



ASEM Eco-Innovation Index 2016 Country Report

- Thailand -



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

- KiJoo Han, EcoServices Consulting Co., Ltd., South Korea
- Sudkla Boonyanant, The CLiK team, Thailand
- Wongeun Choi, 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	9
2.4 Green Growth	12
3. Eco-Innovation Trends	15
3.1 Awareness of Eco-Innovation	15
3.2 Major Actors	17
3.3 Eco-Innovation Policies	21
3.4 Highlighted Sectors	24
3.5 New Trends Observed	26
4. Analysis of ASEI 2016 Results	28
5. Good Practices on Eco-Innovation in Thailand	30
5.1 Composite glass production by BSG Glass Co	31
5.2 Cassava packaging by Universal Bio Pack Co	32
6. Country Synthesis	39
7. References	35



Table List

Table 1 Economic Structure in Thailand5

Table 2 Findings from the Environmental Democracy Index6

Table 3 Fiscal budget allocation for environmental programmes in 2016 and 20157

Table 4 Summary of HDI 2015 for Thailand9

Table 5 Socioeconomic indicators related to work for Thailand10

Table 6 Policy measures for green growth and sustainable development13

Table 7 Strategies and output of the 1st National Science, Technology and Innovation Policy Plan
(2012 – 2021) which related eco-innovation.....23



Figure List

Figure 1 The role of case studies in ASEI research	1
Figure 2 Location of the Kingdom of Thailand	3
Figure 3 Population Growth Forecast	4
Figure 4 GDP Growth 1980-2014	5
Figure 5 Global Competitiveness Index 2015 for Thailand	11
Figure 6 The most problematic factors for doing business in Thailand	12
Figure 7 Results of Thailand's ASEI 2016 measurement	29
Figure 8 Results of ASEI 2016 for Thailand by categories	29
Figure 9 Eco-stone products from BSG Glass Co.	31
Figure 10 BUGBEAT products from BSG Glass Co.....	31
Figure 11 Production process for cassava packaging	33
Figure 12 UB PACK products	33



Summary

This national study plays a key role in understanding eco-innovation in Thailand in comparison to the assessed scores of ASEI 2016. The researchers introduce Thai's current socioeconomic issues, environmental issues and trends of eco-innovation in the beginning and, thereafter, analyze the current status of eco-innovation by combining with results of ASEI 2016. Thailand has been facing environmental problems like other developing countries as its economy and society has rapidly transformed. In order to overcome the problems, Thai government has applied green growth concepts including green technology, sustainable development as well as eco-innovation to its policy plans and strategies. In this context, authors analyze ASEI 2016 results considering local circumstances covering environmental and socioeconomic issues and efforts to promote eco-innovation in private and public sectors. Thailand's ASEI 2016 score is lower than an average of all ASEM member countries, which might be derived due to higher scores of European member countries. Among categories representing development phases in eco-innovation, 'Capacity' and 'Supporting Environment' categories perform relatively better than 'Activities' and 'Performance' categories. It can be explained by the fact that it reflects Thailand's strong economic foundations and governmental supports with a variety of policy measures. The strengths in capacity and supporting environments would be firm foundations for gradual improvement in eco-innovation in Thailand. In addition, it was clearly found that data were limitedly available for ASEI indicators. This implies that ASEIC need to facilitate data collection to improve ASEI research.

1. Background

This report aims to analyze the status of eco-innovation in Thailand in line with the measurement of the ASEM Eco-Innovation Index (ASEI) 2016. The index has been developed and calculated since 2012 by the ASEM SMEs Eco-Innovation Center (ASEIC)¹ based in South Korea. The ASEIC was established in 2011 as a result of the endorsement accepted by the ASEM member countries at the 8th ASEM Summit in 2010. The index was initially developed in 2012 and was calculated only for 15 member countries at the moment. Since then, the number of countries measured has increased, thus, the index was calculated for all ASEM member countries in 2015. Currently, a total of 51 countries are members of ASEM including Croatia and Kazakhstan, which recently joined ASEM in 2014.

ASEI has twenty indicators, which are classified into four categories: Capacity (Category 1), Supporting Environment (Category 2), Activity (Category 3) and Performance (Category 4). The indicators were chosen from a theoretical framework derived from an Input-Output model. Based on the framework, ASEI is ideally expected to describe the overall status of a member country on eco-innovation in addition to different levels among the categories. However, there should be more progress in ASEI development as the theoretical approach demands empirical evidences proving that ASEI reasonably reflects the eco-innovation status of member countries. Moreover, data availability for the indicators varies among member countries. Especially, the availability gap between European member countries and Asian member countries was found significant. This context led ASEIC to make more country-specific efforts to understand how ASEI represents the status of eco-innovation in a country and assesses how much data can be collected in the field.

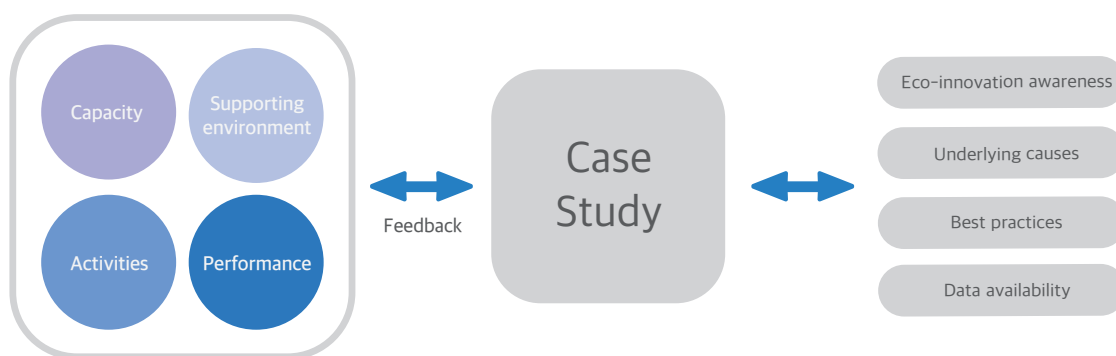



Figure 1 The role of case studies in ASEI research

This report plays a key role in understanding eco-innovation in Thailand in comparison to the calculated scores from ASEI. As the development and annual measurement of ASEI are highly dependent on currently available data, it is challenging to explain the exact status on eco-innovation and underlying circumstances in the ASEM member countries based on their ASEI scores. Rather, the results of ASEI measurement present trends and differing patterns of eco-

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



innovation among the member countries (Figure 1). For overcoming the limitation of country specific analysis, ASEIC began to conduct case studies in 2015. For the first year, it selected four countries from Asian member countries for the case studies. Japan and Republic of Korea accounted for developed and leading countries in Asia on eco-innovation while Vietnam and Myanmar did the equivalent for developing countries. Asian countries were chosen mainly due to the lack of research and surveys on eco-innovation in Asian countries, to collect more data for Asian countries. This trend implies that even the concept of eco-innovation has not prevailed in developing countries. In terms of data availability for the ASEI indicators, case studies for developing countries would provide an opportunity to assess how much data can be potentially collected for future ASEI measurement.

Following this background, a country profile chapter serves as an introduction to general environments of the country in terms of basic factors affecting eco-innovation covering socioeconomic issues and environmental issues. 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 changes in the country are reviewed in this chapter. Policy issues specified on eco-innovation are 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 currently operating policy measures affecting eco-innovation. Next, in the analysis of ASEI 2016, the research team explains what the assessed score of ASEI 2016 means reflecting the current situation and trends reviewed in the previous chapters. In the first part of the chapter, the assessed scores are presented in detail for each indicator, category and the index score itself. The analysis of ASEI 2016 with evidences in this chapter provides implications not only on how appropriately the Index presents the status of the country, but also on which indicator or category needs to be improved for further measurement. Next, before simply synthesizing the national study, good practices from different industrial sectors are shared with a focus on implementing capacity of involved entities and policy environments to support the practices. Finally, national 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 activities.

2. Country Profile

2.1 Introduction

Thailand, officially stated as the Kingdom of Thailand is located in the center of the Indochinese peninsula in Southeast Asia. It is bordered by Myanmar to the north and west, by Lao PDR to the north and east by Cambodia to the southeast, and by Malaysia to the south. The Southern part of the country embraces the Gulf of Thailand to the east, and a portion of the Malay Peninsula faces the Andaman Sea to the west (Figure 2). The total land area is approximately 513,120km² and the total population reached 68 million in 2015 (CIA, 2016). Thailand consists of 76 provinces, called 'Changwat', including Bangkok, the capital city of the country, and one municipality called Maha Nakhon (CIA, 2016). As a province is divided into districts, there are 877 districts as of 2016².



Figure 2 Location of the Kingdom of Thailand

Source: Wikipedia (<https://commons.wikimedia.org/w/index.php?curid=7350868>)

Thailand is a kingdom headed by King Bhumibol Adulyadej, the ninth monarch of the Chakri Dynasty who has been ruling the country since 1946. The Chakri Dynasty began its ruling in 1782 when the country was known as Siam. Bangkok was founded then as a new capital. During the reign of King Mongkut (Rama IV) in early 19th century, western innovations were embraced, initiating the country's modernization. The reign of King Chulalongkorn, thereafter, employed western advisers to modernize Siam's administration and commerce (BBC, 2015). In early 20th century, a constitutional monarchy was introduced with parliamentary government through a coup against the absolute monarch King Parjadhikok in 1932. After the transition, the name of the country became Thailand, meaning 'Land of the Free', in 1939. After World War II, political situations have been in turmoil until recently, as power has shifted among the monarch, military and civilian ruling (Baker & Phongpaichit, 2014).

Among the total population of over 68 million people, Thai, Burmese and other ethnic groups represents 95.9 percent, 2 percent, 2.1 percent, respectively, while languages used are Thai, the official language, Burmese and others, accounting for 90.7 percent, 1.3 percent and 8 percent, respectively (CIA, 2016). According to the World Population Prospects (WPP) developed by the United Nations

² https://en.wikipedia.org/wiki/List_of_districts_of_Thailand

Department of Economics and Social Affairs³, population density was 133 persons per km² in 2015 and the annual growth rate from 2010 to 2015 was 0.38 percent per year. Undergoing population decline and aging population in line with economic development in developed countries, Thailand has experienced this transition quickly, the average number of children born to the typical woman dropped from 6 to 2 between 1970 and 1990 (WPR, 2015). The World Population Review predicts that the population would reach slightly more than 7 million until the population growth stops (Figure 3). In addition to an aging population, population increase in urban areas has occurred in the last few decades. The urban population of Thailand increased from 9.3 million to 11.8 million in 2010⁴ with an average annual growth rate of 2.3 percent and a population density of 4,300 person per square kilometers in 2010 (World Bank Group, 2015)⁵.

