ASEM SMEs Eco-Innovation Center

ESG Information, Analytics & Investment
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Small & Medium Business Administration

SBC Small & medium Business Corporation

SUSTAINALYTICS

ASEM Eco-Innovation Index (ASEI) 2012

Measuring Sustainable Future for Asia and Europe

Sustinvest
Editor

ASEIC
Ordering Organization

About ASEIC (ASEM SMEs Eco-Innovation Center)

The ASEM SMEs Eco-Innovation Center (ASEIC) aims to promote eco-innovation for Small and Medium-sized Enterprises (SMEs) in Asia and Europe. Its establishment was endorsed by the leaders of ASEM member countries at the 8th ASEM Summit in Brussels, Belgium. ASEIC seeks to serve as an international platform where eco-innovation practices are shared and new green growth opportunities are created. ASEIC is currently funded by the Small and Medium Business Administration, the Republic of Korea. Its office is located in Seoul.

www.aseic.org

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Table of Contents

Tables and Figures

Tables (page)

Figures (page)

Executive Summary

This ASEM Eco-Innovation Index 2012 is the first attempt to investigate the global state of eco-innovation beyond Europe. Developing a measuring framework for eco-innovation involves a comprehensive understanding and in-depth analysis of the determinants of eco-innovation and of its implications. This report highlights the importance of eco-innovation in green growth policy agenda. The ASEM Eco-Innovation Index introduces a new way of understanding the current trends and key characteristics of eco-innovation. To enhance the quality of the analysis, this report includes appropriate information on policies, regulations, initiatives and business case studies related to eco-innovation.

The definition of eco-innovation used in this report is as follows;

"Eco-innovation is any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of resources including both intended and unintended environmental effects from innovation as well as not only environmental technology but processes, systems and services."[1] (European Commission, 2012)

Previous studies have developed framework conditions that promote eco-innovation since the 1990s. Set of indicators were introduced in these framework conditions but due to lack of available data, limited attempts have been made to quantitatively measure eco-innovation.

It is even harder to measure eco-innovation of Asian countries due to further lack of statistics and indicators in the field of eco-innovation. There is lack of internationally or regionally comparable data that can be used as the key set of indicators. For this reason, there has been no attempt, up to the present, to measure the eco-innovation state of Asian countries. ASEI 2012 represents an effort to overcome this challenge. This marks the starting point for measuring eco-innovation beyond Europe.

The goals of the ASEM Eco-Innovation Index 2012 Report

The primary objective of ASEM Eco-Innovation Index 2012 is to provide quantitative information and qualitative analysis on eco-innovation and to help understand the increasing importance of eco-innovation.

Other main objectives of the ASEM Eco-Innovation Index are:

- To examine whether countries are putting eco-innovation at the heart of promoting national green growth strategy
- To undertake an analysis in which countries are active in eco-innovation and which countries may emerge as the frontrunners of eco-innovation in the next ten years
- To understand the different types of eco-innovation opportunities and the strengths each country possesses on each type and assess each country's performance on this basis
- To become an index that allows comparing the eco-innovation status between countries and regions
- To become an index that can be used to monitor each country's progress as the concept evolves
- To help countries develop policies based on the analysis of eco-innovation
- To emphasize the roles of governments and companies as enablers of eco-innovation

[1] *http://ec.europa.eu/environment/eco-innovation/faq/index_en.htm#1.1*

- To anticipate Asian companies particularly SMEs to implement eco-innovation through their business
- To stimulate global partnership and build active communication channels between Asian and European countries on eco-innovation
- To encourage public-private partnership to share and collect knowledge and practices on eco-innovation

Measurement Framework

The ASEM Eco-Innovation Index 2012 examines eight European and seven Asian countries on 20 generic indicators or data sources which are aggregated into four criteria; "eco-innovation capacity", "eco-innovation activities", "eco-innovation supporting environment" and "eco-innovation performance". The twenty generic indicators represent a selected number of key indicators that represent central elements of the eco-innovation concept and issues. To measure the "eco-innovation capacity" of a country, five generic indicators were selected that reflect the country's potential to generate eco-innovation (e.g. general innovation capacity). Six set of data sources were selected that describe current activities that are categorized to be "eco-innovation activities" (e.g. green patents). Regarding the "eco-innovation supporting environment", four generic indicators were chosen that describe a government's effort to create a supporting environment to promote eco-innovation such as the government's R&D expenditure in green industry. To measure "eco-innovation performance", five generic indicators were brought together to reflect the overall green competitiveness of a country and the country's economic, social and environmental value gained from eco-innovation activities such as resource efficiency.

A preliminary selection of ASEM member countries for 2012 ASEI assessment, were selected on the basis of reliable data source availability, level of GDP and the country's environmental load.

Qualitative Analysis

In addition to the quantitative analysis through the ASEI framework, ASEI report includes qualitative analysis on policies, national strategies, initiatives, business case studies that relate closely to eco-innovation. In-depth research has led to the finding that each country possesses similar but different drivers of eco-innovation. As a result, for each country analysis three key driving environments of eco-innovation have been indicated and explained

ASEI considered the inclusion of data sources that reflect the eco-innovation of SMEs. This is because we recognized that SMEs are active developers and users of eco-innovation. In line with such understanding, this report includes three eco-innovation business case studies for each country, that show the different forms of eco-innovation that can emerge at the business level, in different sectors with different supporting environment.

Key Findings

Good understanding of eco-innovation and of its implications has allowed eco-innovation as a key pre-requisite for green growth for all ASEM member countries. With such principle, the main findings of the report in relation to measuring the eco-innovation status of ASEM member countries are as follows;

- Since the formation of the EU, the European countries' eco-innovation activities are stimulated by regional initiatives and policies. **As the pioneer of eco-innovation, most European countries sit at the top tier of the ASEI showing high levels of "eco-innovation capacity", "eco-innovation activities", "eco-**

innovation supporting environment" and "eco-innovation performance". Sweden, Denmark and the United Kingdom emerged as frontrunners of eco-innovation in ASEI. On the basis of both quantitative and qualitative analysis, these European countries are currently leading the global market, initiatives and trade related to eco-innovation.

- Some Asian countries like China and South Korea, which has put eco-innovation at the heart of its national green growth strategy, show signs that they are rapidly catching up with the early starters of eco-innovation. **Asian governments increasingly understand the concept and the importance of eco-innovation and are encouraging eco-innovation activities through national regulations and incentives.** They are creating the environment where eco-innovation is enforced to emerge.

- Although the eco-innovation capacities of Asian and European countries are comparable, **Asian countries are experiencing more difficulty in transforming such "eco-innovation capacity" to "eco-innovation activities". It is clear that the gap between "eco-innovation capacity" and "eco-innovation activities" exists for both European and Asian countries; however, this gap remains bigger for Asian countries.** Top runners of the ASEI show a smaller gap between "eco-innovation capacity" and "eco- innovation activities" (e.g. Sweden). More firm linkages need to be created between eco-innovation capacity, activities and supporting environment to improve the eco-innovation performance.

- **Governments need to play a central role by implementing government regulations and policies to transform eco-innovation potential to actual activities that can eventually improve the environmental performance at national level.** There is a strong correlation between "eco-innovation supporting environment" and "eco-innovation activities". Eco-innovation frontrunners like Sweden and United Kingdom show high levels of eco-innovation supporting environment and activities. The stronger the correlation, the stronger the eco-innovation performance of a country.

- **While the European countries have regional programmes and initiatives that target direct stimulation of eco-innovation (e.g. EcoAP), there are no such regional programmes and initiatives in Asia. In Asia, each country has its own policy mix that promotes certain eco-innovation activities. Asian countries have their own eco-innovation focus and target points.** Asian governments are increasing their support of eco-innovation and most of their support remains to focus on developing renewable energy and green technology.

- Many European countries are achieving both environmental and socio-economic outcomes through good eco-innovation performance while Asian countries lag behind in this. This may due to different socio-economic structures, growth of GDP and other considerable factors. For this reason, **each country may demonstrate various unique eco-innovation activities on the basis of its national environmental, social and economic conditions.**

Role of Companies

- Both technical and non-technical eco-innovation at the company and industry levels allows countries to break away from resource intensive growth models that bring negative environmental impact. SMEs which dominate a large part of both European and Asian economy can be key drivers of eco-innovation growth. SMEs are key players in scaling up and accelerating eco-innovation, as they are flexible and quick to integrate eco-innovation concepts into their business operation, ideas and production.

- Innovative ways of doing business in consideration of environmental issues contributes to the emergence of systematic eco-innovations and the implication of this could be greater than expected.

- In case of European countries, companies demonstrate various types of non-technical eco-innovation via changing its operation process, marketing strategy, designs of products and production process. In contrast, Asian companies' practice of eco-innovation is more technical focused such as developing green technology solutions. This may be due to increased emphasis on technology development during the rapid economic growth in Asia within the last decade.

Beyond identifying the above findings, the report suggests that further attention should be placed on a broad set of eco-innovation issues. The framework and policy insights included in this report can provide guidance for further analysis on monitoring the progress of eco-innovation at the national and regional level. Greater encouragement is needed to stimulate global partnership between Asian and European countries on eco-innovation and close the gap between the two regions. This report hopes to support governments to take one step further in facilitating and developing eco-innovation policies and programmes by acknowledging where their capacities lie. In addition, this report encourages companies to participate in public-private partnership initiatives to implement and start eco-innovation.

ASEI will enhance its measuring approach for ASEI 2013, to become a more internationally reliable index on eco-innovation.

Introduction

This is the first report on eco-innovation of ASEM member countries. The report looks at the potential and the mental attitude towards eco-innovation of fifteen countries as a pilot. Throughout the report, we provide a positive perspective towards the potential of eco-innovation in green growth agenda. This report introduces a new measurement approach that captures a central part of the trends and characteristics of eco-innovation. The ASEM Eco-Innovation Index aims to enhance the quantitative empirical analysis on eco-innovation.

ASEI Measuring Approach

The ASEM Eco-Innovation Framework introduced in this report is constructed within a theoretical background. It was built with a good understanding of the determinants of eco-innovation and its outcomes. Eco-innovation is a broad term. Until now much focus has gone to defining the concept and meaning. Due to the meaning behind eco-innovation, it is difficult to capture eco-innovation by a single metric measurement or indicator. Thus, the ASEM Eco-Innovation Framework includes different sets of generic indicators that reflect the green technology market, environmental performance, innovation capacity and other representative elements that define eco-innovation.

Previous studies or notions have emphasized green technology as the representative tool for eco-innovation. The ASEI Framework moves away from this notion. The new framework includes indicators such as the level of environmental management that reflect both non-technical and technical eco-innovation activities. Examples of non-technical eco-innovation are business model, partnership, business strategy, pricing following regulations, entrepreneurship and infrastructure. Currently, there are limited data sources that well-represent the non-technical side of eco-innovation. Nonetheless, ASEI have made effort to include several indicators that reflect certain part of non-technical side of eco-innovation.

Particular attention has gone to SMEs' activities and governmental support towards eco-innovation when building this framework. Previously, there have been studies on eco-innovation framework conditions. However, these working papers and reports only propose the framework structure and set of indicators that are still difficult to measure.

Eco-innovation scoreboard was first developed by the Eco-innovation Observatory with "tentative set of eco-innovation indicators"[2] using regional comparable generic data from sources such as the Eurostats and/or Eurobarometer. This had been the first attempt to quantitatively measure eco-innovation of European countries. Asian countries lack such regional statistical data in the field of eco-innovation. Thus, the final set of generic indicators selected for ASEI had to consider the availability of the internationally comparable data. The measuring approach will need to improve over time as the concept evolves and better data is available. Thus, it is expected that some indicators will be replaced by data sources that are more reliable in the second ASEI 2013.

Considering such challenges, the ranking of ASEI 2012 is less significant in this report. Rather, it is the attempt to include Asian countries in measuring eco-innovation status that should be more noteworthy. It is an effort to understand which part of eco-innovation had been successfully addressed by which country and where each country's eco-innovation potential lies.

Report Structure

This report is presented in three parts. Since the concept of eco-innovation may be fairly new to some, the first part of the report introduces the concept of eco-innovation and how the concept was understood in order to

[2] *EIO (2012), Methodological Report*

select the key indicators for ASEM Eco-Innovation Framework. Part One highlights the importance of eco-innovation and emphasizes the role of companies in driving eco-innovation. Part Two, introduces the ASEM Eco-Innovation Index and provides some insights on how the measuring framework had been developed. Part Three presents the key regional findings and Part Four presents the results found for fifteen countries. Part Four also includes qualitative analysis on policies, national strategies, initiatives, business case studies for each country assessed. For each country analysis, three case studies are included as examples to show how eco-innovation is put into practice at the company level. These case studies do not represent best eco-innovative business practices in each country but they are valuable in showing different ways eco-innovation can be implemented on the business side. The report concludes with lessons learned, recommendations and the way forward. This report went through a review process by two external referees who possess academic credentials and expertise in the field of eco-innovation.

Part 1. Understanding Eco-Innovation

Eco-innovation for Green Growth Policy Agenda

Since the introduction of the concept "eco-innovation" in the article, Driving Eco-Innovation: A Breakthrough Discipline for Innovation and Sustainability by Claude Fussler & Peter James in 1996, the concept has been developed rapidly and diffused into national policies, initiatives and movements as a means to create and foster future green growth. Eco-innovation represents environmental and sustainable dimension of innovation that improves energy security and resource efficiency and eventually takes one step forward towards sustainable development. It has been commented by several international organizations such as the OECD that "eco-innovation" activities have a "leveraging effect" on environmental, economic and social development by stimulating the use of fewer materials or energy inputs per output.[3] In OECD's *Better Policies to Support Eco-innovation* report published in 2011, it clearly states the important role of eco-innovation in pursuing green growth policy agenda at national level.

As first drivers of eco-innovation, European countries initiated various eco-innovation measures that foster regional programmes including ETAP (Environmental Technology Action Plan), ECOPOL and CIP (Competitiveness and Innovation Framework Programme). Since then, other non-European countries have followed the steps of the European Commission and European governments, to develop national strategies and regional roadmaps to stimulate eco-innovation.[4] More recently, environmental and social issues such as climate change and energy security are forcing Asian governments to consider green growth strategy, which is a new development paradigm that sustains economic growth while at the same time ensuring climate and environmental sustainability. Eco-innovation can be a key catalyst for businesses to promote and implement green growth and green economy since it promotes any form of innovation that reduces negative impacts-environmental impacts, enhances resilience to environmental pressures and promotes resource efficiency. Moreover, eco-innovation can be actively implemented at the company level by, integrating environmental management with innovative ideas, knowledge and skills. Such implications require national governments to set an ambivalent eco-innovation friendly policies and pressure industry sectors to consider eco-innovation.

Role of Business in Eco-innovation

Previous studies have emphasized green technology as the main tool for eco-innovation. Recently eco-innovation not only refers to green technologies but a wider spectrum of innovation that enhances environmental performance. In a recent OECD report, it emphasizes the role of business in fostering eco-innovation activities and describes companies that promote or practice eco-innovation as 'radical and systemic eco-innovation'[5]. Companies that practice eco-innovation may include both technical and non-technical approaches such as business model, partnership, regulation and pricing, entrepreneurship, infrastructure and change in consumer behavior. When companies integrate the concept of eco-innovation into company's strategies, policies and daily decision making, they can introduce entirely new solutions, new technologies and new modifications or adaptation of an existing technology that further enhances the green market. Through eco-innovation, companies can support the current economy's separation from previous resource intensive growth models and demonstration of a successful decoupling[6] effect.

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[3] *OECD (2012), The Future of Eco-innovation: The Role of Business Models in Green Transformation*

[4] *OECD (2011), Better Policies to Support Eco-Innovation*

[5] *OECD (2012), The Future of Eco-innovation: The Role of Business Models in Green Transformation*

[6] *OECD defines decoupling as breaking the link between "environmental bads" and "economic goods"*

Fig. 1 Various factors surrounding eco-innovation <OECD, 2012>

Eco-Innovation of SMEs & MNEs

In both Asian and European countries, SMEs represent a large part of the economy. SMEs provide job creation and are key factors of domestic and export earnings. More than 99 percent of European Union companies are SMEs and are responsible for over 60 percent of the EU's GDP.[7] In Asia, SMEs account for around 90 percent of businesses and employ around 60 percent of the workforce.[8] The definition of SMEs varies from country to country; thus, in this report we understand SMEs in a broader term with regards to asset size or cumulative productivity.

In both Asia and Europe, SMEs are extensively recognized as key drivers of eco-innovation growth and a key instrument for environmental and social development efforts. Therefore, in Europe, SMEs have been the main target of eco-innovation initiatives and programmes at the national and regional level.[9] More recently, there has been an increase in number of SMEs that develop and trade green technology solutions and products which comes under the paradigm of eco-innovation. SMEs are often more flexible to integrate eco-innovation concept into their operation, product and strategy, thus can be more inventive than MNEs overtime. It is expected that more SMEs will challenge many existing eco-innovation related technologies, processes, products and solutions of bigger companies.

