FEASIBILITY STUDY OF ENERGY EFFICIENCY IN SINGAPORE

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ABSTRACT

As a small city state without any significant energy resources, Singapore has always been dependent on imports of oil and natural gas to meet the energy needs, causing it to remain vulnerable to numerous supply risks such as insufficient investments in production capacity by energy producers and events such as geopolitical conflicts. Faced with rising energy prices and unpredictable supply disruptions, energy efficiency has become increasingly important to decrease its dependence on energy imports and enhance our energy security whilst reducing business costs and emissions. While energy demand is expected to grow in the future due to economic growth and an increasing population, part of this growing energy demand can be met by using energy more efficiently instead of increasing energy production. Due to the use of better and more efficient technology in the power generation and other sectors, Singapore has reduced its energy intensity by 15% from 1990 to 2005 and 16% between 2005 and 2010. In 2007, the Ministry of Trade and Industry (MTI) developed a national energy policy framework, with Singapore targeting to reduce its energy intensity by 35% from its 2005 levels by 2030 and pledging to cut back on carbon emissions by 16% from 2020 business-as-usual levels. With the industrial sector accounting for 60% of Singapore's energy consumption and 54% of Singapore's carbon dioxide emissions, energy efficiency in the industry is necessary to achieve higher productivity and better profitability. In addition, the case study is the platform of the sharing information and technology to implement the EE.


1. INTRODUCTION

In Asia regional, energy demand growth continued even through the more recent global economic crisis. For example, Singapore is a strategically situated; it has become Asia’s key oil trading and refining hub and could become a major gas hub. Refer Figure 1.
The country’s electricity consumption reached 8,100 kWh in 2011, which is 17 percent lower than in South Korea but 7 percent higher than in Japan. Since 2000 total electricity consumption has increased by 3.6 percent/year; the growth has slowed down compared with the 90s (7.5 percent/year). Electricity consumption growth is mainly driven by the residential and services sector, which now accounts for 63 percent of the electricity demand. Industrial electricity consumption decreased from 47 percent in 1990 to one third of the total in 2011. Refer Figure 2.

Meanwhile, in demand-side which is consumer, the energy consumption divides according the load show in Figure 3.
By that, energy efficiency (EE) is one of the solutions to balance the generation with the energy demand. EE defined as delivered energy service per unit of energy supplied into a system [1]. From the viewpoint of a business owner or household, the ability to operate lighting, machinery, or other equipment are not diminished if an electricity system, for example, can meet that demand with less inputs or units of energy. The value of EE accordingly grounded upon its ability to aid energy systems in meeting end-user needs without requiring an expansion of system capacity.

In a way to provide the energy service and improved the performances between two sides, technology approaches needed like supply side energy efficiency and demand-side of energy efficiency. Not simply expand energy supply; EE prioritizes actions that first reduce the need for energy, decrease energy losses in the supply chain.

2. KEY OF ENERGY POLICIES, TARGETS & OBJECTIVES

Energy policies across the ten ASEAN member states vary considerably, reflecting differences in political direction, economic development and natural resource endowments. Common themes include improving energy security (driven by increasing reliance on imported energy), reducing economic costs (linked to rising imports during this period of persistently high energy prices) and improving the sustainability of energy use (driven by concerns over local pollution and as the region is among the most vulnerable to the adverse impacts of climate change). To achieve these objectives, many ASEAN countries have adopted or announced policies to diversify energy supply, primarily through the increased use of coal, greater use of modern renewables and/or the eventual introduction of nuclear power [4].

EE laws and initiatives are expected to be ramped up in the coming years throughout the region. For instance, the Singapore government will be enacting an Energy Conservation Act from 2013 onwards which will introduce minimum energy management standards and mandatory energy management requirements for energy users that consume more than 15 GWh per annum in the industrial sector. In Malaysia, the Ministry of Energy, Green Technology & Water is currently developing a Master Plan to accelerate the development of EE for the 10th Malaysian Plan and beyond.
Singapore has five key strategies consist of:

i. Diversity energy supplies
ii. Enhance infrastructure and systems
iii. Improve energy efficiency
iv. Strengthen the green economy
v. Ensure competitive energy pricing

Also, Singapore takes steps to become a major gas hub in ASEAN region. Aims to have 5% of peak electricity demand supplied from renewable energy sources by 2020, reduce energy intensity by 20% by 2020 and 35% by 2030 compared with 2005 levels. Singapore has started to implement mitigation and energy efficiency measures with a view to reducing CO2 emissions by 7-11% below the 2020 business-as-usual level. Refer Table 1.

### 3. GRANT AND INCENTIVE SCHEME

Singapore’s unpolluted environment is ensured with the help of our partners from the People and Private sectors who take ownership of a common urban living space. As such, NEA encourages environment friendly practices through our grants and incentives to help organizations adopt greener schemes.

The National Environment Agency (NEA) is the leading public organization responsible for improving and sustaining a clean and green environment in Singapore. The NEA is the agency that develops and leads the environmental initiatives and program through their partnership with the People, Public and Private sectors. NEA is one of the organizations that provides grants and incentives to encourage and helps other organizations to involve in the energy efficiency awareness.

