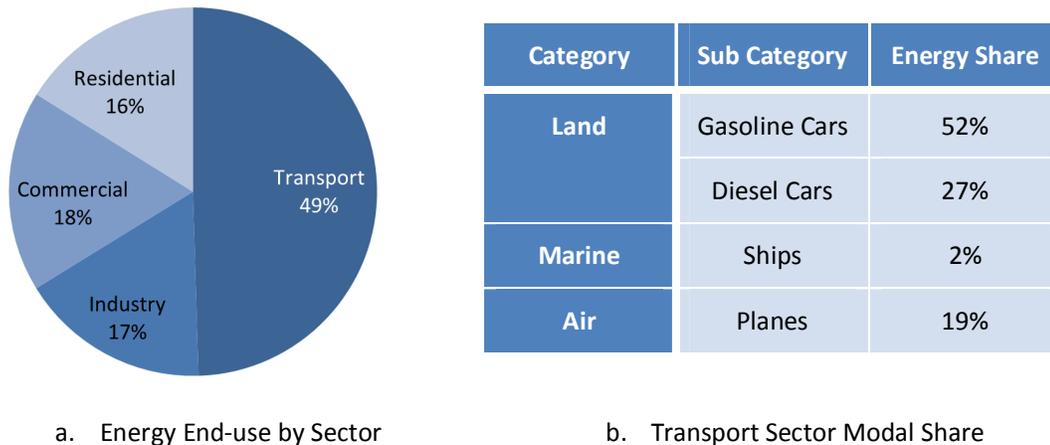


Figure 5-1: Energy End-Use in Brunei Darussalam in 2009

Brunei Darussalam has a good quality road infrastructure. The vehicle fleet is relatively modern with 65% of registered vehicles under 9 years old. In 2012, there were around 190,000 registered vehicles with a diverse fleet comprising around 190 different models. There is ready access to light vehicles with vehicle ownership rates being one of the highest rates in the world, given Brunei Darussalam's population of just under 400,000 people. Ownership rates are equivalent to more than two vehicles per licensed driver. Vehicle numbers are growing at around 4% per year, although it should be noted that with the number of vehicles exceeding the number of licensed drivers, increasing vehicle numbers may not necessarily translate into a corresponding increase in transport energy demand.

The government is considering fuel economy regulations and other policies and strategies to promote the uptake of energy efficient vehicles in the Sultanate. Brunei Darussalam has already started compiling a database of the fuel efficiency of vehicles entering the fleet.

There is an existing fixed-route public bus network in Brunei Darussalam, but patronage is relatively low. A five-year roadmap to enhance public transport was announced earlier this year and lays out plans to increase bus frequency, extend operating hours, revise routes, develop kerbside infrastructure (designated bus stops and shelters) and revise fare systems.

Despite these achievements, the low price of transport fuels enjoyed by the people of Brunei Darussalam remains one of the significant challenges for improving transport energy efficiency. At the time of our visit in June 2013, petrol was retailing at BND 0.53 per litre. The World Bank ranked

³³ Mitsubishi Research Institute (2011), *Brunei Energy Efficiency and Conservation Study: Roadmap Formulation and Policy Advice*.

Brunei Darussalam as the eleventh cheapest in the world for the pump price of petrol (in USD equivalent) in 2012³⁴.

Brunei Darussalam's relatively low urban density, small population and high car ownership rates make it difficult for conventional, fixed-route public transport to meet the needs of potential customers and attract their ridership. These factors also provide challenges for other alternatives to private vehicle transport such as carpooling, walking and cycling.

Based on observations, it appears that traffic movements and parking management around commercial developments could be better integrated at the time of planning to reduce localized congestion.

5.2 RECOMMENDATIONS

Recommendation 27: *Continue developing a database of fuel efficiency of light vehicles in the Brunei Darussalam fleet to be the basis on which vehicle fuel efficiency policies and initiatives, including consumer information, can be designed and monitored.*

Private car transport is likely to remain the dominant mode of transport in Brunei Darussalam in the future due to existing high car ownership rates, low fuel prices in comparison with other economies and low urban density. Brunei Darussalam should therefore focus on transport energy efficiency initiatives on improving the energy efficiency of the vehicle fleet and encouraging more energy efficient driver behaviour. Increasing the understanding of the nominal fuel efficiency of the national light vehicle fleet (comprising cars, Special Utility Vehicles (SUVs), pick-ups, vans and multi-purpose vehicles) is the foundation on which vehicle fuel efficiency can be designed, implemented and monitored. Such a database is a pre-requisite for vehicle fuel economy labelling to provide consumer information to help people select the most fuel efficient vehicle that meets their requirements.

Brunei Darussalam does not have a domestic vehicle manufacturing industry and so is able import the latest technology vehicles from around the world. Consequently, the economy is positioned to readily take advantage of energy efficiency technology improvements as these are introduced to the market. Due to Brunei Darussalam's small population and wide range of imported vehicle models it would not be cost effective for Brunei to conduct vehicle fuel economy tests itself. Brunei Darussalam should use data from testing in other regions, backfilling the database as far as possible with fuel economy figures for existing light fleet vehicles.

Recommendation 28: *Provide consumer information on vehicle fuel consumption through the implementation of a vehicle labelling programme and energy efficient driver behaviour.*

There is considerable variation between the fuel consumption of vehicles which otherwise appear similar and have similar engine displacement (cc rating). Providing vehicle buyers with fuel consumption information helps them determine which vehicles can meet their requirements on a total cost of ownership basis, rather than vehicle purchase price alone. The advantages of energy efficient technology advances, such as hybrid³⁵ vehicles, modern turbocharged diesel engines and

³⁴ The World Bank (2013), *Pump price for gasoline (US\$ per liter)*, <http://data.worldbank.org/indicator/EP.PMP.SGAS.CD/countries/1W?display=default>, accessed June 2013.

³⁵ Hybrid vehicles ('hybrids') use a combination of a petrol or diesel engine, a battery and an on-board electric motor to improve overall energy efficiency. The battery in a hybrid vehicle is charged by the engine and regenerative braking. This means that hybrids do not plug in to an electricity supply to recharge, their only source of energy is the fuel used by the engine.

engine stop-start systems, can also be more readily understood by vehicle buyers with fuel consumption labelling.

Brunei Darussalam should require all new vehicles to display a label giving standardised fuel consumption information at the point of sale. The requirement should ideally cover vehicles offered for sale via the internet and promoted in other traditional and non-traditional media. Co-promotion of fuel economy information with safety ratings for vehicles will help ensure that fuel economy is not promoted at the expense of vehicle safety (safety is usually a core function of transport agencies).

Brunei Darussalam has also expressed an interest in promoting natural gas vehicles and electric vehicles and so consideration should be given to how consumers can readily compare energy consumption between vehicles with different fuel/energy and prime mover technologies. Annual or five-year total running costs for a standardised annual distance may be one way to approach this, and also direct potential buyers into thinking about energy costs in terms of the length of time they will own and operate the vehicle.

Monitoring consumer awareness of the label and the degree to which fuel consumption is a factor in vehicle purchase decisions will help evaluate the benefits of the labelling programme.

Example: Vehicle fuel economy labels are used for petrol and electric vehicles in New Zealand to allow consumers to more easily understand the significant difference in energy costs between these two types of vehicles. Examples of the labels are shown in Figure 5-2. The label for electric vehicles also provides important additional consumer information about the range the EV will travel on one charge.

