



ASEM Eco-Innovation Index 2016 Country Report

- Singapore -



Published by:
ASEM SMEs Eco-Innovation Center (ASEIC)
E-2ndFL, Pangyo Inno-Valley 255
Pangyo-ro Bundang-gu Seongnamsi
Gyeonggido, Korea 13486

December 2016

List of Contributors

Leading Authors

- Wongeun Choi, EcoServices Consulting Co., Ltd., South Korea
- Farizan d`Avezac de Moran, GreenA Consultants Pte Ltd., Singapore
- KiJoo Han, EcoServices Consulting Co., Ltd., South Korea

Contributing Authors

- Chaiyod Bunyagidj, United Analyst and Engineering Consultant Co., Ltd., Thailand
- Mi Sun Park, Konkuk University, South Korea
- Eunkyung Jang, Konkuk University, South Korea
- Jihyung Joo, ASEM SMEs Eco-Innovation Center, South Korea

Design

- JiYeong Jeon, Konkuk University, South Korea



Contact info@aseic.org to request the full version of ASEM Eco-Innovation Index 2016 Country Report.
The PDF version is also available on the ASEIC website www.aseic.org.



Table of Contents

Table of Contents	i
Table List	ii
Figure List	iii
Summary	iv
1. Background	1
2. Country Profile	3
2.1 Introduction	3
2.2 Environmental Issues	6
2.3 Socioeconomic Issues	8
2.4 Green Growth	14
3. Eco-Innovation Trends	17
3.1 Awareness of Eco-Innovation	17
3.2 Major Actors in Singapore	18
3.3 Eco-Innovation Policies	19
3.4 Singapore Legislation on Environmental regulation	20
3.5 Highlighted Sectors	21
3.6 New Trends Observed	24
4. Analysis of ASEI 2016 Results	26
5. Good Practices on Eco-Innovation in Singapore	29
5.1 Eco Campus (Hive) - Nanyang Technological University	29
5.2 PAssion Wave @ Marina Bay – Water Venture.	31
6. Country Synthesis	34
7. References	35



Table List

Table 1 Economic Structure in Singapore5

Table 2 Total Expenditure by Programme8

Table 3 Summary of HDI 2015 for Singapore10

Table 4 HDI indicators for 2014; Singapore, HK, China, Brunei11

Table 5 Socioeconomic indicators related to work for Singapore11

Table 6 Policy measures for green growth and sustainable development15

Table 7 PAssionWave energy savings summary.....31



Figure List

Figure 1 The role of case studies in ASEI research	1
Figure 2 Location of the Republic of Singapore	3
Figure 3 Population Growth Forecast	4
Figure 4 GDP Growth 1980-2015	5
Figure 5 Singapore Waste Statistics from 2000 to 2014	7
Figure 6 Singapore's Total Fertility Rate and family planning policies/measures	9
Figure 7 HDI trends for Singapore HK, China, Brunei	10
Figure 8 Global Competitiveness Index 2015 for Singapore	12
Figure 9 The most problematic factors for doing business in Singapore	13
Figure 10 Singapore's most problematic factors for doing business 2012-2015	13
Figure 11 Results of Singapore's ASEI 2016 Measurement	26
Figure 12 Results of ASEI 2016 for Singapore by categories	27
Figure 13 The Hive – Learning Hub	30
Figure 14 The interior of the Hive	30
Figure 15 The building model of Hive	30
Figure 16 The floor plan of Hive	30
Figure 17 PAssion Wave @ Marina Bay	31
Figure 18 Wind turbines for boat washing	32
Figure 19 boat washing station – using water and air together to reduce water consumption	33
Figure 20 Compressor – Using wind from compressor to dry life jackets	33



Summary

This study is a country case study to further understand the ASEI 2016 evaluation results. Before analyzing the results of the ASEI 2016, the researchers introduced Singapore's general aspects such as socio-economic issues and environmental issues and reviewed the trends in eco-innovation in Singapore including eco-innovation awareness, related policies, stakeholders and trends. Singapore became a developed country based on rapid economic growth through actively and quickly introduced foreign capital. In order to manage the environmental problems such as air pollution, water pollution, and waste that may arise in this process, the government has been leading initiatives from the early stage of development focusing on sustainable, green technology, clean energy, etc. in the same line as eco-innovation and implementation of an aggressive environmental policy. Based on these environmental issues, socio-economic issues and policy environment in Singapore, the researchers analyzed the results of ASEI 2016 evaluation. Singapore's ASEI 2016 score is higher than the average of European Member States, Asian Member States and total ASEM member countries. In each category that shows the stages of eco-innovation development, the categories of 'Capacity', 'Supporting environment', and 'Performance' were relatively better than the category of 'Activity'. These results of the ASEI 2016 evaluation show that Singapore has a capacity for eco-innovation based on a highly-developed economy and a strong government has led eco-innovation through various policy measures that leads to eco-innovation performance. However, the reason why the score of the 'Activity' category is relatively lower than other category scores is because Singapore's major industries are concentrated in the tertiary industry and the proportion of the primary industry is remarkably low. In general, the high categories and the ASEI score show that Singapore's eco-innovation level is already quite high and likely to continue.

1. Background

This report aims to analyze the status of eco-innovation in Singapore in accordance with the evaluation of the ASEM Eco-Innovation Index (ASEI) 2016. This index was developed in 2012 by ASEM SMEs Eco-Innovation Center (ASEIC)¹ based in Korea. This center was founded in 2011 as a result of the approval by ASEM member countries at the 8th ASEM Summit in 2010. When the index was originally developed in 2012, the index was evaluated for only 15 member countries. Since then, the number of countries assessed has increased. Currently, ASEM members have expanded to 51 members as Croatia and Kazakhstan joined ASEM in 2014. ASEI has 20 indicators that fall into four categories: Capacity (category 1), Supporting Environment (category 2), Activity (category 3), Performance (category 4). Indicators were selected from a theoretical framework derived from an input and output model. Based on that framework, ASEI is expected ideally to describe the overall situation of member countries on eco-innovation, in addition to different levels among categories. However, since the theoretical approach requires empirical evidences to prove that ASEI reasonably reflects the eco-innovation situation of member states, the progress of ASEI development should be explored further. Furthermore, the availability of indicator data varies from member country to country. In particular, the availability gap between European member states and Asian member states proved to be remarkable. This context led ASEIC to make more country-specific efforts to understand how ASEI represents the status of eco-innovation in a country, and assess how much data can be collected in the field.

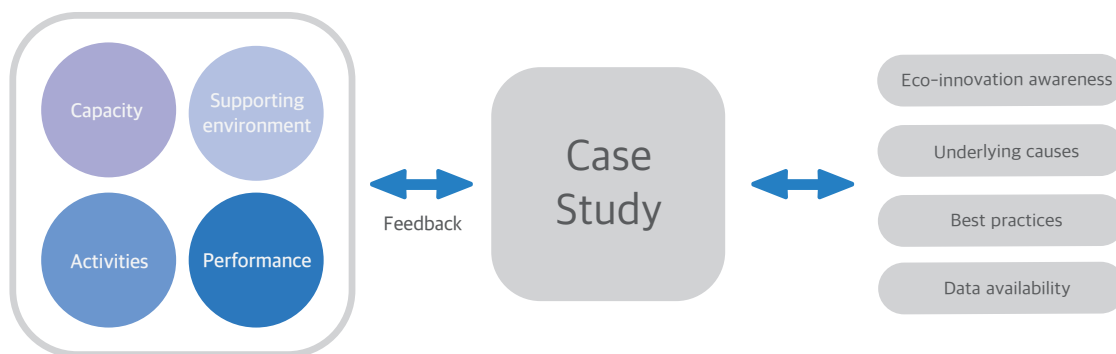



Figure 1 The role of case studies in ASEI research

The report of this country plays an important role in understanding the environmental innovation in Singapore compared to the evaluated score of ASEI. Because the development and annual measurement of ASEI are heavily dependent on currently available data, it is difficult to explain the exact situation on eco-innovation and its underlying situation based on the ASEI score of ASEM member countries. Rather, the results of the ASEI evaluation show

¹ For further information, please visit <http://www.aseic.org/main.do>



the trends and differences in eco-innovation among member countries (Figure 1). In order to overcome the limits of national analysis, ASEIC began case studies in 2015. In the first year, four Asian member countries were subject to case studies: Japan, South Korea, Vietnam, and Myanmar. Japan and South Korea are developed nations with advancements in eco-innovation, while Vietnam and Myanmar correspond to developing countries. Asian countries were chosen mainly due to lack of research and survey on environmental innovation in Asian countries. In fact, the concept of environmental innovation has not yet spread in developing countries. Case studies in developing countries provide opportunities to evaluate how much data can be collected for future ASEI evaluation from the viewpoint of data availability of ASEI indicators.

Following this background, the country profile chapter follows as an introduction to general environments of the country in terms of basic factors affecting eco-innovation, market sophistication and business sophistication regarding eco-innovation. Next, an eco-innovation trends chapter deals with the level of awareness of eco-innovation in the country, major entities contributing to the promotion of eco-innovation and highlighted sectors in the country which lead eco-innovation in terms of capacity, practices and outcomes. Newly observed trends and/or changes in the country are reviewed in this chapter. Policy issues specifically tied to eco-innovation is presented thereafter. As the role of governments is critical in mobilizing economic and technological efforts to promote eco-innovation, this chapter examines stakeholders developing policy measures on eco-innovation and presents current policy measures affecting eco-innovation. Next, in the analysis of ASEI 2016, the research team explains what the assessed score of ASEI 2016 means in terms of the current situation and trends reviewed in previous chapters. In the first part of the chapter, the assessed scores are presented in detail for each indicator, for each category and the Index score itself. The analysis of ASEI 2016 with evidences in this chapter provides feedback not only on how appropriately the Index present the current status of the country, but also on which indicator or category needs to be improved for further measurement. Next, before simply synthesizing the country study, the chapter shares good practices from different industrial sectors with a focus on capacity of involved entities and policy environments to support the practices. Finally, country synthesis highlights implications derived from this research on eco-innovation. The implications are expected to contribute to the improvement of current policy measures and the development of new measures to encourage eco-innovation related Activity.

2. Country Profile

2.1 Introduction

Singapore, officially stated as the Republic of Singapore, is the world's only island city-state located in Southeast Asia, south of the southernmost tip of continental Asia and peninsular Malaysia with Indonesia's Riau islands to the south. Singapore consists of a main island along with 62 other inlets (Figure 2). The total land area is approximately 697km² and the total population reached 5.6 million in 2015(CIA, 2016). While the small size of the city-state does not qualify the creation of national subdivisions in the form of provinces, states, and other national political divisions found in larger countries, the city has nonetheless been administratively subdivided in various ways throughout its history for local administration and urban planning.



Figure 2 Location of the Republic of Singapore

Source: Wikipedia (<https://commons.wikimedia.org>)

Modern Singapore was founded in the 19th century, due to an interplay of factors, including politics, trade, and a person known as Sir Thomas Stamford Raffles. During this time, the British empire was eyeing a port of call in this region to base its merchant fleet, and to forestall any advance made by the Dutch. Singapore, already an up-and-coming trading post along the Malacca Straits, seemed ideal. Singapore continued to develop as a trading post, with the establishment of several key banks, commercial associations and Chambers of Commerce. (BBC, 2015). As the Japanese conquered Malaysia in 1942, Singapore was forced to surrender on February 15th, 1942. However, Japan surrendered in August 1945 and on September 5th, 1945, the British re-occupied Singapore. In the following years, Singapore slowly moved towards independence. In 1946, the Strait Settlements were dissolved and Singapore was separated from Malaysia. The People's Action Party² was formed in 1954 and it proved to be a major force in Singaporean politics as the party concentrated on the independence of the country. In 1955, a new constitution was introduced, and in 1963, Singapore joined

with Malaysia. However, the union was short-lived, as Singapore left in 1965 and became completely independent. From 1965 to the 1990s, Singapore enjoyed rapid economic growth. By the 1990s, it was an NIC (newly industrialized country), and its people had a high standard of living. However, the government was authoritarian and society was strictly controlled. In 1990, Lee Kuan Yew resigned as prime minister. He was replaced by Goh Chok Tong, who introduced a more liberal regime. Today, Singapore is a prosperous nation and its economy is growing steadily (Lambert, 2016).