Thailand has made remarkable development in economy, ascending from a low-income country to an upper-income country during the last four decades⁶. According to data from the World Bank, in 2014, the Gross Domestic Production (GDP) of the country was US\$404.8 billion (current US\$)⁷. The economy grew at an average annual rate higher than 5 percent in the late 1980s and early 1990s until the country faced the Asian financial crisis in 1997 (Figure 4). The strong and continuous growth created jobs, which contributed significantly to poverty reduction and the improvement of social security (Krongkaew & Nitithanprapas, 2006). Similar to other Asian countries suffering from financial crisis in late 1990's, Thailand experienced economic difficulties during this period. Due to

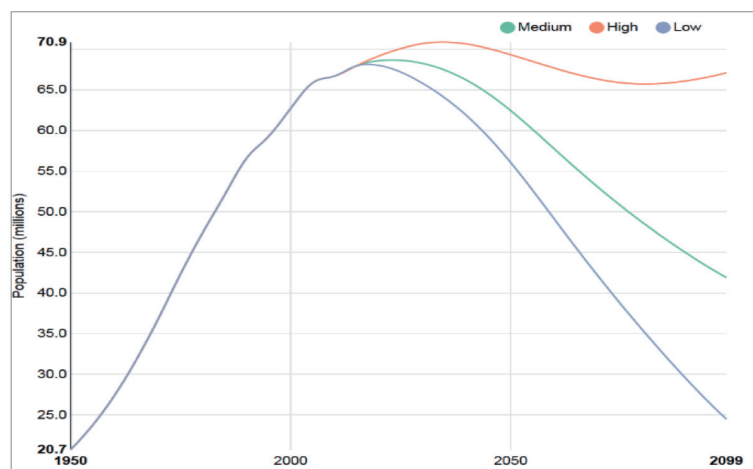


Figure 3 Population Growth Forecast

Source: World Population Review using WPP data
<http://worldpopulationreview.com/countries/thailand-population/>

³ <http://esa.un.org/unpd/wpp/>

⁴ The Bangkok urban area dominates other areas in the country as the population of the urban area in 2010 was estimated as 9.6 million

⁵ The average growth rate of urban areas in East Asia was 3.0 percent between 2000 to 2010 and the average population density was 5,800 people per square kilometer in 2010 (World Bank Group, 2015).

⁶ World Bank Country Overview - Thailand. <http://www.worldbank.org/en/country/thailand/overview>

⁷ World Bank Data - Thailand. <http://data.worldbank.org/country/thailand>

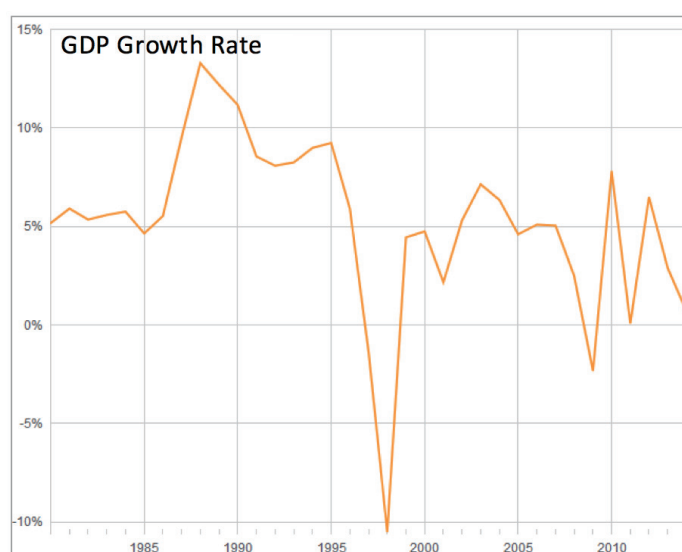


Figure 4 GDP Growth 1980-2014
 Source: World Bank Data
<http://data.worldbank.org/country/thailand>

the sharp value drop of the country’s currency, which provoked bankruptcies and unemployment, the IMF intervened in its economy in 1997 (BBC, 2015). However, the economy recovered quickly after the crisis and has performed modestly except in 2008 due to the subprime mortgage crisis and in 2011 due to severe flood in the country (Figure 4). ADB forecasts that the growth rate of the economy to rise consistently until 2017 up to 3.5 percent (ADB, 2015). In primary industries, agriculture sectors have grown at an annual rate of more than 3 percent since early 1960s until 2007. During the period, rice, rubber, sugar cane and cassava were main products (Leturque & Wiggins, 2011). Agricultural sectors accounted for 10.48 percent of the total GDP in 2014. Manufacturing and service sectors have expanded their roles in the economy since 1980 from 77 percent in 1980 to 90 percent of the total GDP in 2014 (Table 1). According to the data from the World Bank in Table 1, the size of import and export of goods and services accounted for 69.19 percent and 62.59 percent of GDP in 2014, respectively.

Table 1 Economic Structure in Thailand

Series Name	1980	1985	1990	1995	2000	2005	2010	2014
Agriculture, value added (percent of GDP)	23.24	15.81	12.50	9.08	8.50	9.20	10.53	10.48
Industry, value added (percent of GDP)	28.68	31.84	37.22	37.53	36.84	38.63	40.03	36.85
Services, etc., value added (percent of GDP)	48.08	52.35	50.28	53.39	54.66	52.17	49.44	52.67
Exports of goods and services (percent of GDP)	24.11	23.21	34.13	41.53	64.84	68.40	66.15	69.19
Imports of goods and services (percent of GDP)	30.37	25.94	41.65	48.22	56.46	69.45	60.61	62.59

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

2.2 Environmental Issues

Thailand faces environmental problems similar to those of other developing countries as the economy and society have rapidly transformed. According to a report from the Global Environment Forum, in later 1990s, Thailand faced the following environmental issues: water pollution, as the most critical environmental problem, mainly derived from wastewater from households and industrial facilities and heavy metal contamination; air pollution largely caused by motor vehicles; waste problems resulting from disposal of hazardous materials such as battery and medical wastes; and other ecosystem-related environmental problems such as deforestation, mangrove forest degradation and soil erosion (Global Environmental Forum, 1999). A decade later, the Pollution Control Department under the Ministry of Natural Resources and Environment disclosed the status of environmental conditions with numbers based on field assessment. The report presented that there are still environmental problems in water, waste and air but each problem has different patterns of change. Air and water quality showed an improving trend while waste problems became more serious as the amount of hazardous material waste increased (PCD, 2012). Especially, the report highlighted that the country imported 10.38 million tons of hazardous substances in 2011 to be used in industrial and agricultural sectors.

In the final report of the Environmental Performance Index (EPI)⁸ 2016 conducted by Yale University, Thailand ranked 91st out of 175 countries assessed with a score of 69.54 out of 100. Compared to neighboring countries, the score of the country is slightly lower than that of Singapore (87.04), Malaysia (74.23), and Philippines (73.7) while higher than that of Indonesia (65.85), Vietnam (58.5), Cambodia (51.24) and Lao PDR (50.29) (Hsu et al., 2016). Thailand's EPI score has improved over the last decade by 17.68 percent, which indicates relatively low improvement in comparison with other countries, whose improvement ranges from -2.2 to 48.8 percent.

Table 2 Findings from the Environmental Democracy Index

Doing well	To be improved
<ul style="list-style-type: none"> • Government authorities must proactively make environmental information available to the public. • The law recognizes a right to access environmental information on request. • The law requires government agencies to seek input from the public during the preparation of legally binding rules that might have a significant effect on the environment. • There are strong legal mechanisms to ensure judicial independence and impartiality. 	<ul style="list-style-type: none"> • The government is not obligated to collect and update information on the performance and compliance of operators of activities that are impacting the environment. • The government is not required to incorporate public comments in environmental decisions. • The law does not establish alternative dispute resolution mechanisms, such as arbitration or mediation, which can be utilized by members of the public to settle environmental disputes. • In practice, annual drinking water quality data for the capital city are not publicly available.

Source: The Environmental Democracy Index - <http://www.environmentaldemocracyindex.org>

⁸ 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)."

The Environmental Democracy Index (EDI)⁹, assessed in 2014, presents that Thailand ranks 38th out of 70 countries overall, 32nd in transparency (subcategory 1), 56th in participation (subcategory 2) and 26th in justice (subcategory 3). The index presents that the country performs relatively well in terms of transparency and justice while there exists greater room for improvement in participation. Table 2 describes what the country is doing well and what it could improve on.

Counteracting to the environmental problems, the government of Thailand introduced policy measures to prevent environmental deterioration and to improve the current environmental conditions. In 2016, the government allocated 69,931.6 million Baht to a budget category of ‘Management of natural resources and environment’ which accounted for 2.57 percent¹⁰ of the total fiscal budget (Bureau of the Budget, 2016). Among environmental issues, water resource management and disaster management account for a greater portion of the budget (Table 3).

Table 3 Fiscal budget allocation for environmental programmes in 2016 and 2015

Category	Budget items	Year 2016		Year 2015	
		Amount (Million Baht)	percent	Amount (Million Baht)	percent
5.1	Programme on preventing and reducing the impact of climate change	469.9	0.02	602.5	0.02
5.2	Programme on preserving security of the national resource base and rectifying the problems of making the livelihood from land	26,994.4	0.99	23,069.6	0.90
5.3	Programme on managing waste and environment	6,325.7	0.23	3,583.2	0.14
5.4	Programme on restoring, preventing and managing disasters	36,141.6	1.32	36,528.0	1.42
1.8	Programme on management of water resources	79,165.4	2.91	69,310.2	2.70
3.8	Programme on development and improving efficiency in energy consumption	2,104.1	0.08	1,975.1	0.08

Source: Fiscal budget in 2016 (http://www.bb.go.th/budget_book/e-Book2559/FILEROOM/CABILIBRARY59 / DRAWER01/GENERAL/DATA0000/inBrief2016.pdf)

† This item was moved to ‘budget category 1’ in 2016 from ‘budget category 5’ in 2015.

⁹ The Environmental Democracy Index was developed by The Access Initiative (TAI) and World Resources Institute (WRI) in collaboration with partners around the world. The index evaluates 70 countries, across 75 legal indicators, based on objective and internationally recognized standards established by the United Nations Environment Programme’s (UNEP) Bali Guidelines. Please refer to <http://www.environmentaldemocracyindex.org/> for further information.

¹⁰ As ‘water resource management’ item moved to the other budget category, it excludes a budget for water resource management. Please refer to Table 3 for detailed information.



Pollution Control Department (PCD, 2012) listed tools and mechanisms to regulate environment as follows.

- Environmental Quality Management Plan (EQMP) for year 2012 – 2016;
- Notification and/or regulations under related laws regarding air, noise, and water pollution, as well as waste, hazardous substances, the environment in general, and the local regulations regarding pollution;
- Criteria and conditions establishment regarding wastewater and waste management under the Public Health Act, B.E. 2535 (1992) to be referred by businesses in preparation of the wastewater and waste management guideline when applying for or extending their business licenses;
- A list of five hazardous waste forbidden in the Kingdom under the Basel Convention and the Stockholm Convention;
- Draft decree on the principle of product usage fees and collections in accordance with electronic waste and electronic equipment integrative strategies;
- Determination of wastewater and waste disposal service rates according to Article 88 of the Enhancement and Conservation of the National Environmental Quality Act, B.E. 2535 (1992); and
- Eco-Friendly Goods and Service Procurement Promotion Plan of the year 2012 – 2016

Among the tools and mechanisms, EQMP plays a key role as an overall framework in controlling pollution and formulating resource management measures in Thailand. The plan was prepared according to the Enhancement and Conservation of National Environmental Quality Act 1992 and a subsequent long-term plan called ‘the Policy and Prospective Plan for the Enhancement and Conservation of National Environmental Quality 1997-2016’. The plan outlines principles, visions, objectives, goals, strategies and mechanisms of environmental policy measures (ONREP, 2011).