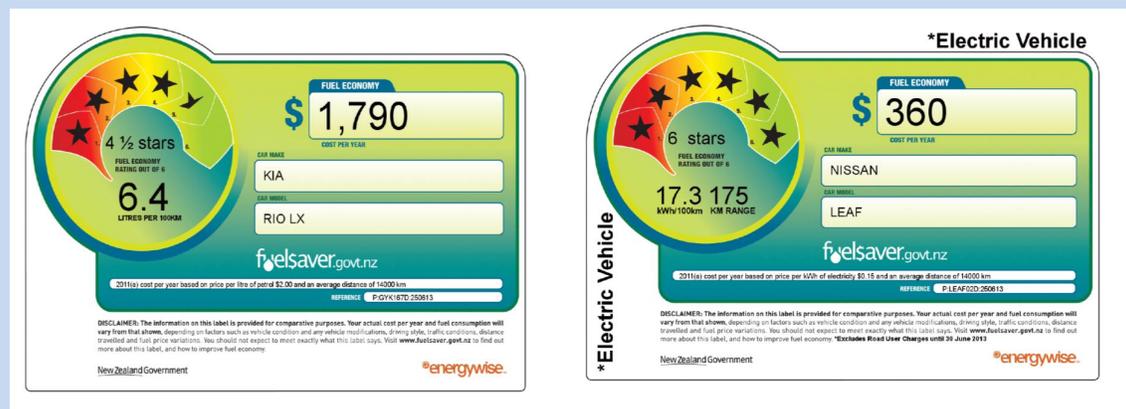


Figure 5-2: New Zealand fuel economy labels for a petrol vehicle and an electric vehicle which highlight the difference in annual energy costs to consumers

Recommendation 29: Incorporate fuel efficiency into new driver education and driver licensing.

The education and subsequent test that new drivers have to sit in order to be awarded a driver license is an opportunity for encouraging fuel efficient driver behaviour. Fuel efficient driver behaviours, such as anticipating traffic flow to avoid heavy braking and checking tyres are inflated correctly, are also safe driver behaviours. Teaching these skills from the start is always much easier than trying to get driver to change ingrained habits.

Example: In Finland, fuel efficient driver training was first introduced in 1995 and became part of the driving test in 1998³⁶ (CIECA, 2007). Fuel efficient driving is also included in testing in Germany, the Netherlands, Switzerland and Sweden.

Continuing driver education around energy efficiency should also be considered, particularly for commercial drivers of taxis, buses and freight vehicles. Government could lead the way by introducing continuing driver education for employees using government fleet vehicles. Such initiatives have been shown to save not only on fuel but also on accident-related costs, and their implementation may attract lower cost insurance premiums for drivers.

Recommendation 30: *Set CO₂ emissions based vehicle acquisition or taxation policies which encourage both fuel efficient vehicles and lower carbon fuel vehicles, such as gas vehicles, electric vehicles and plug-in hybrids.*

Brunei Darussalam is already considering fuel economy regulations and other policies and strategies to promote the uptake of energy efficient vehicles. The economy is also interested in encouraging electric vehicles and natural gas vehicles. The two aims could be integrated into one by considering fuel economy regulation or incentives based on “well-to-wheel” CO₂ emissions per km. This would allow diesel, gasoline, natural gas, electric vehicles and plug-in hybrids³⁷ (plus other vehicle fuel/technologies) to be compared using a common metric. For example, a policy could require the fleet average CO₂ emissions of vehicles first entering the national fleet to meet a set maximum level which is signalled to gradually reduce over time, with the government specifying the emissions factors that apply for different fuel types. The requirement should fall on vehicle importers (as there is no vehicle manufacturing industry in Brunei Darussalam). Given the size of the market, vehicle importers should be allowed to “trade” requirements amongst each other to achieve the overall aim of a fleet average target.

While annual registration taxes for vehicles are very low in Brunei Darussalam, import duties are levied at a much more influential rate. They are applied on the basis of engine displacement (cc) for petrol and diesel vehicles, as shown in Table 5-1, which will help encourage vehicles with smaller engines which are generally more fuel efficient.

Table 5-1: Import duties for motor vehicles in Brunei Darussalam³⁸

Fuel Type	Engine displacement	Import duty rate
Petrol Motor Vehicle	Not exceeding 1,000 cc	40%
	Exceeding 1,000 but not exceeding 2,000 cc	60%
	Exceeding 2,000 but not exceeding 3,000 cc	80%
	Exceeding 3,000 but not exceeding 4,000 cc	100%
	Exceeding 4,000 cc	200%
Diesel or semi diesel motor vehicle	Not exceeding 2,000 cc	40%
	Exceeding 2,000 but not exceeding 4,000 cc	80%
	Exceeding 4,000 cc	200%

³⁶ International Commission for Driver Testing, CIECA (2007), *Internal Project on ‘Eco-Driving’ in Category B Driver Training and the Driving Test*

³⁷ Generally the term electric vehicle refers to cars that are partly or wholly powered by an external source of electricity typically stored in batteries. The main variants are battery electric vehicles (BEVs), which are wholly powered by an external source of electricity, and plug-in hybrid electric vehicles (PHEVs), which are vehicles that operate on a combination of external electricity and other fuels.

³⁸ ASEAN, *Brunei Darussalam Tariff and Duty Rates*, <http://www.asean.org/communities/asean-economic-community/item/brunei-darussalam-6>

Brunei Darussalam could consider setting vehicle import duties on the basis of fuel efficiency or CO₂ emissions instead of engine capacity, to better incentivise energy efficient vehicles and alternative energy vehicles such as electrical vehicles. Linking import duties with climate change measures may be seen as more acceptable than the status quo in terms of border measures.

One of the questions raised during the PREE Review Team’s visit to Brunei Darussalam was whether electric vehicles, including plug-in hybrids, should be encouraged in Brunei Darussalam, given that current electricity generation is relatively inefficient. As well as diversifying energy types for transport, electric motors are inherently significantly more energy efficient than internal combustion engines as a vehicle prime mover. Figure 5-3 below illustrates a comparative analysis of the energy losses for a typical petrol vehicle, including losses associated with petrol refining and supply, with losses for a typical electric vehicle, including losses associated with electricity generation, transmission and distribution.

Two scenarios are presented for the electric vehicle analysis. The first, in light purple, is based on the current average generation efficiency in Brunei Darussalam of 23%³⁹. The second, in dark purple, is based on the planned future average generation efficiency of 45% once upgrades from single cycle gas turbine generators are implemented, along with other efficiency initiatives. The analysis also includes the lower losses from electric vehicles in use when compared with conventional vehicles; electric vehicles are able to capture, through regenerative braking, some of the losses associated with braking and coasting, and avoid losses by not consuming energy while stationary in congested traffic.