In contrast to SMEs, MNEs have sufficient resources, sector professionals and strong infrastructure to explore beyond the standardized level of Environmental Management System (EMS) and to integrate eco-innovation into their corporate strategies, business processes and policies.[10] Moreover, eco-innovation in MNEs can also be related to changing behavior of employees, creating new innovative business models and designs that are environmentally friendly, utilizing energy efficient buildings, promoting eco-innovation to customers and many others.

Synergetic effect between eco-innovation activities of MNEs and SMEs can show positive impacts towards green economy at the sectoral level which eventually will reflect through environmental performance at the country level.[11] Moreover, overtime, MNEs and SMEs in developed countries that have been successful

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[7] *EIO (2012), Emerging Markets*

[8] *Small and Medium Enterprises, Asia-Pacific Economic Cooperation*

[9] *EIO (2012), Emerging Markets*

[10] *Pablo del Rio & Totti Könnölä (2009), Eco-Innovation: When Sustainability and Competitiveness Shake Hands*

[11] *OECD (2012), The Future of Eco-innovation: The Role of Business Models in Green Transformation*

in implementing eco-innovation can use the opportunity of globalization to share eco-innovation business practices to companies in developing countries.

Closing the eco-innovation gap between Asian and European countries

It has been obvious that European countries have been and still is driving the eco-innovation trends while Asian countries lag behind. The EU and Asian countries have had different starting points for eco-innovation. Compared to European countries, a few Asian governments have difficulty in understanding the concept of eco-innovation. This corresponds closely with the lack of governmental support for eco-innovation. For some Asian developing countries, government priority support remains at enhancing the quality of skills, education and training, building labor market, alleviating poverty and, building infrastructure and housing.

However, on the whole Asian countries are advancing national strategies that tackle environmental and social challenges. In line with this trend, ASEI highlights the importance of understanding the concept of eco-innovation by Asian governments. Eco-innovation in developing Asian countries can lead to better living environment, as well as play a significant role in poverty alleviation.[12] Moreover, by understanding both non-technical and technical eco-innovations as social and environmental solutions, Asian companies may find cheaper and better technical and non-technical solutions to gain green competitiveness[13] while meeting local social and environmental demand and tackling such local challenges.

[12] *UNIDO (2011), Policies for Supporting Green Industries*

[13] *Green Competitiveness: Applying strategy to achieve productivity and overall performance of socio-economic development while reaching the goal of sustainable development (OECD, 2012)*

Part 2. The ASEM Eco-Innovation Index 2012

ASEM Eco-Innovation Index (ASEI) was developed to quantitatively and qualitatively measure the level of eco-innovation of ASEM member countries. In 2012, the first ASEI assesses 15 ASEM member countries in their "eco-innovation capacity", "eco-innovation activities", "eco-innovation supporting environment" and "eco-innovation performance". This is based on twenty indicators which are aggregated into four criteria. The fifteen countries were selected based on data availability, level of GDP and environmental load. In a recent OECD report, it is stated that quantitative analysis of eco-innovation is currently lacking; therefore, there is a need for a 'eco-innovation scoreboard' with reasonable measurement framework that can be applied to all countries.[14] As mentioned in the previous part of the report, development of a 'eco-innovation scoreboard' has been a challenge due to the lack of indicators and statistics in the field of eco-innovation.

Measuring Scope of "Eco-Innovation"

The term "eco-innovation" is fairly recent. During the last 15 years, the concept has been used within broader economic, social and environmental arenas. Defining and understanding the concept of eco-innovation is therefore a challenge as the concept expands globally without a development of a structured knowledge and meaning. This report aims to use EU's definition of eco-innovation to understand the same concept:

"Eco-innovation is any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures or achieving a more efficient and responsible use of natural resources including both intended and unintended environmental effects from innovation as well as not only environmental technology but processes, systems and services." (European Commission, 2012)[15]

This report provides quantitative and qualitative results found from measuring key elements of eco-innovation. The reason for emphasizing "central elements" is due to a broad understanding of eco-innovation and broader aspects incorporated within the term. Indicators measuring eco-innovation can vary on where the focus is and how it is defined. This report has focused on the scope of measuring eco-innovation in four criteria; 1) eco-innovation capacity, 2) eco-innovation activities, 3) eco-innovation supporting environment and 4) eco-innovation performance, with 20 indicators.

In this report, we have included case studies to show the different forms of eco-innovation that can emerge at the business level within different contexts. These case studies are not selected with specific selection criteria yet we have made the effort to select acknowledged companies in the field of eco-innovation such as companies with eco-innovation related awards or ones that have been acknowledged by the media for possessing the best eco-innovation practices. The case studies provide a valuable opportunity to assess different eco-innovative solutions, processes, services, systems and products to encourage new and existing companies to implement eco-innovation.

[14] *OECD (2012), Sustainable Manufacturing and Eco-innovation: Framework, practices and measurement*

[15] *http://ec.europa.eu/environment/eco-innovation/faq/index_en.htm#1.1*

FRAMEWORK STORYLINE

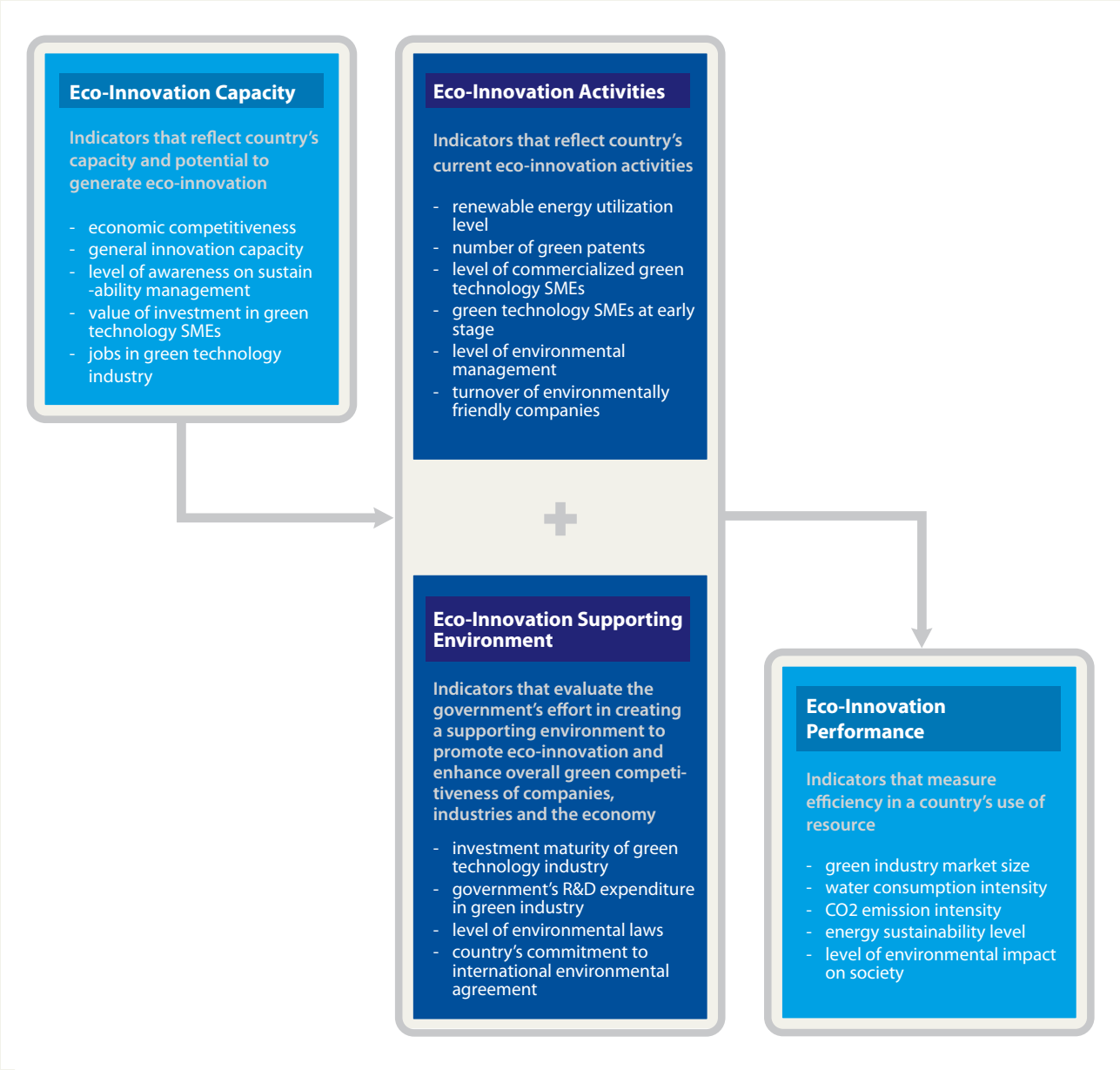

Fig. 2 Storyline of ASEI framework

METHODOLOGY & DATA SELECTION

Discussions have emerged in the last few years on the practical methods of measuring eco-innovation. In relation to this, several reports state that there is no ideal method or specific indicators to measure eco-innovation. The EU, UNESC (2011), United Nations University (2009), European Environment Agency (2006), OECD (2009) and other institutions have previously worked on developing framework conditions or guidelines to measure eco-innovation at sectoral, regional and national level. However, there have been limited cases where these researches have led to the actual measuring of eco-innovation quantitatively.

To measure eco-innovation various available generic sources of data can be combined to construct a framework with composite indicators. Referring to previous working papers and reports, following data sources had been purposed and emphasized to be important in constructing composite indicators for eco-innovation:

<EEA, 2006>, <UNU, 2009>

Considering the purposed key indicators shown above, we have tried to find and select existing environmental and innovation data sources that apply to both European and Asian countries. However, there have been challenges due to insufficient data sources for Asian countries. Emergence of different data sources is expected to improve the methodology of measuring eco-innovation in the future. ASEI also considered the inclusion of data source that represent SMEs, as these are seen as active developers and users of eco-innovation.

While constructing a suitable framework for ASEI, the Analytic Hierarchy Process (AHP) was used to select the most important indicators among a number of candidate indicators. Surveys conducted by experts' ensure that indicators were chosen on the basis of in depth knowledge and expertise of key factors of eco-innovation at the national level. For more details of AHP, refer to the appendix of this report.

The statistical indicators for ASEI demonstrate different units and ideal directives from each other. If the values for the indicators are not normalised into the same scale, their relative performances are not measurable and hence the final outcome cannot be trusted at all. To tackle this problem, all the values were standardised by referencing the most desirable case or the best practice observed for each indicator. In case the higher value of an indicator is the better, the standardised scores were given in the percentage compared to its best practice (i.e. the maximum value[1)]) for the indicator. Then, all the data were assigned a score ranging from 0 to 100, and the maximum values of each indicator were given a score of 100. In case that the lower value is better, the original values were standardised by referencing the minimum value[2)].

1) ideal direction : ↗

$$I_{ij} = 100 \times \frac{x_{ij}}{\max_j(x_{ij})}$$

i, j = indices for indicators and countries, resp.
I_{ij} = standardized value
x_{ij} = original value
$\max_j(x_{ij})$ = maximum value for the indicator i

2) ideal direction : ↘

$$I_{ij} = 100 \times \frac{\min_j(x_{ij})}{x_{ij}}$$

i, j = indices for indicators and countries, resp.
I_{ij} = standardized value
x_{ij} = original value
$\min_j(x_{ij})$ = minimum value for the indicator i

Table 1. Equations used to standardize values of ASEI indicators

The standardized values were aggregated into the scores for criteria, and then again into the final score. Each criterion, regardless of the number of corresponding indicators, was given the same weight, that is 25%(4X25=100), so that the weights of the criteria comprising the final score were locked. Also, each indicator for a criterion was assigned with the same weight. That is, the scores of criteria were obtained by averaging the corresponding (standardized) indicator values, and the final score was computed by taking the average of scores of four criteria.

Among all 20 indicators of ASEI framework, a few missing values in data were not collectable for some countries especially for Asian countries. However, the final result was not influenced by those missing observations. If an indicator for a criterion contained missing observations for some countries, the missing values were replaced with the aggregated score of the country for the criterion.

The Framework of the ASEM Eco-Innovation Index

Eco-Innovation Capacity	Country's Economic Competitiveness
	General Innovation Capacity
	Level of Awareness on Sustainability Management
	Value of Investment in Green Technology SMEs
	Jobs in Green Technology Industry
Eco-Innovation Activities	Renewable Energy Utilization Level
	Green Patents
	Level of Commercialized Green Technology SMEs
	Green Technology SMEs at Early Stage
	Level of Environmental Management
	Turnover of Environmentally Friendly Companies
Eco-Innovation Supporting Environment	Investment Maturity of Green Technology Industry
	Government's R&D Expenditure in Green Industry
	Level of Environmental Laws
	Country's Commitment to International Environmental Agreement
Eco-Innovation Performance	Green Industry Market Size
	Water Consumption Intensity
	CO2 Emission Intensity
	Energy Sustainability
	Level of Environmental Impact on Society

Table 2. The framework of the ASEI

The following sources of data were drawn upon to build the above framework:

INSEAD, Global Innovation Index, 2012
WEF, Global Competitiveness Index, 2012
International Energy Agency, Renewable Energy Database, 2012
Cleantech Group Data, 2012
World Intellectual Property Organization
International Institute for Management
World Energy Council
Environmental Performance Index, 2012

The ASEM Eco-Innovation Index – Factor Table

Country/Criteria	Eco-Innovation Capacity	Eco-Innovation Activities	Eco-Innovation Environment	Eco-Innovation Outcome
Austria	56	31	68	39
Belgium	70	37	61	34
China	55	32	70	32
Denmark	88	65	58	60
France	75	48	67	56
Germany	75	41	63	50
India	60	27	59	17
Indonesia	45	19	49	15
Italy	53	43	55	40
Japan	65	31	57	48
Korea	61	38	60	28
Malaysia	54	18	56	25
Sweden	85	79	79	67
Thailand	49	17	46	18
United Kingdom	82	66	87	47

Table 3. Factor Table of the ASEI

Part 3. Regional Results and Analysis

Regional Results

The results show that higher ranks of the ASEI are dominated by European countries, followed by economically advanced Asian countries such as Japan, China and Korea. It is also apparent that European and Asian countries are at different stages of understanding and implementing eco-innovation. In other words, Europe and Asia are currently at different maturity level of eco-innovation. As late starters of eco-innovation, Asian countries lag behind in all four criteria of examined scope of eco-innovation.

Among European countries, Sweden Denmark and the UK reveal the highest scores in all four criteria. These three countries are known to have introduced both direct and indirect measures to stimulate eco-innovation from the early stage. These three countries lead the way in implementing regional eco-innovation policies and stimulated the growth of the green market. Sweden and Denmark's successful business practices in the field of eco-innovation are frequently introduced as the best case studies in Europe. Products and solutions introduced in these business best practices are now delivered to wider consumers in developing countries. Amongst the Asian countries, Japan managed to position itself between the advanced European countries in the overall ranking of ASEI. Nevertheless, most of the Asian countries excluding Japan fall further below the average of the EU countries in all four criteria, further in the criteria of "eco-innovation activities' and "eco-innovation performance".

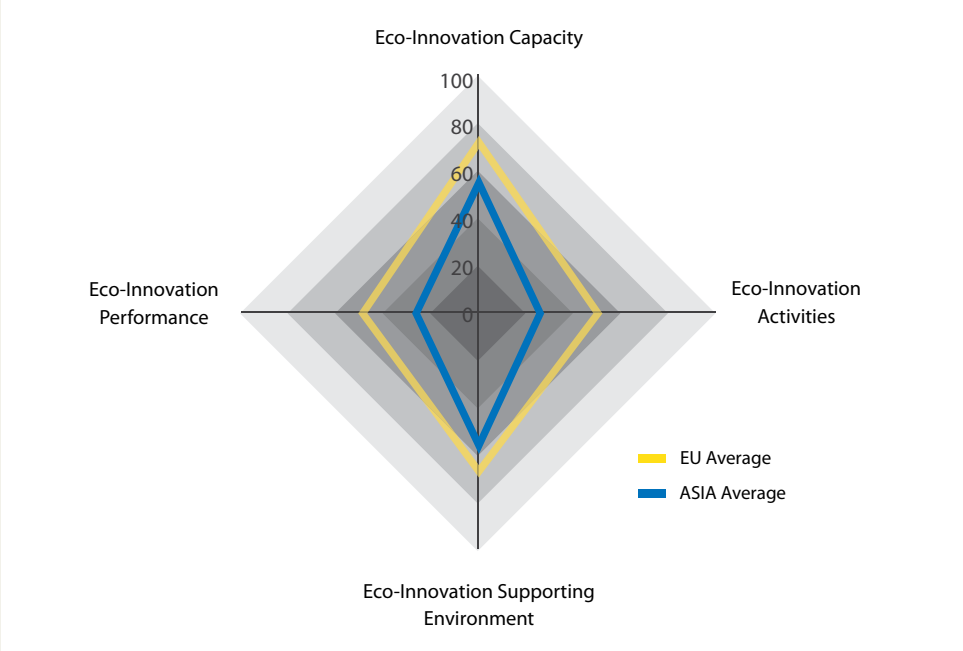

Fig. 3 Radar chart to compare results between Asia and Europe.