In addition to the existing environmental policy frameworks, the government announced a long-term goal and measures for reducing greenhouse gas emissions. According to the country’s Intended Nationally Determined Contribution (INDC) submitted in October 2015, the country intends to reduce greenhouse gas emissions by 20 percent from the projected business-as-usual (BAU) level by 2030 (Government of Thailand, 2015). The plan is based on the country’s Climate Change Master Plan 2015-2050 and also incorporates the following economic plans.

- National Economic and Social Development Plans
- Climate Change Master Plan B.E. 2558–2593 (2015-2050)
- Power Development Plan B.E. 2558–2579 (2015-2036)
- Thailand Smart Grid Development Master Plan B.E. 2558-2579 (2015-2036)
- Energy Efficiency Plan B.E. 2558–2579 (2015-2036)
- Alternative Energy Development Plan B.E. 2558–2579 (2015-2036)
- Environmentally Sustainable Transport System Plan B.E. 2556–2573 (2013-2030)
- National Industrial Development Master Plan B.E. 2555–2574 (2012-2031)
- Waste Management Roadmap

2.3 Socioeconomic Issues

Rapid economic growth has driven Thailand to be an upper-income developing country; still, the society has been experiencing socioeconomic challenges. It is easily found from various sources that the country faces a variety of socioeconomic issues including poverty, inequality, corruption, adolescent pregnancy, aging population and drug uses (Areemit et al., 2012; Jitapunkul & Wivatvanit, 2008; Krongkaew & Nitithanprapas, 2006; Phongpaichit & Benyaapikul, 2013; Quah, 2003). However, it is also clear that the status of the socioeconomic issues has been improved gradually. In this report, the authors try to take a look at Thailand's socioeconomic circumstances by reviewing results of corresponding assessment.

In the most recent Human Development Index (HDI)¹¹ report published by the United Nation Development Programme, Thailand scored 0.726 for 2014 which ranked the country at 93rd out of 188 countries and territories (UNDP, 2015b). According to this report, the country's HDI value went up from 0.502 to 0.726, which presents 44.6 percent increase during the period or an average annual increase of about 1.09 percent. Thailand performed better than neighboring countries such as Vietnam (0.666) and Philippines (0.668) and performed close to an average score of East Asia and the Pacific countries¹² (0.710) (UNDP, 2015a). Table 4 depicts Thailand's progress in each of the HDI indicators. Between 1980 and 2014, the country's life expectancy at birth increased by 10.0 years, mean years of schooling increased by 3.6 years and expected years of schooling increased by 5.6 years. Thailand's GNI per capita increased by about 277.4 percent during the period. These numbers highlight the improvement in health, education and economic well-being.

Table 4 Summary of HDI 2015 for Thailand

Year	Life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita (2011 PPP\$)	HDI value
1980	64.4	7.9	3.7	3,530	0.502
1985	67.9	8.6	4.1	4,154	0.539
1990	70.3	8.4	4.6	6,263	0.572
1995	70.2	9.6	5.0	9,051	0.611
2000	70.6	11.2	6.1	8,771	0.648
2005	72.2	12.4	6.7	10,387	0.684
2010	73.7	13.2	7.3	12,270	0.716
2011	73.9	13.6	7.3	12,341	0.721
2012	74.1	13.5	7.3	13,056	0.723
2013	74.3	13.5	7.3	13,050	0.724
2014	74.4	13.5	7.3	13,323	0.726

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

¹¹ UNDP have been examining human development for the last 25 years. The recent report subtitled 'Work for Human Development' examines the intrinsic relationship between work and human development. HDI focuses on human health, accessibility to knowledge and living standard.

¹² Cambodia, China, Fiji, Indonesia, Kiribati, Democratic People's Republic of Korea, Lao People's Democratic Republic, Malaysia, Marshall Islands, Federated States of Micronesia, Mongolia, Myanmar, Nauru, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Thailand, Timor-Leste, Tonga, Tuvalu, Vanuatu, Vietnam Pacific (24 countries)

However, the report also underscores, based on a comparative research among developing countries, that there still occurs discrimination at all stages in job seeking process, including education and training, access to jobs, advancement in opportunities, social security and partner benefits (UNDP, 2015b). These trends were reflected in UNDP's Inequality-adjusted HDI (IHDI) such that Thailand HDI score fell to 0.576, a drop of 20.6 percent for the inequality discount (UNDP, 2015a). The percentage of the loss of Thailand is larger than that of Vietnam, Philippines and East Asia and Pacific countries. In addition to the above-mentioned index, the report provides additional information on socioeconomic indicators which show overall works related to environments in Thailand (Table 5).

Table 5 Socioeconomic indicators related to work for Thailand

	Thailand	High HDI	Developing countries	East Asia and the Pacific
Employment to population ratio (percent ages 15 and older)	71.7	63.4	60.7	67.9
Labour force participation rate (percent ages 15 and older)	72.3	67.1	64.3	71.1
Share of employment in agriculture (percent of total employment)	39.6	28.8	36.9	35.5
Share of employment in services (percent of total employment)	39.4	43.8	39.1	37.3
Vulnerable employment (percent of total employment)	55.9	28.7	54.0	-
Total unemployment (percent of labour force)	0.8	4.7	5.6	3.3
Youth unemployment (percent of youth labour force)	3.4	16.7	14.6	18.6
Child labour (percent ages 5-14 years)	8.3	8.3	14.5	-
Unemployment benefits recipients (percent of unemployed ages 15-64)	28.5	6.0	2.5	1.6
Mandatory paid maternity leave (days)	45	125	99	
Old age pension recipients (percent of statutory pension age population)	81.7	73.9	51.0	65.3
Internet users (percent of population)	34.9	49.8	31.9	42.1
Mobile phone subscribers (per 100 people)	144.4	104.6	91.2	100.5

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

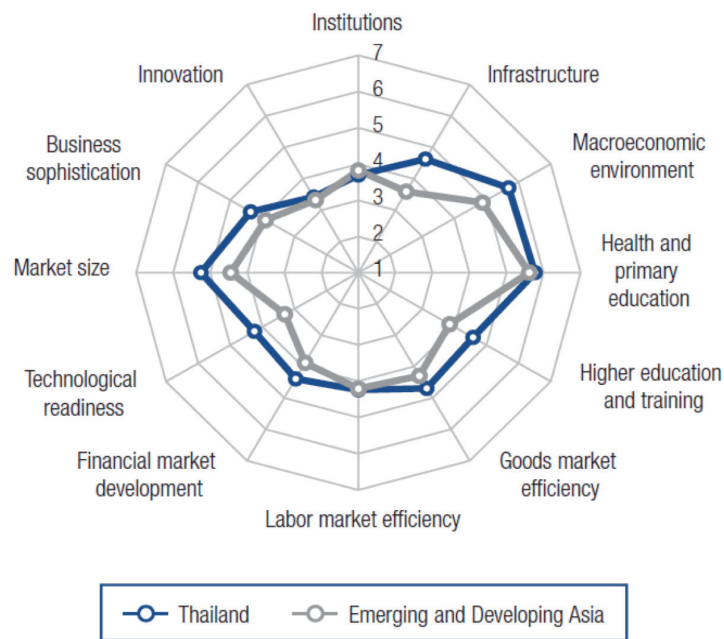


Figure 5 Global Competitiveness Index 2015 for Thailand
 Source: WEC (2015) The Global Competitiveness Index

Based on its rapid economic growth in the last decades, Thailand presents strong performance in competitiveness against other countries in various socioeconomic fields. Thailand ranked 32nd out of 140 countries worldwide in the Global Competitiveness Index (GCI) examined by the World Economic Forum (WEF, 2015). 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, Thailand’s score increased by 0.1 and the ranking went up from 38th to 32nd. Figure 5 depicts country specific performance in key factors for Thailand. Compared with other emerging and developing Asian countries, Thailand outperforms others in infrastructure, macroeconomic environment, education, technological readiness and market size while the country keeps similar level to others in institution, health, market efficiency and innovation. As GCI focuses on strengths and weaknesses of countries’ economy, the report summarizes the most problematic factors for business in each country based on expert interview. In Thailand, the most problematic factors are government instability/coups, corruption, inefficient government bureaucracy and policy instability (WEF, 2015) (Figure 6).

As represented previously by the GCI report, the inefficiency and instability of the government itself are key factors influencing the country’s economy. The country needs to overcome this weakness in order to move forward to the next stage of eco-innovation since eco-innovation is highly dependent on governmental policies and bureaucracy, especially in the beginning stage. According to the Transparency International (TI)’s most recent assessment on corruption perception¹³, Thailand ranked 76th out of 168 countries which is more tolerable result than surrounding countries in Asia Pacific

¹³ The Corruption Perceptions Index ranks countries/territories based on how corrupt a country’s public sector is perceived to be. It is a composite index, drawing on corruption-related data from expert and business surveys carried out by a variety of independent and reputable institutions. Source: The Transparency International <http://www.transparency.org/country/#THA>

such as Vietnam (112th), Cambodia (150th), Indonesia (88th) and Philippines (95th), but demands more effort to catch up with Malaysia (54th) and Singapore (8th) (The Transparency International, 2015). An encouraging trend is that corruption perception status for Thailand based on the index was improved from 84th in 2009 and 103rd in 2013. However, recent observations call for more efforts to diminish corruption. TI's another report called 'The Global Corruption Barometer', through face-to-face

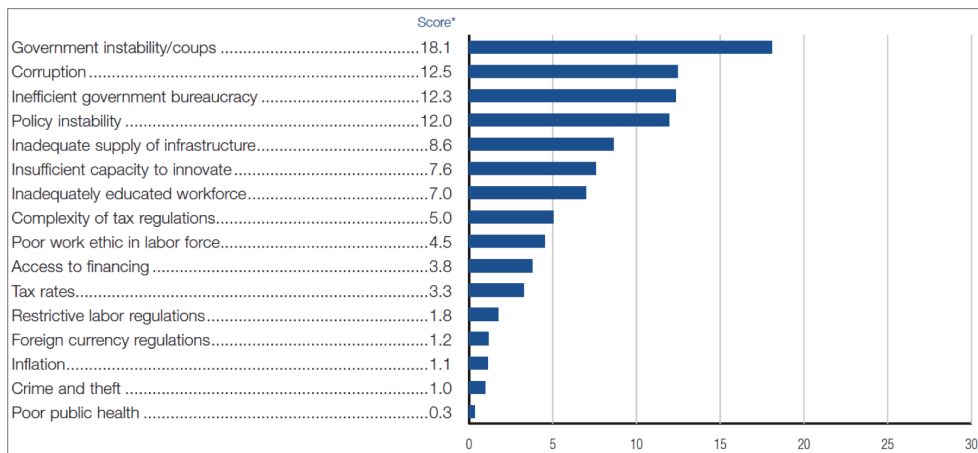


Figure 6 The most problematic factors for doing business in Thailand
Source: WEF (2015) The Global Competitiveness Index

interviews, presents the majority of people feel that public institutions are corrupt (The Transparency International, 2013). For example, 68 percent of respondents felt that political parties were corrupt or extremely corrupt and 58 percent of respondents felt that public officials and civil servants were corrupt or extremely corrupt. In business sector, 48 percent of interviewees expect financial losses from bribery and corruption (PwC Thailand, 2014). Contrary to these dark sides, there is an obvious trend of increased collaboration between the anti-corruption agencies and business entities to advocate for the removal of corruption and promote transparency in public-private relationship (USDS, 2016). Additionally, legal instruments exemplified by the revised Organic Act Counter Corruption, which became enforced in July 2015, would be able to strengthen the country's efforts to combat against corruption.