The population of more than 5.6 million consists of Singaporean, Chinese, Malay, Indian – 74.2%, 13.3%, 9.2%, 3.3%, respectively. The official languages of Singapore are Mandarin (36.3%), English (29.8%), Malay (11.9%), Tamil (3.2%). Other languages include Hongqien (8.1%), Cantonese (4.1%), Teochu (3.2%) and others (3.4%). According to the World Population Prospects (WPP) formulated by the United Nations Economic and Social Affairs³, the population density is 8,137 persons per km², and the annual growth rate was 2.5% in 2012. Similar to developed countries such as Japan and South Korea, which experienced population declines and aging population due to economic development, Singapore has undergone a rapid transition. In the world population survey, we predict, considering the low growth rate, that the population will slightly exceed 6.6 million people before growth stops (Figure 3). Comparing 1950 and 2016, the population of Singapore increased from 1 million to 5.6 million, the annual average growth rate increased from 4.4% to 1.5%, and the population density increased from 1,460 persons per km² to 8,137 persons per km² (WPR, 2015)

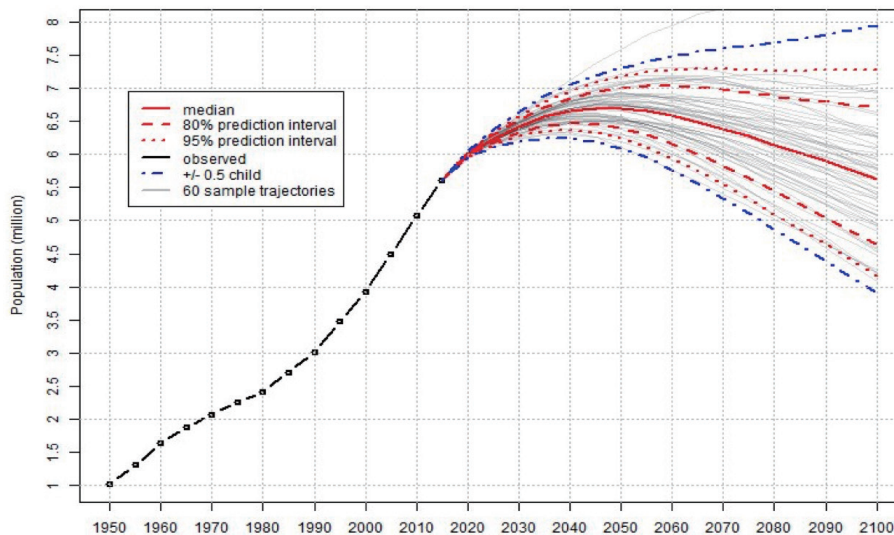


Figure 3 Population Growth Forecast

Source: United Nations, Department of Economic and Social Affairs (2015)
World population Prospects: 2015 Revision, <http://esa.un.org/unpd/wpp>

² <http://www.yoursingapore.com/travel-guide-tips/about-singapore.html>

³ <http://esa.un.org/unpd/wpp/>

Singapore is a high-income economy and provides the world's most business-friendly regulatory environment for local entrepreneurs and is ranked among the world's most competitive economies⁴. According to data from the World Bank, in 2015, the Gross Domestic Production (GDP) of the country was US\$292.7 billion (current US\$)⁵. The economy grew at an average annual rate higher than 8 percent in 1980 and 1997 (except 1985) until the country faced the Asian financial crisis in 1997 (Figure 4). Like other Asian countries suffering from financial crisis in late 1990's, Singapore experienced economic difficulties during this period. Due to the Asian financial crisis, Singapore slipped into recession for the first time in 1998 (BBC, 2016).

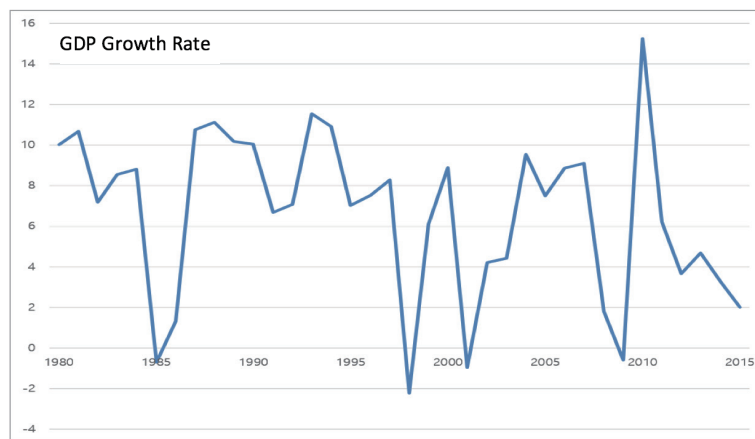


Figure 4 GDP Growth 1980–2015

Source: World Bank Data (<http://data.worldbank.org/country/Singapore>)

However, the economy recovered quickly after the crisis and has performed modestly except in 2001 due to the 9/11 attacks in USA and in 2009 due to the subprime mortgage crisis (Figure 4). ADB forecasts the growth rate of the economy to rise consistently until 2017 up to 2.2 percent (ADB, 2016). Services sectors have expanded their roles in the economy from 62.2 percent in 1980 to 75 percent of the total GDP in 2014. The size of import and export of goods and services accounted for 192.11 percent and 167.66 percent of GDP in 2014, respectively (Table 1).

Table 1 Economic Structure in Singapore

Series Name	1980	1985	1990	1995	2000	2005	2010	2014
Agriculture, value added (% of GDP)	1.57	0.96	0.34	0.16	0.10	0.06	0.04	0.03
Industry, value added (% of GDP)	36.23	33.44	32.34	33.75	34.83	32.36	27.63	24.94
Services, etc., value added (% of GDP)	62.20	65.60	67.32	66.09	65.07	67.58	72.33	75.02
Exports of goods and services (% of GDP)	202.05	152.37	177.15	181.22	189.18	226.08	199.26	192.11
Imports of goods and services (% of GDP)	208.98	152.07	167.10	164.52	176.89	196.25	172.84	167.66

Source: World Bank Data – Singapore <http://data.worldbank.org/country/Singapore>

⁴ World Bank Country Overview - Singapore. <http://www.worldbank.org/en/country/singapore/overview>

⁵ World Bank Data - Singapore. <http://data.worldbank.org/country/singapore>



2.2 Environmental Issues

Singapore has achieved high economic growth through the free trade policy and active introduction of foreign capital while successfully maintaining a favorable living environment. Some neighboring countries in the Southeast Asian region are suffering from serious environmental pollution caused by economic growth. Thus, Singapore is unique in that it is developing its economy while maintaining a favorable living environment. The reason for this success in environmental management is that Singapore has carried out various environmental policies proactively since the initial stage of rapid economic growth and industrialization. The country's environmental management policy consists of three strategies: pollution prevention, law enforcement, and environmental monitoring. One example of the government effort is a "Singapore Green Plan" The Ministry of the Environment and Water Resources (MEWR) issued "Singapore Green Plan" in 1992, which incorporated various strategies for realizing a sustainable society. The latest version of the Green Plan is Singapore Green Plan 2012 (edited 2006), which was released in 2002 (The Ministry of Environment and Water Resources, 2012). The Plan comprises 8 distinct groups and aims to create an environmentally-conscious Singapore, promoting conservation of the nation's natural resources and the use of green technology to conserve the environment, both locally and globally. In 2005, three focus groups on Air and Climate Change, Water and Clean Land, Nature and Public Health were officially formed to undertake a three-yearly review of the SGP 2012. The three main environmental problems in Singapore are water pollution, air pollution, and wastes (Global Environmental Forum, 2003).

- Water pollution

Singapore is short of water resources, purchasing water from neighboring Malaysia to meet half of the water demand, and the country is highly interested in the water environment. For this reason, water quality conservation is the most important issue for environmental management, and we are actively working to improve sewage facilities. In order to manage water pollution, Water Body monitors the water environment in Singapore. There are rivers and ponds that are used as sources of drinking water. The main reason for maintaining good water quality is the construction of advanced public sewer systems. In Singapore, both domestic and industrial wastewater are handled basically in the public sewer system.

- Air pollution

The main sources of air pollutants in Singapore are those that are stationary, such as industrial plants and vehicles. The quality of the atmosphere is adequately managed like water quality. While internal factors contributing to air pollution are well-managed, external factors, especially the smoke from the forest fire in Indonesia, are quite serious.. Air pollution in Singapore became troublesome as fumes hid most of the city. However, new cross-border efforts to deal with Indonesian forest fires are expected to make a progress in the future.

- Waste

Waste generation amount refers to the total amount of waste generated in Singapore, which is the sum of waste disposal and waste recycling. Waste refers to the total amount of waste that goes to energy plant and offshore Semakau landfill. Waste recycling refers to the total amount of waste recycled locally or recycled waste exported overseas. Approximately 7.5 million tons of waste occurred in Singapore in 2014, generating about 1,370 kg of waste per person. The recycling rate in Singapore in 2014 was 60%, slightly falling from 61% in 2013. Government is still on track to achieve 65% recycling goal in 2020 and 70% in 2030. According to Figure 5, despite the 9% increase in waste from 2000 to 2014, recycled waste has increased by 141% in large quantities. The total amount of waste generated increased from 4.7 million tons in 2000 to 7.5 million tons in 2014 (The National Environment Agency, 2015). Waste data indicate that efforts by the government to promote waste recycling have been successful for many years. Waste generated in 2014 declined by 4.3% from 2013 (first decline in 10 years), while waste disposed was up by 0.6% from 2013 (compared with 3% in 2012-2013 and 2011-2012. Then it is a low growth rate). Recycled waste decreased by 7.4%. The decline in recycled waste is mainly due to a substantial decrease in construction waste recycled in 2014 (423,000 tons or 25% from 2013).

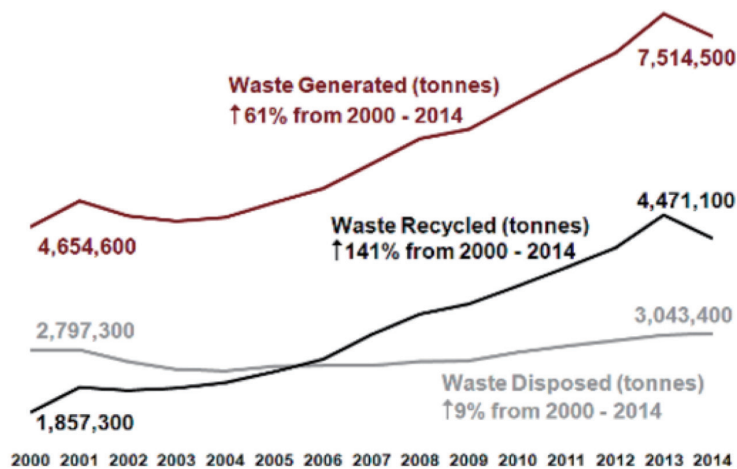


Figure 5 Singapore Waste Statistics from 2000 to 2014

Source: National Environment Agency
<http://www.zerowastesg.com/2015/03/18/singapore-waste-statistics-2014/>

In the final report of Environmental Performance Indicator (EPI)⁶ 2016 conducted by Yale University, Singapore ranked 14th in 180 countries with a rate of 87.04 points out of 100, which is higher than that of neighboring countries, such as Malaysia (74.23), Vietnam (58.5), Cambodia (51.24), Laos (50.29) and

⁶ The Environmental Performance Index (EPI) developed and assessed by Yale University and the authors describe “EPI ranks countries’ performance on high-priority environmental issues in two areas: protection of human health and protection of ecosystems (Hsu et al., 2016).”

