Chapter 15

Singapore Country Report

Tilak K. Doshi
Energy Studies Institute (ESI), National University of Singapore (NUS), Singapore

Allan Loi
Energy Studies Institute (ESI), National University of Singapore (NUS), Singapore

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CHAPTER 15

Singapore Country Report

TILAK K DOSHI AND ALLAN LOI

Energy Studies Institute (ESI), National University of Singapore (NUS), Singapore

1. Background

Singapore is a small island-state in Southeast Asia, located along the Straits of Malacca between Malaysia and Indonesia. It is the most urbanized and industrialized country in the ASEAN, with a yearly GDP per capita of S$65,048 in 2012[1] and is fully electrified. It has a national policy framework to maintain a balance among the policy objectives of economic competitiveness, energy security and environmental sustainability.[2] Singapore has a national target of improving energy intensity by 20.0 percent by 2020 and 35.0 percent by 2030 as compared to 2005[3]. It also has a voluntary target of reducing carbon dioxide (CO_2) emissions by 7-11 percent below business-as-usual levels in 2020,[4] which will be increased to 16.0 percent below business-as-usual levels if there is a global agreement on climate change.

[1]Singapore Department of Statistics (2013).
[2]Ministry of Trade and Industry of Singapore (2007).
[3]Singapore Government (2009).
[4]National Climate Change Secretariat (2012).

Singapore's Policy Initiatives

An inter-agency Energy Efficiency Programme Office (E^2PO), led by the National Environment Agency (NEA) and the Energy Market Authority (EMA), was established in May 2007 to help promote and facilitate the adoption of energy efficiency in Singapore.[5]

Since January 2008, the Mandatory Energy Labelling Scheme (MELS) imposed the compulsory display of energy labels on household appliances.[6] Currently, all registrable refrigerators, air-conditioners and clothes dryers sold in Singapore must have an energy label. Televisions will be included in the scheme from 2014 onwards.[7] NEA is reviewing the design of energy labels and is looking into incorporating the estimated energy cost of operating appliances to help consumers make more informed decisions.[8] MELS has so far been successful and will continue to improve energy efficiency and mitigate growth of energy use in the residential, commercial and transport sectors. NEA also launched a "10% Energy Challenge" national campaign in 2008 to promote electricity saving in households.[9] The further efficacy of these existing labelling standards and educational campaigns in facilitating energy conservation and efficiency improvements will depend on how responsive end-users are to these initiatives.

After introducing the MELS and the Fuel Economy Labelling Scheme (FELS), NEA subsequently implemented Minimum Energy Performance Standards (MEPS) for household air conditioners and refrigerators. MEPS eliminate energy inefficient appliances from the market by prohibiting the sale of appliances that fall short of a specified minimum efficiency level. It helps consumers avoid being locked into using inefficient appliances with high operating costs and encourages suppliers to bring more energy-efficient appliances to the market as technology improves. MEPS standards have recently been tightened this year, and will start to incorporate clothes dryers and general lighting in 2014.

The Building and Construction Authority (BCA) of Singapore launched the BCA

[5]Energy Efficiency Programme Office (2013b).
[6]National Environment Agency (2008a).
[7]Ministry of the Environment and Water Resources (2013).
[8]Ministry for the Environment and Water Resources (2012b).
[9]National Environment Agency (2008b).

Green Mark Scheme in January 2005 to promote environmental awareness in the construction and real estate sectors. Since April 2008, all new buildings and existing buildings undergoing major retrofitting works with a gross floor area above 2000 square meters must meet Green Mark Certified standards. The BCA Green Mark Scheme promotes the adoption of green building technologies and reduces the use of electricity in the commercial sector via efficiency improvements and conservation.[10] This scheme has recently been extended to include data centres. The BCA has also recently developed a web-based carbon emission calculator that takes into account a building's lifespan and major construction materials to help builders quantify the carbon impacts of each carbon-related Green Mark criteria.[11] In the case of building standards, there are some uncertainties as to how effective these standards will be in the long run, even if relatively detailed calculations about expected energy savings from engineering measurements can be made.

Certificates of Entitlement (COEs) give Singaporeans the right to own a vehicle. COEs are integral to the Vehicle Quota System (VQS), a landmark scheme implemented to regulate the growth of the vehicle population in Singapore. Under the VQS, the vehicle population growth rate has been capped at 1.5 percent per year between 2009 and 2011,[12] down from the 3.0 percent cap in place three years ago given the constrained expansion of roads and highways in Singapore's urban environment. The actual compound annual growth rate of the vehicle population between 1990 and 2008 was 2.8 percent per year. The existing annual vehicle growth rates imposed by the Land Transport Authority (LTA) for a period of 3 quota years (2012-2014) is 1.0 percent in 2012 and 0.5 percent in 2013 and 2014.[13]

The Fuel Economy Labelling Scheme (FELS) mandated fuel economy labels to be affixed to vehicles at the point of sale. The FELS has been complemented by a Green Vehicle Rebate (GVR) Scheme which provides rebates of up to 40.0 percent of the vehicle's Open Market Value for green vehicles such as electric, petro-electric hybrid, Compressed Natural Gas (CNG) and Bi-fuel (CNG/Petrol) vehicles, narrowing their cost differentials. The GVR seeks to encourage the purchase of

[10]Building and Construction Authority Singapore(n.d.).
[11]Energy Efficiency Programme Office (2013a).
[12] Land Transport Authority (2010).
[13] Land Transport Authority Singapore (n.d.).

green vehicles, which are more fuel efficient and emit less air pollutants than their internal combustion equivalents.