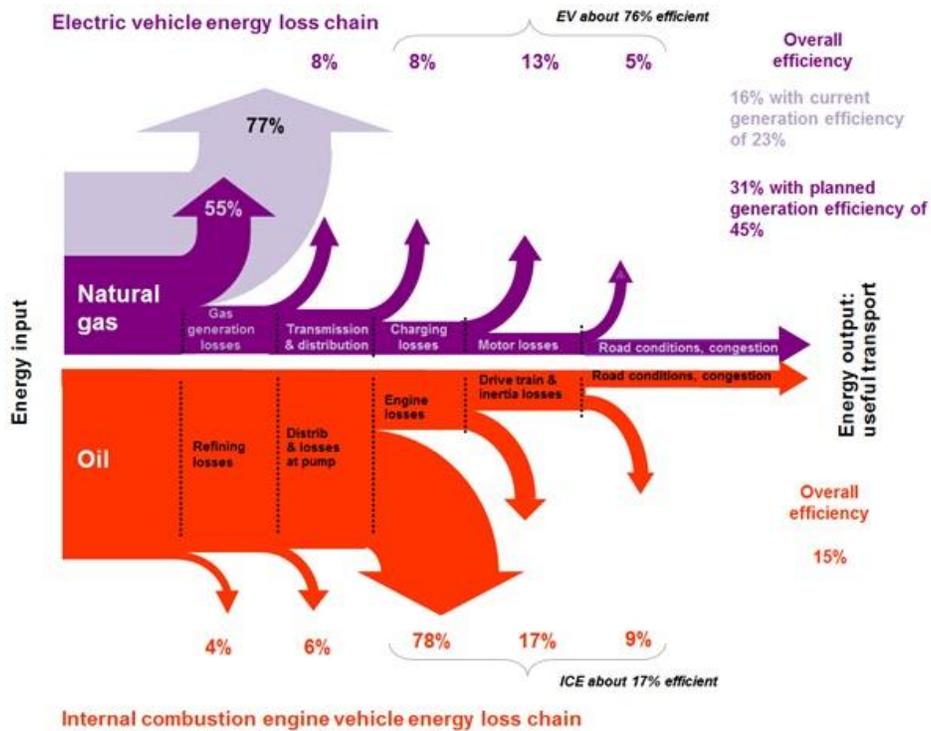


Figure 5.3: Comparison of energy loss chains and overall energy efficiency between electric vehicles (EV) and internal combustion engine (ICE) vehicles, taking into account Brunei Darussalam electricity generation

³⁹ Energy Department Prime Minister’s Office (2013), *PREE Background Report for Brunei Darussalam*

This analysis shows that even with the current relatively low average efficiency of gas generation in Brunei Darussalam of 23%, an electric vehicle would have an overall “well-to-wheel” efficiency slightly better than that of a typical internal combustion engine. As planned generation efficiency improvements are realised, this will increase the energy efficiency benefits of electric vehicles further. For an average planned generation efficiency of 45%, electric vehicles in Brunei Darussalam will be twice as efficient as internal combustion engine vehicles on a “well-to-wheel” basis. Brunei Darussalam does not need to wait until these electricity sector improvements are underway to start promoting the use of electric vehicles.

Electric vehicles also offer other co-benefits, such as improved air quality, reduced noise and increased comfort. Pre-cooling of electric vehicles while they are parked and plugged into a charger is an innovation which also provides energy efficiency benefits, as vehicle air conditioning is likely to be significant factor in actual fuel use for vehicles in Brunei Darussalam. For example, there is a smartphone application for the Nissan Leaf which allows drivers to send a message to the car to start it cooling ahead of use, using electricity direct from the local network. Such innovations may make electric vehicles appealing to consumers in Brunei Darussalam, as well as contributing to efficiency.

The question of a lack of recharging infrastructure for electric vehicles was also raised. Practical experience in other countries has shown that electric vehicles are typically charged overnight at home or, for company owned vehicles, at workplaces. The world’s largest EV use monitoring project, The EV Project sponsored by the US Department of Energy, has shown that even when public recharging facilities are widely available, 88% of recharging happens at home⁴⁰ (Level 2 charging) and only 3% of recharging events occur at fast recharging stations (Level 3 charging). Brunei Darussalam’s 230V network means that fully depleted electric vehicle batteries can be completely charged at home overnight in less than 6-8 hours while people are sleeping (Level 2 charging), providing at least 100km of daily driving range, with considerably higher ranges possible depending on vehicle type⁴¹. Given Brunei Darussalam’s physical size and typical daily travel patterns, an overnight charge should be more than adequate for over 90% of travel needs.

Overnight charging can occur when daily electricity demand is at its lowest in Brunei Darussalam, between the hours of 11 pm to 7 am as shown in Figure 5.4. Increased night-time demand for electricity for electric vehicle charging, as part of overall energy efficiency improvements, will contribute to increased off-peak utilisation of generation and transmission/distribution assets improving their overall return on investment in these assets.

The fact that there are two cars for every licensed driver in Brunei Darussalam suggests that an alternative vehicle may be available for those occasions when a pure electric vehicle is not suitable. Plug-in hybrids should also be promoted which allow for electric powered driving for most situations, and hybrid driving for long-distance travel (e.g. to Malaysia).

Simply having an electrical vehicle recharger at the owner’s home should be sufficient infrastructure for successful electric vehicle deployment. Installation of such rechargers is straightforward and usually comes as part of an electric vehicle purchase package. However, it may be helpful to install some Level 2 public recharging facilities in premium, high visibility parking locations, such as at the airport, to overcome the initial perceptions around “range anxiety” and raise awareness of electric vehicles.

Government purchase and use of electric vehicles will help promote this technology through leading by example.

⁴⁰ The EV Project (2013). Q1 2013 Report. <http://www.theevproject.com/cms-assets/documents/113177-646795.q1-2013-rpt.pdf>

⁴¹ Some electric vehicles now on the international market have a range of over 450 km on a single charge.

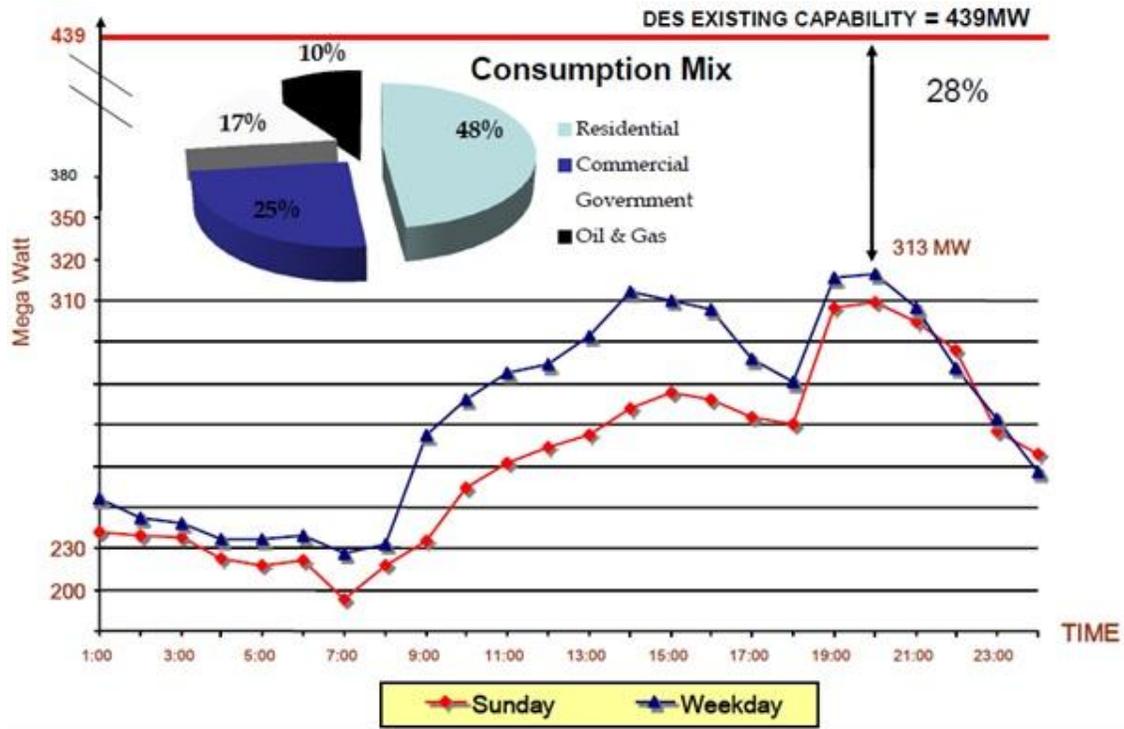


Figure 5.4: Typical Daily Electricity Consumption in Brunei Darussalam by Time of Day⁴²

Recommendation 31: Continue to periodically survey daily vehicle usage patterns (range of trip distances, range of daily driving distances and trip purpose) to increase understanding of travel patterns to assist in the design of future policies and initiatives.