Philippines (73.7) (Yale University, 2016). Singapore's EPI score has dropped by -0.43% over the past 10 years, and Singapore has consistently maintained top rank.

In order to counteract these environmental problems, the government of Singapore has allocated budget to manage environmental issue. In 2016, the government allocated 1,926 million dollars for the Ministry of Environment and Water Resources (MEWR), a sum which accounted for 2.62 percent of the total fiscal budget (The Ministry of Environment and Water Resources, 2016). Among these budget, Development Expenditure in FY2016 is expected to be \$704 million, an increase of 137.16 million or 24.2% from the revised FY2015 figure of \$566.93 million. The higher estimate accounts for funding for drainage and sewerage projects. The budget of Development Expenditure included Administration, Public Utilities Board and National Environment Agency (Table 2). There are about 130 projects under the Development Expenditure and the details of the Development Expenditure by project can be accessed through the web site of the Ministry of Finance⁷.

Table 2 Total Expenditure by Programme

Programme	Running Cost	Transfers	Operating Expenditure	Development Expenditure	Total Expenditure
Administration	49,863,700	14,430,000	64,293,700	13,150,000	77,443,700
Public Utilities Board	318,535,900	0	318,535,900	560,153,400	878,689,300
National Environment Agency	837,675,400	1,321,400	838,996,800	130,784,900	969,781,700
Total	1,206,075,000	15,751,400	1,221,826,400	704,088,300	1,925,914,700

Source: The Ministry of Environment and Water Resources (2016)

2.3 Socioeconomic Issues

Singapore is one of 'Four Asian Dragons' that has grown throughout the 1970~1980's. The population policy successfully fueled economic development at the time. However, this policy had unexpected side effects. Singapore has recently faced a crisis that threatens national population. Even though birth-friendly policies were implemented in 1987, a low fertility phenomenon has persisted in Singapore. Despite the introduction of Marriage and Parenthood Package (M&P Package), a comprehensive and proactive policy of childbirth support in 2001, the total fertility rate has stayed below 1.3 since 2003 (Figure 6). Similar to other low fertility countries, the biggest concern in Singapore regarding the continuation of low fertility and population phenomenon is the increase in financial costs for the elderly. Elderly support payments are calculated by dividing the number of people aged over 65 years old by the number of people aged from 15 to 64 years of productive population. Elderly support payments more than doubled over 30 years, from 7.3% in 1980 to 15.2% in 2014 (KIHASA, 2016).

⁷ <http://www.mof.gov.sg/>

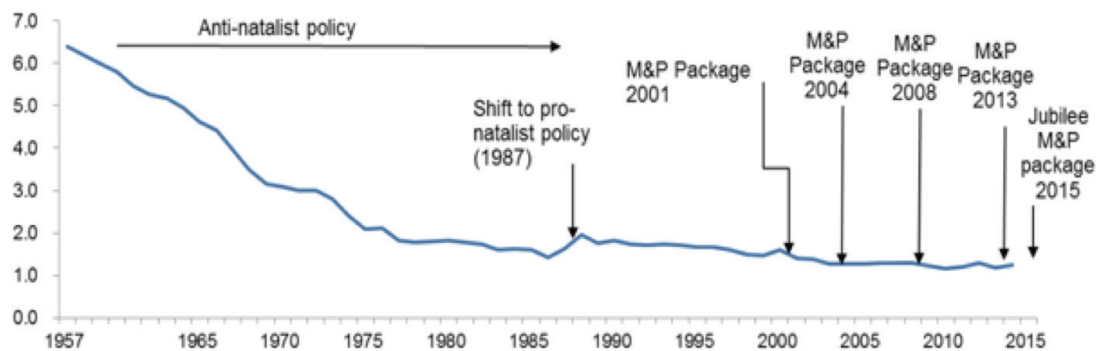


Figure 6 Singapore's Total Fertility Rate and family planning policies/measures
 Source: Shin et al. (2013)

Singapore has been actively utilizing the immigration policy as means of controlling labor market supply. When unemployment was high, it strictly regulated the foreign worker inflow. Since 1972, the labor market has exceeded supply. When the state was resolved, employment and immigration regulations for highly skilled workers were planned to facilitate qualitative improvement of the labor force. In the late 1980s, employment regulations were eased further for low-skilled workers because labor market demand was increasing. This immigration deregulation policy has had a significant impact on the population of Singapore. The net inflow of population was always recorded except during the mid-1980's and 2003. Thus, the proportion of the population accounted citizen decreased from 90.4% in 1970 to 63.6% in 2010, while the ratio of non-resident foreigners increased from 2.9% to 25.7% during the same period. It is also argued that the domestic labor shortages due to falling birth rate must be resolved through the foreign worker inflow. Still, the side effect must be taken into consideration. Because the country is multiethnic (Chinese, Malay, Indian), the acceptance of foreigners is high. Despite this high acceptance of foreigners, anti-immigrant sentiment has risen in Singapore. Due to the increased proportion of foreign-born population in Singapore, native-born citizens have become more concerned about losing good jobs to foreigners and facing various social problems caused by them (Mui-Teng, 2014).

In the most recent Human Development Index (HDI) report published by the United Nation Development Programme, Singapore scored 0.912 for 2014, which positioned the country at (earning the rank of) 11 out of 188 countries and territories (UNDP, 2015b). According to this report, the country's HDI value went up from 0.718 (1990) to 0.912 (2014) with an average annual increase of about 1.00 percent. Singapore performed in score better than surrounding neighbor countries such as Malaysia (0.779), Indonesia (0.684), Viet Nam (0.666), Philippines (0.668) and an average of East Asian and the Pacific countries (0.710)(UNDP, 2015a). Table 3 shows Singapore's HDI trends based on consistent time series data. Between 1980 and 2014, the country's life expectancy at birth increased by 11.0 years, mean years of schooling increased by 6.9 years and expected years of schooling increased by 4.8 years. Singapore's GNI per capita increased by about 297.3 percent during the same period.

Table 3 Summary of HDI 2015 for Singapore

Year	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (2011 PPP\$)	HDI value
1980	72.0		3.7	19,287	
1985	73.9		5.1	25,460	
1990	76.0	10.6	5.8	33,949	0.718
1995	77.4	11.6	7.3	45,187	0.773
2000	78.3	12.7	8.9	51,309	0.819
2005	80.2	13.9	8.5	57,583	0.841
2010	82.0	15.2	10.2	71,599	0.897
2011	82.3	15.4	10.3	73,239	0.903
2012	82.5	15.4	10.4	73,461	0.905
2013	82.8	15.4	10.5	75,400	0.909
2014	83.0	15.4	10.6	76,628	0.912

Source: UNDP (2015) Briefing note for countries on the 2015 Human Development Report: Singapore

The report also compared HDI scores among Singapore, Hong Kong, China, Brunei Darussalam during the period between 1990 and 2014 (see figure 7 and table 4). Singapore's 2014 HDI of 0.912 is above the average of 0.8906 for countries in the very high human development group and above the average of 0.710 for countries in East Asia and the Pacific. From East Asia and the Pacific, countries which are close to Singapore in 2014 HDI rank and to some extent in population size are Brunei Darussalam and Hong Kong, China (SAR), which have HDIs ranked 31 and 12 respectively (UNDP, 2015a).

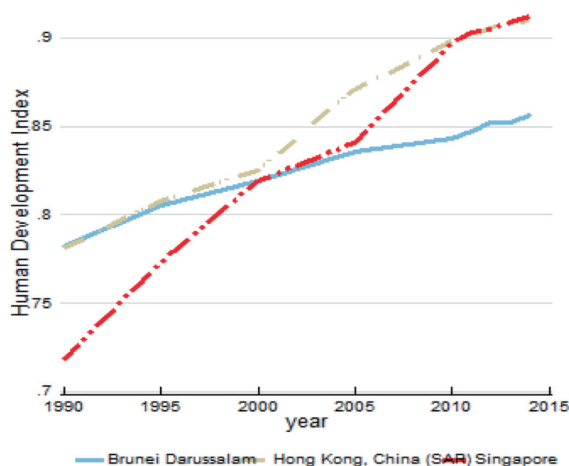


Figure 7 HDI trends for Singapore HK, China, Brunei

Source: UNDP (2015) Briefing note for countries on the 2015 Human Development Report: Singapore

Table 4 HDI indicators for 2014; Singapore, HK, China, Brunei

	HDI Value	HDI rank	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (ppp US\$)
Singapore	0.912	11	83.0	15.4	10.6	76,628
Brunei	0.856	31	78.8	14.5	8.8	72,570
HongKong	0.910	12	84.0	15.6	11.2	53,959
East Asia and Pacific	0.710	-	74.0	12.7	7.5	11,449
Very high HDI	0.896	-	80.5	16.4	11.8	41,584

Source: UNDP (2015) Briefing note for countries on the 2015 Human Development Report: Singapore

In addition to the above-mentioned index, the report provides additional indicators related to work for countries which show overall environment-related work in Singapore. Singapore has the third highest HDI value in Asia, after Australia and New Zealand. Table 5 shows some factors of these score results. Higher scores on employment indicators (employment rate, female/male labor participation rate) were higher than high HDI scores countries (49 countries) However, women's labor participation rate is lower than those of the countries around East Asia and the Pacific. The reason is that the ratio of primary industries such as agriculture is low and proportion of tertiary industries is high among the industrial structure in Singapore. This industrial structure in Singapore also contributes to the sharp contrast between the agricultural employment rate of only 1.1% and the service employment rate of 77%. In addition, the employment rate and unemployment rate are only 8.7% and 2.8%, which is significantly lower than the average of the top 49 countries (12.4% and 8.3%).

Table 5 Socioeconomic indicators related to work for Singapore

	Singapore	Very high HDI	East Asia and the Pacific
Employment to population ratio (% ages 15 and older)	65.9	55.4	67.9
Labour force participation rate (% ages 15 and older)	67.8	60.3	71.1
Female	58.8	52.1	62.6
Male	77.2	68.7	79.4
Share of employment in agriculture (% of total employment)	1.1	3.3	35.5
Share of employment in services (% of total employment)	77.1	74.3	37.3
Labour force with tertiary education (%)	-	32.5	-
Vulnerable employment (% of total employment)	8.7	12.4	-
Total unemployment (% of labour force)	2.8	8.3	3.3
Long term unemployment (% of labour force)	0.6	3.0	-
Youth unemployment (% of youth labour force)	7.0	18.0	18.6
Youth not in school or employment (% ages 15-24)	-	13.4	-
Labour productivity: output per worker (2011 PPP \$)	96,573	64,041	-
Child labour (% ages 5-14 years)	-	-	-
Domestic workers (% of total employment)			
Female	-	4.3	-

Male	-	0.4	-
Working poor, PPP \$2 per day (% of total employment)	-	-	23.8
Unemployment benefits recipients (% of unemployed ages 15-64)	0.0	43.4	1.6
Mandatory paid maternity leave (days)	112.0	123.0	-
Old age pension recipients (% of statutory pension age population)	0.0	89.4	65.3
Internet users (% of population)	82.0	82.5	42.1
Mobile phone subscribers (per 100 people)	158.1	119.8	100.5

Source: UNDP (2015) Briefing note for countries on the 2015 Human Development Report: Singapore

Singapore presents strong performance in various competitiveness against other countries. Singapore ranks 2nd out of 140 countries worldwide in the Global Competitiveness Index (GCI) examined by the World Economic Forum(WEF, 2015). Singapore is one of the most consistent performers in all economies, being in the top 10 in nine out of 12 areas which are depicted in Figure 8.