There are a few current grants under the supervision of the NEA, which is the energy efficiency, green technology, 3P Partnership Fund and 3R Fund. For example:

i. Clean Development Mechanism (CDM)
ii. Energy Efficiency Improvement Assistance Scheme (EASe)
iii. Grant for Energy Efficient Technologies (GREET)
iv. Green Technology Grant & Scheme Environment Technology Research
v. Green Vehicle Rebate (GVR)

<table>
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<th>Country</th>
<th>Target</th>
<th>Policies/Programmes</th>
<th>Required Investment (Million)</th>
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<tr>
<td>Singapore</td>
<td>Reduce energy intensity by 20% by 2020 and by 31% in 2030 (excluding)</td>
<td>Sustainable Singapore Initiative (in the Eye of a Environmentalist &amp; Citizen 2020) / Energy Efficiency Improvement Programme (on buildings)</td>
<td>9</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Increase total energy consumption in the industrial, commercial and residential sectors by 19% from 2011 to 2020</td>
<td>Malaysia Industrial Energy Efficiency Improvement Programme (in the Eye of a Environmentalist &amp; Citizen 2020)</td>
<td>90</td>
</tr>
<tr>
<td>Thailand</td>
<td>Reduce 20% of total energy in 2020 relative to the 1990 scenario</td>
<td>Energy Conservation Act (generation for conservation investments in buildings sector)</td>
<td>1200</td>
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<tr>
<td>Vietnam</td>
<td>Reduce energy consumption by 3.5% by 2020 and between 15% by 2016-2015</td>
<td>Vietnam National Efficiency Program (Demand savings of 30.1% national energy consumption by 2015 - 2020)</td>
<td>460</td>
</tr>
</tbody>
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4. EE PROGRAMMES

EE is a practical and cost-effective means of mitigating carbon dioxide emissions while sustaining economic development. Singapore is vulnerable to rising energy costs that can affect the economic competitiveness. Singapore's key strategies in mitigating greenhouse gas emissions are to switch to less carbon-intensive fuels and to improve the energy efficiency.

The Singapore government approach has been adopted to implement measures to improve the energy efficiency and to reduce the energy use of various sectors. To this end, the Energy Efficiency Program Office (E2PO), which is a multi-agency committee lead by National Environment Agency (NEA) and the Energy Market Authority (EMA) has been established. NEA has been actively promoting energy efficiency in the industry, households and public sectors through legislation, incentives and providing information.

Singapore has switched from fuel oil to natural gas as the main energy source for electricity generation. Natural gas produces the least carbon emissions per unit of electricity generated amongst fossil fuel-fired power plants. By increasing the share of natural gas used in electricity generation, from only 19% in 2000 to about 80% today, Singapore has substantially reduced its emissions growth over the last ten years.

E2PO divide into three sectors: -

i) Household Sector
ii) Public Sector
iii) Industrial Sector

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<th>Sector</th>
<th>Role</th>
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<tr>
<td>Household</td>
<td>Designing an energy efficient home, buying energy efficient appliances and adopting energy-saving approaches.</td>
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<td>Save Energy Save Money initiative – awareness for high-end users.</td>
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<td></td>
<td>A simple Home Energy Audit can be conducted to find out the most energy-consumed appliances in the house and find a way to reduce/manage the energy use.</td>
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<td>Mandatory Energy Labeling was introduced for registrable goods since 1 January 2008. Refer Figure 4.</td>
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<tr>
<td>Public</td>
<td>Taking lead in using resources more efficiently. Improving energy which benefits the environment and saves money is a key thrust of the public sector taking the lead in environmental sustainability (PSTLES) programed.</td>
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<tr>
<td>Industrial</td>
<td>The largest energy-consuming sector in Singapore.</td>
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<td></td>
<td>The Energy Efficiency Promotion Centre (EEPC) serves as a convenient one-stop entre for providing industrial energy efficiency related resources.</td>
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5. CASE STUDIES

Case 1: Punggol Eco-Town in Singapore
The project is collaboration between Japanese electronics giant Panasonic and government agencies – the Housing and Development Board (HDB), the Economic Development Board (EDB) and the Energy Market Authority (EMA). This projects start with 10 households in the block of HDB flats. An integrated energy system will help families reduce their carbon footprint as well as their utilities bills. Energy producing solar panels will be fitted on the block of flats that will help power lifts and lighting during the day. Excess electricity generated by the solar panels will be stored in batteries, which households can tap on for energy at night. Meanwhile, Panasonic will help upgrade appliances like air-conditioning to more energy efficient models at no cost to them. The new technology called Home Energy Management Systems.

Case 2: Civil Aviation Authority of Singapore-Singapore Aviation Academy
The Singapore Aviation Academy (SAA), the training arm of Civil Aviation Authority called a Guaranteed Energy Savings Performance (GESP) contract to replace its chiller plant system, air handling units (AHUs) and electrical systems. Refer Figure 5.