The old Rebate Scheme based on engine type expired on 31 December 2012. Under the current scheme, buyers of cars with low carbon dioxide emissions (≤ 160 g carbon emissions per kilometre) will enjoy tax rebates (of up to SGD 20,000) to offset the Additional Registration Fee[14]. This is referred to as the Carbon Emission-based Vehicle Scheme (CEVS). To give consumers and the automobile industry more time to adjust, those who buy cars with high CO_2 emission (≥ 211 gCO_2/km) will face registration surcharges (of up to SGD 20,000) levied in cash six months later (July 2013). The majority of car buyers will not be affected either way by the new Scheme if they keep to their usual buying patterns. Around 60.0 percent of cars registered in 2011 fall into a neutral category (with 161-210 gCO_2/km carbon dioxide emission), implying neither rebates nor surcharges will be faced.[15] The new Scheme will be in place for two (2) years and be reviewed at the end of 2014.

The Government launched the Energy Efficiency National Partnership (EENP) programme in 2010 to help companies put in place energy management systems and implement projects to improve energy efficiency. The Government introduced mandatory energy management requirements for large energy users who consume more than 15GWh in the industry sector. Under the Energy Conservation Act from April 2013 onwards, these large energy users have to appoint an energy manager, monitor and report energy use and greenhouse gas emissions and submit annual energy efficiency improvement plans to the government from 2014 onwards.[16] The Energy Conservation Bill, which was passed in Parliament on 9 April 2012, consolidates laws on energy efficiency. The Energy Conservation Act will be jointly administered by the Ministry of Environment and Water Resources, which will oversee the measures in the industry and household sectors and the Transport Ministry, which will oversee the transport measures.[17]

[14]Additional Registration Fee is a tax imposed upon registration of a vehicle and calculated based on a percentage of the Open Market Value of the vehicle.
[15]Ministry of Transport (2012).
[16]National Environment Agency (2013).
[17]Ministry of the Environment and Water Resources (2012a).

2. Modelling Assumptions

Two scenarios were developed to assess the energy saving potential of the energy efficiency and conservation policies in Singapore. The "Business As Usual" (BAU) scenario forecasts energy demand and CO_2 emissions by incorporating energy policies implemented up until the end of 2012, while the "Alternative Policy Scenario" (APS) projects energy use and CO_2 emissions with a comparatively higher uptake of energy efficiency and conservation policies. In this case, demand management policies are assumed to be more effective, as human behaviour is more "elastic" or responsive to such policies.

In 2010, the overall thermal efficiency of gas fired power plants in Singapore was 49 percent. According to the International Energy Agency (IEA), the average thermal efficiency of combined cycle gas turbine (CCGT) generators was 57.0 percent and that of conventional power plants was 41.1 percent.[18] It is assumed that the efficiency of gas and thermal power plants will improve under both the BAU and APS scenarios. By 2035 under APS, it is assumed that gas-fired turbines will attain 54.0 percent efficiency, while thermal power plants will attain an efficiency of approximately 41.0 percent. In both scenarios, the share of electricity contributed by solar power reaches 5 percent by 2035.

Another assumption made is that gasoline demand is linearly proportional to Singapore's car population. The LTA has capped the growth rate of vehicles at 1.5 percent between 2009 and 2011. The annual vehicle population growth rate was further reduced to 1.0 percent in 2012 and is currently at 0.5 percent till 2014.

A joint study conducted by the Building and Construction Authority (BCA) and the National University of Singapore (NUS) demonstrated that retrofitting to achieve the standard BCA Green Mark certification can result in a 17.0 percent reduction in energy demand.[19] If measured by the area of the buildings where owners are responsible for paying for the utilities, the average savings are even higher at nearly 30.0 percent. In 2005, the total number of buildings awarded the Green Mark Scheme was 17. As in March 2013, there were around 1500 Green Mark building

[18]International Energy Agency (2010).
[19]Yu, *et al.* (2011).

projects in Singapore.[20] At this pace, Singapore is on track to achieve its target of having 80.0 percent of its existing and future buildings Green-Mark-certified by 2030.[21]Given our understanding of the vintage of building stock in Singapore and building stock replacement rates, a 17.0 percent reduction in electricity use relative to the baseline case in the BAU scenario, and a 20.0 percent reduction in the APS has been assumed in the commercial sector.

With reference to the IEA's Energy Technology Transitions for Industry 2009, the application of Best Available Technology (BAT) could reduce energy use in the industry sector by 13-29 percent.[22] Hence, the energy saving potential in the industry sector is taken to be 5.0 percent and 10.0 percent in 2030 in the BAU and APS scenarios, respectively.

Singapore has a long-term aim of expanding ethylene production to a range of 6-8 million tons per year by 2020.[23] Singapore's petrochemical complex primarily uses LPG and naphtha to produce olefins, ethylene, and propylene. Most ethylene plants in Singapore are naphtha-based; therefore, capacity additions in the petrochemical sector will affect naphtha demand. In 2010, naphtha accounted for 99.0 percent of the petrochemical feedstock in Singapore and LPG 1.0 percent.[24]In December 2012, a new 220 megawatt petrochemical co-generation plant was added to ExxonMobil's existing petrochemical operations, adding 2.6 million tons per year to its finished product capacity.[25] According to the IEA, 155.0 GJ of naphtha is required to produce one ton of ethylene. If the share of naphtha in the production of ethylene increases to 100.0 percent by 2020 and the above conversion factor is used, the production of 6.0 million tons of ethylene implies the demand of 22.2 Mtoe of naphtha in the non-energy sector.

[20]Building and Construction Authority Singapore (2013).
[21]Building and Construction Authority Singapore (n.d.).
[22]International Energy Agency (2009).
[23]Economic Development Board (2007).
[24]International Energy Agency (2012).
[25]ExxonMobil Chemical (2012).