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. Thailand has achieved rapid economic growth for the past three decades, which has resulted in corresponding increases in energy use, natural resources extraction, and greenhouse gas emissions. As interests in environment and sustainability increased, it is found that Thailand is trying to integrate green growth concepts into its socioeconomic system. The Thai government recently completed to develop GHG reduction roadmap in cooperation with the Global Green Growth Institute. The roadmap recommends emission reduction pathways for three focused industrial sectors, palm oil, automotive parts and fishery, by collecting robust and reliable evidences (GGGI, 2016). Back in 2012, the government introduced the 11th National Economic and Social Development Plan (NESDP) 2012-2016 which incorporated green growth concept into its strategies and policy instruments. The plan is pursuing social and economic restructuring forward a sustainable society (World Bank, 2011).

Table 6 Policy measures for green growth and sustainable development

Types of Policy Instruments		Category		Title of Policy (Year)	
National Plan And Strategy	Sustainability			• Sustainable Development Goal (2015)	
	Eco-Innovation	Building		-	
		Energy	Energy Generation	-	
			(Renewable) Energy	<ul style="list-style-type: none"> • Renewable Energy Development Plan (REDP) (2008-2022) • Thailand Alternative Energy Development Plan (AEDP) (2015-2036) • Strategic Plan for Renewable Energy Development : 8percent Target (2004) 	
		Manufacturing & Industry		<ul style="list-style-type: none"> • National Master Plan on Cleaner Production (2008) • Green Growth Strategic Plan (2013)-draft • Thailand 20-Year Energy Efficiency Development Plan (2011 - 2030) (EEDP) 	
		Tourism		-	
		Transport		-	
		Waste		-	
		Water		-	
		Climate Change		<ul style="list-style-type: none"> • Thailand Climate Change Master Plan 2012-2050 (2014) • Bangkok: Bangkok Action Plan on Global Warming Mitigation 2007 - 2012(2007) • National Strategy on Climate Change (2013) • Intended Nationally Determined Contribution (INDC) to the Paris Agreement (2015) 	
		Others		<ul style="list-style-type: none"> • Policy Statement of the Council of Ministers Area 9 • Environmental Quality Management Plan 2012-2016 (2012) 	
	Programmes And Actions	National	Building		-
			Energy	Energy Generation	-
(Renewable) Energy				-	
Manufacturing & Industry			<ul style="list-style-type: none"> • Energy Efficiency Label No.5 Refrigerator (1995, 2001) • Energy Efficiency Label No.5 Air Conditioner (1994,2004) • Energy Conservation (ENCON) Program • MEPS Refrigerator (TIS 2186-2547) (2005) • Energy Standards for Room Air Conditioners (2002) • Energy Efficiency Resource Standards (2011) • Thai Green Label (2012) • Carbon Reduction label • Carbon Foot Print (2011) 		
Tourism			-		
Transport			-		
Waste			-		
Water			-		
Climate Change					
Others					

Types of Policy Instruments		Category	Title of Policy (Year)
	International	Multilateral	• Sustainable Consumption and Production (2011-2014)
		Bilateral	• Bangkok: Bangkok Master Plan on Climate Change 2013 - 2023 (In Progress) (2013)
		Others	-
Legislation		Building	-
	Energy	Energy Generation	• Energy Industry Act (2007) • Small and Very Small Power Purchase Agreements (1992)
		(Renewable) Energy	-
		Manufacturing & Industry	-
		Tourism	-
		Transport	• Biodiesel Blending Mandate (2012)
		Waste	-
		Water	-
		Climate Change	-
		Others	• Financial Measures for Environmental Act • The Enhancement and Conservation of National Environment Quality Act, B E 2535 (NEQA) (1992)
Finance		Building	-
	Energy	Energy Generation	• Feed-in Tariff for Very Small Power Producers (VSPP) (excluding solar PV) (2014) • Solar Hot Water Hybrid System Promotion Project (2008-2011)
		(Renewable) Energy	• Energy Conservation Promotion Fund (ECPF) • Feed-in Premium for Renewable Power (2007, 2009, 2015) • Feed-in Tariff for Distributed Solar Systems (2013, 2014)
		Manufacturing & Industry	• Energy Efficiency Revolving Fund (EERF) (2011) • ESCO Venture Capital Fund (2008)
		Tourism	-
		Transport	-
		Waste	-
		Water	-
		Climate Change	-
		Others	-



Types of Policy Instruments	Category	Title of Policy (Year)	
Information	Building	-	
	Energy	Energy Generation	• The 9th Sustainable Energy and Environment Forum (SEE Forum) (2012)
		(Renewable) Energy	-
	Manufacturing & Industry	• Science and Innovation for Sustainable Development Forum • Technology Needs Assessment	
	Tourism	-	
	Transport	-	
	Waste	-	
	Water	-	
	Climate Change	• Thailand Climate Change	
	Others	• A Quest for Sustainable Development: Goals for Asia and Europe (Asia-Pacific Ministerial Dialogue) (2013) • Thailand Business Council for Sustainable Development • Thailand Country Development Partnership-environment (2004)	

Source: Park et al. (2016)

3. Eco-Innovation Trends


3.1 Awareness of Eco-Innovation

Eco-innovation approach is a new term in Thai context but the term has not been obviously presented in any policy. However, it was inserted as related concept or detail in several plans. Thailand’s 11th National Economic and Social Development Plan (2012-2016) aimed to develop country economy with stability and sustainability especially in agricultural sector and small and medium-sized enterprises (SMEs). The concept of Eco-innovation was presented in several important strategies. They are connectivity of network among ASEAN countries for products and service production based on knowledge, innovation and creation, sustainable consumption and production (SCP) and low carbon society¹⁴.

Government plan with eco-innovation concept for SMEs covers both policy and action levels. For the policy level, it implements through the green growth strategic plan, which is one of the goals of the 11th National Economic and Social Development Plan. Aiming to create awareness among the government sector, private sector and people, the direction of country’s development plan includes encouraging behaviors to be more eco-friendly for both producers and consumers. The plan demands information needed for research and development in order to produce products that can compete in the market and are good for the environment. In addition, building conscious and eco-friendly society is a critical plan for government sector to implement in order to grow in more sustainable manner.

¹⁴ National Economic and Social Development Board (NESDB), The Eleventh National Economic and Social Development Plan (2012-2016). http://www.nesdb.go.th/Portals/0/news/plan/p11/SummaryPlan11_thai.pdf.





level, it implements through the green growth strategic plan, which is one of the goals of the 11th National Economic and Social Development Plan. Aiming to create awareness among the government sector, private sector and people, the direction of country's development plan includes encouraging behaviors to be more eco-friendly for both producers and consumers¹⁵. The plan demands information needed for research and development in order to produce products that can compete in the market and are good for the environment. In addition, building conscious and eco-friendly society is a critical plan for government sector to implement in order to grow in more sustainable manner.

At the implementation level, raising awareness on eco-innovation for SMEs have been supported and promoted by coordination among Ministry of Industry (MOI), Ministry of Science and Technology (MOST) and Ministry of Natural Resource and Environment (MNRE). The SMEs have more knowledge and understanding of eco-innovation concept. SMEs are creating the attitude and perspective for business development applying eco-innovation¹⁶. Several activities for raising awareness consist of^{17 18} ;

- Seminar for SMEs business owners
- Expert assistance including product's research and development with business owners
- Government sector's policy and activity that support business owners in eco-friendly production process through projects e.g. clean technology and Green Industry Mark (GIM), green cart and carbon footprint of products.
- Innovative eco-friendly product awards for SMEs to promote it as a good model
- Public relations on eco-product by coordinating with shopping malls on exhibition spaces to display and sell SMEs' products with low renting fee rate or for free, publishing products in magazine, website, an eco-friendly product directory or other public relation publications.
- Setting up eco-finance scheme by cooperating with banks for SMEs to conduct research and develop innovative eco-friendly products and creating other incentives for business owners.
- Benchmarking studies by comparing SMEs capability both nationally and internationally to identify the needs to change their thought, behavior and production format to eco-innovation in order to effectively compete in the market.

¹⁵ Office of Natural Resources and Environmental Policy and Planning (ONEP), (Draft) Green Growth Strategy (2014-2018).

¹⁶ National Science and Technology Development Agency (NSTDA), Science, Technology and Innovation for Sustainable Development. <http://www.nstda.or.th/pub/2014/20140404-sustainable-development.pdf>

¹⁷ Department of Industry Promotion, Ministry of Industry, Annual Report 2015. http://www.dip.go.th/Portals/0/Busarin/รายงานประจำปี2558/รายงานประจำปี2558_กรมส่งเสริมอุตสาหกรรม.pdf.

¹⁸ National Science and Technology Development Agency (NSTDA), 2014, Raising technology level of Thai SMEs through the works of iTAP. http://www.clinictech.most.go.th/online/filemanager/fileclinic/F1/files/Book_iTAP-All-FINAL-small-edit.pdf.

3.2 Major Actors

Operations to develop eco-innovation for SMEs in Thailand started by the cooperation from many institutes under Ministry of Science and Technology (MOST) and Ministry of Industry (MOI) as well as Ministry of Natural Resources and Environment (MNRE). They are focusing primarily on building awareness and setting up pilot projects. In addition, for the private sector, several institutes under the Federation of Thai Industries (FTI) are playing a major role in supporting SMEs and using eco-innovation concept for management. Information of the main institutes can be summarized as follows.