Increased knowledge of daily vehicle usage patterns will help with the improvement of public transport as a viable alternative to private car use, and will also improve understanding of how new technologies, such as electric vehicles, could potentially be encouraged in Brunei Darussalam.

Recommendation 32: Investigate information technology based, demand responsive transit models which may be more suitable to Brunei Darussalam's population size and urban density than traditional fixed-route public transport and better meet customers' needs.

Improving the bus system remains important to provide an alternative to private car use, particularly for those members of society who cannot afford a private car, those who cannot drive or who choose not to drive. Information technology and widespread uptake of mobile phones provides an opportunity for Brunei Darussalam to leapfrog to a more intelligent and flexible public transport system which suits the country's small population, low urban density and low public transport demand levels. This approach, termed "demand responsive transport" and sometimes known as "dial-a-ride" public transport, could provide an alternative to some of the current and proposed traditional fixed public transport routes, particularly on feeder routes or at off-peak periods.

⁴² Figure from the Department of Electrical Services (DES) presentation during the PREE Review Visit to Brunei Darussalam

Example: This type of shared “taxi-bus” public transport has been growing in popularity over the last couple of decades and is in operation in parts of the UK, France, Germany, Canada, Australia and many other economies. Transport Scotland has published a good overview of how it works there⁴³.

Brunei Darussalam should investigate not only existing demand responsive transport operations but investigate the emerging use of intelligent transport systems and mobile telecommunications technology to increase the customer responsiveness of this type of public transport.

Recommendation 33: *Encourage greater coordination between the infrastructure functions of the Ministry of Development and the transport functions of the Ministry of Communications.*

The increased integration of land use planning with transport, both for individual commercial developments and residential/mixed-use developments, is a vital factor in ensuring overall transport energy efficiency improvements in the long term. Proposed developments should be required to provide a transport impact analysis, including parking management plans, with any mitigations identified being a required part of the approvals for the development. New developments should ideally be sited around existing or planned public transport routes. Provision of quality walking and cycling infrastructure should also be improved.

⁴³ Transport Scotland (2009), *A further review of demand responsive transport in Scotland*, http://www.transportscotland.gov.uk/files/documents/public-transport/Demand_Responsive_Transport.pdf

6. POLICY MEASURES – ELECTRICITY SECTOR

6.1 ACHIEVEMENTS AND CHALLENGES

The Department of Electrical Services (DES) and the Berakas Power Management Company (BPMC) are the two major electric utilities in Brunei Darussalam. The electricity sector in Brunei Darussalam has an installed capacity of 895 MW and can generate more than 3.9 TWh per year. It has achieved the ability to produce significantly more power than is needed on a daily basis, for example, it has a peak capacity of more than 700 MW and in 2012 its highest peak demand was only 540 MW. The economy has a spinning reserve of approximately 25% and the ability to interconnect with another electricity generator in the case of a major loss of capacity.

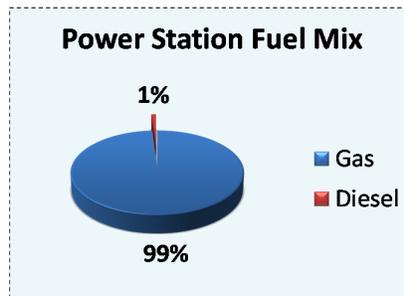


Figure 6-1: Brunei Darussalam Electricity Fuel Mix

The economy uses an indigenous fuel, natural gas, for 99% of its generation with less than one per cent diesel generation and a solar generating station on the order of 1 MW. Consequently, it has achieved an enviable energy security position and a fairly clean generation profile from a climate change/greenhouse gas emission viewpoint.



Figure 6-2: Tenaga Suria Brunei (Solar Energy Brunei) 1.2MW PV System Demonstration Project

Another achievement is that the DES is developing initiatives to increase efficiency in the power generation from 23% to 45%. Plans include implementing a number of smart policies and measures

including energy-saving technologies⁴⁴ – the combined cycle turbine, reducing partial load operation and transmission and distribution losses, mandating an energy efficiency target for any new power plant, installing smart meters (i.e. dynamic pricing based on energy consumption), evaluating feasibility of altering tariff structure to promote desired consumption behaviour and reduction in gas consumption through integration of renewable energy to meet the demands on power in Brunei Darussalam.

Furthermore, Brunei Darussalam recognized that there is a need for electricity tariff reforms as a means to promote energy efficiency. Early last year, His Majesty the Sultan and Yang Di-Pertuan of Negara Brunei Darussalam consented for the review of the electricity tariff structure in the residential sector and a new electricity tariff was implemented. The new tariff corrected the old tariff which was regressive and incentivized the wasteful use of electricity. By implementing a reverse block rate and keeping the cost for the first 600 kWh extremely low (BND 0.01), the new tariff ensures that low income citizens would not be adversely impacted. A pre-paid meter system was also installed. After the first year, the DES achieved excellent results; it reduced electric consumption by 12.4% and saved more than BND 21 million.

Nevertheless, the electricity sector does face some challenges. Brunei Darussalam’s electricity consumption is around 8,300 kWh per capita in 2008. An average of 48% of the electricity generated goes to residential, 25% is consumed by the commercial sector, the government sector consumes 17% and the remaining 10% is used by the oil and gas industrial sector (see Figure 6-3).

Average Electricity Consumption by Sector in Brunei Darussalam

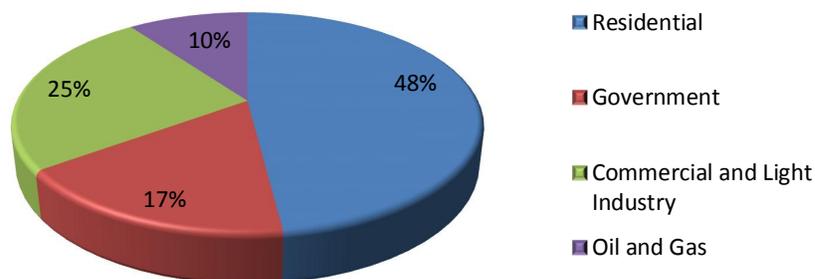


Figure 6-3: Average Electricity Consumption by Sector in Brunei Darussalam for 2008

Brunei Darussalam ranks fourth in the world for highest CO₂ emissions on a metric ton per capita basis⁴⁵. While some of this emissions may be attributed to the production and flaring of natural gas, a portion of the emissions may well be attributed to the inefficiency of the gas turbines used in electricity generation. Most of the power plants in Brunei Darussalam are still using single cycle gas turbines, which have low efficiency, burn more fossil fuel and emit more carbon dioxide to the

⁴⁴ Two major projects have been initiated at two of the major power plants in the country – the Lumut Co-Generation Power Station which has an overall efficiency of greater than 60% through the application of combined heat and power (CHP) integration or Co-Generation. The other project at Bukit Panggal Combined Cycle Power Station has already reached an efficiency of about 47% using "Combined Cycle Gas Turbine" technology to increase efficiency by more than one-third.