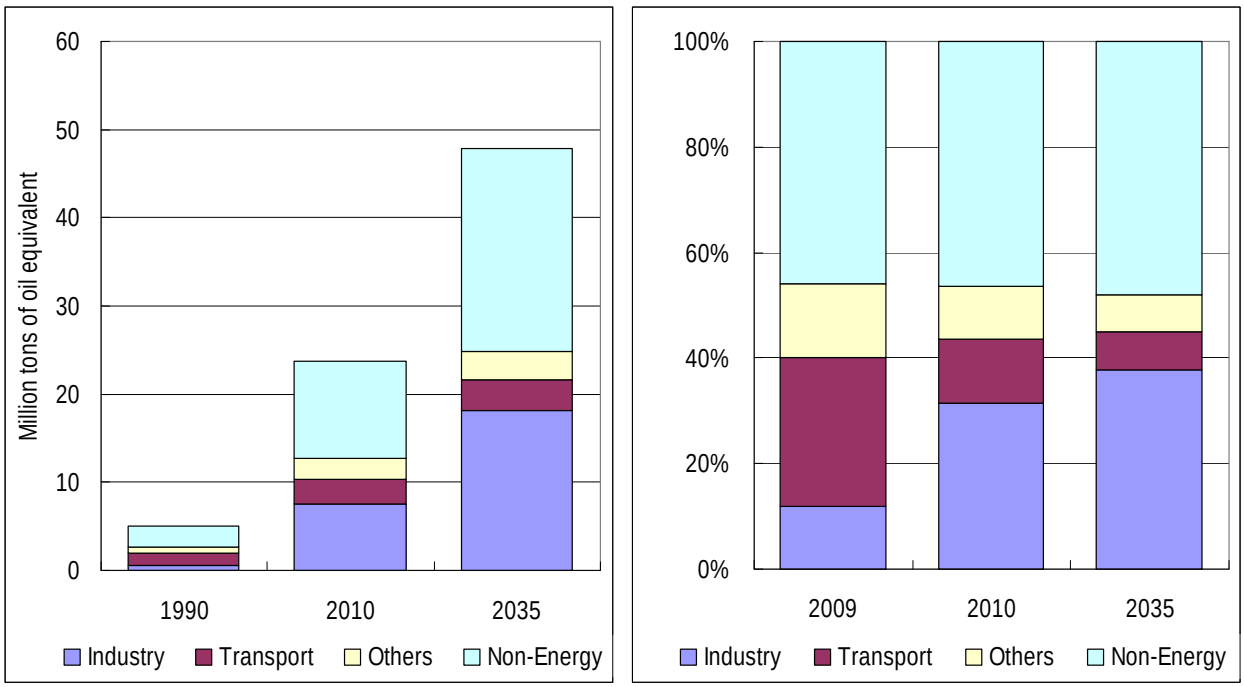
3. Outlook Results

3.1. Business-as-Usual

3.1.1. Total Final Energy Demand

Singapore's total final energy demand grew at an annual rate of 8.1 percent from 5.0 Mtoe in 1990 to 23.7 Mtoe in 2010. Also for the same period, oil constitute majority of the country's final energy demand from 3.8 Mtoe in 1990 to 19.1 percent in 2010. More than 46.0 percent of the country's final energy is consumed for non-energy uses, particularly as feedstock for petrochemical production. In year 1990, 28.0 percent of the total final energy demand is used in the transport sector although its share to the total final energy demand declined to more than fifty (50) percent reaching around 11.9 percent only in 2010.

Figure 15-1: Final Energy Demand by Sector, BAU



Under the BAU, total final energy demand is projected to grow by 2.8 percent a year between 2010 and 2035. The fastest growth is expected to occur in the industry sector, increasing by 3.6 percent a year. This is followed by the non-energy sector which is projected to grow by 3.0 percent a year (Figure 15-1 above). The transport sector is projected to grow by 0.8 percent per year while the "others" (residential and

commercial) sector is projected to grow by 1.3 percent per year.

Under the BAU, non-energy consumption will comprise the highest share in the total final energy demand followed by the industrial sector. By end of 2035, non-energy use will reach almost 50.0 percent of the total final energy demand of the country. Similarly, the industrial sector's share will increase from a mere 12.0 percent share in 1990 to around 37.8 percent in 2035.

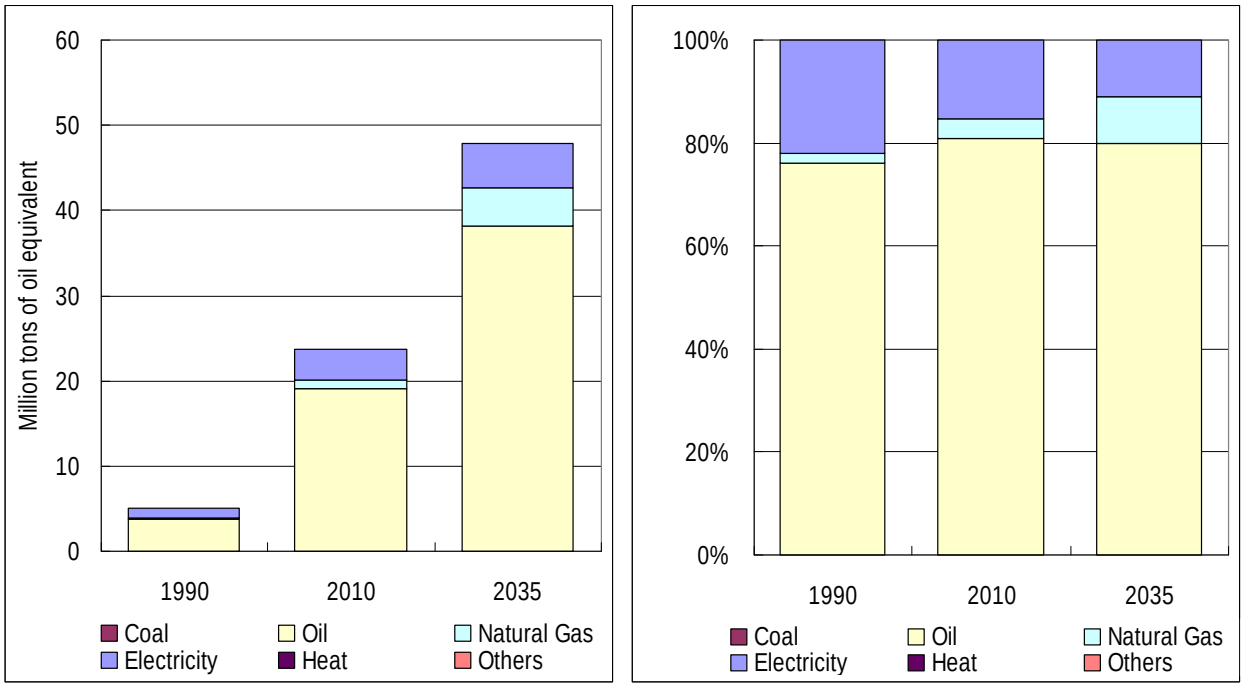
The transport sector share in the total final energy demand for the period 2010 to 2035 is expected to decrease to 7.3 percent from its 11.9 share in 1990. The decrease is due to the country's promotion for more efficient technology and use of mass transit for transport.