Current positioning of some countries in ASEI may differ in ten years time as there are countries that stand out as having the potential to catch up to the top tier performers. Countries such as Korea and China are showing signs to rise higher in the ranks in the coming years, perhaps sooner than later. To give a brief overview of the results at the criteria level, Sweden leads in "eco-innovation activities" and "eco-innovation performance" while Denmark takes the lead in "eco-innovation capacity" and the United Kingdom in "eco-innovation supporting environment". Amongst the Asian peers, Japan leads among Asian countries in "eco-innovation capacity" and "eco-innovation performance" while China takes the lead in "eco-innovation supporting environment".

Regional Analysis

Since the formation of the EU, the European countries have placed green growth at the front of developing regional strategy. The EU has taken pre-emptive measures in developing policy and preventable measures on the issues of environmental protection and resource efficiency. Consequently, this led to early recognition of eco-innovation as the central idea of green growth agenda by the European Commission. Since then, the European Commission launched initiatives to aggressively encourage eco-innovation including the Environmental Technologies Action Plan (ETAP) launched in 2004 which has been updated and re-launched as Eco-innovation Action Plan (EcoAP) in December 2011. The objective of EcoAP 2011 is to support the "Europe Strategy 2020". The "Europe Strategy 2020" is a ten year strategy proposed by the European Commission in March 2010 and its key focus is innovation. Presently, the EcoAP is viewed and recognized as the representative regional tool to proactively promote eco-innovation in the EU. Additionally, the Competitiveness and Innovation Framework Programme (CIP) (2007-2013) was launched to fund eco-innovative SMEs and has helped many eco-innovative products and solutions to enter the market. The EU has constantly put effort to invest in green technologies, promote eco-innovation businesses best practices, and provide funds for eco-innovation related R&D activities.

More recently, Asian countries are being pressured from more advanced countries to understand the issues of environmental protection and sustainable development. Asian countries are becoming the target for international environmental regulations at company, industry and national levels. Moreover, the increasing in energy price due to rapid economic growth, climate change and the risk of resource depletion, are forcing Asian countries to search for innovative solutions and to take proactive actions towards climate action and resource efficiency. In line with such trend, it is increasingly becoming essential for Asian countries to find socio-environmental solutions through eco-innovation.

KEY REGIONAL FINDINGS

1. Growing "Eco-Innovation Capacity" in Asia

"Eco-innovation capacity" addresses the country's mental attitude towards eco-innovation and its foundation to create eco-innovation activities such as enabling infrastructure, general capacity, human resources and capital. The results show that European countries' "eco-innovation capacity" is slightly higher than most Asian countries. The difference in "eco-innovation capacity" between the two regions is small. At the indicator level, United Kingdom, Sweden and Japan scored the highest in country's economic competitiveness and general innovation capacity. However, Korea and Indonesia are quickly catching up to the top performers of economic competitiveness and general innovation capacity.

Asian countries like China, India, Japan and Korea are increasing their awareness on green growth. As shown in Figure 4, the "eco-innovation capacity" level of China, India, Japan and Korea is at a similar or higher level than some European countries including Italy.

There are signs that the Value of Investment in Green Technology in Asian countries are growing. Despite the global economic slowdown, Asia's investment in green technology is expected to increase over the years. This trend is particularly significant for China and India. ASEI results show that, India and China score higher in the "value of investment in green technology SMEs".

It is noteworthy to see that the score for the "level of awareness on sustainability management" indicator is high for some Asian countries such as Malaysia. Compared to the European countries, Asian countries may lack researchers, employees, capital for initial investment, training, and awareness of eco-innovation. Nonetheless, the enhanced quality of education, entrepreneurship and research culture, business skill, and other economic

and social factors will gradually boost the overall level of "eco-innovation capacity" for Asia.

Increase in economic competitive and general capacity level of Asian countries will lead to the establishment of small enterprises with innovative business models and technologies. Overtime, increased awareness on environmental issues will increase the number of young enterprises in the field of eco-innovation. These enterprises established in Asia will have the potential to be creators and active traders of eco-innovation solutions and products in the future.

2. *Importance of bridging the gap between "Eco-Innovation Capacity" and "Eco-Innovation Activities"*

The top tier performers of ASEI show smaller gap between the levels of "eco-innovation capacity" and "eco-innovation activities". In other words, there is evidence that top performers such as Sweden are successful in transitioning "eco-innovation capacity" to "eco-innovation activities". It is important that eco-innovation capacity needs to be transformed into active eco-innovation tools that can get commercialized and used towards implementing growth of the green market.

However, there seems to be various barriers that impede the transition. These barriers may include lack of government fund, private investors and awareness on ways to implement eco-innovation. Such barriers seem to exist for both European and Asian countries. Yet, Asian countries lag further behind in forming a firm linkage between "eco-innovation capacity" and "eco-innovation activities" compared to the European countries. Forming a better linkage between eco-innovation capacity and activities may be linked to improved linkage between research and market. The role of the government is central in forming a firm linkage between the two different levels of eco-innovation growth.

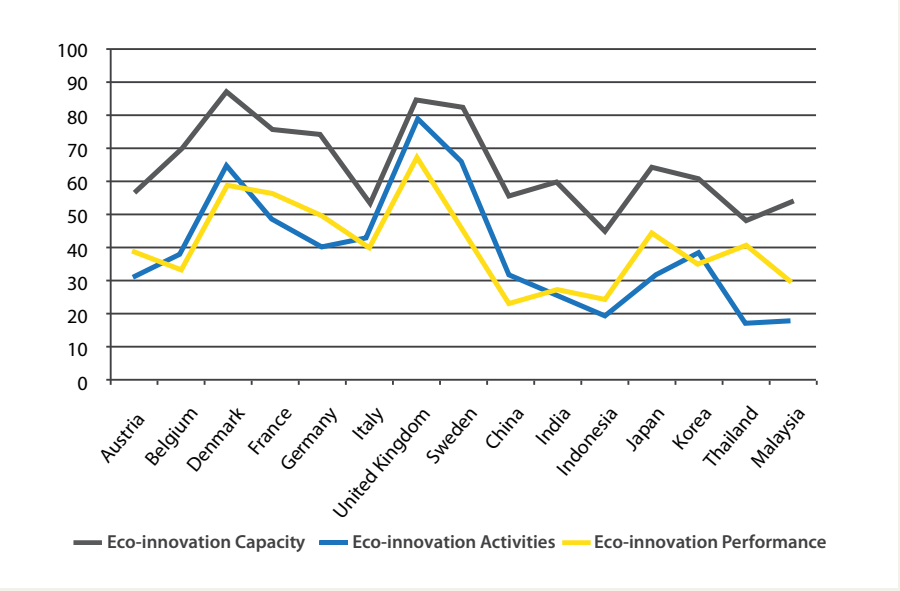

Fig. 4 Comparison results of "eco-innovation capacity", "eco-innovation activities", and "eco-innovation performance" of analyzed countries

3. *Growing Support for Eco-Innovation from Asian governments*

In relation to previous findings, eco-innovation is difficult to develop without eco-innovation friendly policies or support from the government. The lack of eco-innovation supporting environments puts a barrier in applying eco-innovation activities. This principle is reflected in the ASEI result as shown in Figure 5. It is significant

to note that Sweden and United Kingdom, the top tier performers of ASEI, show positive correlations between the level of eco-innovation supporting environment and activities.

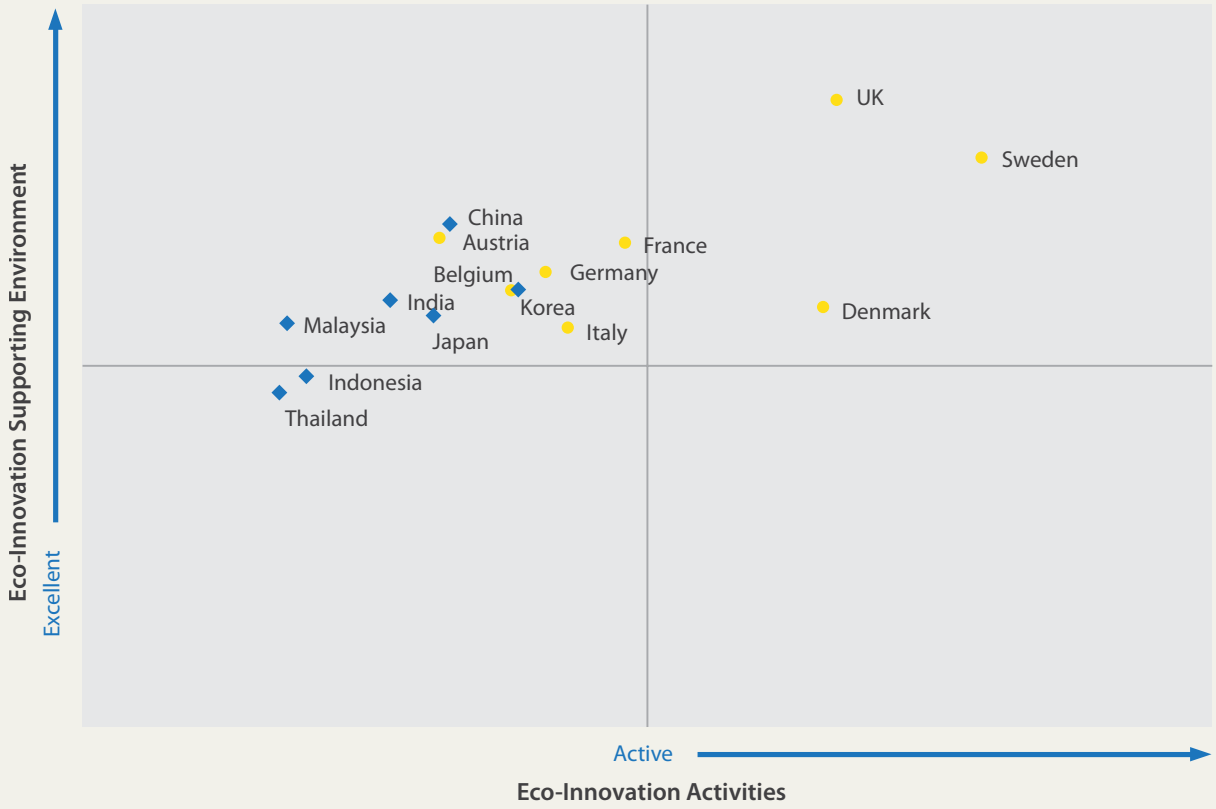

Fig. 5 Relationship between "eco-innovation activities" and "eco-innovation supporting environment"

Asian countries with less active "eco-innovation activities" may be due to the limited government regulations, policies and initiatives that foster public-private partnership in the field of eco-innovation compared to European countries. The European Commission and the European governments promote eco-innovation under multifaceted concepts or holistic terms such as eco-industries, eco-products, environmental technology, eco-efficiency, green business, resource efficiency, eco-design, waste minimization, new materials, recycling or cleaner production and others. Various policies and programs of the European Commission target direct stimulation of eco-innovation by providing R&D support, technology development and market mechanism of eco-innovation. Various regional networking platforms such as the European Forum for Eco-innovation also foster best practice and knowledge sharing. With such regional and national governments' effort, 3.4 million people in Europe are employed in the eco-innovation related field, and are generating 300 billion Euros in revenue.[16] Unlike the EU, Asian countries do not have a regional body to encourage and support eco-innovation. For such reasons, each government takes different approaches to stimulate eco-innovation in certain focused areas. The Asian governments are not yet familiar with the term eco-innovation, thus, their approaches to promote eco-innovation are perceived to be more indirect.

A country's national environmental targets act as a significant factor that triggers all types of green revolution at the micro and macroeconomic level. In the case of China and India, their national targets are set to increase renewable energy and have motivated Chinese and Indian companies to develop green technology solutions using government funding. Government support towards eco-innovation is a significant factor in motivating companies to eco-innovate. Asian governments' participation in global climate action will steadily increase the government support towards green growth; thus, it would be interesting to observe over a period of time various kinds of approaches that Asian governments take to stimulate the growth of eco-innovation.

[16] *http://ec.europa.eu/dgs/energy/newsletter/dg/2012/0504newsletter.html*

4. Europe promotes both Non-Technical and Technical Eco-innovation

In reference to the result of ASEI, the number of green patents awarded was most high for Denmark, followed by Italy, France, Korea and Germany. In line with the growing support from the Chinese government, China's number of green patents is growing rapidly along with the increase of domestic green technology market developers.

Introduction of green technologies bring renewable energy development, better waste management, water treatment and other environmental solution advancement. For this reason, green technology is the key element in representing the technical eco-innovation. While Asian countries such as China and Korea with technological know-how and mass production skills are striving to catch up to European countries, ASEI result shows that European countries still take the lead in the "number of green technology SMEs at Early Stage" and "commercialized green technology SMEs".

Along with advanced technical eco-innovation activities, non-technical eco-innovation activities are also vibrant in Europe. As mentioned in the beginning of this report, non-technical eco-innovation activities range from sustainability management strategy to eco-product design implemented at the company and industry level. European companies are implementing various types of non-technical eco-innovation by changing most of its operation process, marketing strategy, designs of products and production process. Regional precautionary measures such as REACH[17], WEEE[18], Eco-Management and Audit Scheme, EMAS and regional initiatives such as EU Ecolabel[19] have encouraged the European based companies to rethink about their negative implications towards the environment, forcing these companies to adapt and design innovative business processes to protect the environment.

The European countries seem to understand eco-innovation with a broader perspective; eco-innovation includes both technical and non-technical innovations with consideration of the environment. Since the 1990s, companies based in Europe have endeavored to meet the global standards of environmental management system. Environmental management system (EMAS) is a tool that enhances diffusion of both non-technical and technical eco-innovation of companies. The maturity level of the implemented environmental management system relates closely to the level of eco-innovation performance by companies.

Many companies including SMEs based in Europe actively participate in the development of EMS. On the contrary, Asian companies still lack understanding in the need for EMS. Such trend is reflected at the indicator level, most of the European countries scored high for "level of environmental management" while Asian countries lagged behind. However, globalizing market is pressurizing more companies based in Asian countries to implement EMS and follow environment related global industry and company standards and initiatives such as Carbon Disclosure Project, GRI and ISO. Following the footsteps of the European countries, MNEs based in Asian countries are starting to realize the positive implications of environmental management. Asian MNEs need to take the first step to setting higher goals on environmental management so that SMEs can gradually follow their footsteps.

5. Europe and Asia in Different Stages for "Eco-Innovation Performance"

"Eco-innovation performance" is described with indicators representing green industry market size, water consumption intensity, CO2 emission intensity, energy sustainability level and level of environmental impact on society. While many European countries are demonstrating high "eco-innovation performance", as late enactors of green growth policy, Asian countries fall far behind in this specific criteria. It is inevitable that this

[17] *REACH (Registration, Evaluation, Authorization and Restriction of Chemical substances) is the European Community Regulation on chemicals and their safe use.*

[18] *WEEE Directive (Waste Electrical and Electronic Equipment Directive) aims to reduce the amount of electrical and electronic equipment being produced and to encourage everyone to reuse, recycle and recover it.*

[19] *EU Ecolabel helps European consumers to distinguish greener, more environmentally friendly, products of high quality.*

outcome may also be influenced by differences between the socio-economic structures of Europe and Asia. Since the economic structure of Asian countries' are based on agriculture and manufacturing, they generally lack the infrastructure to perform positive environmental performance. Furthermore, consumer readiness for the green market is still immature in most Asia countries. Asian countries have the potential to bring up the eco-innovation performance; however, more effort will be needed to enhance the level of eco-innovation supporting environment and activities.

6. Eco-innovation approaches vary with different initial drivers

Eco-innovation is one of the ways for countries to respond to contemporary environmental challenges such as climate change, volatility of natural resources, and other socio-environmental problems. However, the initial drivers and approaches to promote eco-innovation may differ for all countries due to variance in economic, social, political and cultural environmental levels. As there is no blueprint for a successful eco-innovation model, each country should apply a different policy mix and implement direct programmes to support eco-innovation on the basis of each country's strength and opportunity.