- **Ministry of Science and Technology**

- **National Science and Technology Development Agency (NSTDA)**

National Science and Technology Development Agency (NSTDA) has been an institute under Ministry of Science and Technology since 1991. NSTDA supports science and technology that help agricultural and industrial sector to compete in international market. NSTDA has implemented through five institutes which are: National Center for Genetic Engineering and Biotechnology (BIOTEC), National Metal and Materials Technology Center (MTEC), National Electronics and Computer Technology Center (NECTEC), National Nanotechnology Center (NANOTEC) and Technology Management Center (TMC)¹⁹. From five institutes, TMC has a role and practice related eco-innovation clearly with aiming to help researchers and companies to bring their findings and technologies into commercialization. It launched Innovation and Technology Assistance Program (iTAP) which focuses on providing service for industrial sector in research and development including upscale manufacture technology through technical experts at the SMEs factory²⁰.

- **National Innovation Agency (NIA)**

The National Innovation Agency (NIA) was established as a public agency on September 2nd, 2009. NIA's missions are to change the supply chain in order to create values and increase advantages²¹. NIA innovation strategy has been divided into strategic innovation programs and sub-innovation programs which also concern on environmental aspect. The strategic innovation programs are: 1) Thai Kitchen to the World to develop business owners into cluster in order to meet safe food production and meet value chain standard; 2) Organic Agriculture Business to build organic agriculture into a system that integrates local wisdom, innovation, scientific soil conservation knowledge and ecology; 3) Bio-based Material to create value to agricultural product and waste from agricultural product by using science, technology and innovation to develop a new bio-material for industrial production, for examples, packaging, automotive parts or furniture; 4) Bio Medical to develop medical equipment for special groups; less fortunate and elderly; and 5) Clean Energy Industry to support stability on energy and reduce imported energy.

For sub-innovation program, it consists of: 1) Bio-Business to create new business by taking advantages from biodiversity and science and technology knowledge, together with creativity; and

¹⁹ National Science and Technology Development Agency (NSTDA). <http://www.nstda.or.th/aboutus-nstda>.

²⁰ Innovation and Technology Assistance Program. <https://itap.nstda.or.th/page/1/เกี่ยวกับ-ITAP>.

²¹ National Innovation Agency (NIA). <http://www.nia.or.th/nia/organization/background/>.

2) Eco-Solutions to strengthen SMEs for sustainability growth by considering environment damages and protection to prevent further environment problems. They are focused on waste management, eco-products and design & solution using engineering, science and product design knowledge. NIA supports business owners in the following four ways: 1) knowledge and technical assistance that lead to innovation projects; 2) financial support on pilot in technology possibility test at prototype level or pilot project; 3) Eco-financing for innovation projects up to five million baht for three years; and 4) Innovation Cluster Funding Project supporting innovation projects with characteristic in developing project as a cluster, for example, industrial groups, clubs, provinces or group of provinces, covering from prototype testing, testing, pilot level and commercial production²² .

- National Science Technology and Innovation Policy Office (STI)

National Science Technology and Innovation Policy Office (STI) was set up in 2008 to develop, drive and integrate science, technology and innovation for sustainability of quality of life and country competitiveness. The missions of STI are: 1) to develop the National Science, Technology and Innovation (STI) policy; 2) to support and promote the implementation of National Science, Technology and Innovation policy in governmental agencies, private and public sectors; and 3) to coordinate with national and international research and educational institutes to develop projects according to STI policy²³ . Under STI policy framework, eco-innovation is called as green innovation focusing on green production and services, creativity platform and technological changes under emerging technology, basic science, biotechnology, materials technology, ICT and nanotechnology. The vision of the 1st STI (2012-2021) plan is 'Green Innovation for Quality Society and Sustainable Economic Growth'.

The 1st STI plan defines 'green economy' as the development of science, technology and innovation to promote and support quality of society and sustain economy. Several practices under green innovation are enhancing society for happiness, knowledge based, self-reliance and sufficiency, and security of life. The practices to enhance the economy are developing the country's competitiveness, value and productivity and ability to cope with the rapid change global environment. The balance between natural resources conservation and consumption for economic development has been of concern and focusing on environmental friendliness²⁴ .

• Ministry of Industry

- Department of Industrial Promotion (DIP)

Department of Industrial Promotion (DIP) was set up under Ministry of Industry in 1942²⁵ . The missions of DIP are to promote and support SMEs, microenterprises and SMEs providers to be able to compete nationally and internationally in more sustainable manner. The current development strategy is focusing on using digital system to improve business management. In addition, the program will

²² National Innovation Agency (NIA), Innovation Strategy. <http://www.nia.or.th/nia/strategy/>.

²³ National Science Technology and Innovation Policy Office (STI). http://www.sti.or.th/about.php?content_type=6

²⁴ National Science Technology and Innovation Policy Office (STI), 1st National Science Technology and Innovation Plan.

http://www.sti.or.th/uploads/content_file//%E0%B9%81%E0%B8%9C%E0%B8%99_%E0%B8%A7%E0%B8%97%E0%B8%99.pdf

²⁵ Department of Industrial Promotion (DIP). <https://www.dip.go.th/th/category/about-us/about>.

support new entrepreneurs and develop new products using innovation to create SMEs connection to prepare them for Thailand Industry 4.0²⁶. The example of activity related eco-innovation is consulting to SMEs to implement clean and green technology to improve resource efficiency and enhance environmental friendly production processes throughout supply chain²⁷.

- Institute for small and Medium Enterprises Development (ISMED)

The Institute for Small and Medium Enterprises Development (ISMED) was established in 1999²⁸. The mission is to assist existing entrepreneurs and create new entrepreneurs to improve completeness through training, seminar, consulting, research and information service, connecting business. In addition, they have to develop service tools such as knowledge, advisors, courses/media as well as service system such as business planning system and business analysis system in order to create and produce a connection development service and cooperate with other organizations. An important project is an upscaling Thai herbs project “from rags to riches” project on creative e-marketing which is relates to eco-innovation concept²⁹. Moreover, ISEMED has published interesting case studies of SMEs in e-book via ISEMED website including Eco Shop Common (Eco Design and Knowledge Center)³⁰.

- Thailand Productivity Institute (FTPI)

Thailand Productivity Institute (FTPI) was established on January 18th, 1994. The Missions are to increase productivity for sustainable growth in every sector in society. TPI’s mission can help SMEs in several ways: 1) to collaborate with the public sector in order to increase awareness of target organizations on productivity concept; 2) to assist target organizations to improve competitiveness through development, knowledge transfer and adoption of productivity attitude; 3) to expand on productivity initiatives with local and global partners; 4) to consistently develop innovation in the areas of services, processes and products; and 5) to promote a productivity-based work culture. The examples of activities related to eco-innovation are presented in the knowledge center of TPI website entitled Strategic Scanning (Future Focus). The examples of articles in environmental aspects consist of “NIKE: attempting of innovation development for sustainability”, “Eco-Products sustainability of future” and “SolarRoad: Change the road to be the electrical generation”³¹. In addition, the Eco-Products International Fair (EPIF) was first held in Thailand in 2005 through the collaboration between the Federation of Thai Industries (FTI), Thailand Productivity Institute (FTPI) and Asian Productivity Organization (APO)³².

²⁵ Department of Industrial Promotion (DIP). <https://www.dip.go.th/th/category/about-us/about>.

²⁶ Department of Industrial Promotion (DIP). <https://www.dip.go.th/th/category/2016-07-26-09-30-57/2016-07-26-09-54-38>.

²⁷ Department of Industrial Promotion (DIP), Annual Report 2015, iSMEs Intelligent SMEs. <https://www.dip.go.th/files/article/attachments/dip/9c7bd208cb4cc7364ec6eb735655ce9a.pdf>.

²⁸ Institute for small and Medium Enterprises Development (ISMED). <http://www.ismed.or.th/ประวัติความเป็นมา/>

²⁹ Institute for small and Medium Enterprises Development (ISMED). <http://www.ismed.or.th/category/knowledge/project/>.

³⁰ Institute for small and Medium Enterprises Development (ISMED). <https://drive.google.com/file/d/OB-collr03JQieGV4TE16b0wwaUE/view>.

- The Federation of Thai Industries (FTI)

The Federation of Thai Industries is a non-profit organization. It was set up on December 29th, 1987 under supervision of Minister of MOI. FIT's missions are to develop and strengthen industrial sector and to support national economic development. Key institutes that can support eco-innovation in SMEs are as follows³³.

- The Industrial Environment Institute's objectives are: 1) to manage knowledge on industrial environment; 2) to promote the collaboration among government sector, private sector, NGO and other stakeholders for sustainable development; 3) to promote and support eco-industry development; and 4) to provide Technical and advices on industrial environment management³⁴. Important projects are Green Supply Chain of exporting industry (cassava industry), Green Procurement Policy and Eco-Factory and Eco-Product Directory³⁵.
- The Research Development and Innovation for Industry Institute's main responsibilities are to provide industrial input to government on scientific, technology and innovation cooperation. Important projects are Innovation Market and Government Research Association Project, Innovation Funds (Prepaid R&D Tax), Thai Industry's capacity improvement with Talent Mobility Project and Research and Researcher Development for Industry Sector Project³⁶.
- Small & Medium Industrial Institute's objectives are: 1) to collect information on problems and needs of SME and propose to government sector; 2) to implement SMEs' policy; 3) to gather and share knowledge including news that benefits SMEs; and 4) to produce network internally and externally to improve competitiveness³⁷. Important project is "7 Innovation Award" which aims to transform research and new inventions to be products in the market. The award is divided into two types: Type 1 is the innovation for economy and Type 2 is the innovation for community or social including environment³⁸.

³¹ Thailand Productivity Institute (TPI). <http://www.ftpi.or.th/category/knowledge/strategic-scanning/environment>.

³² <http://www.epif2016-thailand.com/en/aboutus.html>

³³ The Federation of Thai Industries (FTI). <http://www.fti.or.th/2016/thai/ftiaboutfti.aspx>.

³⁴ The Industrial Environment Institute. http://www.iei.or.th/ns-about_us-dir-NQ=.htm.

³⁵ The Industrial Environment Institute. <http://www.iei.or.th/project.php#V7U5EqK4R1Y>.

³⁶ The Research Development and Innovation for Industry Institute. <http://www.nrct.go.th/Portals/0/data/2557/8สภาอุตสาหกรรมแห่งประเทศไทย.pdf>.

³⁷ Small & Medium Industrial Institute. <http://www.smi.or.th/index.php/sample-sites-3/sample-sites-4>

³⁸ 7 innovation awards. <http://www.7innovationawards.com/about>.

• Ministry of Natural Resources and Environment

- Department of Environmental Quality Promotion (DEQP)

DEQP plays a key role in developing network both at local and national level including government, private and NGOs on sustainable production and consumption. DEQP's main mission is to build awareness in all sectors on eco-products and sustainable development³⁹. The main target groups are micro entrepreneurs at village level. Examples of projects in green consumption system are green products, G-upcycling, green hotels, and green offices as well as sustainable cities⁴⁰.