By fuel type, electricity experienced the fastest growth over the 1990 to 2010 period, at an average rate of 11.8 percent per year. The rapid growth of electricity was due increasing demand for electricity, particularly of the productive sectors of the economy (industry and commercial sectors). Also for the period 1990 to 2010, demand for natural gas grew at an average annual growth of 8.4 percent yearly.

Under the BAU, the share of natural gas is expected to expand increasing at an average growth of 6.4 percent per year. Meanwhile, there will be a minimal growth on electricity demand of 1.5 percent per year.

Oil still plays a major role in the country's final energy demand. For the past two decades, that is, periods 1990 to 2010, the share of oil increased from 76.0 percent to around 81.0 percent. Under the BAU, oil's share to the total final energy demand will remain at around 80.0 percent until 2035. Further, natural gas usage will increase from its share of 3.9 percent in 2010 to 9.1 percent in 2035. Meanwhile, the share of electricity in the final energy demand will be decreased to around 11.0 percent starting 2025 and this level will be maintained until 2035. Figure 15-2 shows the final energy demand by fuel in 1990, 2010 and 2035.

Figure 15-2: Final Energy Demand by Fuel, BAU



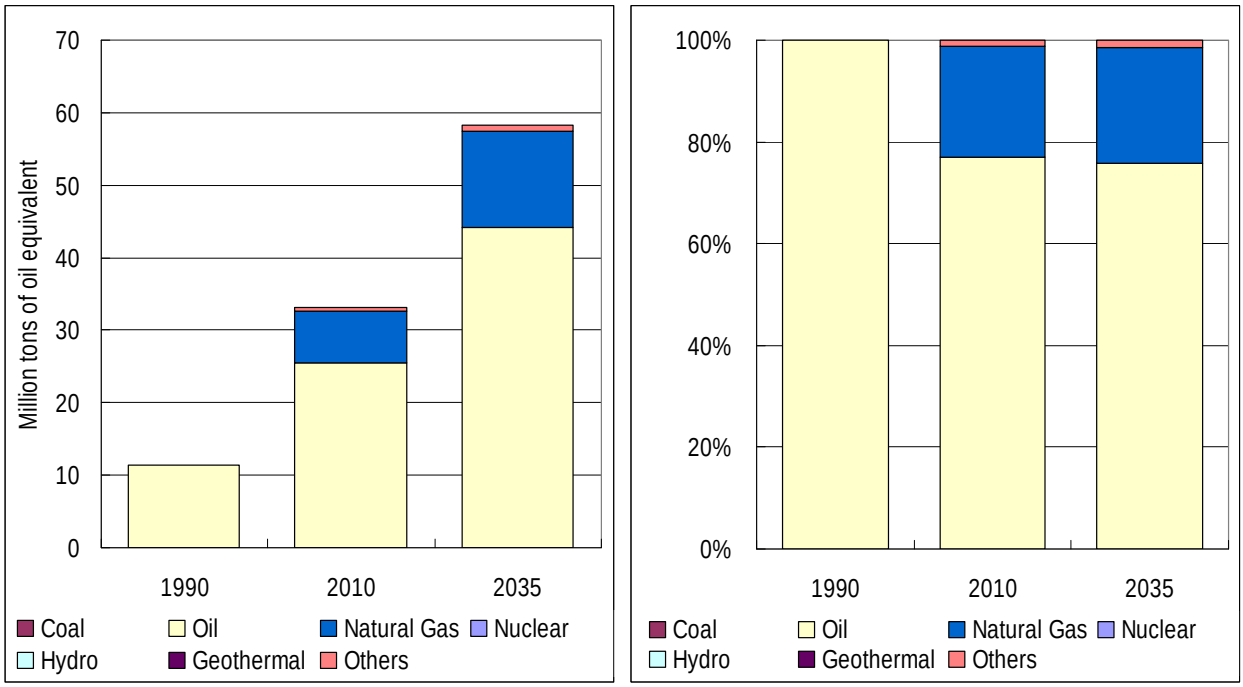
3.1.2. Total Primary Energy Demand

Total primary energy demand grew by 5.5 percent per year, from 11.4 Mtoe in 1990 to 33.1 Mtoe in 2010. Singapore's only source of energy in 1990 was oil, of which consumption increased by 4.1 percent yearly from 11.4 Mtoe in 1990 to 25.5 Mtoe in 2010. Following the construction of pipelines for gas-fired power plants, the first of which sourced gas from Malaysia in 1991, and two (2) more recent pipelines from Indonesia, the share of natural gas has increased. Consumption of natural gas increased rapidly from 0.4 Mtoe in 1992 to 7.2 Mtoe in 2010 at a growth rate of 16.4 percent per annum. To expand the country's import capability and sourcing options, Singapore has recently commenced commercial operations with its newly constructed LNG terminal, which will reach a throughput capacity of 6.0 million tons per year by the end of 2013[26], and 9 million metric tons per annum (Mtpa) thereafter in the near future.