Part 4. Country Results and Analysis

AUSTRIA

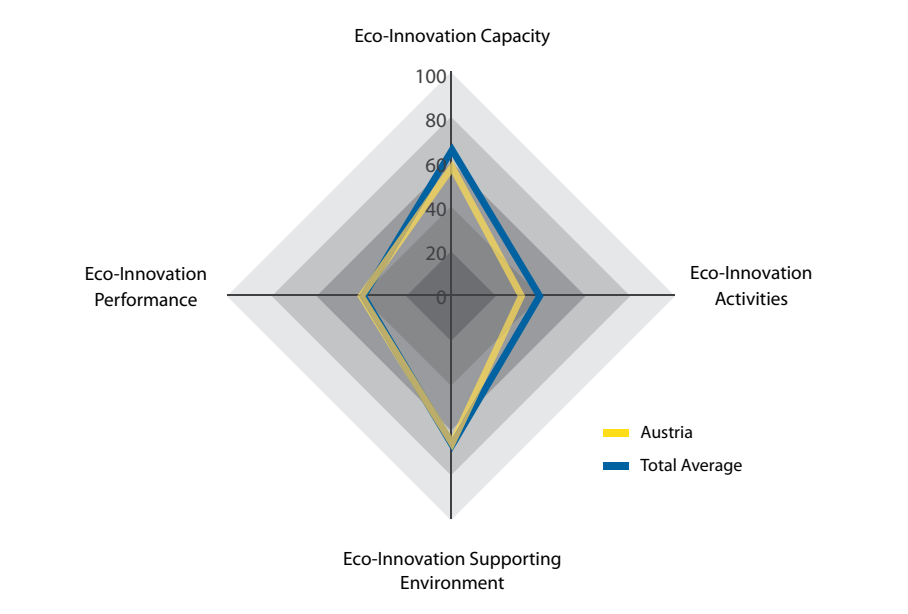

Fig. 6 Result analysis of Austria

Country Result & Analysis

Based on twenty indicators aggregated into four criteria, Austria positions below the average of ASEI (48/100). In regards to "eco-innovation capacity", Austria shows average "level of economic competitiveness" and "general innovation capacity" but relatively high "awareness on sustainability management". In the area of "eco-innovation activities", the country shows low level of "renewable energy utilization", "commercialized green technology SMEs", "green technology SMEs at early stage", "environmental management" and "turnover of environmentally friendly companies". However, Austria holds high "number of green patents" compared to the average of ASEM member countries. Austria's "eco-innovation supporting environment" is above the average level backed with the government's high expenditure on R&D of environmental technology solutions and average level of environmental laws and country's commitment to international environmental agreed goals. Yet, Austria scores quite low on the level of investment maturity on green technology. This may due to low number of local investors investing in green technology. Austria demonstrates average "eco-innovation performance" in ASEI. In terms of "eco-innovation performance", Austria shows high score in "water consumption intensity" and "CO2 emission intensity" and in the "level of environmental impact on society" yet, falls below average in "green industry market size" and "energy sustainability level". Overall, Austria ranks slightly below average in ASEI.

Austria's Key Eco-Innovation Environment

Austria may not be one of the eco-innovation leading countries in the EU. However, Austria recognizes the importance of eco-innovation and puts effort to follow and participate in the EU's eco-innovation related policies and programs. Under the Austrian Sustainable Development Strategy announced in 2010, Austria's eco-innovation seems to focus on stimulating resource efficiency, green public procurement and supporting new SMEs.

Dedicated Policy on Resource Efficiency

Austria has a strong reputation for its expertise and know-how in the sustainable use of natural resources, and in fact, it is one of few countries with policy dedicated to resource efficiency. As a main element of Austrian Sustainability Strategy and part of Austrian government's coalition agreement, Resource Efficiency Action Plan (REAP) was set up in the late 2000's. REAP sets both qualitative and quantitative targets to reduce consumption level of resources and increase the resource efficiency. Under this action plan, the country performs various regional efforts on resource efficiency. In case of Upper Austria, the government of Upper Austria has adopted "Energy efficiency, energy management and renewable energies" as part of its strategic economic and research program, "Innovative Upper Austria 2010 Plus." In Upper Austria, following the provincial and federal visions and related policy measure, a good amount of R&D efforts are being demonstrated in pursuit of 'less input, more output.'[20] Dedicated policy on resource efficiency is stimulating more eco-innovation activities at the industrial level in Austria.

Supporting Local Eco-Innovative SMEs

The portion of SMEs in Austria accounts for approximately 99.7 percent with about 68 percent of the total workforce employed by SMEs.[21] Accordingly, a number of Austrian policies and programmes are linked to fostering of entrepreneurship and innovation of SMEs. In Austria, Seedfinancing program is set up to foster the creation of small innovative companies by providing a loan of up to EUR 1 million. Another financial program promoting innovative start-ups is the AplusB program. The program provides financial aid to foster academic spin-offs of institutionalized centers at universities which may result in successful technology transfer.[22]
Since mid-2000s, more SMEs support programs that are closely linked to eco-innovation have set up. In 2005, Environmental Technology Export Initiative was established with 270 participating companies and its purpose is to support eco-innovative SMEs to develop international presence. Austria is a small country, but the country demonstrates strong and active export activities on environmental technology. About 85 percent of Austrian exports come from environmental technology sector[23], which shows good standing of Austria in eco-innovation export market with a strong potential for future growth.

Expanding Eco-Innovation through Green Public Procurement

Public authorities are major consumers in Europe accounting for about 20 percent of the EU's GDP. ECOPOL states that GPP is considered vital for supporting eco-innovation and a "potential major incentive for eco-innovative products and services"[24]. The Austrian Action Plan for Sustainable Public Procurement (naBe-Actionplan) was established in July 2010 providing green purchasing guideline. Green public procurement works as an instrument to provide incentives for developing green technologies thus can act as a great catalyst to advance eco-innovation market of a nation. Best practices of green public procurements are found in several provincial areas. In Vorarlberg of Austria, GPP approved apparel and equipments are available to public organizations via on-line. The managing organization is Eco Procurement Service (ÖBS), and GPP experts check and evaluate the products before they can be sold by ÖBS.[25]

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[20] *Innovative Upper Austria (2011)*

[21] *European Commission, Enterprises and Industry Fact Sheet, Austria, http://ec.europa.eu/enterprise/policies /sme/facts-figures-analysis/performance-review/files/countries-sheets/2008/austria_en.pdf*

[22] *OECD (2010), SMEs, Entrepreneurship and Innovation, Austria*

[23] *EIO (2012), Emerging Markets*

[24] *http://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/eu/20121029-making-the-most-public-purchasing-power_en.htm*

[25] *Eco-Innovation Policies for Green Public Procurement, http://www.ecopol-roject.eu/easydata/customers/ ecopol/files/materials/ gpp-poster.pdf*

Eco-Innovation Case Studies

CASE STUDY 1

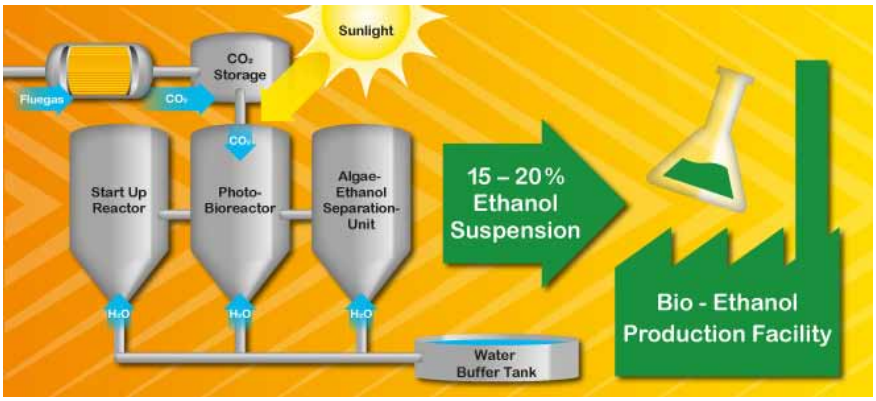
Kraft und Wärme aus Biomasse

Kraft und Wärme aus Biomasse (KWB) is an Austrian SME manufacturing wood-chip, firewood and wood pellet heating systems along with hot water storage systems and supporting control infrastructure. KWB introduces its eco-innovative heating system in a belief that heating with wood protects environment, safeguards local jobs and provides independence of the global market. Burning wood does not release any additional CO2 as opposed to burning fossil fuel, and this fact allows KWB's product to contribute to reducing GHGs emissions and responding to global climate change. KWB's biomass heating system uses wood chips and pellet. Wood chips can be produced without deforestation by using wood from storm damaged wood, bark, branches and even waste from carpenters' shops and joiner's workshops. Furthermore, pellets are even more eco-efficient than woodchips since they can be produced from sawdust without any synthetic additives. KWB's pellet heating system can be installed for residential, commercial and municipal purposes, and the company serves a 40,000 customer base throughout Europe.

Source: http://www.dulas.org.uk/downloads/KWB_TDS_Brochure.pdf

CASE STUDY 2

SEE Algae Technology (SAT)



SEE Algae Technology (SAT) is an Austrian enterprise that builds production plants for algae-based compounds. Algae lipids, 50 percent of algae biomass, can be used to produce biofuels and biochemicals. After the algae lipids are extracted, the remaining algae meal can also be used to supplement or replace other food crops in its livestock feed with no adverse effects. Based on this fact and with optimal analysis of algae life cycle, SAT tries to maximize biomass production greatly enhancing system efficiency and cost-effectiveness. SAT's technology contains high potential to play a key role in reducing GHGs emissions as SAT utilizes a customer's CO2 waste stream to drive the microalgae's photosynthetic process. In 2012, SAT was named a winner of the Brazilian Bioenergy Innovation of the Year 2012 Award.

Source: http://www.seealgae.com/documents/SAT_Company_Eng.pdf

CASE STUDY 3

Buchdruckerei Lustenau

Buchdruckerei Lustenau (BuLu) is a printing company founded in 1913. BuLu's services include small and large printed products such as folders, brochures, leaflets, packaging, books, posters, notepads, labels and small print articles. BuLu not only considers environmental protection as one of the company's great concerns but also seeks to become Austria's most climate friendly printing company. In addition to standard printing machines, the company has 'green printing' equipments which minimize waste, resource consumption and emissions in the production process. In addition, BuLu also offers carbon-neutral printing by which quantity of carbon dioxide produced in the printing process is offset by the reduction in the same quantity in a different place. In order to do so, the company made a material flow analysis in which all specific factors in printing process were included and evaluated for calculation of CO2 emissions they produce. BuLu provides climate-neutral printing certificate to its customers of carbon-neutral printing products so that they can show their commitment toward climate protection. BuLu has been recognized for its company level eco-innovative efforts. In 2010, BuLu received the Austrian Eco-label from the Minister for the Environment for the company's emphasis on environmental and climate protection. Other certificates include FSC label granted by the Forest Stewardship Council (FSC) and PEFC certification given by an independent organization dedicated to improving sustainable forest cultivation. In addition, the company received GREEN Brands award for the company's awareness of its responsibility for the environment.

Source: http://www.bulu.at/en/index.php

BELGIUM

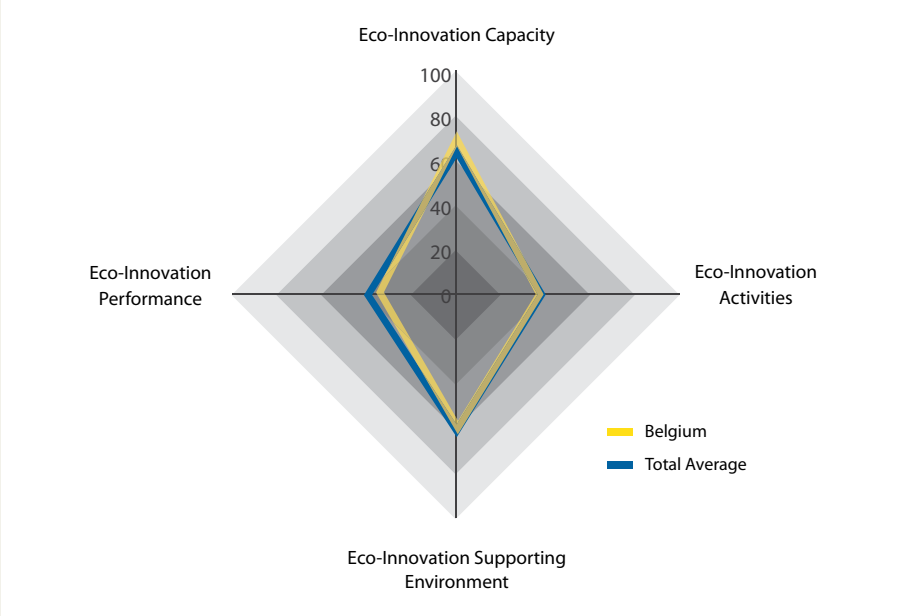


Fig. 7 Result analysis of Belgium

Country Result & Analysis

Belgium scores average (50/100) in all four criteria of ASEI. The country's high general innovation capacity level and economic competitiveness pull up the country's overall "eco-innovation capacity" score to be slightly above average. In regards to "eco-innovation activities", the country scores below average in the "level of environmental management of companies", "turnover of environmentally friendly companies", "renewable energy utilization level", and "green technology SMEs at Early Stage". However, "number of green patents" and "level of commercialized green technology" are relatively high compared to the average of ASEM member countries. Belgium has few natural resources and a small share of renewable energy thus, the government has put direct attention to activate and develop green technology start ups in the recent years as a way to overcome such challenge. As with "eco-innovation supporting environment", the country scores relatively high in the level of systematic environmental laws applied at national level and the "level of country's commitment to international environmental agreed goals" compared to the other indicators score in the criteria. In terms of "eco-innovation performance", the country shows a moderate criteria score. The moderate "eco-innovation performance" is described by the country's low energy sustainability, low score on water consumption intensity and small size of green industry market. Yet, the country scores higher than average in the "level of environmental impact on society" and "CO2 emissions intensity". Overall, Belgium ranks slightly below average on the ASEI index.

Belgium's Key Eco-Innovation Environment

In the recent ETAP conference held in 2011, the Belgium government showed its recognition on the broader understanding of eco-innovation; that eco-innovation is not merely signifying new technologies but new management skills, new governance paradigms and business models to reduce overconsumption of natural resources and to protect the environment. Belgium's three Regions have slightly different approaches towards promotion of eco-innovation. Blend of Belgium's different regional policies and programmes may bring a synergetic effect at the national level in the future.

Regional Clusters Activating Eco-innovation

Belgium contributes to developing innovation solutions through clustered environment. In Wallonia region, Greenwin[26] was set up in 2011 focusing on green technologies and in effect creating green jobs in the region. Greenwin was an outcome of announcement of the Walloon Marshall Plan 2(2009-2014)[27], which is a national roadmap to addresses the challenges of climate change and greening of the economy. In Flanders region, Energyville, Ghent Bio-Energy Valley and Greenbridge Science Park are dedicated to biotechnology and energy efficiency solution development. Different regional clusters have taken their own initiatives to develop the eco-industries related to renewable energies, and green technologies. While currently, green clusters like Greenwin are seen as a driver of eco-innovation, there are potential for other regional clusters focusing on different sectors to integrate eco-innovation solutions into their business, production and supply processes which will uptake further eco-innovation activities in Belgium.

Frontrunner of Eco-innovative Recycling Waste Management

Belgium is known to recycle 93 percent of its household packaging and 78.4 percent of industrial packaging waste.[28] This figure is highest in Europe. Various governmental measures have been put into action to support this figure. Walloon and Flander's waste management policy follows the standards of the European Waste Framework Directive. A number of Belgium companies such as Fost Plus, VAL-I-PAC and Recupel have developed eco-innovation solutions to recover waste materials to create economic and environmental values. In Walloon region, the solid waste cluster VAL+, pools over 60 SMEs dedicated to solid waste treatment and valorization. Belgium based companies like Umicore recycles metals to turn them into catalytic converters and fuel cells, Cumerio recycles copper, and CMI Nesa recycles solid waste and ores to electric energy.[29] These companies are putting attention to use energy efficient high technologies during the converting process with household or industrial waste, dangerous industrial refuse or plant waste, contaminated soil or mud and others. Their advanced technologies and solutions are providing eco-innovation solutions on recycling waste management in Belgium.