- Pollution Control Department (PCD)

PCD, under Ministry of Natural Resource and Environment (MNRE), is responsible for implementation of Green Public Procurement (GPP) program in Thailand. PCD is responsible for the selection of products and development of criteria for environmentally friendly products and services. It also supports the GPP implementation in a pilot phase to evaluate, adjust and expand the implementation of Thai GPP to other governmental agencies (170 central government agencies as target groups). The 1st Green Public Procurement Promotion Plan (2008-2011) for the government was approved by a cabinet resolution in 2008. In 2012, the 2nd Green Public Procurement Promotion Plan (2013-2016) was initiated. It expands the scope of GPP to cover central to local authority, private sector and public. The 2nd Plan has been approved by the National Environment Board. Currently, a new GPP Plan (2017-2021) is being developed⁴¹.

3.3 Eco-Innovation Policies

According to the 11th National Economic and Social Development Plan, it focuses on economic development through innovation with specific emphasis on SMEs and eco-innovation. Policy measures include the 11th National Economic and Social Development Plan, Eco-friendly Growth Strategy (Green Growth) and National Technology and Innovation Policy and Framework.

• 11th National Economic and Social Development Plan (2012-2016)

The 11th National Economic and Social Development Plan is focusing on strengthening and stabilizing the domestic economy through agricultural base and SMEs. It aims to create economic opportunity using technology, innovation and creativity on eco-production and eco-consumption platform. To develop an efficient and sustainable economy, it links to production and service networks in ASEAN, based on technology, innovation and creativity. It will focus on improving food and energy security, and upgrading eco-friendly production and consumption to achieve a low carbon society. The Thai economy will achieve inclusive growth at a moderate pace based on its potential by: focusing on upgrading total factor productivity (TFP) to be higher than 3 percent per annum; improving Thailand's competitiveness ranking; and increasing the contribution of SMEs to at least 40 percent of GDP. A related

³⁹ Department of Environmental Quality Promotion (DEQP). <http://www.deqp.go.th/institution>.

⁴⁰ Department of Environmental Quality Promotion (DEQP). <http://www.deqp.go.th/service-portal/g-products-system/>.

⁴¹ Department of Environmental Quality Promotion (PCD), Green Procurement. <http://ptech.pcd.go.th/gp/>.

strategy to restructure the economy toward quality and sustainability is focusing on strengthening SMEs and pushing them to play a key role in developing internal economy. It will also emphasize on strength and competitiveness using creativity, local wisdom, intellectual property and research and development. It is expected to create commercial social value with scientific, technology and innovation base structure and eco-production to support collaboration between government and private sector⁴².

• Green Growth Strategy (2014-2018)⁴³

According to the National Economics and Social Development Board, they focus on three main issues of country strategies: 1) growth and competitiveness; 2) inclusive growth; and 3) green growth covering three dimensions of sustainable development (Economy, Society and Environment). Office of Natural Resources and Environmental Policy and Planning (ONEP) of Ministry of Natural Resources and Environment (MNRE) is the main organization in integration with eco-development. It has developed Green Growth Strategies Framework (2014-2018) so that all sectors can use the framework to guide the action plan in the same direction to promote green growth.

The Office of the National Economics and Social Development Board defined the scope of green growth as “A development towards economical and societal growth that are eco-friendly and sustainably”. Activities under this plan have focused on using natural resources, producing greenhouse gas in such amount that does not affect the environment, and supporting every people’s lifestyle without losing life balance.

The Green Growth Strategy (2014-2018) has recognized the importance of the study, research and development to be the main contributors to enhance the national competitiveness especially on eco-technology and eco-innovation which will reduce the country’s production costs throughout product’s life cycle. Thus, it is an opportunity for the country to produce eco-friendly products and services to compete with other countries. It consists of four strategies, which are related to eco-innovation.

- Strategy No.1: To promote eco-production and eco-services (Indicators: increase ratio of eco-agro products to the total agro products and increase rates of eco-services and products ratio to total industrial products)
- Strategy No.2: To encourage reduction of greenhouse gas production (Indicators: increase renewable energy ratio to final energy consumption at least 20 percent, establish a proper protocol to support low carbon growth)
- Strategy No.3: To effectively manage natural resources and environment (Indicators: increase value of biological resources and solid waste with the reuse and recycle ratio of at least 30 percent of solid waste throughout the country)
- Strategy No.4: To create eco-friendly society including awareness formation and involvement to develop eco-society plan (Indicators: ratio of green public procurement, goods procurement proportion and eco-service increase, increasing number of

⁴² National Economic and Social Development Board (NESDB), Summary of 11th National Economic and Social Development Plan (2012-2016). http://www.nesdb.go.th/Portals/0/news/plan/p11/SummaryPlan11_thai.pdf.

⁴³ Office of Natural Resources and Environmental Policy and Planning (ONEP), Green Growth Strategy (2014-2018).

products and services certified with environmental labeling system) and to create skill development plan for eco-friendly career (Indicators: increase ratio of costs of research and development to gross domestic product and increasing amount of eco-technology and innovation)

• **1st National Science, Technology and Innovation Plan (2012-2021)**⁴⁴

National Science Technology and Innovation Policy Office (STI) has developed the 1st National Science, Technology and Innovation Policy Plan (2012 – 2021) to serve as a framework for national science, technology and innovation action plan. It has focused on the core issues that will affect development in the next ten years. The core issues cover social and culture, health, wealth distribution, economy and trade, geopolitics, natural resources, environment and global warming, sustainable energy, agriculture, food and change in science, technology and innovation including past development resulted and Thailand’s competitiveness in the world’s stage. The summary of strategies relating to eco-innovation is presented in Table 1.

Table 7 Strategies and output of the 1st National Science, Technology and Innovation Policy Plan (2012 - 2021) which related eco-innovation

Strategy	Output
<p>Strategy No. 1: To strengthen the society and local communities with STI agricultural production and services.</p>	<ul style="list-style-type: none"> • Increase of income and productivity in the community and decrease of debts through the use of STI • Awareness of initiative prototype and further contribution on STI products • Community growth base on STI operation
<p>Strategy No. 2: To increase the adaptation and innovation in agriculture, manufacturing and services sectors with STI.</p>	<ul style="list-style-type: none"> • Increase income, employment and productivity of target group using STI to leverage technology in various fields • Increase number of enterprises that are Original Brand Manufacturer (OBM) and Original Design Manufacturer (ODM) • Increase number of enterprises in Thailand that have been registered trademark, Intellectual Property (IP) and / or increase new market
<p>Strategy No. 3: To enhance the security of energy, natural resource and environment of the nation with STI</p>	<ul style="list-style-type: none"> • Decrease of greenhouse gas emissions and waste generation • Decrease of consumption that has impacts on the ecosystem and local ecosystems in Thailand
<p>Strategy No. 4: To develop and enhance the human resources on STI</p>	<ul style="list-style-type: none"> • Stable economic growth from increasing labor productivity • Increase STI productivity and STI labor • Increase number of research articles, patents and innovation
<p>Strategy No. 5: To promote and support the development of infrastructure and contributing factors to use STI of the country to increase competitiveness.</p>	<ul style="list-style-type: none"> • Effective performance of the government to support private investment for better STI development • Effective monitoring performance on Country’s STI development

⁴⁴ National Science Technology and Innovation Policy Office (STI), 1st National Science, Technology and Innovation Plan. http://www.sti.or.th/uploads/content_file/%E0%B9%81%E0%B8%9C%E0%B8%99_%E0%B8%A7%E0%B8%97%E0%B8%99.pdf.


3.4 Highlighted Sectors

Thai Industrial Technology Development Support Project (iTAP) was launched in 1993 under NSTDA. The objective was enhancing Thai SMEs competitiveness in science and technology. Since the beginning, iTAP has passed on technology solution to up to 3,000 of Thai's SMEs (4,200 Projects)⁴⁵. iTAP announced the "Guideline for Identification of Industrial Team" to classify the industrial groups for matching between the industry and Industrial Technology Advisor (ITA) appropriately. There are 4 industrial groups with the sub-industries as below⁴⁶.

1. Food, Agricultural and Health industry
 - A. Food industry consists of vegetable, fruit, plant bulb, meat, feedstock, processed food from flour and sugar, food additive etc.
 - B. Agricultural industry and related industry consist of planting, harvesting, livestock and fishery (except rubber tree).
 - C. Pharmaceutical industry consists of medicine, herb, supplementary food, cosmetic and medical equipment
 - D. Quality System of food, agricultural and health industry
2. Manufacturing Industry
 - A. Wood and Furniture
 - B. Production Quality Improvement
 - C. Quality System in Manufacturing
 - D. Machinery, Automation and Software
 - E. Energy
3. Electronics and Software Industry
 - A. Electronics
 - B. Electric Appliance
 - C. Telecommunication

⁴⁵ National Science Technology and Innovation Policy Office (STI), Raising technology level of Thai SMEs through the works of iTAP. http://www.clinictech.most.go.th/online/filemanager/fileclinic/F1/files/Book_iTAP-All-FINAL-small-edit.pdf.

⁴⁶ National Science and Technology Development Agency, Guideline for Identification of Industrial Team. <http://www.nstda.or.th/pub/2016/20160411-G-TMC-iTAP-02-Rev.3.pdf>.

- 
- D. Computer and Hardware
 - E. Software
 - 4. Advanced Material Industry
 - A. Plastic and Mold
 - B. Textile
 - C. Rubber and Rubber Products
 - D. Ceramics
 - E. Pulp, Paper and Printing
 - F. Glass
 - G. Chemical
 - H. Related Material Science Industry

The proportion of industries that joined and were supported by iTAP from 2006 to 2013 are⁴⁷;

- A. Food Industry: The most supported industry by iTAP with the total of 988 projects (about 29 percent)
 - Examples: Processed gummy from vegetable and fruit by Chiangmai Bioveggie Co., Ltd., Automatic vegetable washing machine with ozone, chemical contamination detection and water saving by Zaap Soi9 Limited Partnership.
- B. Agricultural Industry: 397 Projects (about 12 percent)
 - Examples: Organic fertilizer from eucalyptus bark by Suwannapoom Woodchip Co., Ltd., Chemical free vegetable by research and develop along life cycle by Santipap (Chiang Mai 1988) Co., Ltd.
- C. Wood and Furniture Industry: 376 Projects (about 11 percent)
 - Examples: Wood-plastic composite capsule for mangrove nursery by Artowood (Thailand) Co., Ltd., Microwave heating for getting rid of termite from wooden toy by Plan Creations Co., Ltd.
- D. Health and Medical Equipment Industry: 286 Projects (about 8 percent)
 - Examples: Research and develop wound dressing produced from bio-cellulose by Thai Nano Cellulose Co., Ltd., Herb tea for health by The Giving Tea Co., Ltd.

⁴⁷ National Science Technology and Innovation Policy Office (STI), Raising technology level of Thai SMEs through the works of iTAP. http://www.clinictech.most.go.th/online/filemanager/fileclinic/F1/files/Book_iTAP-All-FINAL-small-edit.pdf.

- E. Other industries such as software, construction and materials, automotive parts, textile, electronics, plastic, machine, metal, service and delivery business, packaging and publication, chemical supplies, ceramics, jewelry and ornaments and energy and environment

Examples: Enterprise Resources Planning (ERP) software for real time monitoring of gold loss in production process by Shining Gold Co., Ltd., Eco stone from porous glass with citronella oil (for decoration and mosquito repellent) by Thai Techno Glass Co., Ltd.