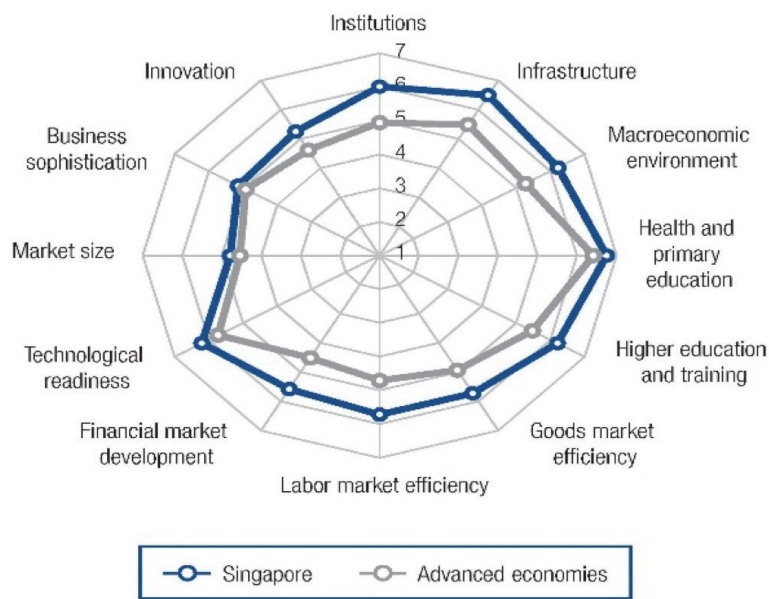


Figure 8 Global Competitiveness Index 2015 for Singapore
Source: WEF (2015) The Global Competitiveness Index

GCI assesses the key factors and their interrelations that determine economic growth and a country's level of present and future prosperity. Between 2012 and 2015, Singapore's score and ranking have stayed constant at 5.7 and the second. Figure 8 depicts Singapore's performance in various categories of the economy in relation to that of advanced economies. In particular, Singapore can rely on the most flexible and the second most attractive labor market in the world, although the participation of women in the workforce remains relatively low (75th). It also has the best higher education and training system in the world.



As GCI focuses on the strengths and weaknesses of each country's economy, it summarizes the most problematic factors in doing business in each country based on expert interviews. The most problematic issues in Singapore are limited labor regulation, lack of innovation capacity, inflation, poorly educated workforce, poor labor ethics, and low labor force. The most highlighted point of this result is that corruption and government instability/coup scores are nearly zero (WEF, 2015) (Figure 9). Transparency International's (TI) recent assessment of corruption recognition has ranked Singapore 8th among 168 countries (The Transparency International, 2015).

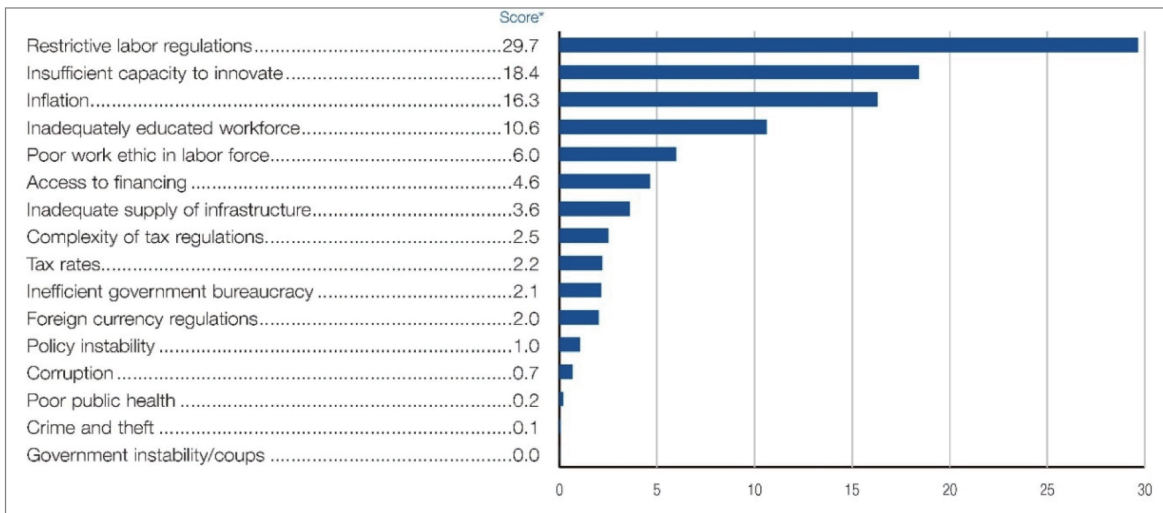


Figure 9 The most problematic factors for doing business in Singapore
Source: WEF (2015) The Global Competitiveness Index

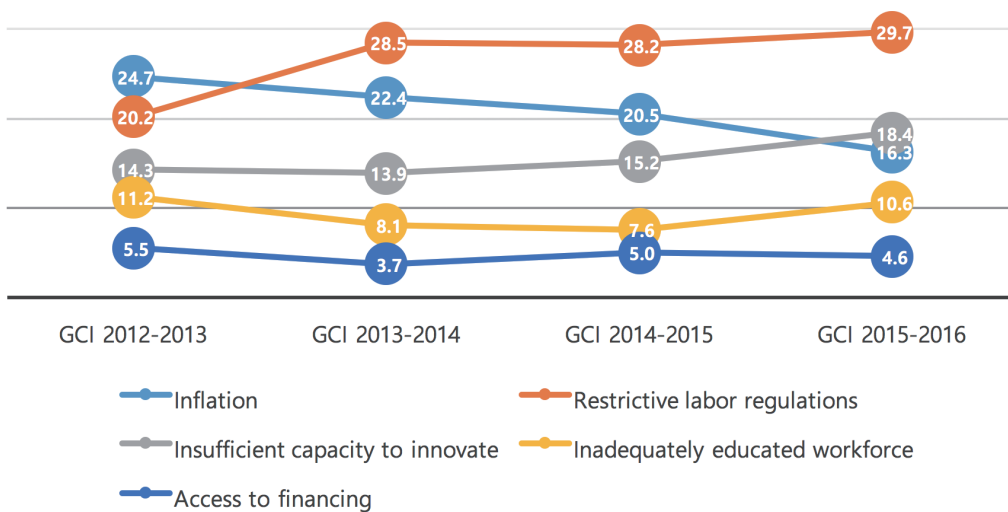



Figure 10 Singapore's most problematic factors for doing business 2012-2015
Data: The Global Competitiveness Index 2012~2015



As indicated previously in the GCI report, limited labor regulation and lack of innovation are important factors affecting the economy. Since eco-innovation is heavily dependent on government policy and deregulation, in order to proceed to the next stage of eco-innovation, Singapore needs to overcome this weakness from limited labor regulation and lack of innovation. Singapore's inflation situation based on the GCI report is encouraged to improve from 24.7 in 2012 - 2013 to 16.3 from 2015 - 2016. However, the score of the restrictive labor regulation has remained low from 20.2 in 2012 - 2013 to 29.7 in 2015 - 2016.

The Employment Act (EA) is the main employment legislation in Singapore. The following legislation and its subsidiary regulations also form part of the legal framework for employment and labor:

- the Central Provident Fund Act (Cap. 36);
- the Child Development Co-Savings Act (Cap. 38A);
- the Employment of Foreign Manpower Act (Cap. 91A);
- the Industrial Relations Act (Cap. 136);
- the Personal Data Protection Act (Act 26 of 2012);
- the Retirement and Re-employment Act (Cap. 274A);
- the Trade Unions Act (Cap. 333);
- the Work Injury Compensation Act (Cap. 354); and
- the Workplace Safety and Health Act (Cap. 354A).

In addition to The Employment Act, the Tripartite Partners (comprising the Ministry of Manpower ("MOM"), the National Trades Union Congress ("NTUC"), and the Singapore National Employers Federation ("SNEF")) issue non-binding guidelines and advisories from time to time, establishing official standards expected of employers and employees. The employer-employee relationship is also governed by common law, in particular by contract law (LCLG, 2016).

2.4 Green Growth

Green growth has been a central theme in economic development during the past decade led by climate change and sustainable development issues. Singapore has achieved rapid economic growth in the past years, which has resulted in corresponding increases in energy use, natural resources extraction, and greenhouse gas emissions. Singapore's government set up the Inter-Ministerial Committee on Sustainable Development (IMCSD) in 2008 to formulate a national strategy for Singapore's sustainable development in the context of emerging domestic and global challenges. The committee consulted extensively with businesses, community leaders and members of the public to develop the strategy. The resulting vision was to 'Make Singapore a livable and lively city state, one that Singaporeans love and are proud to call home'. A series of strategies were developed to work towards the transition into a sustainable Singapore: Boosting Resource Efficiency, Enhancing the Urban Environment, Building Capabilities, and Fostering Community Action. These strategies are documented in detail in the overarching sustainable development strategy and include targets and time-based actions (The Ministry of Environment and Water Resources, 2009).

To fight against climate change, Singapore recently submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC). In accordance with Decisions 1/CP.19 and 1/CP.20, Singapore communicates that it intends to reduce its Emissions Intensity by 36% from level in 2005 by 2030, and stabilize its emissions with the aim of peaking around 2030 (Choy, Jindal, & Low, 2015).