⁴⁵ The World Bank Database, <http://data.worldbank.org/indicator/EN.ATM.CO2E.PC/countries>

atmosphere than the combined cycle gas turbines (CCGT) commonly used in new power plant construction today. However, replacement of all the existing gas turbines in Brunei Darussalam is an expensive proposition. A financial plan to pay for the replacement needs to be developed to ensure the viability of DES and still keep rates to consumers as low as possible.



Figure 6-4: Bukit Panggal Combined Cycle Power Station in Brunei Darussalam

Nonetheless, the Bukit Panggal Power Station is an excellent example of the increased efficiency attributable to new technologies and is the only non-simple cycle turbine generator in the economy's generating portfolio. This generating station is a CCGT plant in which the CCGT technology added one third more capacity (approximately 32 MW) more than if the plant had been just two simple cycle gas turbines. But the major benefit to the economy was that the plant produces an additional 32 MW of electricity with no additional need for natural gas fuel; thereby saving approximately BND 36 million in fuel costs per year (or if taken from the perspective of the government, the natural gas not burned at the plant was able to be exported and brought an additional BND 36 million in revenues to the economy).

Energy management is another area where improvements in efficiency can be made. The ISO 50001 is a well-recognized international standard that provides guidelines to the best practices in energy management. It recommends that each facility (of a certain size) have an energy manager at each site to ensure that all operational measures are optimized at all times. For example, if the equipment is not maintained or operating at its prescribed settings, then all the other measures are compromised – adoption of ISO 50001's energy management requirements by the utility sector would ensure that equipment is operating at optimal levels. The Bukit Panggal Power Station already performs some regular maintenance activities which result in increased energy efficiency, for example, online and offline washing of compressors significantly increases production efficiency up to 5%.

In addition, the hot and humid weather of Brunei Darussalam drives consumers in both the residential and commercial sectors to utilize significant amounts of air conditioning all year long. Air-conditioning is the leading consumer of electricity in the economy and accounts for almost 60% of electricity consumption in buildings. With the relatively low electricity tariff, Brunei Darussalam enjoys a relatively cheap cost for air conditioning, which may not be sustainable in the long-term. In fact, Mr Asrul Sany Haji Mohammad Ali's presentation on the new tariff shows that Brunei Darussalam's average tariff is the lowest by half of nine other ASEAN countries.

Nonetheless, Brunei Darussalam has charted a good path forward. In addition to the upgrading of old inefficiency power stations to CCGT or combined heat and power (CHP), tariff reform, and prepaid meter programs mentioned above, new demand side efforts are underway in developing appliance standards for the two largest appliance/products in the economy; air conditioners and lighting (fully discussed in Section 7 of this report).

Furthermore, Brunei Darussalam is pursuing a sustainable development funding vehicle to drive more energy efficiency into the economy. The Brunei Darussalam Energy Efficiency Fund was proposed by the Sustainable Development Capital (Asia) Limited (SDCL) and under this proposal, subsidies currently paid to the utility will be shifted to the fund to pay for verified energy savings resulting from successful energy efficiency and conservation projects.

SDCL's analysis of the power sector shows that energy efficiency could eliminate six new power plants by 2035 and the corresponding dollar savings are very large (SDCL's independent analysis verifies a Mitsubishi consulting report from a few years ago which showed a very similar result). This fund is a critical piece needed to ensure that the capital is available to improve the efficiency on the supply side of the equation.

Brunei Darussalam's path forward for the electricity sector is well thought out and takes into account both supply and demand side efficiency measures. On the supply efficiency side, the government's goals are threefold:

1. *Reduce line losses by 50%.* Line losses are calculated to be only 6% at this time (this might be a hard goal to meet from both a technical and cost effective perspective).
2. *More optimal operation of the transmission network.* It should also be noted that although there was very little discussion about this in our meetings, it was mentioned that equipment maintenance will be increased to improve distribution efficiency.
3. *Enhance grid control.* Some of this would be done through smart metering and controls, while the 1.2 MW Seria Solar power plant (which is being used to study 6 types of PV cells) is also being used as a test-bed to provide the DES with experience related to connecting renewable energy technologies to the grid.

On the demand side, many new initiatives across all the sectors have been implemented or are being contemplated:

1. A new pricing structure was implemented as of January 2012. The new tariff for electricity consumption moved from a regressive system (in which the more electricity a consumer used, the less the consumer was charged for it on a kWh basis) to a progressive system (in which consumers have a lower price for the first 2,500 kWh used and higher prices when they use more than that first level of consumption). The latter tariff encourages efficiency and conservation, while the former tariff encourages waste of electricity.
2. Prepaid meters have been installed as a means to adjust consumer behaviour by making the consumer more directly aware of the link between energy use and cost.
3. Incentives to subsidize the cost of a variety of energy efficiency technologies are being discussed under the EE&C regulatory framework being developed by the EDPMO. These technologies include equipment, such as; energy efficient air conditioners, chillers, lighting equipment (from lamps to controls and sensors, solar hot water heaters, and smart meters).
4. Brunei Darussalam is developing new appliance standards for air-conditioners and lighting. The economy is also developing a labelling scheme for appliances. Upon advice of the experts, they are now looking at harmonizing the standards and labels with other economies in the region. See, Section 7 of this report for more details.
5. Brunei Darussalam is also developing energy building codes to improve the energy performance of buildings. They are looking at a number of code measures to accomplish this goal; reduction of solar heat gain, increase in insulation, reduction in air leakage, and temperature settings.

6. In the industrial sector, energy management is the target. As noted above, the government is looking at mandating energy managers at facilities.
7. Fuel economy standards set to European Union (EU) levels is another initiative undertaken by the government.
8. Awareness-raising through customer education is also recognized by both the government and the power plant operators as a key element to get their consumers to be more efficient by understanding the connection of energy use and cost.

The above measures are critical to the power sector and the government as they are committed to a more energy efficient economy that can provide Brunei Darussalam a more secure and reliable power sector in the future.

6.2 RECOMMENDATIONS

Recommendation 34: *DES should develop a roadmap to improve overall power systems efficiency.*

Older, inefficient power generation capacity should be phased out and replaced by new CCGT or co-generation units on a pre-set schedule.

The older transmission and distribution assets should be upgraded to have SCADA or smart grid applications for better efficiency.

Recommendation 35: *DES should work closely with the Ministry of Finance to ensure that a well structured finance plan is put in place to provide the capitalization needed to finance the roadmap.*

Recommendation 36: *DES should implement ISO 50001 in all of its power generating stations.*

Recommendation 37: *Continue to implement progressively increasing tariffs over a specified long-term schedule, similar to what is currently being practiced in Japan and California.*

Daily load profile monitoring of the total power consumption and by sector in Brunei Darussalam should be conducted to enable better understanding of their characteristics that can be used as a basis for further enhancing the electricity pricing policy.

Recommendation 38: *Consider using other innovative tariffs such as “time of use (TOU) tariffs” to encourage consumers to increase their use of energy efficiency and lower overall system consumption.*

Recommendation 39: *Install smart meters for enhancing both demand side and supply side operations and programs.*

Recommendation 40: *Accelerate efforts to implement demand-side measures such as those being implemented for air conditioning units, chillers and lighting and consider Building Management Systems (BMS) for the commercial sector.*

Recommendation 41: *Consider implementing an energy efficiency (and water saving) program for drinking water and waste water treatment facilities.*

Recommendation 42: *As part of the efforts to supply electricity to the eco-tourism Temburong area, conduct a feasibility study that applies intensive energy efficiency measures integrating small-scale renewable energy supply (keeping the diesel generation facility as a back-up if needed).*

The results of this feasibility study can be compared with the proposed transmission line projects or other options.