3.5 New Trends Observed

New trends are observed to support SMEs with eco-innovation using science and technology integrating with local wisdom and knowledge management. Currently, competency enhancement of SMEs is a national agenda. SMEs have to develop and improve themselves to compete in global markets and drive Thailand from the middle-income trap.

• 20-year National Strategy (2017 – 2036)

In 2015, the government under General Prayut Chan-o-cha, Prime Minister, has set a vision of Thailand to be “The country has stability, prosperity, sustainability adhering to sufficient economy philosophy principles” (Stability, Prosperity and Sustainability)⁴⁸. In order to reach Thailand’s vision, the government has developed 20-year national strategy framework (2017-2036) with the following specific goals to be achieved by 2036: 1) to achieve sustainable, stable economy and society development; 2) to attain eco-friendly economy; 3) to reach a fair society with less inequality; 4) to manage government sector effectively, accountability, transparent using multi-stakeholder approaches; 5) to expand economic system through the retail and wholesale trading and focusing on digital economy; and 6) to build capability to work together for the country and to adapt to the context of future development, which the government has set up in 11 areas. The specific areas of eco-innovation in SMEs are to increase competitiveness of the country and to develop and promote the utilization of science, technology, research and innovation⁴⁹.

Under the national strategy, the government has set up a new economic model to overcome the middle-income trap, which is now known as “Thailand 4.0” model. The past developments included Thailand 1.0 focusing on agriculture sector, Thailand 2.0 focusing on light industry sector, and Thailand 3.0 focusing on heavy industry sector. As a result, Thailand fell into the middle-income trap, wealth disparity trap and imbalance trap. Thailand 4.0, in contrast, is a restructuring economic development to become “Value-Based Economy” or innovation-driven economy. As for the role of SMEs, they have to change from traditional SMEs that always need government’s assistance to ‘Smart Enterprises’ and ‘High-potential Startups’ by bringing science, technology, innovation, creativity,

⁴⁸ Secretariat of the Prime Minister, Draught Solution for Farmer; Cabinet Resolution for People to Develop 20-year Country Strategy. <http://gmdigitalmedia.com/ebook/emagazine/cabinet/EBook24/files/downloads/Ebook24.pdf>.

⁴⁹ Nucharee Wongsan, Direction and Development of Government Policy and 12th National Economic and Social Development Plan. <http://www.ic.moi.go.th/doc/bmt29/slide/2.pdf>.

research and development for further advantages. There are five target groups of technology and industrial as follows⁵⁰.

- Food, Agriculture & Bio-Tech
- Health, Wellness & Bio-Med
- Smart Devices, Robotics & Mechatronics
- Digital, Internet of Things (IOT), Artificial Intelligence & Embedded Technology
- Creative, Culture & High Value Services

Thailand wants to develop five target industries by itself and later can collaborate with international networks. This strategy follows three step - ladder of sufficiency economy philosophy: self-reliance, community networking and synergy of the group power. Therefore, Thai SMEs can develop themselves with cooperation among networks and institutions using science, technology and innovation to develop country economy, quality of life and environment.

Thai economic-driven mechanism according to Thailand 4.0 model is “Civil State”. This is to link between technology and economic development from upstream to midstream and downstream by the close cooperation of various sectors in the society such as private sector, finance and banking sector, academy and research institutes and with the government sector as supporters.

• **12th National Economic and Social Development Plan (Draft) (2017-2021)**⁵¹

From the 20-year National Strategy, National Economic and Social Development Board is using it as a framework for the 12th National Economic and Social Development Plan (2017-2021) and transform into a 5-year plan. The clear indicators are set and will be used for evaluation which will be conducted annually. There are 10 strategies under the 12th National Economic and Social Development Plan. The strategies that concern economic development related eco-innovation for SMEs are:

- Strategy No. 3: To strengthen economic performance and compete sustainably
Currently, the overall Thailand’s competitiveness ranking has not improved significantly. It has been under pressure from countries with labor cost advantage and high innovation. Nowadays, agricultural and service sectors are the major sectors to drive the Thai economy. SMEs play an important role in the national economy with development goals such as productivity of production factor increasing overall at the average of 2.5 percent per year and labor factor increasing at an average of at least 2.5 percent per year. In order to enhance the competitiveness of Thailand ranking, it is necessary to consider eco-innovation.

⁵⁰ Suwit Mesinsee, Thailand 4.0 concept. https://www.google.co.th/url?sa=t&rct=j&q=&esrc=s&source=web&cd=8&cad=rja&act=8&ved=0ahUKEwiLvNra7JLOAhUKo48KHRQnCcQQFgg7MAc&url=http%3A%2F%2Fwww.industry.go.th%2Fict%2Findex.php%2Fcircular-letter%2Fitem%2Fdownload%2F156_e5b28eb303e_0d3729203b6dec0af3f5a&usq=AFQjCNGUJfbk5ctB0QNX-1T7VRv3eVklpA&sig2=7bpLvMM7gQd5GNg1EBAoOA.

⁵¹ National Economic and Social Development Board (NESDB), 12th National Economic and Social Development Plan (Draft) (2017-2021).

- Strategy No. 8: To increase R&D spending
In the past, it was found that Thailand's expense for research and development per GDP is lower than every country that participated in IMD's competitiveness ranking in the past 5 years. It is demonstrated that scientific and technology structure are at a low level. Research and development personnel are in shortage. Thailand's patent application especially on invention that strongly needs development and the number of Thailand's publication on science and technology are low. It is important for Thailand to develop and apply science, technology and innovation in R&D to achieve the 12th NESDP goals such as increasing the proportion of the investment costs in research and development to 1.5 percent of the GDP and increasing the ratio of R&D investment by private sector to government sector to 70:30. Another goal is to increase the number of personnel in research and development to 25 per 10,000 population and to increase the competitiveness in basic structure of science and technology organized by IMD to be in between number 1 to 30. Any development using eco-innovation is expected for sustainable development.

4. Analysis of ASEI 2016 Results

ASEI 2016 analysis for Thailand presents the status of country's eco-innovation. Data were collected in four categories with twenty indicators, among which twelve were used for the analysis. The score of ASEI 2016 is an average of scores of four categories: Eco-innovation Capacity, Eco-Innovation Supporting Environment, Eco-Innovation Activity and Eco-Innovation Performance. An average of scores of the indicators under each category represents the score of the category. The full reports of ASEI 2014, ASEI 2015 and ASEI 2016 describe details on data collection and data processing for each indicator of the analysis⁵³. The reports also provide theoretical background of ASEI development and the process of indicator selection. Thailand's country score of ASEI 2016 is measured as 33.44 under which the categories of 'Capacity', 'Supporting Environment', 'Activities' and 'Performance' scores are 48.12, 28.97, 13.66 and 43.01, respectively (Figure 7). A web diagram in Figure 7 depicts relative comparison with other ASEM member countries. The green line presents the calculated scores of all indicators for Thailand while the yellow line and red line represent benchmarked scores for the whole ASEM member countries and countries belonging to the same development group with Thailand, respectively. Groups are divided based on national development stages published by the World Economic Forum (WEF, 2015). China, Indonesia, Romania and Bulgaria are the members of the same development group (Group 2) with Thailand.

⁵² IMD business school has been publishing IMD World Competitiveness Yearbook for 61 countries since 1989.

⁵³ Please refer to the final version of 'ASEI 2016 measurement'

Categories and Indicators	Score
ASEI 2016	33.44
Eco-Innovation Capacity	48.12
Economic Competitiveness	54.10
Country's General Innovation Capacity	37.12
Awareness of Sustainability Management	53.15
Eco-Innovation Supporting Environment	28.97
Implementation of Environmental Regulations	28.97
Eco-Innovation Activities	13.66
Firms' Participation on Environmental Management System	14.07
Green Patents	0.00
Activeness of Renewable Energy Utilization	26.90
Eco-Innovation Performance	43.01
Level of Environmental Impact on Society	53.56
CO ₂ Emission Intensity	72.86
Country's Energy Sustainability Level	23.94
Water Consumption Intensity	57.30
Green Industry Market Size	7.41

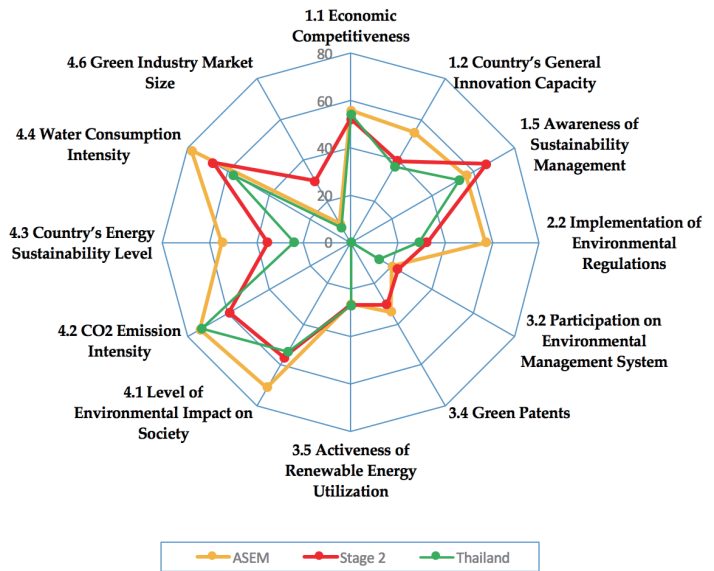


Figure 7 Results of Thailand's ASEI 2016 measurement

CO₂ Emission Intensity (indicator 4.2) of Thailand is higher than the average score of the countries in the same development stage. The scores of 9 indicators among 12 indicators are lower than the average scores of the same development stage countries. Among these indicators, the scores of Country's Energy Sustainability Level (indicator 4.3) and Green Industry Market Size (indicator 4.6) are much lower than the average scores of the same development group countries.