After retrofitting both the chilled water plant and AHUs, SAA’s overall system (water and airside) efficiency improved to 0.80kW/RT and its building’s energy consumption reduced by approximately 11%. The building had awarded the Green Mark Platinum award.
Case 3: Housing & Development Board, Woodlands Civic Centre

Woodlands Civic Centre (WCC) shows in Figure 6 is a commercial complex where is commissioned by the Housing & Development Board (HDB) in 1999, and leased to multiple tenants. In 2014, HDB retrofitted its water-cooled chillers to more efficient ones. By rightsizing the water-cooled chillers, HDB now supplies chilled water to its lessee National Library Board (NLB)’s Woodlands Regional Library, who previously had to operate its own inefficient air-cooled chillers to cater to its cooling needs.

HDB will save an estimate of 3.5 million kWh of energy annually by retrofitting the chiller plant. Together with the revenue generated from the supply of chilled water to NLB, the chilled-water plant retrofit project’s payback period is about 1.6 years. HDB’s initiative to supply chilled water to NLB has also enabled NLB to decommission its inefficient air-cooled chillers. NLB now incurs less operating cost to cool its library.

Case 4: Nan Chiau High School

Aligned to the Vision, Mission and Strategic Thrusts of Nan Chiau High School, Energy Efficiency (EE) 3-year action plans drawn out by the School Leaders/Steering Committee. The objectives and initiatives in the plans communicated to all teachers and students. Supporting programs well planned and executed by the student-Green Ambassadors.

Through concerted efforts, the school has reduced its annual electricity consumption per capita per year by 0.4% and 0.2%, in 2013 and 2014 respectively, despite a series of renovation and upgrading works. Their EE projects continue to see active participation by all staff and students. Refer Figure 7.
6. KEY BARRIER OF EE

The main problem when involve in EE is a technology supplier, users and financial institutions. Many company not willing to put in the money for energy service providers to conduct a proper and thorough energy auditing. Figure 8 shows a summary of the key findings from stakeholder interviews.

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<th>VALUE CHAIN</th>
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- **Governments**
  - Insufficient provision of information channels to match users and suppliers
  - Insufficient financial support and assistance
  - Insufficient technical training provided
  - Lack of standards on energy auditing methods
  - Room for improvement in awareness raising efforts

- **Suppliers/ESCOs**
  - Difficulty in identifying demand
  - Lack of commitment to provide sufficient resources to gauge savings potential
  - Difficulty in convincing clients of benefits of EE equipment
  - Lack of technical know-how to carry out product installation
  - Lack of integration into users’ business lifecycle

- **Users**
  - EE often not regarded as a business priority
  - Lack of confidence that equipment can achieve projected savings
  - Difficulty in identifying customized products to suit specific needs
  - "Quick-win" investments favoured over EE projects with longer payback periods
  - Lack of awareness on energy efficiency
  - Lack of consistent investment plans in EE products and technology

Figure 8: Key Barrier of Value Chain in EE

7. CONCLUSION

Singapore has substantial energy requirements due to development levels and industrial structure. The energy policy must balance between energy security needs with environmental quality including emissions reduction and economic competitiveness. EE are need to improve energy security, reduce emissions, increase economic competitiveness, create job and foster technological developments.

Meanwhile, the desire of EE is to make Singapore as a leader in EE, to create another reason for national pride also, create more comfortable living environment by enhancing air quality. The energy policy need to fair, transparent and consistent application of the rules. Energy Market Authority of Singapore (EMA) regulates the electricity industry to allow the market to set the price but sets price controls for the monopoly of electricity grid company. The price regulation is incentive based, rewarding the grid company for efficiency gains. So that, this policies are benefits to the utilities company and consumer.

The market potential is not predictable. In addition, many programs need to implement to increase general considerations in the region of EE and its benefits. Information sharing is a best practice to make EE programs rapidly spread. The companies pay lip services to the need to improve EE levels. They have more opportunity and credentials to implement it rather than improving from bottom line and heighten their competitiveness. Energy efficiency programs offer large energy saving potentials for the region and open vast new business opportunities. However, the region will only benefit from this opportunities is the government are able to adopt and implement a range of innovative measures that unlock the full potential of energy efficiency.
8. RECOMMENDATION

This is a recommendation that can be applied in a way to achieve the energy efficiency goal for the country.

**Recommendations for governments**

i. Provide overarching policy framework through a combination of mandatory and voluntary policies.

ii. Promote greater awareness of EE among users.

iii. Play an essential role as integrator of the value chain and establish funding mechanisms to jump-start EE Financing.

**Recommendations for businesses**

i. Move towards an integrated value chain approach

ii. Develop innovative financing vehicles for EE projects

iii. Increase awareness of EE and enhance professionalism of the industry

**Recommendations for end-user (customer)**

i. Better upfront information on potential annual cost savings from buying an energy efficient appliance and make it easier for people to calculate the overall cost of ownership.

ii. Provide lists of the most efficient appliances for consumers (appliances with energy save labeling-five tick appliances).

iii. More public education on how energy saving habits can benefit the individual should be carried

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