Examples of Ecotourism and Small-Scale Renewable Energy Installations

- a. A few energy efficiency handbooks targeted specifically for the hotel industry have been published, including an Energy Efficiency Handbook for Thai Hotels by the World Tourism Organization⁴⁶ and an Energy Wise Hotels Toolkit by the Melbourne City Council⁴⁷. The United States Energy Star organization has compiled a list of resources on energy efficiency in the hospitality industry in its website⁴⁸.
- b. The Mae Kam Pong 40 KW Micro-Hydro Electric Project in Thailand was constructed in 1980s by the local community with budget and technical assistance from the government⁴⁹. The project is now operated by the village cooperative and is part of the attractions for this community-based eco-tourism village⁵⁰.



Figure 6-5: Micro-hydropower Installation at Mae Kam Pong, Thailand

⁴⁶ World Tourism Organization (UNWTO), *Energy Efficiency in Thai Hotel: A Practical Guide* (2010), <http://biodiv.unwto.org/sites/all/files/docpdf/peekeehandbook.pdf>

⁴⁷ Melbourne City Council, *Energy Wise Hotels Toolkits* (2007), <http://www.melbourne.vic.gov.au/enterprisemelbourne/environment/Documents/EnergyWiseHotels.pdf>

⁴⁸ Energy Star, *Hotels: An Overview of Energy Use and Energy Efficiency Opportunities*, http://www.energystar.gov/ia/business/challenge/learn_more/Hotel.pdf

⁴⁹ Department of Alternative Energy Development and Efficiency, *Current Status and Development Plan for Grid Small Hydro Power in Thailand* (2013), [http://www.egnret.ewg.apec.org/workshops/SmallHydro/\[S.2.5\] Thailand Current%20status%20&%20development%20plan%20for%20grid%20small%20hydro%20power_dr2.pdf](http://www.egnret.ewg.apec.org/workshops/SmallHydro/[S.2.5] Thailand Current%20status%20&%20development%20plan%20for%20grid%20small%20hydro%20power_dr2.pdf)

⁵⁰ Thailand Community Based Tourism Network Coordination Center, *Mae Kam Pong*, http://cbtnetwork.org/?page_id=93

c. Small-scale renewable energy installations in APEC economies



Figure 6-6: Wind-Solar PV Hybrid System in Korea



Figure 6-7: Building Integrated Solar PV System in Malaysia



Figure 6-8: Windpods integrated directly to signage in Australia⁵¹



Figure 6-9: Micro-hydro in East Java, Indonesia

⁵¹ Windpods Brochure, http://www.windpods.com/pdf/Windpods_Brochure.pdf

7. POLICY MEASURES – APPLIANCES AND EQUIPMENT

7.1 ACHIEVEMENTS AND CHALLENGES

Brunei Darussalam commissioned a study by the Mitsubishi Research Institute in 2011 which, among other things, determined that the economy needs to implement a standards and labelling program for appliances and equipment that would ensure that Brunei Darussalam's goal of a 45% energy intensity reduction by 2035 (using 2005 as the base year) can be achieved. The Energy Department, Prime Minister's Office (EDPMO) is responsible for the policy recommendations and legislative measures for both appliance and equipment standards as well as labelling.

Regarding legislation, EDPMO is collaborating with Brunei National Energy Research Institute (BNERI) to develop a National Energy Efficiency Standards and Labelling Regulation, which initially will be applied to air-conditioners and lighting and later will be extended to cover other appliances and products.



Figure 7-1: Air-conditioners and Light Bulbs

The objective of developing and implementing a National Standards and Labelling Regulation is to halt the importation of non-efficient electrical appliances and products (air conditioners and lighting) into the economy while educating and permitting consumers to still have choices without triggering significant increases in price.

Also, with the implementation of the National Standard and Labelling Regulation, consumers will have a better understanding of which products have better efficiency ratings and therefore, when purchased will reduce the energy consumption nationwide. A labelling scheme is regarded to be one of the most important measures to raise awareness and provide information to the public regarding the energy efficiency of products. Brunei Darussalam's recognition of the importance of labels that rate equipment and appliances is critical as a means to transform the market from inefficient equipment and products to those that are more efficient.

Standards:

The Asia Pacific Energy Research Centre's (APERC) own Policy Template⁵² endorses energy efficiency standards that set a minimum level of energy performance (MEPS) that all products must meet. By developing energy efficiency standards, the economy can prevent the manufacture, import or sales of products that do not meet the standard. However, a robust and effective energy efficiency standards program must also contain a reliable program of testing at two stages; first to set the standard, and second to ensure compliance with the standard.

⁵² APERC's *Appliance Efficiency Standards and Labels* policy template is quoted throughout this section. A link to the Policy template is available at <http://www.ase.org/global-policy-making>.

An example of a report that used the policy template concept is from the first Cooperative Energy Efficiency Design for Sustainability on Standards and Labelling is located at http://aperc.ieei.or.jp/file/2010/9/26/Final_Report_CEEES_Phase_1_20100114.pdf

Economies across the world, both developed and developing, acknowledge that energy efficiency standards (and building energy codes) have had the greatest impact on increasing energy efficiency worldwide. Plug loads (i.e. electrical appliances from refrigerators to air conditioners, televisions to lighting, and computers to charging devices, etc.) are rapidly increasing across all economies. At the same time, the buildings where these electrical products are housed account for approximately 40% of the total energy consumption worldwide. Since electrical products have much shorter lives than buildings or industrial facilities, rapid turnover of these products can lower energy use at a faster pace (compared to improvements in buildings or industry) if a strong standards setting program is in place.

Consequently, many economies have adopted appliance/product standards and have experience in the design and implementation of such standards programs. In fact, efficiency (and labelling) programs are in place in at least 19 APEC economies and more than 57 economies worldwide, and in aggregate cover more than 80 different categories of appliances and products⁵³. These programs have helped transform those market economies to ones that consume less energy and increase the share of efficient appliances and products in their market.

From a manufacturer's perspective, energy efficiency standards (and labelling) programs create an incentive for them to innovate and gain market share. For the consumer, high efficiency appliances and products bring significant savings in their electricity bills. For utilities, these high efficiency products help them meet their increasing demand for electricity without the need or expense of building costly generating plants.

During our discussions in Brunei Darussalam, the question of whether imposing energy efficiency products would cause an adverse action from the World Trade Organization was raised. In fact, just the opposite is true. Trade in the global market has increasingly turned to clean energy and higher energy efficiency as a significant criterion in looking at trade patterns. Dumping inefficient products on economies that have low, lax, or no appliance/product standards is generally not tolerated under trade agreements.

As for standard setting in Brunei Darussalam, a MEPS standard does help meet the multiple objectives set forth by the EDPMO which include promoting and encouraging the use of more energy efficient appliances, ensuring that products sold in (or imported into) Brunei Darussalam meet efficiency standards set by the economy, and with a corresponding labelling program, it helps consumers to understand which products are more efficient and therefore less costly to operate.

However, even after establishing the starting point at which the MEPS standard is set, it is just as critical to set up the process by which the energy efficiency standard can be "ratcheted up" over time (as new, more efficient technologies raise the efficiency of covered products). This step is important for an economy to have a sustainable program over the long-term. Energy efficiency technologies, and the products they are used in, historically show an improvement over time. Two common methods for determining the appropriate efficiency levels over time include both an engineering analysis and a market penetration analysis. While the former looks at the technical options available and the likely cost impact, the latter is a market-based approach that looks at the products and their efficiency in the market to determine where the new higher standard should be set. These methods complement each other and a robust program will include both.