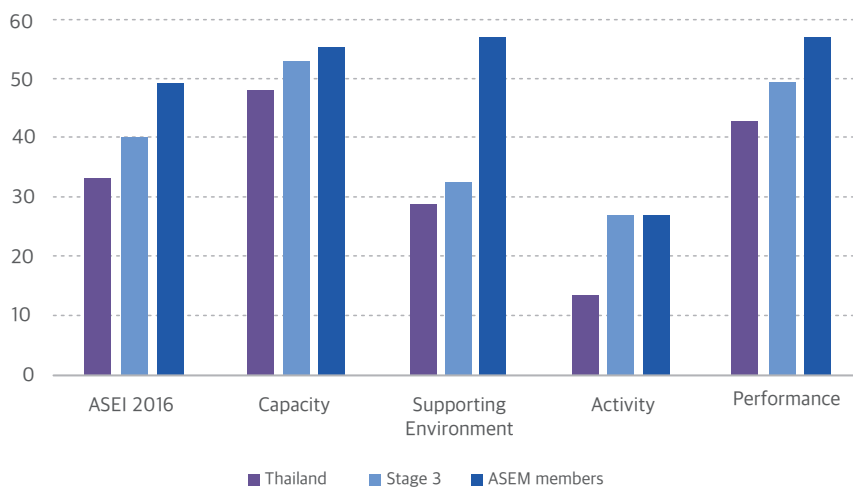


Figure 8 Results of ASEI 2016 for Thailand by categories




Figure 8 depicts Thailand's relative scores to an average of countries in the same group and the average of the whole member countries. Thailand's score of each category is lower than the average scores of the same development group countries and the all ASEM member countries. In each category, specific indicators are highlighted to lower or raise the score of the category as follows:

- In 'Capacity' category, General Innovation Capacity (indicator 1.2) plays a role of lowering the score of the category. Indicator 1.2, retrieved from the Global Innovation Index, is measuring 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 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 Green Patents (indicator 3.4). Indicator 3.4 is a ratio of the number of environmental patents against total patents in a country which is sourced from OECD Green Growth Database; and
- In 'Performance' category, Energy Sustainability Level (indicator 4.3) lowers the score of the category while CO₂ Emission Intensity (indicator 4.2) elevates the score of the category. Indicator 4.3 is measured by energy performance from the Energy Sustainability Index published by the World Energy Council which 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 which the International Energy Agency provides.

5. Good Practices on Eco-Innovation in Thailand

In Thailand, it is found that innovative practices are emerging in a wide view of eco-innovation in various sectors. They have been strengthened by active supports from the government. This report selects the following two good practices related to eco-innovation: composite glass production by Technoglass Co. and packaging practices by Universal Bio Pack Co. The first practice is an example of technological innovation implemented by a private firm linking with a public programme. We can see this case as a result in line with STI (Science, Technology and Innovation) approach which is one of key development area of Thailand in the past 10 years as the 1st Thailand National Science Technology and Innovation Policy and Plan 2012 – 2021 were launched in 2012. The second is a practice of green innovation in product value chain which has been already launched in the market. Cassava is an important industrial crop in Thailand often facing problems of overproduction and low price. This innovative practice was initiated by the company in a partnership with a local university.

5.1 Composite glass production by BSG Glass Co.

This good practice was initiated and supported by iTAP (Innovation and Technology Assistance Program). iTAP started in 1992 as a governmental program managed by the National Science and Technology Development Agency (NSTDA) in order to help SMEs enhance the potentiality of their competitiveness with science and technology by building a connection between technology service providers and technology users and providing professional technicians to help research and development and to give advices and solve problems in the factory. Through this program, iTAP supports BSG Glass Co., Ltd. with experts from the Thailand National Nanotechnology Center (Nanotech) to build an innovation that creates values to Foam Glass (Eco Stone) by compressing lemongrass oil into foam glass with nanotechnology (Figure 9).

The company called BSG Glass or Thai Techno Glass is a glass producing company for inside and outside uses in Asia Pacific region. A new innovative product entitled 'Eco-stone' was born from a process to solve water pollution provoked by waste glass. Eco-stone products contribute soil management by reducing weeds and conserving moisture in soil. However, high prices of the products are market barriers. Currently, the company renovates the products to the 2nd generation by adding fragrance to the previous products and expects that this transition would be able to strengthen the competitiveness of the products in the market (Figure 10).



Figure 9 Eco-stone products from BSG Glass Co.



Figure 10 BUGBEAT products from BSG Glass Co.

5.2 Cassava packaging by Universal Bio Pack Co.

In 1995, a research team from Kasetsart University has studied and developed packaging that produced from cassava (KU GREEN) and achieved its goal in 1997 by Assoc. Prof. Dr. Ngarmthip Phuvarodom and his research team. They managed to develop biodegradable cassava packaging at factory level as prototype. This research got a patent from the Department of Intellectual Property and already applied for a US Patent. They later transferred this technology to Universal BioPack Company Ltd. for a commercial production under the brand 'UBPACK' in 2010 until present.

In Thailand leading plastic production in ASEAN region, an average amount of waste reaches 7,300 tons per day of which 20 percent accounts for plastic up to 2,700 tons per day. These plastic wastes are usually buried in landfills, which make environmental problems due to long lasting characteristics of materials. In this context, pursuing an alternative packaging solution, Universal BioPack Company jumped into market in 2010 to produce a variety of biodegradable materials. It produces its products based on starch extracted from cassava. An idea for cassava based packaging products began from a fact that cassava is abundant as a staple crop in Southeast Asia, and farmers periodically suffer from low price due to oversupply to market. The company has obtained patents in Thailand and US for its own technology to produce packaging products. Currently, it takes 3 minutes to produce one product, which is derived from a lack of production capacity. The company is expanding its production facility so it can produce 5 to 6 products every second. In addition, based on aggressive investment for R&D accounting for 20 percent of total revenue, the company has developed its own coating technology using water replacing prevailed chemicals which is under review for approval by US Food and Drug Administration (FDA).



Extracting starch from cassava



Mixing starch with water



Casting



Putting heat and pressure (1)



Casting Putting heat and pressure (2)



Final products

Figure 11 Production process for cassava packaging



Figure 12 UB PACK products

6. Country Synthesis

This report reviews eco-innovation in Thailand by combining ASEI 2016 measurement with local circumstances on innovative approaches on environment, economy and society. Similar to other developing countries, Thailand, mostly derived 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 that could weaken the country's competitiveness. As demands for transition into more sustainable and environmentally friendly economy to overcome the environmental challenges increase, the government has already initiated countermeasures to introduce the challenges properly to all over the society and keep the country greener without compromising economic prosperity.

The 11th National Economic and Social Development Plan 2012-2016 was the first step for the government to lead structural transition through technology, innovation and creativity on eco-production and eco-consumption platform. It is worth noting that the plan recognized small and medium size enterprises (SMEs) as key actors to propel innovation. Afterwards, the Green Growth Strategy 2014-2018 strengthened the government's efforts by defining the concept of 'green growth' in the country and presenting more concrete paths to sustainability. Moreover, the strategy acknowledges ecological or environmental innovation as a key pillar such as promotion of eco-production and eco-services, reduction of energy uses and greenhouse gas emissions, and sustainable management of natural resources. The 1st National Science, Technology and Innovation Policy 2012-2021 has been encouraging technological innovation which was underscored by the above-mentioned plan and strategy as a main element for successful transition. Through the policy measures, the government is playing an aggressive role in stimulating technological innovation and socioeconomic changes, but research and implementation in practice are still in the early stage. However, we can observe that governmental efforts have created practical application of technologies developed by governmental supports. The Industrial Technology Development Support Project (iTAP) is a good example of long-term supports for SMEs' technology development.

These contexts provide reasonable clues to interpret the results of ASEI 2016 measurement for Thailand. Thailand's ASEI 2016 score is lower than the average of all ASEM member countries, which might be due to higher scores of European member countries. Among categories representing development phases in eco-innovation, 'Capacity' and 'Supporting Environment' categories perform relatively better than 'Activities' and 'Performance' categories. This result can be explained in that it reflects Thailand's strong economic foundations and governmental supports with a variety of policy measures. These strengths in capacity and supporting environment would be able to move the country forward to greener growth in line with gradual improvement of eco-innovation in the country.

7. References

- ADB. (2015) Asian Development Outlook 2016: Asia's Potential Growth. Asia Development Bank.
- Areemit, R., Thinkhamrop, J., Kosuwon, P., Kiatchoosakun, P., Sutra, S., & Thepsuthammarat, K. (2012). Adolescent pregnancy: Thailand's national agenda. *Journal of the Medical Association of Thailand= Chotmai het thangphaet*, 95, S134-142.
- Baker, C., & Phongpaichit, P. (2014). *A history of Thailand*: Cambridge University Press.
- BBC. (2015). Thailand Profile - timeline. Retrieved 1st May 2016, from BBC
- Bureau of the Budget. (2016). THAILAND'S BUDGET IN BRIEF FISCAL YEAR 2016.
- CIA. (2016). The World Factbook. Retrieved 1st May 2016, from Central Intelligence Agency <https://www.cia.gov/library/publications/the-world-factbook/geos/th.html>
- GGGI. (2016). Final GHG Reduction Roadmap Report.
- Global Environmental Forum. (1999). Overseas Environmental Measures of Japanese Companies (Thailand).
- Government of Thailand. (2015). Thailand's Intended Nationally Determined Contribution (INDC). Retrieved from http://www4.unfccc.int/submissions/INDC/Publishedpercent20Documents/Thailand/1/Thailand_INDC.pdf
- Hsu, A., Alexandre, N., Cohen, S., Jao, P., Khusainova, E., Mosteller, D., . . . Zomer, A. (2016). *Environmental Performance Index*. New Haven: Yale University.
- Jitapunkul, S., & Wivatvanit, S. (2008). National policies and programs for the aging population in Thailand. *Ageing international*, 33(1-4), 62-74.
- Krongkaew, M., & Nitithanprapas, S. C. I. (2006). Economic growth, employment, and poverty reduction linkages : the case of Thailand.
- Leturque, H., & Wiggins, S. (2011). Thailand's progress in agriculture: Transition and sustained productivity growth.
- ONREP. (2011). Executive Summary - Environmental Quality Management Plan 2012-2016. Park, M., Han, K., Jang, E., Choi, W., Joo, J. (2016). ASEM Eco-innovation Index 2016.
- PCD. (2012). Thailand State of Pollution Report 2011. Retrieved from http://infofile.pcd.go.th/mgt/Report_Eng2554.pdf?CFID=1284031&CFTOKEN=40784107
- Phongpaichit, P., & Benyaapikul, P. (2013). Political Economy Dimension of a Middle Income Trap: Challenges and Opportunities for Policy Reform: Thailand. Faculty of Economics, Chulalongkorn University.
- PwC Thailand. (2014). Economic crime in Thailand.
- Quah, J. S. (2003). Causes and consequences of corruption in Southeast Asia: A comparative analysis of Indonesia, the Philippines and Thailand. *Asian Journal of Public Administration*, 25(2), 235-266.
- The Transparency International. (2013). Global Corruption Barometer 2013: Thailand Retrieved from <http://www.transparency.org/gcb2013/country/?country=thailand>
- The Transparency International. (2015). Corruption Perceptions Index 2015.
- UNDP. (2015a). Briefing note for countries on the 2015 Human Development Report: Thailand.
- UNDP. (2015b). Human Development Report 2015: Work for Human Development.
- USDS. (2016). Investment Climate Statements for 2016. Retrieved from <http://www.state.gov/e/eb/rls/othr/ics/investmentclimatestatements/index.htm?year=2016&dlid=254319>
- WEF. (2015). The Global Competitiveness Report 2015–2016.
- World Bank. (2011). Thailand: Clean Energy for Green Low-Carbon Growth.
- World Bank Group. (2015). East Asia's Changing Urban Landscape : Measuring a Decade of Spatial Growth. Urban Development.
- WPR. (2015). World Population Review - Thailand. from World Population Reivew <http://worldpopulationreview.com/countries/thailand-population/>