[26] Boon, 2013

Primary energy demand in the BAU is projected to grow by 2.3 percent per year between 2010 and 2035. Among the energy sources, natural gas is expected to grow the fastest at 2.5 percent a year followed by oil at 2.2 percent. Natural gas demand is expected to grow in line with the expansion of gas-fired power plants (Figure 15-3). Other sources of energy will increase their collective share to Singapore's energy mix from 0.4 Mtoe (1.2 percent) in 2010 to 0.9 Mtoe in 2035 (1.5 percent).

Figure 15-3: Total Primary Energy Demand, BAU



Over the next few years, Singapore's net generation capacity will increase by more than 2000 MW or about 20.0 percent of current installed capacity and will comprise by more efficient CCGTs[27]. Nevertheless, oil is expected to remain the primary energy source accounting for 76.0 percent of primary energy demand in 2035 followed by natural gas at 23.0 percent.

3.1.3. Power Generation

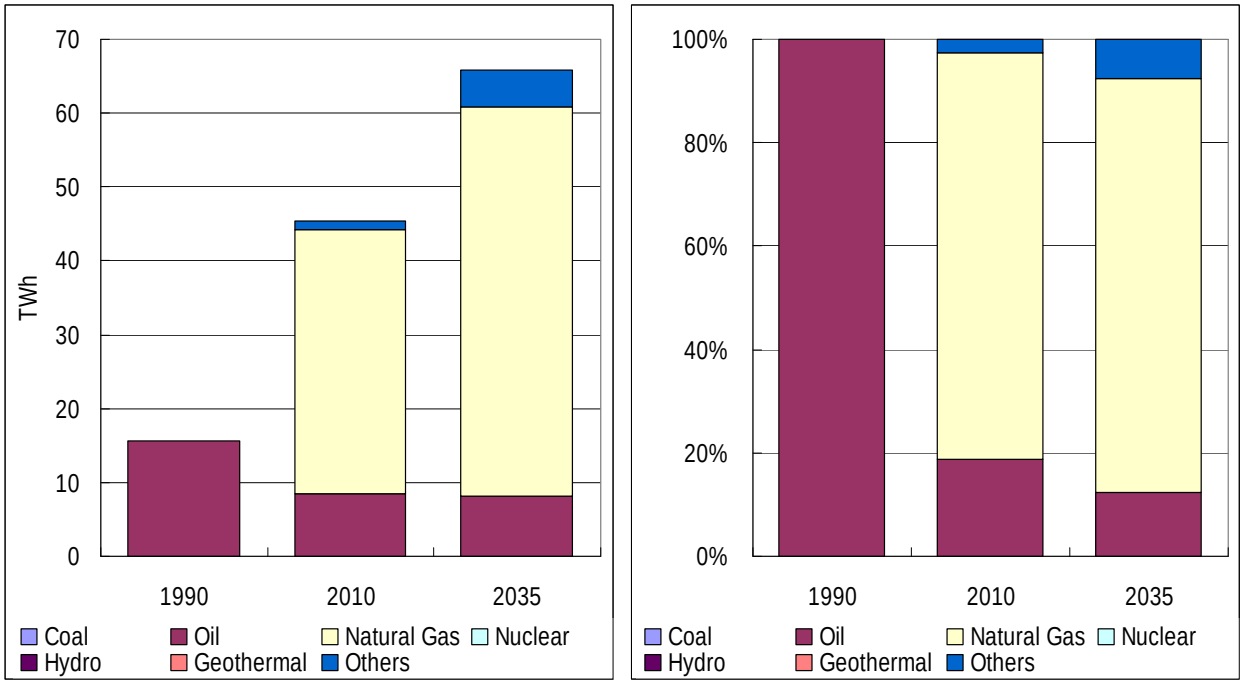
Electricity generation grew by 5.5 percent per year from 15.7 TWh to 45.4 TWh over the period 1990 to 2010. The electricity generation mix has changed

[27]Ministry of Trade and Industry (2012).

significantly over the past decade. Natural gas, which accounted for 28 percent of electricity generation in Singapore in 2001, grew rapidly to supply 79.0 percent of Singapore's electricity by 2010. Currently, fuel oil use for thermal power generation is around 18.4 percent[28] and is seen as a reasonable "balancing" alternative to a total dependence on natural gas. Biomass takes up a small proportion of the mix, at around 3.6 percent

In the BAU scenario, power generation is projected to increase at a slower rate of 1.5 percent per year reaching 65.8 TWh in 2035. By type of fuel, generation from "Others" will have the fastest growth at an average rate of almost 6.0 percent per year. "Others" power generation is expected to increase its share from a minimal share of 2.6 percent in 2010 to 7.6 percent in 2035.

Figure 15-4: Power Generation by Type of Fuel (TWh), BAU



By 2035, almost 80.0 percent of the country's power generation mix will come from natural gas under the BAU. On the other hand, the share of oil will be at 12.4 percent over the same period.