Growing Industrial Biotechnology

In Belgium, high priority was gone to funding biotechnology research to promote bio-based economic activities and expand sectoral innovation system.[30] As a result, over 140 biotechnology companies now operate in Belgium, and Belgian biotechnology companies account for 16 percent of Europe's turnover and 10 percent of R&D expenditure.[31] Most of these biotech companies are closely related to pharmaceuticals and agriculture biotech however, industrial biotechnology companies are increasing in Belgium. Industrial biotechnology also known as the "white biotechnology" is used to make enzymes and micro-organisms turn to bio-based products in various sectors including chemicals, food, detergents, paper, textiles and bio-energy. Advanced industrial biotechnology is increasingly known to be an eco-innovation solution that brings positive results in reducing the greenhouse gas emissions. Ghent Bio-Energy Valley (GBEV) is Europe's largest fully integrated bio-energy cluster in Belgium established in 2005. In this cluster, various companies, research

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[26] *Greenwin, http://www.greenwin.be/en*

[27] *Walloon Marshall Plan 2 (2009-2014): continuation and reinforcement of the first Plan, with up-to-date priorities 1) New challenges and opportunities: climate change and greening of the economy, globalisation, 2) Europe 2020 Strategy, 3) Stronger synergies between regional and community (education and learning) priorities, http://www.investinwallonia.be/why-wallonia/economie-et-plan-marshall/?lang=en*

[28] *EIO (2011), Eco-Innovation Belgium*

[29] *Federation of Enterprises in Belgium (FEB) (2008), Belgian ecobusiness leading the way*

[30] *UNU-MERIT (2007), Case Study: Biotechnology in Belgium*

[31] *http://business.belgium.be/en/investing_in_belgium/key_sectors/biotechnology/*

institutions and service providers related to biodiesel production, biogas technology and other biotechnology solutions are bridged together. It is widely stated that GBEV has made significant performance to grow the biotechnology and products market in Belgium.[32] Further industrial biotechnology development in Belgium will increase the production of bio-fuels, bio-energy, and bio-products, which will eventually contribute to enhancing environmental performance at the national level.

Eco-Innovation Case Studies

CASE STUDY 1

Organic Waste Systems

Organic Waste Systems (OWS), established in 1988, specializes in biological treatment of solid and semi-solid organic substrates through construction and operation of anaerobic digestion plants. Over the years, OWS has developed the DRANCO, SORDISEP and DRANCO-FARM processes. DRANCO process converts solid and semi-solid organic waste into renewable energy, biogas, and a stable end product. SORDISEP process is a wet separation process which can maximize recovery of recyclables and minimize land-filling. Lastly, DRANCO-FARM is a treatment process for pure organic streams such as energy crops and industrial organic waste. Providing these processes, the company is positioning itself as a leading company in Europe for eco-innovation research laboratory in waste management through biological treatment. OWS is also closely associated with the EU project ECOBIONET, a CIP Eco-innovation project, contributing to researching the process and technologies for manufacturing biodegradable and compostable nets.

Source: http://www.ows.be

CASE STUDY 2

Realco

Realco, founded in 1968, has been involved in the field of environmental biotechnology for over 40 years and currently work with private customers as well as industrial clients. Laundry detergent may be one of the essential items in everyday lives, but it also could be one of the items that raise environmental concerns. Chemical ingredients used in detergents are toxic to aquatic organisms and algae and persistent in the environment, and these toxic ingredients may even cause health problem in people such as cancer. Realco's ecological cleaning product allows getting rid of the toxicity used to produce detergents. Instead of using chemical ingredients, Realco uses excellent cleaning properties of natural organism (protein), enzyme, to provide both high level of cleaning performance and environmental benefits. Realco's eco-innovative products are a result of the company's continuous efforts for development of innovative solution through partnerships between its R&D departments and universities and research centers.

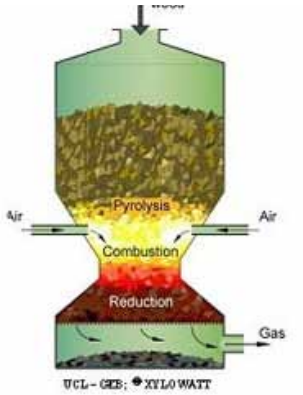
Source: https://vbo-feb.be/media/uploads/public/_custom/Dossier/Energyenvironment/VAN_ecobizBEL_ENv3.pdf

[32] *Belgian foreign trade agency (2011), Belgian Biotechnology Report*

CASE STUDY 3

Xylowatt

Xylowatt, a Belgian SME, is a member of TWEED cluster and designs, builds, and monitors cost-effective bioenergy systems. TWEED (Technology of Wallonia Energy, Environment and sustainable Development) is one of regional clusters in Belgium, and it aims to promote business development in sustainable energy sectors. Sustainable energy refers to renewable energy sources, the implementation of new process to enhance energy savings and efficiency or to reduce GHGs emissions and the development of products and services in the related area. Xylowatt was created in 2001 as a spin-off of the University of Louvain in a mission to develop and provide eco-innovation technology solutions that produce renewable energy from wood chips and other by-products. Xylowatt's small-scale Cogeneration Heat & Power (CHP) plant is operated based on the thermo-chemical extraction of energy from biomass such as wood, wood waste, agricultural by-products, recovered wood and etc.



Source: http://www.biomassenergy.gr/en/articles/news/solid-biofuels/1186-capital-increase-for-xylowatt
http://clusters.wallonie.be/tweed/en/index.html

CHINA

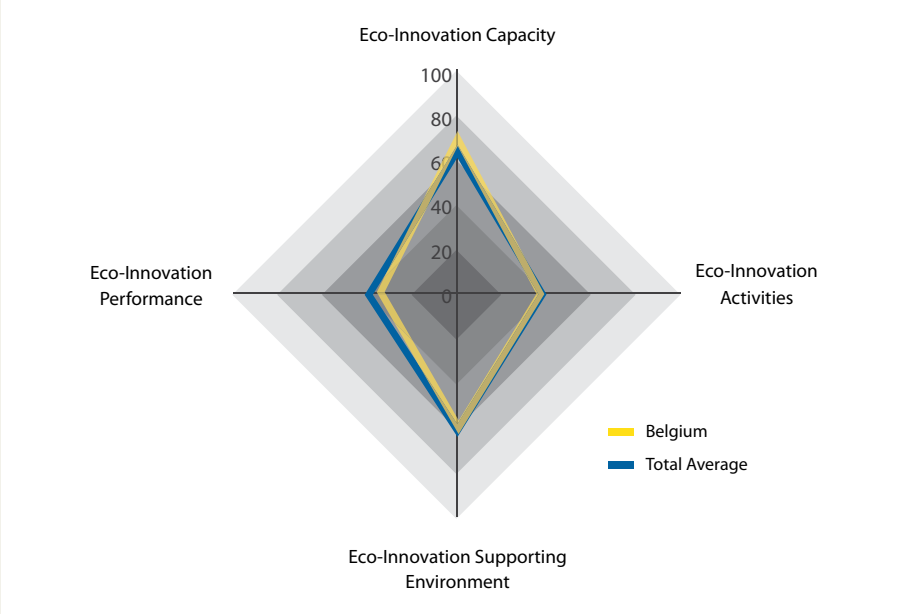


Fig. 8 Result analysis of China

Country Result & Analysis

With an overall score of 47/100, China places below the average in ASEI. China shows average score for all indicators in "the eco-innovation capacity criteria" which consists of "general innovation capacity", "level of economic competitiveness", "level of awareness on sustainability management", "value of investment in green technology SMEs" and "number of jobs in green technology industry". In regards to "eco-innovation activities", China scores average in "number of green patents" and "renewable energy utilization level" but score high in the "level of environmental management". Although, the number of green patents has been increasing rapidly, "level of commercialized green technology SMEs" and "green technology SMEs at Early Stage" is significantly low compared to the average of ASEM member countries. In the recent China Greentech Report 2012, it is stated that tight monetary policy, state focused rapid growth and lack of private funds are acting as barriers to overall green technology development.[33] With regards to "eco-innovation supporting environment", China performs average in implementing systematic environmental laws and getting involved in international environmental agreements. In terms of "eco-innovation performance", China scores below the average in the indicators related to country's "energy sustainability", "CO2 emissions intensity", "water consumption intensity" and the "level of environmental impact on society". However, green industry market size is larger than the average and the market is noticeably increasing. Overall, China ranks just below average in ASEI.

China's Key Eco-Innovation Environment

In March 2011, China launched its twelfth five-year plan for 2011-2016 which includes eight key targets to promote green growth and of the eight key targets, two seem to associate closely to the promotion of eco-innovation; 1) innovation target to increase the expenditure on R&D and patents, and 2) environment & clean energy target related to enhancing water intensity, energy efficiency and air intensity. The twelfth five-year

[33] *China Greentech Initative (2012), The China Greentech report 2012*

plan aims to fulfill the 40-45 percent carbon intensity reduction target by 2020 as well as targets to decline 16 percent in energy intensity and 17 percent in carbon emission relative to 2010 by 2015.[34] Under the twelfth five-year plan, seven new strategic industries have been announced; advanced materials, renewable and alternative energy, information technology, innovative equipment manufacturing, biotechnology, energy conservation and environmental protection and new energy vehicles. These industries provide vast room for the stimulation of eco-innovation in the future.

Rapid Development of Renewable Energy Technologies

China is growing its reputation for rapid development of renewable energy technologies. It is reported that almost one-fifth of total global renewable energy investment comes from China. Growing population and rapid economic growth of China have enforced the government to concern on the amount of energy needed for the growing population. Thus as part of government's long-term development plan, China's current eco-innovation activities are associated to developing and commercializing renewable energy technologies. Going back to the 1990s, the Chinese government initiated various legislative, administrative and economic measures on renewable energy such as the New and Renewable Energy Development Program 1996-2010, Renewable Energy Law, The Eleventh-Five-Year Plan for the Development of Renewable Energy. There has been significant improvement in this area since then, yet recently there have been some setbacks such as oversupply of wind turbines and solar panels. China is intensifying governmental regulations and changing policies to continuously increase the success of commercialization and utilization of renewable energy technologies. China has spent $52 billion on renewable energy in 2011 and expected to contribute around 40 percent of total increase in global renewable energy sources capacity over the next five years.[35] It is expected that China's future eco-innovation activities, regulations and incentives will continue to come from the areas related to renewable energy technologies.

Public Support in R&D

China's centralized government has long supported to increase its eco-innovation capacity by facilitating R&D programs and investing large amount of public budget in R&D. Since the launch of the Medium and Long-term National Plan for Science and Technology Development (2006-2020) policy, China has specified areas of prioritized research within the next 15 years. The prioritized field of research includes energy, water and mineral resources, environment, agriculture, manufacturing technologies, transportation, IT, population and health, urbanization and public security, all of which eco-innovation is closely related to. Under this central policy, China has developed fiscal policies and programs to promote R&D activities through nine ministries, agencies and local governments. The national high-tech research and development program called "863 program" can be seen as the main driver program to foster eco-innovation related R&D activities in China[36]. The "863 program" focuses on the application of advanced technologies in the priority research areas[37] of Medium and Long-term National Plan for Science and Technology Development (2006-2020) policy. The "973 program" established by the Chinese Ministry of Science and Technology is also an R&D program which has also created a foundation for energy and environment related research. In addition, the National Key Technologies R&D program and National New Products Program include research on development of green technologies and sustainable utilization of resources. Rather centralized governmental support towards R&D

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[34] *http://www.forbes.com/sites/jackperkowski/2012/07/27/china-leads-the-world-in-renewable-energy-investment/n*

[35] *http://www.forbes.com/sites/jackperkowski/2012/07/27/china-leads-the-world-in-renewable-energy-investment/*

[36] *Eco-Innovera (2002), Eco-innovation activities in key countries beyond Europe*

[37] *Prioritized Research Areas for Medium and Long-term National Plan for Science and Technology Development (2006-2020) policy: energy, water and mineral resources, environment, agriculture, manufacturing technologies, transportation, IT, population and health, urbanization and public security*

activities in China is building a firm foundation to increase the potential for rather active eco-innovation activities in the future. Local governments are recently working on the development of green technology business clusters in China.

Fostering Companies to Innovate

Previously, governmental funds in China were mostly gone to research institutions and universities. Only little amount of governmental funds was gone to private companies. However, over the past years, public programs such as the Thousand Enterprises Program established in 2006 are providing benefits to companies. The Thousand Enterprise Program allows the government to select 1000 top companies to improve their energy efficiency by cooperating with local officials. Although, the benefiting companies are mostly large companies rather than SMEs, it is important that available fund and programs are slowly flowing towards private companies. In recent years, China has been undertaking a reform to improve company's competitiveness by encouraging companies to pursue excellence in environmental management and carry out R&D activities that contribute to green technology development. As an expected result, radical eco-innovation at the business level may become more visible in the future.

Eco-Innovation Case Studies

CASE STUDY 1

Sunrain Solar Energy

Sunrain Solar Energy (Sunrain), an innovative renewable energy company, is the biggest listed company in China in the solar water heater sector. During 2009 and 2011, the Sunrain Group's revenue doubled from solar water heating technology. Much portion of this broad dissemination of solar water heater in China is attributed to support policy of the Eleventh Five-Year Plan as well as its market competitiveness. The Twelfth Five-year Plan is also keeping the same track on expanding the application of solar thermal energy industry with more focus on the engineering, agricultural and international markets. China ranks first in the solar hot water market due to growing domestic demand and more than 10 percent of Chinese households rely on this solution. Sunrain's renewable energy facility attracted both the rural and urban consumers in China. Sunrain Solar Energy was founded in 1999 specializing in research and application of solar energy manufacturing. Now the company is the frontrunner in exporting, reaching global customers in more than 100 countries.

Source: http://en.sunrain.com

CASE STUDY 2

Xinjiang Goldwind Science & Technology Company

Through the 863 and 973 Programs launched in 2005 and 2008 respectively, the central government provided a large amount of research funding to domestic turbine manufacturers to develop and design wind energy technology. China's current top wind turbine manufacturers are the companies that have received such funding and support from the government. One of them is **Xinjiang Goldwind Company (Goldwind)** established in 1998. The company was selected as one of the target companies of National High-tech R&D program (863 program). In 1999, the company developed 600KW generating set for the first time in China. Under the implementation of the Tenth Five-Year Plan, Goldwind obtained three National Science and Technology Projects, which enabled Goldwind to develop 1.2MW, 1.5MW turbine manufacturing technology subsequently. Goldwind is now designing 5MW generator. Goldwind has received full support from the Xinjiang Autonomous Regional government. The local government provided a high-tech development zone for Goldwind and made an infrastructure investment. In addition, the government gave Goldwind up to 15 percent income tax deduction between 2001 and 2010.

Source: http://www.goldwindglobal.com

CASE STUDY 3

Haier Group

Founded in Qingdao, Shandong province, in 1984, **Haier Group (Haier)** is the world's fourth largest home appliance manufacturer. Since Haier established a company-wide green strategy, the company has combined the green strategy with every part of its value chains, from the product development to the logistical chain. Through this green R&D base, Haier rolled out a variety of eco-friendly and energy-efficient products with its own technologies; refrigerators using carbon dioxide as a coolant, air conditioners using water as a natural cooler instead of HFC, washing machines using electrolyzed water instead of detergents to wash and dish washers with green wash option on it to save energy and water use, etc. In addition to this, Haier made Green Procurement Partnerships with more than 50 key suppliers. As an effort to make the overall industry greener, Haier initiated the Low Carbon Inverter CFC-free Air Conditioner Alliance with 8 leading companies, including Mitsubishi and Panasonic. According to Haier, the annual quantity of energy saved by Haier's energy-saving household appliances could support Hainan Province with population of 8.26 million for a whole year. Haier also contributed to making the Olympic Games green by providing over 60,000 environmentally-friendly and energy-efficient products to all the Olympic venues in Beijing.

Source: WEF (2012), The Corporate Global Citizenship Challenge, https://www.haier.net

DENMARK

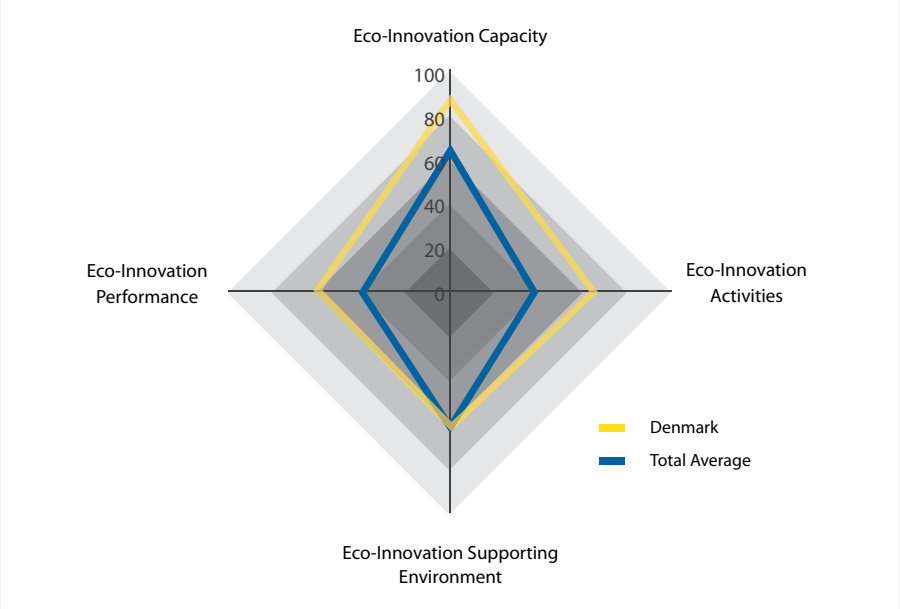

Fig. 9 Result analysis of Denmark

Country Result & Analysis

With an overall score of 68/100, Denmark ranks high in ASEI. Denmark's high score on "eco-innovation capacity" is backed with high "general innovation capacity" level, strong country's overall "economic competitiveness", high awareness "level on sustainability management" and a relatively large amount of investment capital flow in green technology industry. In regards to "eco-innovation activities", the country scores high in "number of green patents", "number of commercialized green technology related SMEs" and "number of green technology SMEs at early stage". It is significant to note that the number of green patent in Denmark is three times the average of the EU based on the findings of ASEI. With 1,100 Danish cleantech companies, 60,000 employees and a 12 billion Euro export value[38], Denmark is strong in the green technology sector. In the area of "eco-innovation supporting environment", the country scores high in the "level of systematic environmental laws" and "country's commitment to international environmental agreements". Yet, the country scores low in the "level of investment maturity of green technology industry" and "government's R&D expenditure in green industry". As an early starter of eco-innovation, there is significant evidence of high performance in "eco-innovation performance" with the support of high score in "water consumption intensity", "CO2 emission intensity" and "level of environmental impact on society". Overall, Denmark ranks well above the average in ASEI.