Developing the metrics and testing for each appliance or product is also a critical, and sometimes, difficult task. Collaborating with other economies can greatly assist with this effort. Harmonizing the standard levels with another economy and collaborating with that other economy can make a significant impact on reducing the time and effort when either raising energy efficiency standards for

⁵³ CLASP, *Global S&L Database*, http://clasponline.org/en/ResourcesTools/Tools/SL_Search

products or ensuring that products meet their stated efficiency rating. Also, this collaboration can mean huge savings for the manufacturers as well since they will have one less set of testing and reporting to carry out.

Involving the major stakeholders in the development of standards is a best practice, but one that may sometimes lead into contentious battles, while other times it may lead into a consensus that can more quickly move the market to higher efficiencies. Nevertheless, a frank, open and transparent discussion with all the major stakeholders is a “must” for a viable standards program. Policy decision makers, manufacturers, retailers, importers, distributors, and end-users should all be brought together to craft the “best” standard and get the most buy-in from all of the stakeholders. This will lead to all the parties to be more willing to comply with the new standards.

Finally, as mentioned earlier, decisions must be made as to whether the standard levels should be pegged to other economies’ standards so as to have a strong regional program, which gives product manufacturers and resellers the certainty and ability to have the benefits of high-volume production and sales in the region. And even after all these decisions are made, one will still encounter implementation challenges, such as how the economy handles inventories of inefficient products in the market before the standard becomes effective.

Because of the high use of cooling and lighting in Brunei Darussalam’s residential and commercial sector, Brunei Darussalam has determined that the first two MEPS should be for air conditioning equipment and lighting. The charts below show that cooling consumes between 62% and 74% of building energy and lighting consumes up to 14%.

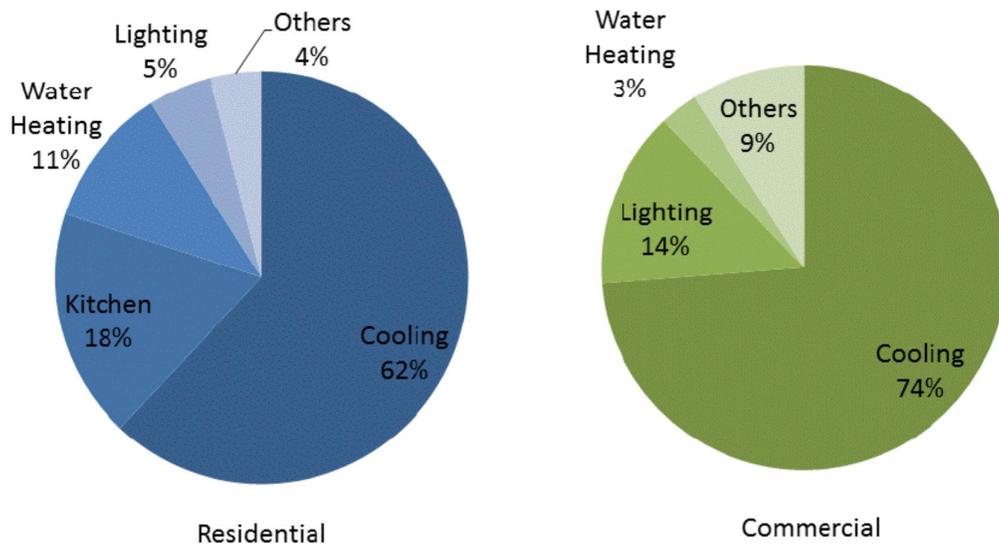


Figure 7-2: Proportion of Appliance-based Energy Consumption

Nonetheless, there are challenges to setting appropriate levels of standards and developing ratings (labels) that provide the recognition by and information for consumers. For example, in setting appliance and equipment standards, it is critical to set the appropriate level for the desired minimum energy performance, particularly when this is being done in an economy for the first time. Prioritizing which products or equipment to do first is crucial, in order to get the maximum energy savings at the earliest time. It is recommended Brunei Darussalam choice to first select air conditioners considering the amount of energy consumed by this product and there is no prior experience in implement standards and labeling. However, the government should look at establishing a priority list of other products and a timetable as to when it would be appropriate to set energy efficiency standards for them as well.

As for setting standards on air conditioners, the EDPMO has begun to look at what levels other economies have set for their air conditioning standard. This process has also provided the government with a benchmark to view where Brunei Darussalam stands with other economies. For example, looking at the chart below, it can be easily seen that Japan’s standard for the common small air conditioners (which are the majority of units sold in the economy), particularly those under 3.6kW but also for under 5kW, are much higher than those sold in Brunei Darussalam.

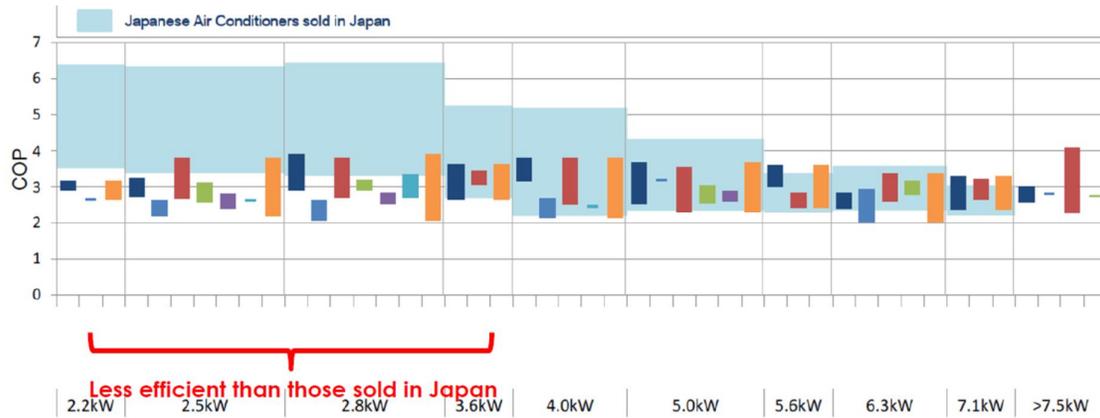


Figure 7-3: Comparative Efficiencies of AC Models in Brunei Darussalam

Brunei Darussalam has also looked at a more similar economy to itself, that of Singapore which has a similar market structure and a similar technology pattern. Using Singapore’s standards to benchmark the Brunei Darussalam’s standards makes sense from a number of perspective; it will be less work and costly than developing its own standards, it will be expanding the market and volume of those products (and likely bringing down the cost), and it will help harmonize the standard in the region (which benefits the manufacturers as they will not have to manufacture different products with different standards in a single region). However Singapore has recently increased its MEPS, which may make it difficult for a beginner to follow up.

Lighting is the other area where Brunei Darussalam may set an efficiency standard. They have completed the preliminary analysis to determine that a ballast standard for fluorescent lighting is needed since it represents the largest of the various lighting products sold in the economy. As seen in the chart below, standards for ballasts based on the European Community’s standard EC 245/2009. It has been suggested that the first standard for electronic ballasts in Brunei Darussalam should be set to the Level 1 standard. The PREE Review Team believes this to be a reasonable level and a good starting point for the new lighting/ballast standard.