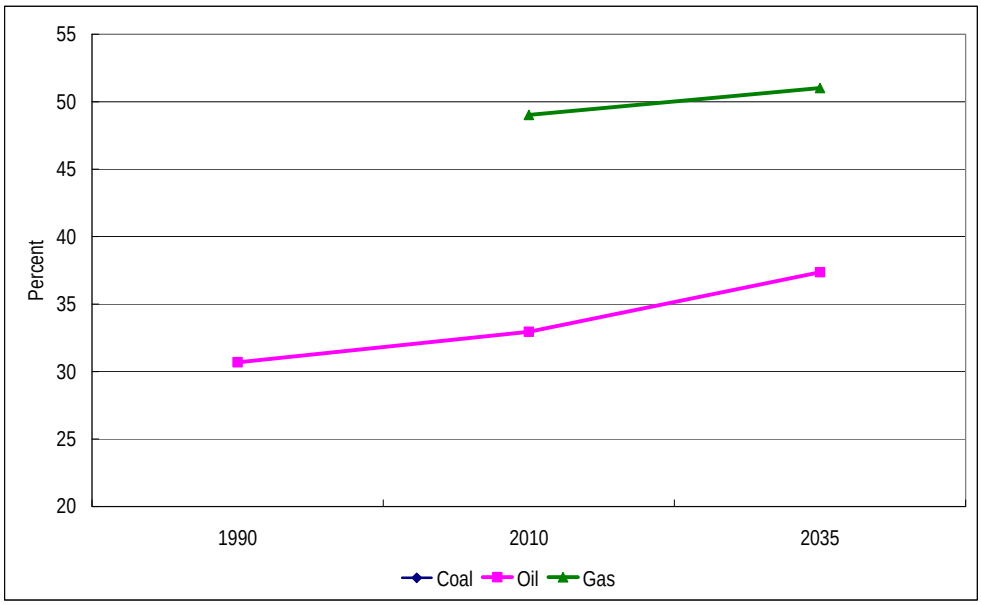
The average thermal efficiency of fossil power plant was around 30.7 percent

[28]Energy Market Authority (2012).

in 1990 and improved to 44.8 percent in 2010. In the BAU scenario, thermal efficiency of fosssil plants is expected to improve at around 48.6 percent in 2035.

By fuel, natural gas plants thermal efficiency will be 51.0 percent in 2035 while oil will be at 37.4 percent.

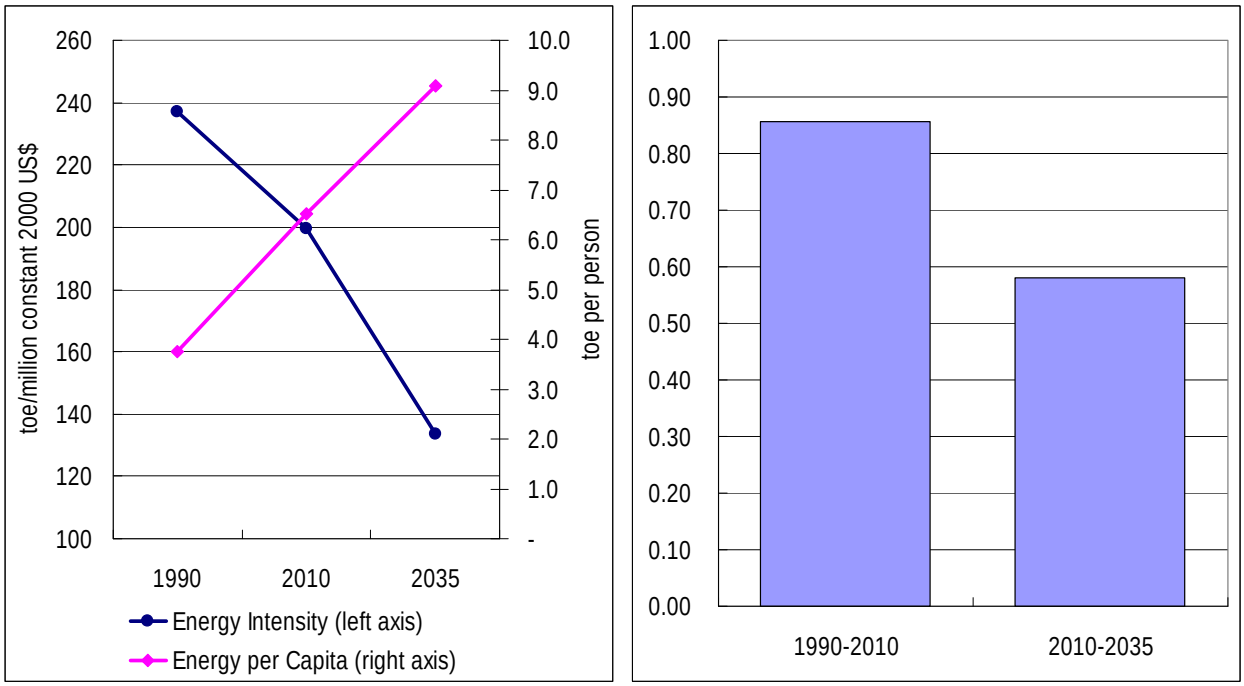
Figure 15-5: Thermal Efficiency, BAU



3.1.4. Energy Indicators

Total primary energy intensity which is computed as the ratio of total primary energy demand over GDP is expected to drop by 33.0 percent from 2010 to 2035 from 200 toe/million 2000 USD to 133 toe/million 2000 USD in 2035. This is an indication that energy producers and consumers has started to effectively use energy through the implemetation of energy conservation measures and greater utilization of efficient energy technologies.

Figure 15-6: Energy Intensity, Energy Per Capita and Energy Elasticity, BAU



The per capita energy demand, measured as the ratio of total primary energy demand to the total population, has been increasing since 1990 from 3.7 toe/person to 6.5 toe/person in 2010. This level of per capita energy demand is high compared to other East ASEAN countries which is an indication that energy access of the society is very high.

Under the BAU scenario, the energy demand per capita will continue to increase and will reach 9.1 toe per person in 2035.

Further, the elasticity of final energy demand under the BAU is expected to decline from 3.3 in periods 1990 to 2010 to around 0.7 in 2035. Elasticity below 1.0 is an indicator that growth in final energy demand will be slower than growth in GDP over the period 2010 to 2035.