Denmark's Key Eco-Innovation Environment

In 2012, the Danish Minister for the Environment has announced the focus areas for its activities to promote environmentally sustainable future: water and climate mitigation, resources and waste, air pollution and noise, chemicals and industrial enterprises. With this announcement, a new program called the Environmental Technology Development and Demonstration Program was launched. This recent program aims to support Danish enterprises to develop green technology solutions and products. Denmark is imposing an integrated push to shape the necessary enabling conditions for eco-innovation activities to emerge.

[38] *http://um.dk/en/tradecouncil/investindk/*

Development of Technologies to Overcome National Environmental Challenge

Denmark is one of the water-scarce countries with highest water price, yet the country managed to position itself as a leader of water management technology solutions. Denmark demonstrates the top class technical knowhow in water supply, transportation and treatment. Denmark is amongst the largest global investee in R&D in water sector in proportion to the market size. Around 13 percent of Danish companies in water management sector allocate more than 25 percent of their market revenue in R&D activities.[39] A good amount of public spending has also gone to developing water management technology solutions: 8.6 million Euros in 2010 and 9.5 million Euros in 2011, through schemes such as Grant Scheme for Environmental Technologies, Foundation for the Development of Technology in the Danish Water Sector, Danish National Advanced Technology Foundation, and Business Innovation Fund.[40]

Biomass is another strong technology sector in Denmark. Denmark produces a large amount of agricultural waste from approximately 60 percent of its land use for agricultural purposes, and the country saw this as an opportunity to advance its biomass technologies. Since 1993, the Danish government stimulated the growth of biomass technologies and the use of biomass through investment and the "Biomass Agreement". As a result, biomass in Denmark accounts for approximately 70 percent of renewable energy consumption. This consumption of biomass for energy production has more than quadrupled between 1980 and 2005. Continuous promotion of biomass technologies and biomass-based products, biomass has become one of the most advanced energy solutions in Denmark. Denmark is successfully addressing climate change and other environmental challenges faced by the country through the development of technologies that provide environmental solutions.

Importance of Partnerships & Collaboration in Eco-innovation Implementation

In 2006, Denmark announced its first roadmap for promoting green technology, "Danish Solutions to Global Environmental Challenges", which emphasizes the promotion of nine specific areas including innovation, research, climate and energy technology and a clean and unspoiled aquatic environment. In 2010, the renewed version of this plan was established with the name of "Environmental technology– for improvement of the environment and growth". In this new plan, the government emphasizes the importance of partnership and collaboration in stimulating growth through green technology. The government states that partnership is needed in the area of water, industrial biotechnology, mega wind turbines, biofuels, hydrogen/fuel calls, cleaner shipping, technology transfer, groundwater co-operation with China, ballast water, shredder waste and managing on-site rainwater. The Danish government is putting further effort to establish partnerships to implement bilateral co-operation agreements that would allow development and testing of pilot projects abroad in the field of the environment, climate and energy. Better partnership will provide better enabling infrastructure for Danish actors to perform eco-innovation activities.

Public Effort to Commercialize Eco-innovation Products and Services

The Danish Government uses Green Public Procurement (GPP) as an effective means to increase commercialization of eco-innovative products and services. Denmark has for years been one of the global frontrunners in GPP practice. Denmark established the framework of the Action Plan for a Sustainable Public Procurement Strategy in 1994 publishing a GPP guideline for 46 products and service. Since then, a majority of Danish authorities have applied this GPP guideline in their procurement process. The government also established the funding programmes such as Business Innovation Fund to mature the green market. The Business Innovation Fund not only grants financial supports but also helps pre-commercialized eco-

[39] *National Environmental Research Institute, Cleaner water in Denmark*

[40] *Copenhagen Cleantech Cluster (2012), Denmark: Where water matters*

innovative products and services to be readily launched in the market. In Denmark, public effort is made to project the green market by creating a better market mechanism for eco-innovation products and services.

Eco-innovation Case Studies

CASE STUDY 1

TEGnology

TEGnology, a Danish research based SME, is a young enterprise founded in 2010. In collaboration with the Center for Energy Materials at Aarhus University, the company brought Thermoelectric Generation (TEG) Technology to hybrid cars helping it run 10 percent further per liter. The new technology power supplies convert waste heat to electricity. TEGnology's eco-innovative product offers economic and environmental benefits such as better fuel economy, less CO2 emissions, cheaper operation and more energy-efficient and environmentally friendly vehicles. The company believes that its invention holds high potential not only in the automotive industry but also in maritime, biofuel, combined heat & power and sensor industry. The company has won an international innovation award from Network of Automotive Excellence in 2012 for the invention.

TEGnology's thermoelectric module and innovation award winner

Source: http://tegnology.dk/

CASE STUDY 2

The Water Partnership

The Water Partnership was established in the autumn of 2006 with a wide circle of manufacturers, civil engineering contractors, consultants, consumers and authorities. It is a co-operation between the Danish Ministry of the Environment, Danish Water Forum (DWF), the Royal Danish Embassy in Delhi and 6 Danish companies: COWI, Danfoss, DHI, Grundfos, VCS Denmark and Siemens Turbo Machinery. The Water Partnership was signed as part of the implementation of the Government Environmental Technology Action Plan (2007-2009), under the initiative on export promotion and partnerships. In 2009 India exhibition, Danish companies found a great capability for process improvement with cost-saving and India also expressed interest in Danish water treatment technology. The partnership is a strategic collaboration to confirm at least one demonstration project in India within the wastewater area, focusing on energy savings and process optimization. It aims for facilitating Danish water technology enterprises' expansion to the Indian market as well as contributing better wastewater treatment system in India.

Source: http://www.ecoinnovation.dk

CASE STUDY 3

Aquaporin

Aquaporin is a startup company dedicated to developing biomimetic water purification technology. 'Aquaporin' refers to protein channels for water in organism membrane. When water goes through this membrane, purification or desalination occurs. The company's target is to develop, produce and commercialize Aquaporin Inside™ membranes for industrial water treatment purposes and desalination of seawater. It is not yet commercialized however, is recognized as a promising eco-innovation solution that is getting attention from partners in Europe, US and Asia.

Source: http://www.aquaporin.dk

FRANCE

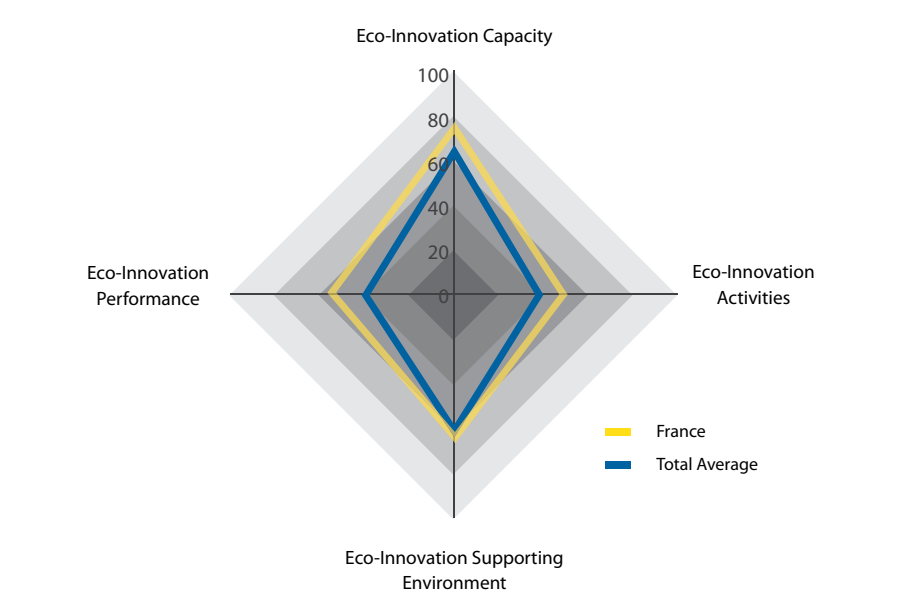

Fig. 10 Result analysis of France

Country Result & Analysis

Based on 20 indicators, which are aggregated into four criteria, France positions relatively high (62/100) in ASEI. France demonstrates slightly above average level of "eco-innovation capacity". While most of indicators examined in the area of eco-innovation capacity are average, the large "number of jobs in green technology industry" particularly improves the overall criteria level. In regards to the "eco-innovation activities", the country reveals high "number of green patents" high "level of commercialized green technology SMEs", and a large "turnover of environmentally friendly companies". Among French companies involved in the field of green technology, approximately 34.7 percent of these companies possess already commercialized green technology solutions while only 6.7 percent of the companies possess green technology solutions at early stage.[41] The country shows average level of "eco-innovation supporting environment". It is found that France has larger number of local investors in green technology and successful investment deals in the area. France has matured environmental market and relatively long history of public efforts regarding environmental issues. Thus, the country shows strong "eco-innovation performance" backed with good score in "green industry market size", "level of environmental impact on society", "CO2 emission intensity level" and "level of energy sustainability". Overall, France ranks higher than the average in ASEI.

France's Key Eco-Innovation Environment

With strict environmental regulations, the government has continuously set ambitious targets achieve environmentally sustainable economic progress. Instigated by the former President Nicolas Sarkozy in 2007, "Grenelle Environment Roundtable (Grenelle de l'environnement)", a wider environmental protection framework was launched. Under this Grenelle Environment Roundtable, legislations were adopted that

[41] *Cleantech Group Data*

included ambitious mid- and long term commitments towards environmental protection and improvement; to cut 85 percent in CO2 emissions by 2050, to reduce the economy's energy intensity by 2 percent per year by 2015, to increase the share of renewable energy sources to at least 23 percent of energy consumption by 2020, and to increase 45 percent the recycling rate of household waste produced by 2015.[42] In line with the direction of such strict national measures, eco-innovation concept has been diffused into national policies on resource efficiency and growth of eco-industry.

Enhancing Renewable Technology Sector

In July 2012, the new government announced its aim to reduce the share of nuclear power to 50 percent of the total electricity production by 2025.[43] The new government's ambitious energy plan enables eco-innovation activities focused on renewable sector to emerge more rapidly within the next ten years. Early adaptor of renewable energy, France is already the EU's second largest producer and consumer of renewable energy.[44] France is rich in renewable resources and has the second highest wind and electricity energy potential in the EU. Now the government is putting effort to increase the share of renewable energy sources for energy consumption within the next ten years. The government has two instruments to enhance the utilization of renewable energy in France: feed-in-tariff and tax credit system. For example, solar energy industry currently stands in the center of the development of renewable energy solutions. There was a recent announcement of the government to increase feed-in-tariff for PV installations smaller than 100kW. Such active government support expects France to be at the forefront in possessing advanced and diverse renewable energy technologies.

Matured Eco-Innovation Water and Waste Management Solutions

France is the second largest producer of environmental goods and services and amongst the related fields the country provides advanced knowhow in water and waste management services.[45] The two largest companies in water and water management services are Suez Environment and Veolia Environment, which are both France based companies.[46] In France, per capita water consumption of households and agriculture is amongst the highest in EU[47], and industrial water consumption level is also high due to large production of nuclear power and its water use for cooling purpose. Consequently, this has led to the development of technical knowhow in water management sector. The start of water management legislation goes back to the law of 1964 created to provide basis for a modern principle of water management. Eco-innovative approach to water management system was ignited with the introduction of the Water Framework Directive in 2000 targeting to achieve good ecological status of all water bodies by 2015. Waste management is another matured sector that provides advanced environmental services. Waste management policy in France has its focus on two main issues: prevention and reduction of waste generation and recycling of generated waste. The priorities of French government in regards to waste management are in accordance with the EU's waste management directive in 2008. To reduce the amount of industrial waste at the national level, the government applies additional tax on waste and general polluting activities of companies.

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[42] *EIO (2011), Eco-Innovation in France*

[43] *http://www.bbc.co.uk/news/world-europe-18693089*

[44] *http://www.nortonrose.com/knowledge/publications/66831/european-renewable-energy-incentive-guide-france*

[45] *EIO (2011), Eco-Innovation in France*

[46] *EIO (2011), Water Innovation*

[47] *Égert, B. (2011), France's Environmental Policies: Internalising Global and Local Externalities*

National Strategy for Green Technology

In 2008, the Ministry of Industry and Environment launched the Strategic Committee for Eco-Industries (COSEI), which composed of business leaders and professionals in the field of green technologies. The committee was set up to stimulate the eco-industry in France. COSEI presented the Ecotech 2012 in 2008, which included guidelines for policy interventions to support eco-industrial R&D activities. Ecotech aims to support innovative partnerships in the field of green technologies and foster public-private partnerships. It has a funding programme which provides 30 million Euros to R&D activities on green technology over the three years. It also supports commercialization and exportation of eco-innovative products of SMEs. Ecotech can be seen as one of representative bodies that fosters eco-innovation at the national level.

Eco-Innovation Case Studies

CASE STUDY 1

Solairedirect

Solairedirect is a manufacturer of solar PV installations for residential, commercial and community-scale customers. Based in France, Solairedirect has a number of subsidiaries worldwide including South Africa, Chile, United States, Morocco, India, Malaysia and Thailand. Activities of Solairedirect comprise of construction of solar PV rooftops and solar parks and solar power sales. Solairedirect's solar PV rooftops are installed for private residential and industrial buildings. The company aims to not only increase value of rooftops but also achieve energy efficient buildings that comply with low energy building regulations. Another innovative approach of Solairedirect to solar energy business involves solar parks which allow local authorities to respond to climate change issues as well as to develop a robust photovoltaic energy business using unused land. In 2010, with Schneider Electric, another global company specializing in energy management, the company announced to carry out a joint project in the field of solar energy in Morocco. In addition, the company has recently acquired a business partner, JinkoSolar (Jinko), in the fast-growing emerging market, China. Using 25 megawatts of Jinko's solar modules, Solairedirect will execute construction of five ground-mounted solar panels projects. In 2012, Solariedirect was named as one of Global Cleantech 100 companies for two consecutive years, and the company is continuously seeking to expand its business in other emerging markets.

Source: http://www.solairedirect.com

CASE STUDY 2

Veolia Environmental Service

Veolia Environmental Services (Veolia) is a provider of waste management and resource recovery services, and its France-based multinational parent company, Veolia Environment, is a water, waste management and energy services provider. Bioreactor of Veolia Environmental Services is a fruit of the company's strong commitment to eco-innovation. Bioreactors built on landfills are designed to accelerate decomposition process and to efficiently capture biogas. Biogas captured by network of pipes through the residual waste is then converted into green electricity. The Veolia Environmental Service increases the green electricity production volume and biogas emission rate per unit by ten times compared to previous technology. Currently, Veolia's development of bioreactor technology solutions is being carried out in two sites, Woodlawn Bioreactor and Ti Tree Bioenergy facility in Australia.

Source: http://www.veoliaes.com.au/recycling-services/resource-recovery-facilities/bioreactor-landfills

CASE STUDY 3

SP3H SAS

SP3H SAS (SP3H), founded in 2005, presents innovative and ground-breaking technology which offers lower fuel consumption, lower pollution levels and CO2 emissions and optimization of reliable performance and engine power. SP3H's smart on-board fuel sensor analyzes and measures the molecular structure of fuel using the patented HydroCarbon Profiler (HCP) technology. The analyzed information is then transmitted to the engine control unit to compute real time optimization of injection strategies, combustion and post treatment for all possible diesel and gasoline fuels. SP3H may be a young SME, but the company has received a number of awards since creation. In 2011, the company was named the winner of the Engineering Prize of the Year in the category of Sustainable Development among eight other categories. In the same year, the company won the Cleantech Republic 'Grand Prix' at the Pollutec Show. In addition to the numerous public recognitions, the company's project is part-financed by the EU.