Table 6 Policy measures for green growth and sustainable development

Types of Policy Instruments	Category		Title of Policy (Year)	
National Plan And Strategy	Sustainability		<ul style="list-style-type: none"> Green Plan 2012 (2006 edition) The Sustainable Singapore Blueprint 2015 	
	Eco-Innovation	Building	-	
		Energy	Energy Generation	-
			(Renewable) Energy	-
		Manufacturing & Industry	-	
		Tourism	-	
		Transport	-	
		Waste	-	
		Water	-	
		Climate Change	<ul style="list-style-type: none"> Intended Nationally Determined Contribution (INDC) to the Paris Agreement (2015) 	
Others	<ul style="list-style-type: none"> The Maritime Singapore Green Initiative (2011) 			
Programmes And Actions	National	Building	<ul style="list-style-type: none"> Eco-office Programme (2002) BCA Green Mark scheme (2005) 	
		Energy	Energy Generation	<ul style="list-style-type: none"> Increased Efforts to Use Natural Gas (1992) Energy Innovation Programme Office (EIPO) Singapore (2007)
			(Renewable) Energy	<ul style="list-style-type: none"> Experimental Power Grid Center (2011)
		Manufacturing & Industry	<ul style="list-style-type: none"> The Green Technology Programme (2011) Energy Audit Scheme (2002) Mandatory Energy Labeling Scheme (2008) Green Mark Scheme (2005) Singapore Green Label Scheme (SGLS) (1992) Energy Innovation Research Programme (EIRP) (2012) 	
		Tourism	-	
		Transport	<ul style="list-style-type: none"> The Green Port Programme 	
		Waste	-	
		Water	-	
		Climate Change		
		Others		

Types of Policy Instruments		Category	Title of Policy (Year)
	International	Multilateral	-
		Bilateral	-
		Others	-
Legislation		Building	-
	Energy	Energy Generation	-
		(Renewable) Energy	<ul style="list-style-type: none"> • Energy Conservation Act (2012)
		Manufacturing & Industry	<ul style="list-style-type: none"> • Agency for Science, Technology and Research Act (1990, revised 2002)
		Tourism	-
		Transport	-
		Waste	<ul style="list-style-type: none"> • Hazardous Waste Act (1998)
		Water	-
		Climate Change	-
		Others	<ul style="list-style-type: none"> • Environment Protection and Management Act (1999,2002) • Environmental Pollution Control Act (1999) • Parks and Trees Act (2005)
Finance		Building	<ul style="list-style-type: none"> • Pilot Building Retrofit Energy Efficiency Financing (BREEF) Scheme (2011)
	Energy	Energy Generation	<ul style="list-style-type: none"> • Design for Efficiency Scheme (DfE) (2008)-
		(Renewable) Energy	<ul style="list-style-type: none"> • Clean Energy Research and Test-bedding Program (CERT) (2007)
		Manufacturing & Industry	<ul style="list-style-type: none"> • Investment Allowance Scheme (2005) • Grant for Energy Efficient Technologies (GREET) • One-year Accelerated Depreciation Allowance for Energy Efficient Equipment and Technology (ADAS) • Energy Efficiency Improvement Assistance Scheme (EASe) (2005) • Income Tax Act (1996) • Energy National innovation Challenge (NIC) Singapore
		Tourism	-
		Transport	<ul style="list-style-type: none"> • Carbon Emissions-Based Vehicle Scheme (CEVS) (2013) • The Green Ship Programme (2011, 2013)
		Waste	<ul style="list-style-type: none"> • 3R Fund
		Water	<ul style="list-style-type: none"> • Water Efficiency Fund (WEF) (2007)
		Climate Change	-
		Others	<ul style="list-style-type: none"> • Innovation for Environmental Sustainability (IES) Fund (2003) • 3P Partnership Fund

Types of Policy Instruments	Category	Title of Policy (Year)	
Information	Building	-	
	Energy	Energy Generation	-
		(Renewable) Energy	• Solar Energy Research Institute of Singapore (SERIS) (2008)
	Manufacturing & Industry	• Green Pledge	
	Tourism	-	
	Transport	-	
	Waste	-	
	Water	-	
	Climate Change	-	
Others	-		

Source: Park et al. (2016)

3. Eco-Innovation Trends

3.1 Awareness of Eco-Innovation

The terms “sustainability”, “green technology”, and “clean energy” are more often used than “eco-innovation” in Singapore. The term “sustainability” often correlates with company and buildings and is used dominantly in corporate environmental reporting and green buildings. “Green Technology” on the other hand has a direct reference to any innovative energy savings equipment followed closely by “clean energy,” which directly refers to solar and wind which are renewable sources of energy. In Singapore, eco-innovation could refer to green technology as well as innovative business models that have reduced human impact on environment.

Singapore, the greenest city in South East Asia, started their sustainability journey in the 1960s before environmental issues became a global concern. Singapore leaders set a long-term vision in order to solve high unemployment, urban slums, poor infrastructure, lack of sanitation and unskilled labor force. Since then, Singapore has made good progress in its sustainability journey and is on track to achieve 2020 and 2030 targets laid out in the 2009 Sustainable Singapore Blueprint⁸. The new initiatives include

- Smart city pilots with sustainable features at Marina Bay. (Jurong Lake District and Punggol)
- Renewed greening efforts to make Singapore a City in a Garden
- Minimum energy and water efficiency standards for more household appliances
- Ambitious plans to ramp up public transport infrastructure
- A new Maritime Singapore Green Initiative
- More Active, Beautiful, Clean Waters projects
- The 3R fund to encourage waste reduction and recycling

⁸ The Sustainable Singapore Blueprint 2015, page 10

- The Centre for livable Cities to promote knowledge sharing on urban development with other countries

The Maritime Singapore Green Initiative was launched to reduce the environmental impact of shipping and related activities. It was announced by the Maritime and Port Authority of Singapore (MPA) in 2011, to which MPA pledged an investment of up to \$100 million over five years. The Green Ship Programme encourages Singapore-flagged ships to reduce carbon dioxide and sulphur oxides emissions. Qualifying ships that adopt the programme can enjoy up to 75% reduction of Initial Registration Fees and up to 50% rebate on Annual Tonnage Tax⁹.

3.2 Major Actors in Singapore

In Singapore, the government and its agencies have overall responsibility for its country sustainable developments and eco-innovation policies. The following ministries are major contributors to innovation and development in Singapore.

- **Ministry of National Development (MND)**

Mainly responsible for policies related to country eco-innovation and developments, the Ministry of National Development works with Building Construction authority (BCA) to encourage innovative development which promotes sustainable environment, well-built environment and Green Building technology development. BCA is a statutory board under MND. BCA Green Mark Certification Scheme for buildings is an example of a government strategy to increase energy efficiency, water efficiency and sustainable materials and to reduce the carbon footprint in Singapore. BCA Green Mark scheme included the adoption of sustainable construction, which encourages the private sector to use eco-friendly materials and products. Code compliant building that meets the criteria of the Green Mark Certification is mandatory in Singapore. As such, newly-constructed buildings in Singapore are green buildings and meet a minimum environmental performance set forth by BCA.

- **Ministry of Trade and Industry (MTI)**

Ministry of Trade and Industry supervises the JTC Corporation, which drives the plan, promotion and development of dynamic industrial landscape. JTC played a major role in Singapore's economic development through collaborations with local universities such as Nanyang Technological University (NTU), National University of Singapore (NUS) and the Singapore University of Technology and Design (SUTD). It conducted research and experiments, collaborating with private sector organizations. MTI believes that innovation in many areas will transform Singapore into a center of international business and innovation hub and attract many talents in the region, which would boost the country's economic growth.

⁹ Adopted from " <http://www.mpa.gov.sg/web/wcm/connect/www/c49487aa-34a0-4df4-8edc-1365bf92dc53/annex-b-031213.pdf?MOD=AJPERES>"

• Ministry of the Environment and Water Resources (MEWR)

Formerly known as the Ministry of the Environment, the Ministry of the Environment and Water Resources is responsible for providing a quality living environment and a high standard of living for the public¹⁰. The two statutory boards – the National Environment Agency (NEA) and Public Utilities Board work along with MEWR to ensure environmental sustainability in Singapore and manage limited resources such as energy and water through innovation, vibrant partnerships and co-operation with private corporations, public institutions and people¹¹. NEA is a public organization responsible for improving and sustaining a clean and green Singapore. NEA is also responsible for protecting Singapore's resources from pollution, maintaining a high level of public health and providing timely meteorological information¹². On the field level, MEWR is responsible for the overall Sustainable Blueprint 2016 of Singapore and the Blueprint's targets and ambition to turn Singapore into a truly sustainable city. This sets the pace to all the sustainability efforts in Singapore.

• Ministry of Transport (MOT)

The Ministry of Transport oversees and regulates land, sea, air transportation within the Singapore jurisdiction. Land Transport Authority (LTA), a statutory board under MOT, is responsible for the development of rapid transit system and expansion of the rail network. In Singapore, about 5.308 million trips are made on a daily basis through the public transport system. The public transport system is the most important mode of transportation in Singapore, as 52.4% of Singaporean residents (excluding foreigners) go to work using public transport system. LTA also understands the importance of reducing the carbon emission from vehicles. Thus, in January 2013, LTA rolled out the carbon emissions-based vehicle scheme to encourage consumers to shift to low emission models¹³.

Other bodies under the MOT are Civil Aviation Authority of Singapore, Maritime & Port Authority of Singapore (MPA) and the Public Transport Council (PTC), which implement the ministry's policies and tactical directions. Furthermore, there are non-governmental organizations such as the Singapore Transport Association (STA). The main goal of these organizations is to forge trade ties and generate business opportunities in private transportation, such as private busses/coaches and service in the private/touristic driven sectors.

3.3 Eco-Innovation Policies

The Singaporean government plays a crucial role as policy-makers to push eco-innovation in social, economic and environmental contexts. Singaporean Prime Minister Lee Hsien Loong unveiled a \$19 billion plan on January 8th 2016, to support Singapore's R&D efforts over the next five years. This plan is to support and translate research into solutions that address national challenges, build

¹⁰ https://en.wikipedia.org/wiki/Ministry_of_the_Environment_and_Water_Resources

¹¹ "http://www.nea.gov.sg/corporate-functions/about-nea/about-the-national-environment-agency" " https://www.bca.gov.sg/greenmark/green_mark_buildings.html" "https://en.wikipedia.org/wiki/Ministry_of_National_Development_(Singapore)#cite_note-4"

¹² https://en.wikipedia.org/wiki/National_Environment_Agency

¹³ Adopted from-https://en.wikipedia.org/wiki/Transport_in_Singapore#cite_note-Facts-2

up innovation and technology adoption in companies, and drive economic growth through value creation.¹⁴ The government of Singapore understands the importance of environmental conservation, and has invested in eco-innovation, R&D and incentives to create green markets.

Singapore has developed eco-innovation policies and sustainable development for the past 20 years up until now. The country continues its effort to revise and adopt new technology. Singapore has achieved innovation through R&D investment. In fact, the GDP of Singapore has increased 3.9 times from 1990 to 2009 with R&D spending accounting for 2.3% of the GDP. Maritime Singapore Green Initiative was established with \$100 million investment to reduce the environmental impact of shipping and related activities.¹⁵

The Sustainable Singapore Blueprint 2015 outlines Singapore's national vision and plans for a more livable and sustainable Singapore. R&D budget is allocated to ministries in order to set up a scheme for eco-innovation and sustainable development. For example, Singapore is working towards becoming a zero-waste nation by introducing pneumatic waste conveyance systems in selected HDB towns¹⁶ to reduce consumption of, as well as reuse and recycling of, all materials to second lease of life.

The Singapore Green Plan, an environmental blueprint for the future of Singapore, was updated in 2012. Its objective is to ensure that Singapore, through sound environmental management, achieves economic development that meets the needs of the present generation without compromising the needs of future generations.

It is without doubt that what Singapore propels to do is enhancing the quality of life and experience of living in Singapore whilst maintaining its competitiveness. The targets of environmental sectors, including technological or policy-related eco-innovations, may be ambitious and even aggressive, but achievable as long as the right drivers are in place.

Downstream opportunities abound in multi channels/sectors for a robust economy along the eco-innovation policy set. Small in scale but big in implementation is what Singapore is known for. Eco-innovation policy coupled with incentives and good grounds / flexibility in operations, all in all provides a solid platform for success for Singapore.

3.4 Singapore Legislation on Environmental regulation

In Singapore, the term "Eco-innovation" may not be used in laws and legislations, but the following legislation promotes the improvement of environmental quality and assists innovative business models that reduce impact on the environment, essentially serving as a supporter for eco-innovation.