3.2. Energy Saving and CO_2 Reduction Potential

3.2.1. Total Final Energy Demand

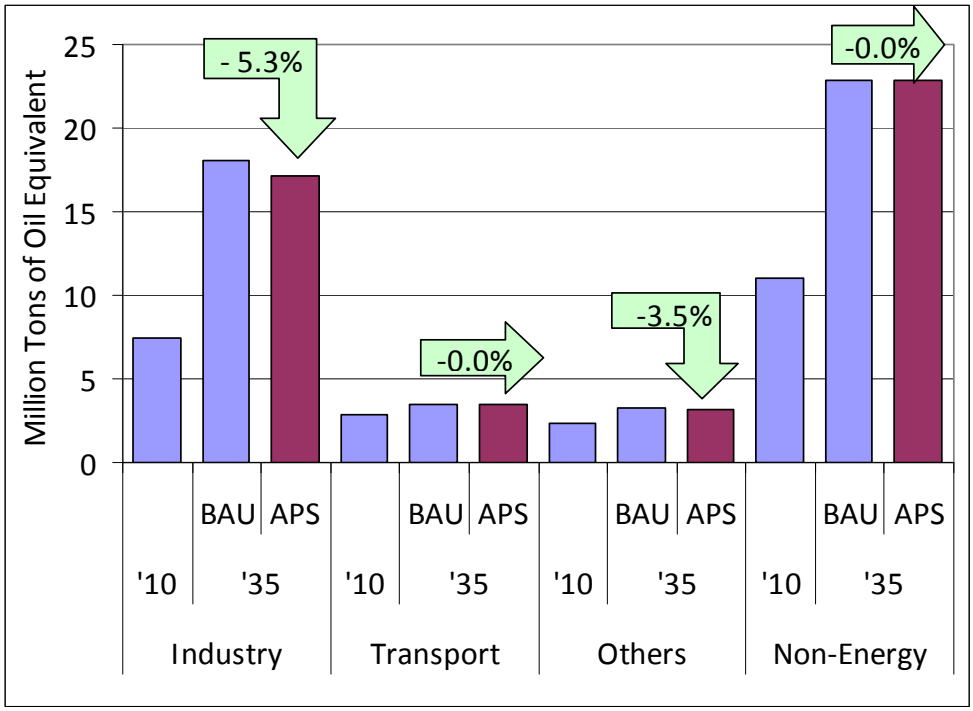
Final energy demand under the APS is projected to increase by 2.8 percent per year between 2010 and 2035. Akin to the BAU, the industry sector is projected to exhibit the fastest growth under the APS at 3.4 percent, followed by the non-energy sector at 3.0 percent and the other (residential and commercial) sector at 1.2 percent.

The industry sector realizes the largest saving at around 5 percent (Figure 15-7). In addition, a 10.8 percent improvement will be achieved on the use of electricity for the period 2010-2035.

In terms of final energy demand savings, it is projected that the industrial sector and the other (residential and commercial) sectors will have savings of 952 ktoe and 115 ktoe, respectively.

Both in the BAU and APS, the Energy Labelling Scheme, the EENP programme and BCA Green Mark Scheme retard the growth of energy use in the industry and other (which includes commercial and residential) sectors. Similarly, the VQS reduces energy use in the transport sector.

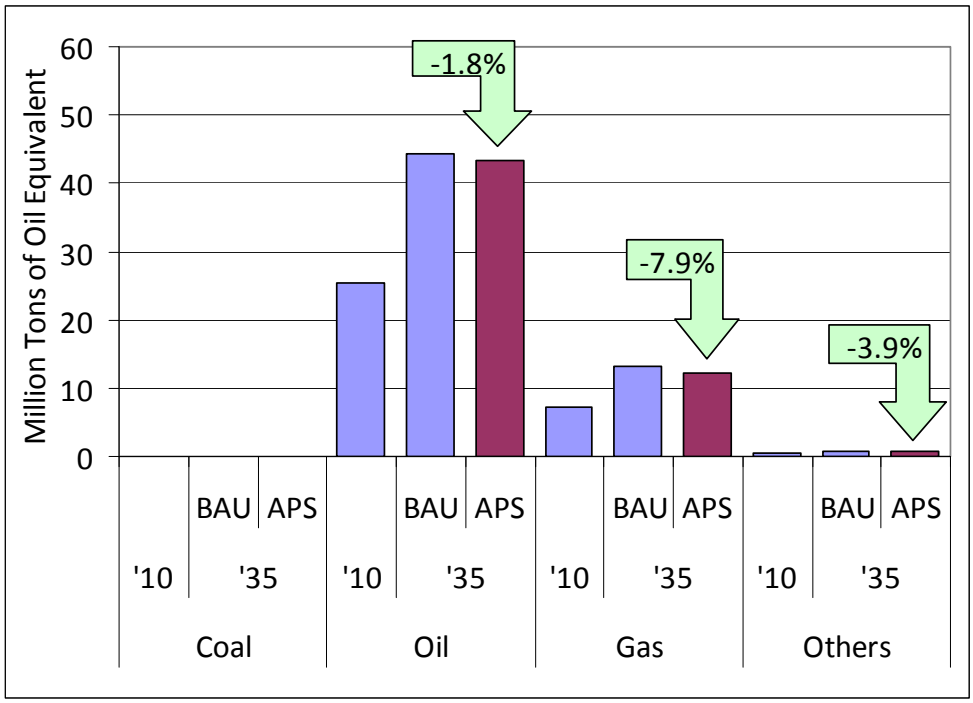
Figure 15-7: Total Final Energy Demand by Sector, BAU and APS