Source: http://www.sp3h.com/en/index.html

GERMANY

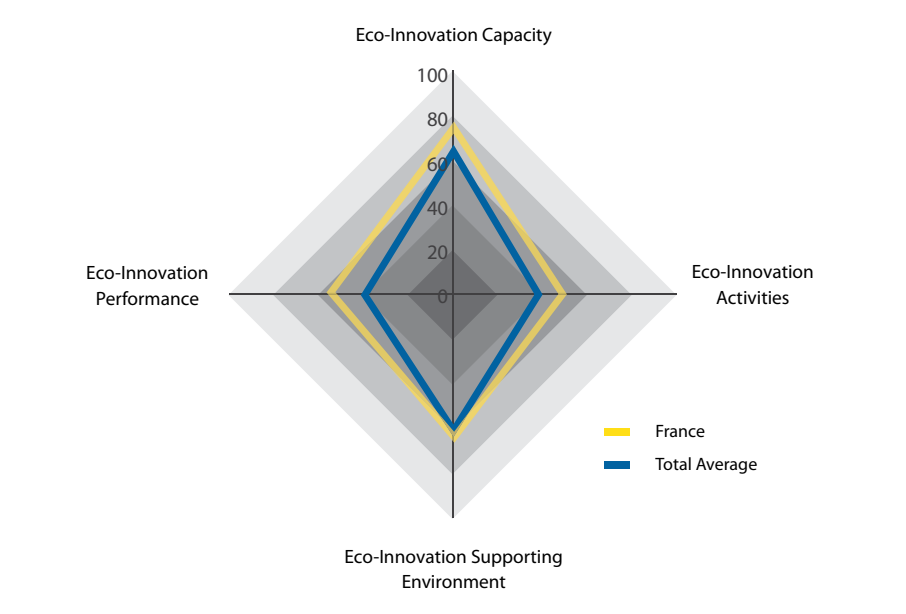

Fig. 11 Result analysis of Germany

Country Result & Analysis

The overall score for Germany is above average (57/100) in ASEI. Germany demonstrates above average level in all four examined criteria. Germany's "eco-innovation capacity" is well supported with the country's high "level of economic competitiveness", strong "general innovation capacity" and high "level of awareness on sustainability management". In regards to the country's "eco-innovation activities", Germany shows relatively large "number of green patents" and high "level of commercialized green technology SMEs". There are more SMEs with already widely commercialized green technologies than ones at early stage of development. There are currently 678 German companies engaged in green technology solutions of which over 33 percent of the companies have commercialized technology solutions.[48] Germany does not stand out in the "eco-innovation supporting environment" however, the green investment environment is well formed within the country and the German government's R&D expenditure in green industry is quite large. Germany scores higher than the average in "eco-innovation performance", backed with its large size of green industry market, low carbon emission, and relatively low level of environmental impact on society. Overall, Germany ranks above average on the ASEI index.

Germany's Key Eco-Innovation Environment

Germany has national program and roadmaps such as ProgRess (German Program on Resource Efficiency), the Sustainable Development Strategy and the High-tech Strategy that directly stimulate the growth of eco-innovation at the national level. Eco-innovation in Germany is mostly associated with enhancing material productivity and renewable energy via development of green technology.

[48] *Cleantech Group Data, as of November 2012*

Overcoming Resource Scarcity through Focus on Resource Efficiency

In 2010, Raw Materials Strategy was announced with the plan to develop a national resource efficiency program. As a follow up action, in February 2012, the Federal Cabinet adopted the ProgRess (German Resource Efficiency Program). Germany became one of the first EU countries to announce a comprehensive resource efficiency program. The aim of this national program is to systematically extract and use natural resources in a sustainable way so that environmental damage is reduced. The program pushes German companies to reduce material and energy inputs, and encourages the sustainable use of abiotic, non-energy resources, biotic resources and natural resources such as water, air, land, soil, biodiversity and ecosystems. The new agenda for resource efficiency policy announced this year, is expected to push further to secure supply of raw material, raise resource efficiency in production, make consumption more resource-efficient and enhance resource-efficient closed cycle management.[49] It is expected that such national efforts will further encourage German companies to integrate the concept of eco-innovation into their business processes.

Toward Nuclear-Free Nation

In 2011, Germany has declared its plan toward nuclear-free nation by 2022. This plan was named the Nuclear Power Phase-out plan. Under this plan, the German government believes a 'renewable era' will open for Germany. Germany already demonstrates relatively high share of electricity generated from renewable sources. There have been a number of suitable policy measures and supporting programs to promote development of critical renewable technologies such as the Renewable Energy Sources Act, market incentive program to promote the utilization of heat and power from renewable sources. In fact, with the enforcement of German Renewable Energy Act in 2000, the share of electricity generated from renewable sources jumped from 6.5 percent in 2000 to 25 percent in the first half of 2012.[50] This Act has been a success in decentralizing energy production and bringing great economic benefits with around 340,000 jobs in the renewable energy sector.[51] The country's high commitment and continuous effort to enhance the utilization of renewable energy will project a larger amount of the total energy supply to come from renewable sources in the future.

Emphasizing the Collaboration to Stimulate Eco-innovation

In 2006, the High-Tech Strategy was adopted. The strategy was reaffirmed by the Federal Government in 2009 and expanded into the High-Tech Strategy 2020 in 2010. The High-Tech Strategy is the first national innovation strategy that aims to improve the framework conditions for innovation by increasing cooperation between different policy areas and departments, science, research and industry. This national innovation strategy expects to trigger the development of new technologies and pioneer solutions in defined five areas that represent global challenges including climate/energy and mobility. The High-Tech Strategy 2020 newly set in 2010 emphasizes to implement "forward-looking" projects such as carbon-neutral, energy-efficient and climate-friendly city, intelligent reorganization of the energy supply system, renewable raw materials as an alternative to oil, one million electric vehicles in Germany by 2020, achieving higher internet use with lower energy consumption. Through the High-Tech Strategy, there have been several successful cases where businesses have been supported to perform eco-innovation. As an example, eco-innovative SMEs in Mittelstand are currently receiving technology funding to increase research partnerships.

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[49] *Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety*

[50] *http://www.spiegel.de/international/crossing-the-20-percent-mark-green-energy-use-jumps-in-germany-a-783314.html*

[51] *DEBRIV. Der Wirtschaftsfaktor Braunkohle. Ausgabe (2010), www.braunkohle-wissen.de/#arbeitspl%20*

Eco-Innovation Case Studies

CASE STUDY 1

Compact Power Motors

Compact Power Motors (CPM), manufactures small, light and energy efficient brushless electric motors. CPM's brushless electric motor was developed in response to the climate change, rising energy costs and limited resources, and CPM's all 'Made in Germany' product is used in all types of vehicles including hybrid and electrical ones, and all battery-driven appliances. This patented solution from CPM can provide efficiencies of up to 97 percent reduced energy, save space and weight of up to 7 kW/kg, and at the same time, offer high-quality performance.CPM was listed in the 2012 Global Cleantech 100 and is in relationship with various companies based in multi nations, many of them in Asia. The company is in development partnership with an Indian company, Lucas TVS, and its various multinational customers include China South Motorcycles and Suzuki, a Japanese automobile company.

Source: http://www.cpmotors.eu

CASE STUDY 2

Micro Combined Heat and Power

Micro Combined Heat and Power (Micro-CHP) is so-called 'power-generating heating systems' which directly provides electricity as well as heating and hot water in detached houses, single and two-family houses. With the power rating of up to 3kW, micro-CHP is not only economical but also environmentally friendly. The less fuel is consumed by using waste heat from power generation as a heating source at home. Moreover, micro-CHP can convert up to 90 percent of the used energy into useful energy. There are a number of German enterprises involved in Micro-CHP retrofits at homes. E.ON, one of the world's largest German investor-owned power and gas companies, works with several manufacturers such as Brötje, Remeha, Senertec, Vaillant and Viessmann to commercialise micro-CHP systems in the market. The company provides a support program in which it provides a subsidy of 1,000 EUR per micro-CHP unit. Another German company, Vaillant, a manufacturer of heating, ventilation and air-conditioning technology, works with Honda, a Japanese technology company, in installing micro-CHP systems throughout the nation.

Source: http://www.eon.com/en/media/news/press-releases/2011/7/22/e-dot-on-supports-micro-cogeneration.html; http://www.vaillant.de/Presse/Press-Releases/article/Vaillant_and_Honda_install_micro-CHP_systems_throughout_Germany.html

CASE STUDY 3

Bayerische Motoren Werke AG

Bayerische Motoren Werke AG (BMW) is a well-known automobile, motorcycle and engine manufacturing multinational company headquartered in Munich, Bavaria, Germany. Began in the 1970's, BMW has pursued sustainability and environmental protection in its process chain, from the development of energy-saving alternative vehicle concepts and environmentally sound production processes to environmentally friendly recycling. Recycling End of Life Vehicles (ELV) has become a mandatory process in EU member states since 2000. Following such regulation, it is notable that BMW has put lots of efforts in recycling of vehicles by establishing a wide spread network of centers in the EU for the acceptance and recycling of vehicles. Within the group, there is an initiative dedicated to company's recycling called Recycling and Dismantling Center (RDC). As of 2009, the company disclosed that 15 percent of plastic parts in BMW vehicles were made of recycled materials. The recovery process of BMW ELV starts from vehicle acceptance to shredding process and finally preparation of individual materials using post-shredder technologies. The company's future recovery target is 95 percent, and its final goal is to "close the gaps in the material cycle" through technological innovation.

Source: BMW Group (2009), Vehicle Recycling: Focusing on Sustainability

INDIA

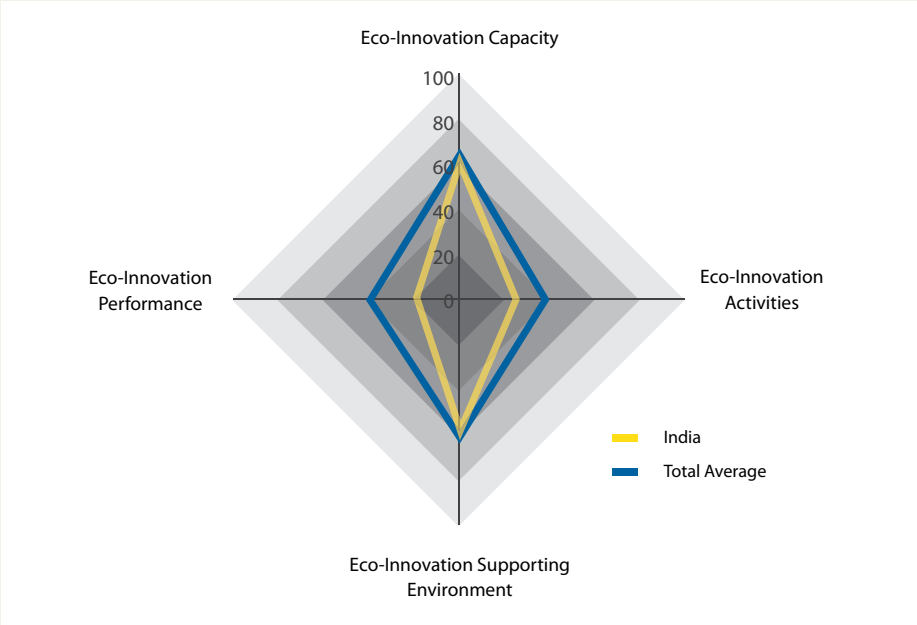

Fig. 12 Result analysis of India

Country Result & Analysis

India's total eco-innovation score is 41 out of 100, which is below the average of ASEI. In regards to "eco-innovation capacity", India shows low score in "country's economic competitiveness", "general innovation capacity", "jobs in green technology industry" and "level of awareness on sustainability management", though the country's "Value of Investment in Green Technology SMEs" is higher than average. In the area of "eco-innovation activities", India performs below average in "number of green patents", "number of green technology SMEs at early stage" and "turnover size of environmentally friendly companies". India performs low in the "level of environmental management" and the "level of commercialized green technology SMEs". In ASEI, India shows an average level in terms of "eco-innovation supporting environment" described by an average level in investment "maturity of green technology industry", country's "commitment to international environmental agreements", and "level of environmental laws". The country's "eco-innovation performance" falls below average particularly the country shows low score towards "energy sustainability", "CO2 emission intensity" and "water consumption intensity". India's "level of environmental impact on society" also falls below average. Yet, for the size of its economy, India's green industry market size looks promising. Overall, India ranks below average on the ASEI index.

India's Key Eco-Innovation Environment

Eco-innovation is a new concept for India, and like China, India has no direct programmes or policies that stimulate eco-innovation at the national or industrial levels. Among various instruments that can be applied to mobilize eco-innovation, development and commercialization of renewable energy and green technology are most strongly emphasized in India. Like China, mix of environment, technology and innovation policy measures and programs are building a firm foundation to develop the capacity needed for eco-innovation to emerge in various industry sectors in the next ten years.

Roadmap for Increasing Renewable Energy

In 2008, India announced its first National Action Plan on Climate Change (NAPCC) as an action to promote and enhance energy efficiency in India. Although India has set its mission, India still lacks in providing the necessary environment and infrastructure to stimulate the related activities. The Ministry of New and Renewable Energy (MNRE) of India is acting as one of the main bodies to mobilize activities that enhance national energy efficiency such as harnessing renewable power, distributing renewable energy in rural and urban areas, utilizing renewable energy in industrial and commercial applications, developing alternative fuels and applications and developing new eco-innovative technologies, products and services. The MNRE announced the Strategic Plan for New and Renewable energy sector (2011-2017), providing a roadmap to stimulate the growth of renewable energy technologies and related market. MNRE recently set up a Solar Energy Center and a Center for Wind Energy Technology in Chennai to provide technical support in developing solar and wind energy. In addition, to finance renewable energy projects, India has set up a separate financing institution focused on renewable and energy efficiency; the Indian Renewable Energy Development Agency (IREDA). India possesses high potential in developing green technologies, eco-entrepreneurships and awareness on environmental issues. Governmental bodies like MNRE are taking a leap forward transform this potential to actual activities that can demonstrate eco-innovation at a more practical level.

Specific Focus on Alternative Fuel: Biofuel

India is seeing biofuel as a future alternative fuel to tackle energy vulnerability. India is developing biofuel solely based on non-edible feedstock and oilseeds from degraded forest and wastelands that are not suited for agriculture. This is because India is putting its effort to avoid the conflict between development of alternative fuel and food security. In 2008, the Indian Government announced its National Biofuel Policy which aims to meet 20 percent of India's diesel demand with fuel derived from plants or indigenous biomass feedstock. The proposed target is 20 percent blending of biofuels from bio-diesel and bio-ethanol by 2017[52]. Due to increasing concerns towards urbanization, growing energy demand and growth of the automobile industry, more biofuel will be needed in the future. India's effort towards the production of biodiesel and of its commercialization provides a larger room to increase its eco-innovation activities focused on alternative energy development.

Efforts to Enhance General Innovation Capacity

In 2010, Indian government declared the year as 'a Decade of Innovation', and a roadmap 2010-2020 for innovation, the Roadmap for Inclusive Innovation, was announced. Indian government is aiming to use its innovation capacity to reduce poverty and disparity. India has 300 million people below the poverty line and eco-innovation can be a solution for tackling the social and environmental challenges. In a recent report from the Office of Advisor to the Prime Minister, it illustrates that Indian government's understanding of innovation is broad; innovation is seen as "new and unique applications of old technologies, using design to develop new products and services, new processes and structures to improve performance in diverse areas, organizational creativity and public sector initiatives to enhance delivery of services"[53]. The country is starting to understand that innovation can come across all sectors in any types. This recently emerged holistic and flexible understanding of innovation will provide a firm foundation where eco-innovation can emerge. There are several government initiatives such as the NMITLI (New Millennium India Technology Leadership Initiative), TePP (Techno-Entrepreneurs Promotion Programme), the National Innovation Foundation, TDB (Technology Development Board), HGT (Home Grown Technology Programme), TDDP (Technology Development and

[52] *Ministry of New and Renewable Energy (MNRE), http://www.mnre.gov.in/information/policies-2/*

[53] *Public Information Infrastructure & Innovation (2011), Towards a more inclusive and innovative India*

Demonstration Programme), GIAN (the Grassroots Innovation Augmentation Network) and SBIRI (the Small Business Innovation Research Initiative) that enhances general innovation capacity of India, which eventually increase the capacity for eco-innovation. To implement the Roadmap for Inclusive innovation, the Indian government established the National Innovation Council (NIC), State Innovation Councils (SIC) and Sectoral Innovation Councils. The Roadmap for Inclusive Innovation is crucial for India's future in promoting innovation in various sectors including environment, water, transport, sanitation, commerce, manufacturing, products, biotech, materials, nanotech, design organization etc. Such governmental focus on "inclusive innovation" may generate more local-friendly eco-innovation solutions and products that can address both social and environmental challenges in India.