- Energy intensive companies in the industry sector are required under the Energy Conservation Act¹⁷ to register with National Environment Agency (NEA) within 6 months of qualifying as a registrable corporation. The Act mandates companies to implement energy management practices. It also aims to push large corporations to increase their energy efficiency and reduce the environmental impact by cutting

¹⁴ <http://www.channelnewsasia.com/news/business/singapore/govt-commits-s-19b-to-new/2409426.html>

¹⁵ paragraph was adopted from "ASEM Eco-Innovation Index 2014"

¹⁶ <http://www.channelnewsasia.com/news/singapore/hdb-introduces-new-waste/1885104.html>

¹⁷ <http://www.nea.gov.sg/corporate-functions/about-nea/legislation>



down their greenhouse gas emissions. Under the Act, corporations will need to appoint an energy manager, monitor and report energy use as well as greenhouse gas emissions annually, and submit energy efficiency improvement plans annually.

- The Environmental Pollution Control Act (1999) is a legislation that consolidated various environmental pollution control laws such as Clean Air Act and Water Pollution Control and Drainage Act.
- Hazardous Waste Act (1998) requires that any person who wishes to export, import or transit hazardous wastes obtain a permit from Pollution Control Department (PCD), the national competent authority for the Basel Convention. It was passed to control toxic industrial wastes and ensure their safe treatment and disposal.
- Parks and Trees Act (2005) is an act to provide for the planting, maintenance and conservation of trees and plants within national parks, natural reserves, tree conservation areas, heritage road green buffers and other specified areas¹⁸. Trees are considered green infrastructure that improves air quality by removing carbon dioxide, reducing air pollution and producing oxygen.
- The Agency for Science, Technology and Research Act (A*STAR) is a legislation that establishes the Agency for Science, Technology and Research to be driver of scientific research for Singapore. As a statutory board under the Ministry of Trade and Industry (MTI), A*STAR aims to advance the economy and improve lives by growing the knowledge-intensive biomedical, research, scientific and engineering fields.¹⁹

3.5 Highlighted Sectors


- Construction Sector

Singapore's construction sector has grown for the past several decades. With the strong support and investment from the government, the construction sector will continue to expand in coming years. 80% of the Singaporean lives in flats developed by Housing Development Board (HDB). The housing demand from the middle-class population will continue to grow. Besides providing public housing units, the government of Singapore also aims to improve transport and infrastructure in Singapore. The Cross island MRT Masterplan and Tuas West Extension projects are representative examples of government strategies to improve transport and infrastructure in Singapore.

While addressing the housing and infrastructure needs for the development of Singapore, the government also considers the significance of sustainability in this sector. Hence, Green Mark

¹⁸ <https://www.nparks.gov.sg/~media/nparks-real-content/about-us/legislation/parks-and-trees-act.pdf?la=en>

¹⁹ A*STAR mission and vision statements. Retrieved from A*STAR website: <http://www.a-star.edu.sg/About-A-STAR/Overview/A-STAR-Mission-and-Vision.aspx>



Certification programme has been introduced and brought together with financial incentives, legislation, and industry training programmes. The Green Mark Certification standards cover a variety of building types and spaces, the use of sustainable construction materials, energy efficiency, water efficiency with a higher emphasis on passive design. To achieve green and environmentally friendly building and construction, the government has incentive schemes related to energy efficiency, green buildings and construction. The following list includes incentive schemes related to the construction sector.²⁰

- Energy Efficiency Improvement Assistance Scheme (EASe) is a scheme that would fund up to 50% of the qualifying cost of engaging an expert consultant or Energy Services Company(ESCO) to conduct detailed energy assessments and identify potential areas to improve energy efficiency.
- Grant for Energy Efficient Technologies (GREET) encourages owners and operators of new and existing industrial facilities to invest in energy efficient equipment or technologies. Typical funding could cover up to 20% of the qualifying costs, capped at \$4 million per project.
- Design for Efficiency Scheme (DfE) is a scheme to support investors in new facilities in Singapore to integrate energy and resource efficiency improvements into manufacturing development plans early in the design stage. The maximum amount of funding is 50% of the qualifying costs or \$600,00, whichever is lower.
- Building Retrofit Energy Efficiency Financing (BREEF) Scheme was created by Building Construction Authority (BCA) in collaboration with participating financial institutions. BREEF Scheme facilitates financing for the purchase and installation of energy efficient equipment or renewable energy system. The credit facilities are to be used for energy efficiency retrofits of existing buildings , which will achieve minimum Green Mark certified standard. In addition, the building must maintain its Green Mark certification for the period of loan tenure.²¹
- Green Mark Incentive Scheme for Existing Buildings (GMIS-EB) (\$100 million) was launched on April 29th, 2009 in order to encourage developers to adopt energy efficient retrofitting design, technologies and practices in their existing building to achieve a significant improvement in energy efficiency.
- Green Mark Incentive Scheme – Design Prototype (GMIS-DP) is a scheme to support

²⁰ The lists are retrieved from- <http://www.greenfuture.sg/2015/02/16/2015-guide-to-singapore-government-funding-and-incentives-for-the-environment>

²¹ More detail about the scheme - <https://www.bca.gov.sg/GreenMark/brief.html>

developers and building owners with funding to focus on energy efficiency in building during the design stage.


- Green Mark Gross Floor Area Incentive Scheme (GM-GFA) encourages the private sector buildings to perform better to attain higher Green Mark ratings (i.e. Green Mark Platinum or Green Mark Gold Plus). For developments attaining Green Mark Platinum or Gold Plus, Urban Redevelopment Authority(URA) will grant additional floor area over and above the Master Plan Gross Plot Ratio.²²
- Skyrise Greenery Incentive Scheme (SGIS), aims to increase greenery provision in Singapore for which National Park Board will fund up to 50% of installation costs of rooftop greenery and vertical greenery in buildings.
- Green Mark Incentive Scheme for Existing Buildings and Premises (GMIS-EBP), applies to Small and Medium Enterprises(SMEs) building owners and building owners with at least 10% of its tenants who are SMEs. This incentive scheme aims to encourage building owners and tenants to undertake Energy Improvement Works involving the installation of energy efficient equipment approved by BCA.
- MND Research Fund for the Built Environment is a \$50 million funding initiative proposed by the Ministry of National Development (MND) and managed by BCA. The fund is to promote and support applied R&D that will raise the quality of life and make Singapore a distinctive global city.
- Sustainable Construction Capability Development Fund (SC Fund) will focus on developing capabilities in recycling waste arising from the demolition of buildings and in using recycled materials for construction.

- Maritime Sector

In 1982, Singapore became the world's busiest port by shipping tonnage, achieving one million TEUs a year for the first time. Since then, business has grown year by year. Singapore is also known as a leading center for ship repair, and its other key activities include building marine vessels and offshore structures, vessel design, engineering and marine equipment and services. Furthermore, Singapore has become a strategic center for maritime business.²³ In Singapore, maritime industry expands annually. The Maritime Port Authority of Singapore (MPA) also consider sustainability. Therefore, the authority has begun to encourage maritime organizations to demonstrate their commitment towards sustainability and green shipping in Singapore. Since 2011, when the Maritime Singapore Green

²² More detail about the scheme- <https://www.bca.gov.sg/greenmark/gmgfa.html>

²³ Adopted from- <http://www.insis.com/articles/se/the-maritime-industry-in-singapore-past-present-and-future>



Pledge was created, a total of 90 companies have pledged their commitment towards promoting clean and green shipping in Singapore. The MPA also pledged to invest up to \$100 million over 10 years in the Maritime Singapore Green Initiative. To promote green shipping and sustainability in maritime industry, the Authority introduce the following sustainability programme:

- **The Green Ship Programme (GSP)²⁴** is a voluntary programme that encourages Singapore-flagged ships to reduce carbon dioxide and sulphur oxides emissions. Qualifying Singapore-flagged ships can enjoy a reduction of 50% initial registration fees and 20% rebate on annual tonnage tax. From July 1st, 2016, GSP incentives will be extended to ships using Liquefied Natural Gas (LNG) as part of Singapore's long term efforts to advocate LNG as a sustainable alternative fuel source.
- **The Green Port Programme (GPP)²⁵** encourages ocean-going ships calling at the port of Singapore to reduce the emission of pollutants. Under the programme, qualifying ocean-going ships that stay 5 days or less within the Singapore port will be granted 25% reduction in port dues.
- **The Green Technology Programme (GTP)²⁶** encourages local maritime companies to adopt or develop green technologies. The grant can cover up to 50% of total qualifying costs with a cap of \$2 million per project for the technology solution reducing overall emissions more than 20 percent.

Singapore's commitment towards maintaining an environmentally friendly and sustainable global port hub will encourage other nations to join the sustainable movement in global maritime community.

3.6 New Trends Observed


- The Singapore Exchange sustainability report

Singaporean companies listed under Singapore Stock Exchange (SGX) will be obliged to publish a sustainability report once a year. Sustainability reports will give investors an evaluation of long-term value of the company. At the same time, investors can oversee the companies that pollute the environment or create products that harm the environment and society. The "comply or explain" framework will take effect in 2018 for any financial year ending on or after December 31st, 2017. The sustainability report must describe the sustainability practices regarding five primary components:

²⁴ <http://www.mpa.gov.sg/web/portal/home/maritime-singapore/green-efforts/maritime-singapore-green-initiative/green-ship-programme>

²⁵ <http://www.mpa.gov.sg/web/portal/home/maritime-singapore/green-efforts/maritime-singapore-green-initiative/green-port-programme>

²⁶ <http://www.mpa.gov.sg/web/portal/home/maritime-companies/research-development/grants-and-incentives/green-technology-programme>

- 
- Material ESG factors
 - Policies
 - Practices and performance
 - Sustainability reporting framework
 - statement from the Board.

If the company excludes one of the above components, it must explain the reasons. This sustainability reporting will be new to most of the companies in Singapore, but SGX assures that there will be workshops for companies to learn more about sustainability reporting.

- Car-Lite Singapore

Singapore's Prime Minister along with the Minister for National Development Land and Senior Minister of State for Transport announced on July 9th, 2016, the completion of the first phase of works to transform Ang Mo Kio Town into Singapore's first walking and cycling town. This new local system will allow residents to walk and cycle to key amenities such as Ang Mo Kio MRT station, Ang Mo Kio Swimming Complex and Ang Mo Kio Hub.

Beyond Ang Mo Kio Town, the government will develop a comprehensive cycling network spanning more than 700 km across Singapore by 2030, with supporting infrastructure and a code of conduct to promote safe cycling within and across towns.

Additionally, pilot electric car-sharing scheme²⁷ will be implemented across the island by mid-2017, offering Singapore residents a greener alternative to owning a car. The residents will be able to book a car via an app or pick up a car at a starting point and return it at designated stations near their destination. This is part of the Car-lite Singapore vision, which promotes the use of public transport and car sharing to reduce pollution and greenhouse gas emissions.

The government of Singapore hopes to reduce the carbon footprint through various sustainable schemes and let the residents enjoy fresher air, a cleaner environment and a healthier lifestyle.

²⁷ www.straitstimes.com/singapore/electric-car-sharing-scheme-to-be-rolled-out-from-2017

4. Analysis of ASEI 2016 Results

ASEI 2016 analysis in Singapore shows the status of national eco-innovation. Data were collected in 4 areas with 20 indicators, 14 of which were used for analysis. The score of ASEI 2016 is the average of the four categories of eco-innovation ability, eco-innovation support environment, eco-innovation activity, eco-innovation performance. The average value of the indices of each category represents the score of the category. The related report details the data collection and data processing (scoring) of each indicator of the analysis²⁸. This report also provides a theoretical background of ASEI development and a process of indicator selection. The ASEI 2016 score in Singapore was evaluated as 60.92, and the "capacity", "support environment", "activity" and "performance" scores are 79.51, 89.74, 7.48 and 66.95, respectively (Figure 11). The web diagram in Figure 11 shows a relative comparison with other ASEM member countries. The green line shows the evaluation points of all indicators in Singapore and the yellow line and the red line show the benchmark results of ASEM member countries and countries belonging to the same group as Singapore, respectively. The group is divided based on the national development stage published by the World Economic Forum (WEF, 2015). Australia, New Zealand, Japan, Korea are members of the same group as Singapore (Stage 3).