Table 7-1: Standards and Ratings for Ballasts in Brunei Darussalam, based on EC 245/2009

EEL Based on EC 245/2009	Type of Ballast		Efficiency	Possible Rating System for Brunei
A1BAT	Electronic Ballast	Dimming	High	Level 5
A1				Level 4
A2 BAT		Fixed Output	Efficiency is defined as the ratio of lamp power (ballast output) and the input power of lamp-ballast circuit	Level 3
A2				Level 2
A3				Level 1
B1				to be phased out?
B2	Low			

During our discussions with the government officials two questions were raised concerning the possible phase out of magnetic ballasts and incandescent lamps. In both instances, the PREE Review Team was in favour of such a phase out as these are two of the most energy consuming products in the lighting industry. The United States, Japan and the European Union have all moved in the past few years to phase out these products. Phasing them out over time was preferred by the manufacturers who knew that the phase out of the wasteful energy products would require them to increase their manufacturing output of the more efficient products and that they could do so, given a reasonable amount of time. Because these more efficient products are now a much larger share of the market (globally), it means that Brunei Darussalam can phase out the products, but on a faster timeframe.

Overall, the government is proceeding down the proper road in developing energy efficiency standards for its two highest energy consuming products, air conditioners and lighting. Supporting this effort requires both short-term and long-term policy considerations and the resources to fund and staff those who will be responsible for ensuring that the standards setting program will remain robust and viable over the years.

Labels:

Labels are an important part of an appliance/product standard program. Labels help consumers make informed choices about which products to buy when they can compare energy cost savings, consumption, or operating costs when they are ready to purchase a product. Performance labels such as just described are important for consumer education, but an endorsement label which identify products that meet or exceed a specific energy efficiency label are also important.

Examples of Endorsement Labels in Other APEC Economies:

One of the most widely recognized endorsement labels is that of the United States' Energy Star label – consumers recognize the Energy Star brand and know they are purchasing a product in the highest efficiency category.



Likewise, Thailand has developed a well-recognized performance label that has had tremendous success in transforming the market in those product categories and which is based on a numerical system of 1 through 5, with 5 being the most efficient product



Malaysia has a comparative “five star” label system that is easily recognizable and provides a rating (one star worst, 5 stars best) and good consumer information. In addition, Malaysia has a companion label to the Star Label system; an Endorsement Label from its Energy Commission⁵⁴.



Chinese Taipei has an endorsement label for its green building program– buyers understand that this label indicates that the building meets a certain minimum level of efficiency that they can rely upon.



Labels also pose a number of challenges. For example, just deciding on the type of label and rating scheme can be difficult. Recognition by consumers of the rating scheme (Is 5 stars the highest rating?), the need to brand the label over time, and the amount of information that can be displayed on the label are all important aspects that must be addressed.

A simple and straightforward label is generally best, but some energy (and cost) saving information can be critical to the consumer understanding the full benefit that will accrue to them if they purchase the item. An example of a label that shows both energy use on a comparative basis with other similar product models and the cost to operate the specific product can help the consumer easily determine their cost savings and make a decision as to the product they want to purchase.

⁵⁴ APERC's Peer Review on Energy Efficiency in Malaysia (2011), Chapter 8: Appliances and Equipment

EDPMO should also consider establishing a priority list for other products and a timetable for when it would be appropriate to set energy efficiency standards for these products as well.

Recommendation 44: *Benchmark Brunei Darussalam's standards to established international or other regional standards.*

For instance, the air conditioner standard may be set to the level of energy performance required under other regional economies level (e.g. at Singapore's coefficient of performance (COP)) while for ballasts in lighting products, the EC Level 1 standard may be the initial benchmark.

The benchmark should be updated in step with the other economies' benchmarked standards and signal the market in advance.

Recommendation 45: *Enforcement of the set standards should be a priority. Therefore, plan resources to ensure that stringency is maintained and enforcement is carried out.*

Recommendation 46: *Allow a grace period for sellers to sell out their existing inventory of inefficient products and limit their ability to import such products prior to the standards' effective date.*

Recommendation 47: *Develop a product label that is easily identifiable by consumers and uses a simple rating system.*

For example, use a five-star system, such as the rating systems used on labels in some other Asian economies. Cost savings data should be provided on the label as this is the most understandable metric for consumers and will help them make the most cost effective choice of energy efficient products.

APPENDIX A: PEER REVIEW TEAM MEMBERS

Mr Takato Ojimi, Peer Review Team Leader, President, Asia Pacific Energy Research Centre (APERC), Japan

Mr Brian Castelli, Executive Vice President, Programs & Development, Alliance to Save Energy (ASE), Washington, D.C. United States of America

Mr Chirasak Boonrowd, Deputy Executive Director, The Energy Conservation Center of Thailand, Department of Alternative Energy and Efficiency (DEDE), Thailand

Prof Yang Hongwei, Director, Energy Efficiency Center, Energy Research Institute, National Development and Reform Commission, People's Republic of China

Ms Elizabeth Yeaman, Manager, Government Relations and Strategy, Energy Efficiency and Conservation Authority (EECA), New Zealand

Dr Kazutomo Irie, General Manager, Asia Pacific Energy Research Centre (APERC), Japan

Dr Aishah Mohd Isa, Researcher, Asia Pacific Energy Research Centre (APERC), Japan

APPENDIX B: ORGANISATIONS AND OFFICIALS CONSULTED

Energy Department, Prime Minister's Office (EDPMO)

Yang Berhormat Pehin Datu Singamanteri Kolonel (B) Dato Seri (Dr) Awg Hj Mohammad Yasmin Bin Hj Umar, Minister of Energy

Ms Noor Dina Zharina Binti Hj Yahya, Head of Stakeholders Relations, EDPMO

Mr Abdul Hakeem Bin Hj Basir, Head of Policy, Legal & Licensing, EDPMO

Energy Efficiency and Conservation (EEC) Unit, EDPMO

Mr Abdul Salam Bin Hj Abdul Wahab, Head of Energy Efficiency and Conservation (EEC) Unit, EDPMO

Ms Marlina Binti Hj Japar @ Diana, Project Officer, EDPMO

Mr Asrul Sany Bin Hj Mohammad Ali, Chief Technical Assistant, EDPMO

Mr Awang Abdul Rahman Bin Ariffin, Project Coordinator, EDPMO

Strategy, Planning, Economic & Intelligence (SPEI) Unit, EDPMO

Dr Andi Tabrani, Head of Strategy, Planning, Economic & Intelligence (SPEI) Unit, EDPMO

Hj Amirul Ariffin Bin Hj Mohd Salleh, Chief Technical Assistant, EDPMO

Ms Nurkhayrul Bariyyah Binti Hj Abdul Salam, Special Duties Officer, SPEI Unit, EDPMO

Department of Electrical Services (DES), EDPMO

Pg Jamra Weira bin Pg Hj Petra, Acting Deputy Director, DES

Freddie Stephen Tong, Engineer, Generation Division, DES

Mr Edwin Chong Yun Kui, Plant Manager, Bukit Panggal Combined Cycle Power Station

Ministry of Communication

Dr Hj Supry bin Haji Awg Ladi, Acting Director of Transport, Ministry of Communication

Hj Rozaly bin Hj Saedon, Senior Special Duties Officer, Ministry of Communication

Ministry of Development

Dr Rohaniyati Binti Pehin Orang Kaya Laila Wangsa Dato Seri Paduka Hj Md. Salleh, Deputy Director of Mechanical & Electrical Services, Public Works Department

Brunei National Energy Research Institute (BNERI)

Dr Weerawat Chantanakome, Chief Executive Officer, BNERI

Dr Xunpeng Shi, Chief Researcher-Energy Efficiency, BNERI

Dr Romeo Pacudan, Chief Researcher – Renewable Energy, BNERI

Mr Ahmad Bin Hj Mohamad, Senior Researcher, BNERI

Sustainable Development Capital (Asia) Limited (SDCL)

Mr Glen Plumbridge, Director, SDCL

Universiti Brunei Darussalam (UBD)

Assoc. Prof Dr Sathyajith Mathew, Energy Research Group, UBD