3.2.2. Total Primary Energy Demand

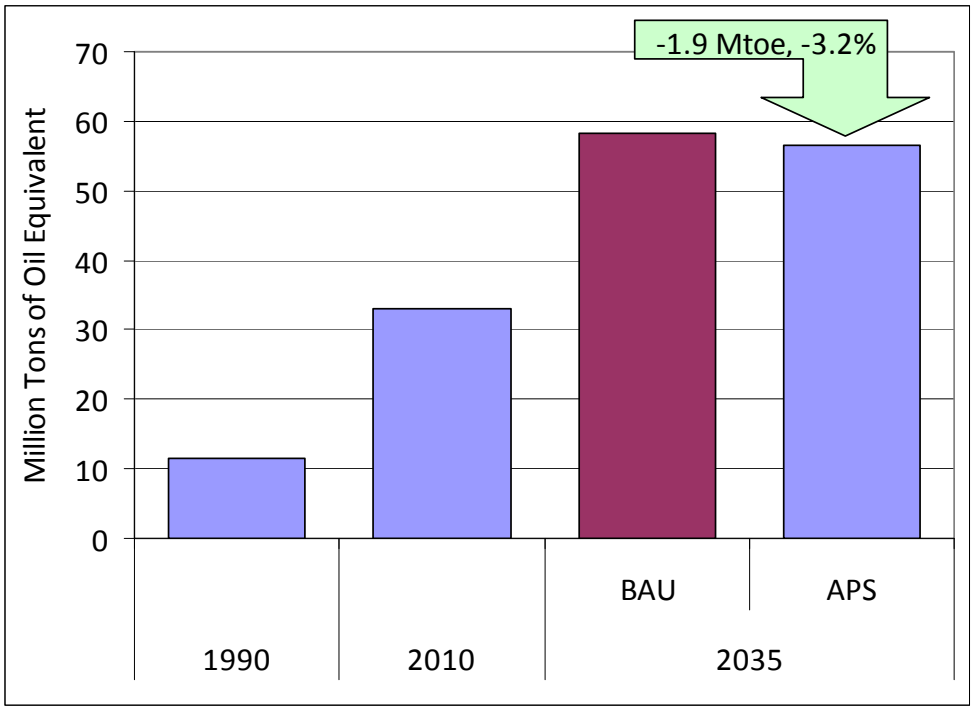
Results of the APS show that primary energy demand for the period 2010-2035 is expected to grow by 2.2 percent a year. In 2035, the difference between the growth rates of the BAU Scenario and the APS results in a 3.2 percent reduction in energy use. Natural gas will have a slower growth rate of around 2.1 percent a year, registering the largest decrease of 7.9% in comparison to BAU (Figure 15-8). Oil will still be the country's primary energy source with a 76.9 percent share, followed by natural gas with a 21.6 percent share.

Figure 15-8: Total Primary Energy demand by Source, BAU and APS



In 2035 it is estimated that Singapore's EEC goals, action plans and policies could result in savings of 1.9 Mtoe which is the difference between primary energy demand in the BAU scenario and the APS (Figure 15-9). This is about 5.6 percent of Singapore's demand in 2010.

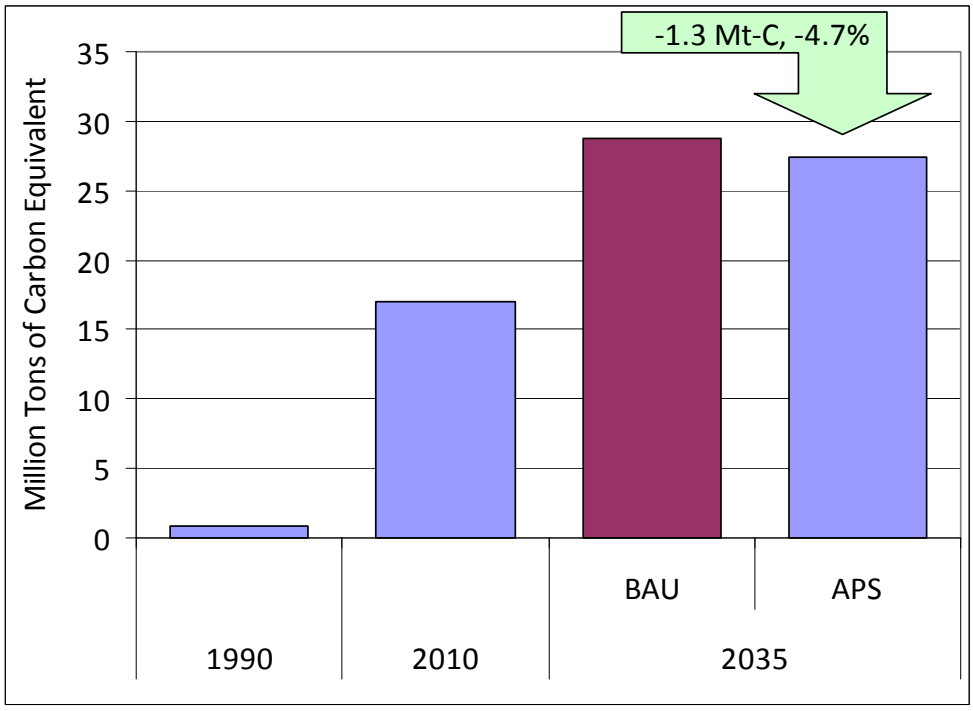
Figure 15-9: Total Primary Energy Demand, BAU and APS



3.2.3. CO_2 Reduction Potential

Carbon dioxide (CO_2) emissions from energy demand are projected to increase at an average annual rate of 2.1 percent, from 17.0 Mt-C in 2010 to around 28.7 Mt-C in 2035 (Figure 15-10). In the APS, the annual average growth in CO_2 emissions from 2010 to 2035 is expected to be lower than in the BAU scenario at 1.9 percent, which is also a 4.7% decrease from the BAU.

Figure 15-10: CO_2 Emissions from Energy Consumption, BAU and APS



4. Implications and Policy Recommendations

The impetus for a reduction in energy use and emissions is provided by the host of programs instituted by the government that seek to incentivize the use of less carbon-intensive fuels and to improve energy efficiency. These programs includes a number of funding schemes, including the Clean Development Mechanism Documentation Grant that help provide companies with financial assistance for the engagement of carbon consultancy services, and Grant for Energy Efficient Technologies (GREET) to help encourage industry investments in energy efficient equipment or technologies.[29] Despite the limitations posed by its small size and paucity of renewable energy sources, Singapore's long-term commitment to building a sustainable city will ensure that the efforts of using energy efficiently and in an environmentally viable manner will continue to receive broad support.

[29]Energy Efficiency Programme Office (2013).

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