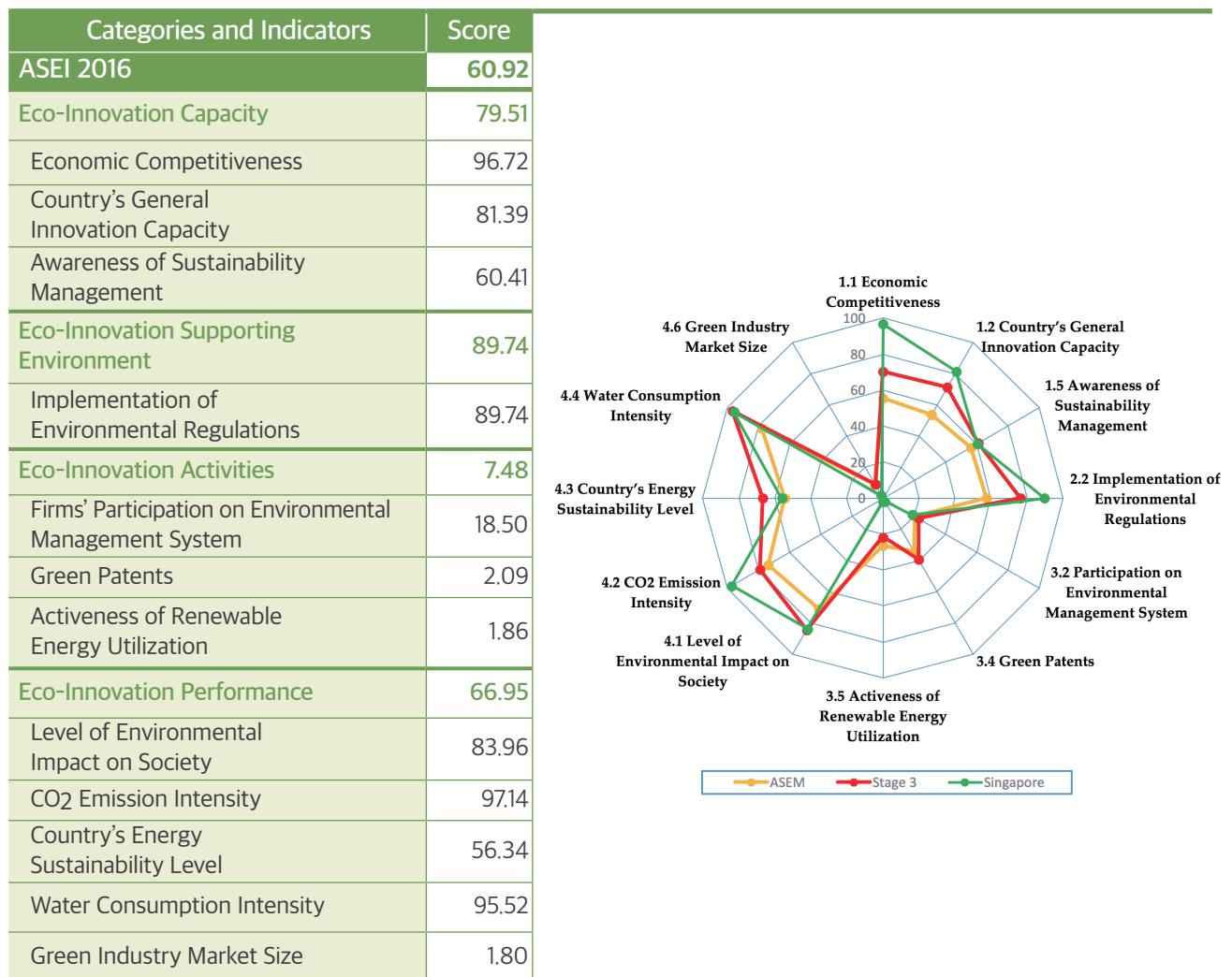


Figure 11 Results of Singapore's ASEI 2016 Measurement

²⁸ Park, M., Han, K., Jang, E., Choi, W., Joo, J (2016) ASEM Eco-innovation Index 2016. ASEM SMEs Eco-Innovation Center

Singapore's Eco-Innovation Capacity, Supporting Environment and performance score are relatively high, and Eco-Innovation Activity score is relatively low. Singapore's economic competitiveness (index number 1.1) and CO2 emission intensity (index number 4.2) are higher than the average score of the same group countries. The national energy sustainability level (index number 4.3) and the activity of renewable energy use (index number 3.5) are lower than the average score of the same group country.

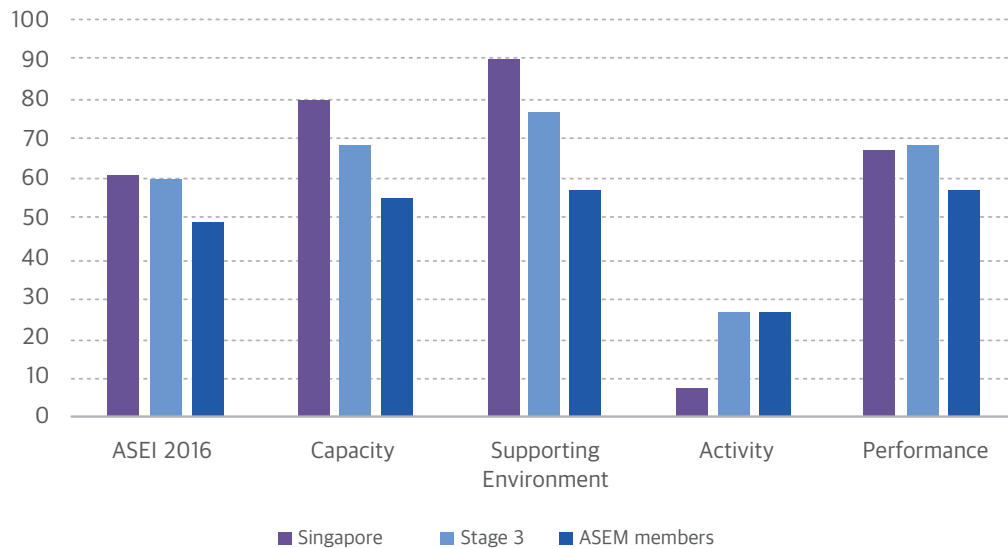



Figure 12 Results of ASEI 2016 for Singapore by categories

Figure 12 depicts Singapore's relative scores to the average of countries in the same development group (Stage 3 group) and the average of all member countries. Singapore's scores for ASEI 2016, Capacity and Supporting Environment categories are higher than the average of the same group countries and the average of all ASEM member countries. However, its activity category score is lower than the average of the same development group countries and all ASEM member countries. The performance category score is higher than the average for all ASEM member countries but is similar to that of the same group.

In each category, specific indicators are highlighted to influence the score of the category as follows:

- In 'Capacity' category, Economic Competitiveness (indicator 1.1) and General innovation capacity indicator (indicator 1.2) play a role in raising the score of the category. Indicator 1.1, retrieved from the Global Competitiveness Index, measures the level of productivity of a country, including the 12 pillars; Institutions, Infrastructure, education Business sophistication and Technological readiness etc. Indicator 1.2, retrieved from the Global Innovation Index, measures the level of innovation capacity, including status of research institutions, human capital, infrastructure, elaborateness of market and industries, and outcomes of technologies.
- In 'Supporting Environment' category, as the category consists of one indicator, the score of the category demonstrates the score of implementation of environmental regulations indicator (indicator 2.2). Indicator 2.2 is derived from stringency and



enforcement of environmental regulation of the Sustainable Competitiveness Index published by the World Economic Forum.

- Regarding 'Activity' category, the score of the category is relatively low due to the \ lower score of all indicators of this category. Indicator 3.2, Participation on Environmental Management System, is the number of firms with ISO14001 certification and Indicator 3.4, Green Patents, is a ratio of the number of environmental patents against total patents in a country which is sourced from OECD Green growth database. The Activeness of Renewable Energy Utilization (indicator 3.5) depends on the contribution of renewable energy to total primary energy supply (TPES).
- In 'Performance' category, energy sustainability level indicator (indicator 4.3) lowers the score of the category while CO₂ emission intensity indicator (indicator 4.2) increase the score of the category. Indicator 4.3 is assessed by energy performance from the energy sustainability index published by the World Energy Council. This indicator reflects the level of energy security, social equity and environmental impact in a country. Indicator 4.2 is examined from CO₂ emissions to GDP ratio provided by the International Energy Agency.

5. Good Practices on Eco-Innovation in Singapore

In Singapore, it is found that innovative practices are emerging in the vision of eco-innovation in green building sectors because Singapore has long advocated a distinctive environmental policy, especially green building due to its narrow territory and scarce resources. The 'Clean and Green Singapore' campaign, which began in 1968, has already set targets for energy efficiency and eco-friendliness. The energy consumption of the Singapore building accounts for 16% of the total energy consumption of the country and 20 ~ 40% of the total energy cost. The Government of Singapore introduced the Building and Construction Authority (BCA) Green Mark System in 2005, focusing on improving energy efficiency and energy costs, which are a significant part of final electricity consumption. The Green Mark scheme is a system that gives a rating from four levels: Certification, Gold, Gold Plus and Platinum. It encourages the spread of design, technology and adoption to reduce building energy consumption and environmental impact of building construction.

In these contexts, this report selects the following two good practices related to eco-innovation: Eco Campus by Nanyang Technological University and PAssion Wave by People's Association²⁹. The first practice examines the Hive, an example of NTU Eco Campus by Nanyang Technological University. The second case is the PAssion Wave@Marina Bay by People's Association. Both cases were affected by government policy and received the Green Mark Platinum Award.

5.1 Eco Campus (Hive) - Nanyang Technological University

In accordance with one of its visions to become the greenest campus in the world, NTU has put in significant effort towards sustainability. This is highly reflected in its recent infrastructural development; for instance, the new innovative Learning Hub South – The Hive. The Hive is an iconic building which displays NTU's commitment towards protecting the environment and showcases NTU's new approaches towards collaborative and interactive learning styles. In 2013, this appealing learning hub received the Green Mark Platinum Award from the Building and Construction Authority (BCA).

One of the building's innovative eco-friendly features is its unique ventilation system – the passive displacement ventilation system. It is the first building in NTU and in Singapore to adopt this full scale innovative air-conditioning system. It serves as a more sustainable alternative to conventional air conditioning, with an expectation of up to 30% energy savings. No fans are needed for air distribution. The building is equipped with special metal coils with cold water flowing through them. This cools the wind that enters classrooms and removes hot air via convection. In addition, the openings between pods allow for natural ventilation to the atrium, corridors, staircases, and lift lobby. In line with NTU's garden campus, the learning hub incorporates a generous amount of natural foliage in its design. Internal vertical greenery and rooftop terraces enhance the garden experience. The greenery also reduces solar glare and natural heat gain, diminishing reliance on artificial cooling devices, while providing reprieve from the tropical heat. The building's inverted shape enables the upper floors to shade the lower levels, further reducing exposure to solar heat. Other energy-saving features include energy-efficient light and motion sensors in classrooms, toilets and staircases, which keep lighting

²⁹ The People's Association (PA) was established in Singapore as a statutory board on 1 July 1960 to promote racial harmony and social cohesion

usage flexible. Furthermore, the layout of the building maximizes natural lightings, which reduces its need for energy. Also, the building is in the off-form concrete for all walls, ceiling and columns. Apart from giving its appealing features, the building does not incorporate materials that pollute the environment such as paints, wall tiles, ceiling boards at cetera.



Figure 13 The Hive - Learning Hub



Figure 14 The interior of the Hive



Figure 15 The building model of Hive

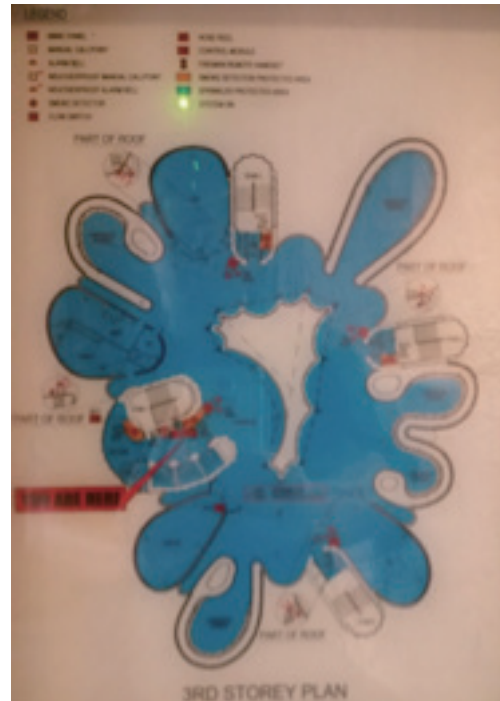


Figure 16 The floor plan of Hive

5.2 PAssion Wave @ Marina Bay – Water Venture.

Organized by the People’s Association, The PAssionWave @ Marina Bay offers water sports and lifestyle sports programmes and facilities to attract the youth and young working adult. Its design aims to capture the essence of a waterfront park ambience and at the same time, effectively serve the operational requirements of a water-sports facility. The layout and circulation were developed to serve the process involved in the operation of the facility.



Figure 17 PAssion Wave @ Marina Bay

The water venture was awarded Singapore Green Mark Platinum. The building orientation was designed to achieve passive cooling and creating of wind channels since artificial cooling, such as air-conditioning, is limited. The building also focuses on minimizing water usage of the boathouse, maintaining biodiversity and water venture, which are good examples of connecting the community with nature biodiversity environment.

Table 7 PAssionWave energy savings summary

	Baseline	Proposed	Savings
VRV System	260847.8	156254.1	40.1%
MV & Air Distribution Fan	8346.5	8346.5	0.0%
Lighting(interior)	137309.8	59117.9	56.9%
Receptacle Loads	85371.0	85371.0	0.0%
Lift	8322.0	8322.0	0.0%
Total Building Energy Consumption	500197.1	317411.5	36.5%
Energy Cost(\$/year) (Based on 20 Cents /kWh)	\$100,039.42	\$63,482.30	\$36,557.12

Source: Building & Construction Authority (BCA), 2014

As shown in Table 7, it achieved 36.5% saving for total building energy consumption and the yearly cost saving of \$36,557.12. In order to achieve these savings, the following strategies were implemented in the project.

- Dual Cooling Option

Ceiling fans are provided to encourage the usage of natural ventilation. The project uses Efficient Air Conditioning System VRV system.

- Lighting Design with sensors

The lighting was designed for efficiency and positioned strategically. The corridor, boat house use LED light and office lights use T5, which is an energy efficient light. In order to maximize the saving, motion sensors and photo sensors are used in staircase, corridor and toilets.

- Water Efficient Features

The water fittings used in the water venture are highly efficient water fittings that received WELS excellent rating. The irrigation system is an auto drip irrigation system with a rain sensor that stops water from dripping when it is raining in the area.

- Water Recycling

Water venture is designed to save as much water as possible Boat washing water will be reused by passing through the filtration and getting sent back to rainwater harvesting tank. Therefore, the water is recycled for the irrigation of landscaped areas.

- Renewable Energy

Wind turbines are used for renewable energy in water venture. The wind from the compressor unit 1 & 7 will be harvested to power wind turbines as shown in figure 18. The inverter will convert the AC current and power the air compressor for boat washing.

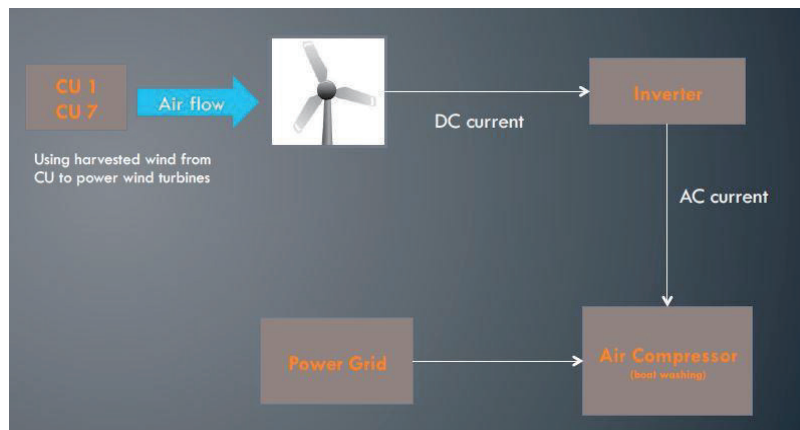


Figure 18 Wind turbines for boat washing

Source: GreenAconsultants, 2016

In addition to these features, PAssion Wave also encourages energy conservation through small innovations even though they do not achieve great conservation. Boats and canoes used in water sports need to spend water for cleaning. The cleaning system is designed for people to use air and water together to reduce water consumption as shown in figure 19. Moreover, a compressor can dry used life vests by using the wind instead of drying them in a separate facility a separate facility as shown in figure 20.



Figure 19 boat washing station - using water and air together to reduce water consumption



Figure 20 Compressor - Using wind from compressor to dry life jackets

6. Country Synthesis

This report reviews eco-innovation in Singapore by combining ASEI measurement with local circumstances on innovative approaches to the environment, economy and society. Singapore, mostly originated from rapid economic growth for the past three decades, is facing significant environmental challenges which could harm momentum of future economic growth. Water pollution, toxic waste and air pollution are explicit threats to the country's competitiveness. As demands for transition into more sustainable and environmentally friendly economy to overcome environmental challenges increase, the government has already initiated measures to raise awareness of the challenges among society and keep the country greener without compromising economic prosperity.

In Singapore, the government plays a key role in shaping policy to encourage eco-innovation in social and economic contexts. In 2016, a budget of \$19 billion was allocated to support R&D, including eco-Innovation R&D efforts for next five years. The Singapore Green Plan 1992-2001 was the first step for the government to lead sustainable development for future generations. A decade later, Singapore Green Plan was renewed again to continue the original objective. In addition, since 2009, Sustainable Singapore Blueprint Plan has served the government's interests in making Singapore a sustainable city in the world. In 2015, Sustainable Singapore Blueprint was revised. Its main vision consists of "Eco-Smart" Town and "Car-Lite City", both of which serve as steps towards a zero-waste nation, a leading green economy and an active and gracious community. Singapore is working towards becoming a zero-waste nation by introducing pneumatic waste conveyance systems to reduce consumption and promote reuse and recycling of all materials. To achieve this vision, it should be encouraging technological eco-innovation.

Singapore has strong laws and legislations concerning the environment, and these regulations encourage industries to reduce their impact on environment. Hazardous Waste Act requires people who want to export and import or transit hazardous wastes to obtain a permit, controlling toxic industrial wastes in the long run. Moreover, Energy Conservation Act implements mandatory energy management practices in companies. This Act makes large companies improve their energy efficiency and reduce their environmental impact.

These contexts provide reasonable clues to interpret the result of ASEI measurement for Singapore. Singapore's ASEI 2016 score is higher than the average of all ASEM member countries. This may be attributed to European and developed countries' influence on Singapore. Among categories representing development phases in eco-innovation, Singapore performs better in 'Capacity' and 'Supporting Environment' categories than in 'Activity' and 'Performance' categories. These results can be explained by Singapore's powerful legislations and regulations in addition to governmental supports through a variety of policies and plans.

7. References

- ADB. (2016). Asian development outlook 2016: Asia's potential growth. Retrieved from <http://www.adb.org/publications/asian-development-outlook-2016-asia-potential-growth>
- BBC. (2016). Singapore Profile - timeline. Retrieved from <http://www.bbc.com/news/world-asia-15971013>
- Building & Construction Authority (BCA). (2014). BCA Awards 2014 Listing (Green Mark Awards Category). Retrieved from <https://www.bca.gov.sg/greenmark/others/gm2014.pdf>
- Choy, H. J., Jindal, G., & Low, M. (2015). Singapore 's Intended Nationally Determined Contribution for COP 21 Climate Conference in Paris, (September), 1–4.
- CIA. (2016). The World Factbook. Retrieved from <https://www.cia.gov/library/publications/the-world-factbook/geos/sn.html>
- Global Environmental Forum. (2003). Overseas environmental measures of Japanese companies (Singapore):Research report on trends in environmental considerations related to overseas activities of Japanese companies FY 2002, (March).
- GreenA consultants. (2016). Water Venture.
- KIHASA. (2015). Comparative Study of Family Policy in East Asia.
- KIHASA. (2016). Singapore's Population Policy History and Recent Issues, 5(February).
- Lambert, T. (2016). A brief history of Singapore. Retrieved from <http://www.localhistories.org/singapore.html>
- LCLG. (2016). Employment & Labour Law 2016: Singapore. Retrieved from <http://www.iclg.co.uk/practice-areas/employment-and-labour-law/employment-and-labour-law-2016/singapore>
- Mui-Teng, Y. (2014). Chapter 10 : Singapore's System for Managing Foreign Manpower. Managing International Migration For Development in East Asia, 2009(March), 220–240. Retrieved from http://lkyspp.nus.edu.sg/ips/wp-content/uploads/sites/2/2013/04/pa_MT_Managing-International-Migration-for-Development-in-East-Asia-Research-Papers_240215.pdf
- Park, M., Han, K., Jang, E., Choi, W. & Joo, J. (2016). ASEM Eco-innovation Index 2016. ASEM SMEs Eco-Innovation Center.
- The Ministry of Environment and Water Resources. (2009). A Lively and Liveable Singapore.
- The Ministry of Environment and Water Resources. (2012). The Singapore Green Plan 2012: Beyond Clean and Green Towards Environmental Sustainability, 1–68.
- The Ministry of Environment and Water Resources. (2016). ANALYSIS OF REVENUE Financial Year 2016, (March).
- The National Environment Agency. (2015). Singapore Waste Statistics 2014. Retrieved from <http://www.zerowastesg.com/2015/03/18/singapore-waste-statistics-2014/>
- The Transparency International. (2015). Corruption Perceptions Index 2015.
- UNDP. (2015a). Briefing note for countries on the 2015 Human Development Report: Singapore, 1–8. Retrieved from http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/TZA.pdf
- UNDP. (2015b). Human Development Report 2015 Work for Human Development.
- WEF. (2015). The global competitiveness report 2015-2016. World Economic Forum (Vol. 5). Retrieved from <https://doi.org/92-95044-35-5>
- WPR. (2015). World Population Review 2015. Retrieved from <http://worldpopulationreview.com/>
- Yale University. (2016). 2016 Environmental Performance Index, 123. Retrieved from www.epi.yale.edu