Eco-innovation case studies

CASE STUDY 1

Biotech India

Biotech is a pioneer company in producing biogas energy from waste since 1994. Biotech manufactures and installs plants which convert gas out of organic waste or landfills to the available form of energy. For exploiting further potential of generating biogas from waste, Biotech has settled R&D collaborations and partnerships with foreign institutions and universities. With the support of local governments, Biotech is cooperating with Ministry of Non-conventional Energy in order to contribute to community's environmental health improvement and help feed local energy needs. To set up the biogas plant in communities, institutions or houses, Biotech goes through the process of consultancy, feasible study, conception and project implementation. Biotech also provides technology transfer and technological advice wherever it is needed. Biotech's biogas energy generation brings environmental effects as a solution for waste and GHG problems in India.

http://www.biotechindialtd.com

CASE STUDY 2

Mera Gao Micro Grid Power

Mera Gao Power (MGP) provides electricity to off-grid rural villages in India through solar micro-grid system. One solar micro-grid unit can provide 50 households with electricity. MGP's grid uses low bolt DC power and uses aluminum wiring instead of copper wiring. Each household can use 2 LED light and mobile phone charging service every night at lower cost than kerosene for lanterns. The service helps people study or work even after dark bringing improvements to learning performance and households' income. Without doubt, it comes with positive environmental effect for solar energy's replacement to fossil fuel. MPG's innovative business model, together with the falling price of solar panel and LED bulb, made it possible to provide solar electricity service at such a low cost targeting low income families in India. The use of larger-scale generation and storage systems minimizes the cost burden on each household in India. MGP's micro-grid technology aims to distribute to 50 villages by end of 2012, and 1,000 to 2,000 villages by 2016. The company received grants from USAID as seed capital and is continuously proving to be a sustainable business model. MGP's micro-grid technology was selected as one of the 10 Emerging Technologies 2012 in MIT Technology Review.

Source: http://meragaopower.com

CASE STUDY 3

Wipro

Wipro is a leading global IT company based in India, established in 1945. The company has been pioneering many innovations particularly in environmental management system. It was chosen as the top five greenest electronics companies in 2010, by Greenpeace. Wipro proactively manages the hazardous chemicals. Wipro introduced 100 percent recyclable toxic-free green-ware desktop models which eliminated chemicals with hazardous properties and launched PVC/BFR-free products. Furthermore, Wipro identified 21 chemicals that may threaten the safety of employees and the environment in the future, applying Wipro's Chemical Precautious Policy. In terms of efforts for greenhouse gases reduction, Wipro tries to make greener manufacturing processes and greener products. In process, it uses alternative sources of energy including wind and solar power. The company uses an intelligent Automated Power Management system which helps power savings, measurement of carbon reduction and implementation of customer organization's green goal. As for products, Wipro developed a solution designed to reduce the carbon footprint in telecom test labs, which helped the equipment manufacturers to make their product development process greener.

Source: http://www.wiprogreentech.com

INDONESIA

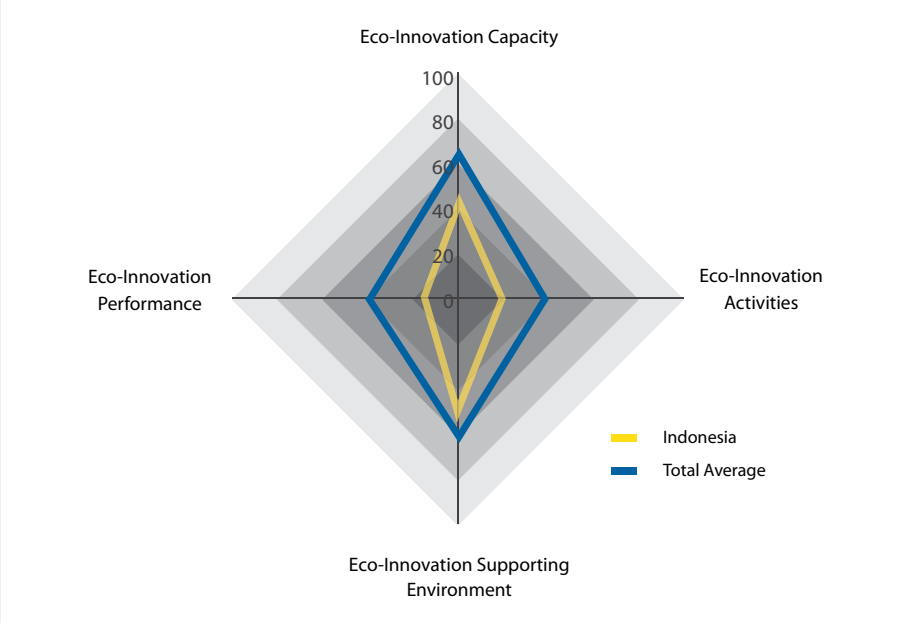

Fig. 13 Result analysis of Indonesia

Country Result & Analysis

Based on 20 indicators, which are aggregated into four criteria, the overall score for Indonesia is low (32/100) in ASEI. In the area of "eco-innovation capacity", the country's score low in the level of "country's economic competitiveness", "general innovation capacity" and "awareness on sustainability management". The country scores particularly low in "the total Value of Investment in Green Technology SMEs" and "number of jobs in green technology industry". In regards to "eco-innovation activities", the country demonstrates low score in "number of green patents", "number of commercialized green technology SMEs", "number of green technology SMEs at early stage", "level of environmental management" and "turnover of environmentally friendly companies". Indonesia's score on "eco-innovation supporting environment" is higher than the other three criteria examined for ASEI. Indonesia's week investment environment is proven by the low score in the level of investment maturity of green technology industry. The country falls below the average in its "level of environmental laws" and "country's commitment to international environmental agreed goals". Indonesia's level of "eco-innovation performance" is among the lowest. The country's green industry market size is small, and the result shows that the country needs to improve its environmental performance including "water consumption intensity", "CO2 emission intensity" and "energy sustainability levels". Overall, Indonesia ranks below the average in ASEI.

Indonesia's Key Eco-Innovation Environment

The Indonesian government pays attention to environmental concerns, but the concept of eco-innovation is just being introduced in Indonesia. The biggest concern for environmental challenges in Indonesia can be categorized into two areas: environmental pollution and destruction. Pollution and destruction of environment is being taken more seriously due to climate change, thus, in recent years, the government has been putting more efforts to reduce environmental impact and implement climate action at the national level. In 2010, an international conference on green productivity was held in Jakarta, with 16 participating countries

in the Asia-Pacific. In this forum, Indonesia announced its effort to work on practicing green productivity with a focus on low-carbon green growth.[54] There are signs that the Indonesian government is starting to understand the notion of green growth and is preparing to take a leap forward in putting the green growth at the heart of the national plan.

Policies to Support Green SMEs

In Indonesia, approximately 99.9 percent of the total companies account for SMEs with more than 97 percent of job contribution in the total workforce.[55] The Indonesian government understands that SMEs play a vital role in the Indonesian economy, thus the government pushes SMEs to promote cleaner production and the use of renewable energy, and reward them with green industry awards. According to the industrial policy, financial incentives are available to companies with strong R&D, companies in partnerships with SMEs and companies with efforts to preserve the environment. The government's effort to promote eco-innovation among SMEs goes beyond the national level. In collaboration with South Korea, Indonesia has founded green business center (GBC) in Jakarta, Indonesia. GBC is supported by ASEM SMEs Eco-Innovation Center (ASEIC), established in 2011 with the principal mandate of promoting Asia-Europe cooperation to create and enhance eco-innovation of SMEs.

Driving Forces for Renewable Energy Technology

As of 2010, the share of electricity supply from renewable sources was only about 4.7 percent in Indonesia. However, as the Indonesian government seeks low-carbon and green economy, Indonesia is expected to shift towards more environmentally friendly and sustainable energy source, renewable energy. In fact, the Indonesian government targets to reduce its reliance on fossil fuels from 47.6 percent of its share in the energy mix to 20 percent and increase the share of renewable energy to 15 percent by the year 2025.[56] The national plan to increase renewable energy production is expected to reduce greenhouse gas emissions, which is one of key environmental challenges in Indonesia. The Indonesian government provides supporting policy and incentive programs to encourage eco-innovation activities in the energy production industry. Companies that provide and utilize new renewable energy are eligible to receive incentives from the government for a certain period of time until it reaches economical development stage. In addition, the government provides tax exemptions on value-added tax and import duty for equipments and machinery used in renewable energy production. To increase the production and consumption of renewable energy, the country will need to catalyze the development and adoption of better renewable technologies; this will then bring more room for eco-innovation activities to emerge.

Eco-innovation through Information-based Incentives

Recently, 'information disclosure' on environmental impact of companies has become a part of the environmental policy. The Indonesian government collects companies' environmental information including pollutants emissions and publicly disclosed information, and this pressurizes companies to take action to reduce environmental damage. The ultimate reason behind this regulation is to improve environmental

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[54] *http://www.uncsd2012.org/index.php?page=view&nr=296&type=99&menu=20*

[55] *APEC (2011), Identifying Policies to Support Green SMEs*

[56] *International Trade Administration (2010) Renewable Energy Market Assessment Report: Indonesia*

performance of the companies. In Indonesia, a national public environmental reporting initiative, Program for Pollution Control, Evaluation, and Rating (PROPER), has been in practice since 1995[57]. This regulatory program works as a tool to promote industrial compliance with environmental regulations and adoption of clean technology to improve environmental management. Indonesian companies have significantly improved their environmental performance since the start of PROPER, which implies that PROPER plays a key role for companies to rethink about how they do business and how they can improve their environmental impact in novel ways. Although PROPER is a regulatory measure, it provides opportunities to help Indonesian companies integrate eco-innovative ideas into company practice, which eventually raises awareness on eco-innovation at the industrial level.

Eco-Innovation Case Studies

CASE STUDY 1

PT. Space Technology

PT Space Technology (Space Tech) is a whole sale supplier of mechanical equipment, electrical equipment, machining centers for punching, engineering equipment, mining equipment, diesel power plant, water filer system and conveyor systems. Like other numerous SMEs in Indonesia, Space Tech used coal-fired boilers in their facilities. The problem with using coal-fired boilers was the wasted cost spent for drying the low rank coal with high moisture content. In order to solve such problem, Space Tech decided to adopt the Waste Heat Recovery System for drying low rank coal to an upgraded coal with low moisture content and high caloric value. The Waste Heat Recovery System basically collects heat released from the chimney of the coal-fired boiler and re-uses the waste heat to dry low rank coal on the ground. The system allows increased efficiency of the boiler, reduction of energy use and carbon emissions by 20 percent. In other words, on every 100,000 USD spent per year on coal consumption, 20,000 USD is expected to be saved with reduced CO2 emissions by 2,000 tons.

Source: http://www.spacetechid.com

[57] *http://news.chosun.com/site/data/html_dir/2008/03/14/2008031400971.html*

CASE STUDY 2

PT. Hasura Mitra Gemilang

PT. Hasura Mitra Gemilang (Hasura), established in 2003, manufactures plastic components for electronics and automobiles. Hasura is a good example among a number of companies in Indonesia to adopt and implement cleaner production. Cleaner production, first introduced by the UNEP in 1990, refers to "the continuous application of an integrated preventative environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment." The three main criteria considered in cleaner production of Hasura are energy efficiency, resource efficiency and waste management. In order to increase energy efficiency, Hasura brought natural sunlight in the factory to reduce its dependency on electric lights. In addition, the company adopted the coolant filtration system in the cooling water system to enhance resource efficiency. Hasura's effort for better waste management began with proper disposal of wastes, which involves separation of wastes by their nature with designated separate areas for different types of waste. Hasura's work put into pursuing cleaner production is compensated with saved costs of 2,920 USD, reduced electricity consumption and water consumption by 30,444 kWh and 1,800 tons respectively, and lowered GHGs emissions by 24 tons of CO2.

Source: ASEIC (2011), ASEM Eco-Innovation Consulting Projects for SMEs Best Practices in Indonesia

CASE STUDY 3

PT Srikaya Maha Restu

PT Srikaya Maha Restu (Srikaya) is a package manufacturing company based in Jakarta, founded in 2004. The company is the first company in Indonesia to provide the environmentally friendly packaging which can be recycled naturally. Srikaya's product can be used for all kinds of packaging in electronic industry, fast food and catering, household, shoes, pharmacy, doctoral, hospital equipment, airlines, and etc. Srikaya's packaging is not only eco-friendly but also cost competitive. Srikaya's packaging product is sold globally, and the company's volume of total annual sales amounts up to around USD 2.5 million.

Source: http://www.alibaba.com/member/smrpulppackaging/company_profile.html

ITALY

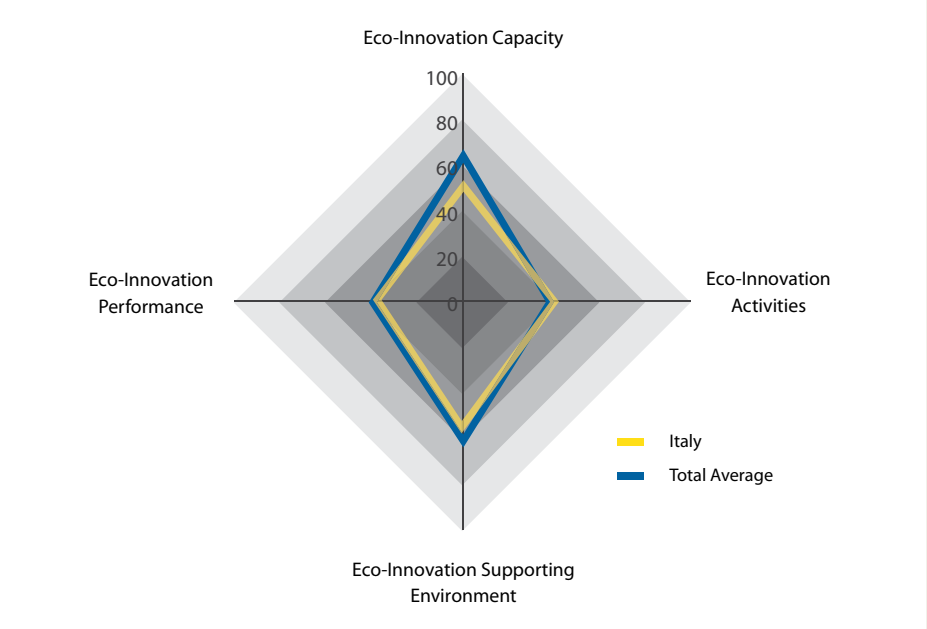

Fig. 14 Result analysis of Italy

Country Result & Analysis

Based on 20 indicators, which are aggregated into four criteria, Italy scores slightly below the average (47/100) of ASEI. In terms of "eco-innovation capacity", Italy scores below the average in "economic competitiveness", "general innovation capacity" and "awareness level on sustainability management". However, Italy shows high score in the "Value of Investment in Green Technology SMEs". In regards to the "eco-innovation activities", Italy scores above the average in the "number of green patents", and the "level of environmental management". Yet, Italy scores much below the average regarding the "level of commercialized green technology SMEs". The score of "eco-innovation supporting environment" is pulled down by the low "investment maturity of green technology industry" and small "public spending on R&D in green industry". However, the country shows high "level of systematic environmental laws" and "commitment to international environmental agreed goals". "Eco-innovation performance" level is slightly above the average backed with good score on level of "CO2 intensity" and "environmental impact on society" and below average score for remaining indicators. Overall, Italy ranks slightly below average on the ASEI index.

Italy's Key Eco-Innovation Environment

Italy does not demonstrate any national level policy work that directly refers to supporting eco-innovation, but in line with EU's vision, the concept of eco-innovation and sustainability is diffused into its environmental policy mix. As Italy is one of largest countries in Europe and one of the six founding members of the European Community founded in 1957, Italy has a significant position within the EU. Therefore, the country seems to do its best to follow philosophy of the EU including the EU's vision for sustainable development strategy by showing relatively high commitment toward international environmental agreed goals. Being one of the countries with largest spending on environmental protection related area, Italy's mix of policy measures and programs in the field of energy, climate and resource use are stimulating eco-innovation activities.

Key National Measures Targeting Greenhouse Gas (GHG) Reduction

Italy's main eco-innovation activities are related to renewable energy and have emerged in effect of the national set target for GHG reduction. Reducing GHG emission is one of primary objectives of the Italian government. Currently, Italy's policy measures addressing GHG reduction mainly focus on promoting deployment of renewable energy sources. Italy's effort to increase the use of renewable energy is actually part of the country's obligation as a member country of the EU; in the EU's Renewable Energy Roadmap, it is proposed that the EU shall reach the mandatory target of 20 percent for renewable energy's share of energy consumption by 2020.[58] To reach the European and the national target of increasing the renewable energy production, a number of policy measures and incentive programs are provided to support development and diffusion of renewable energy sources. One of them is an incentive scheme called 'green certificate system,' which gives two options to electricity producers; either meet the mandatory share of electricity production from renewable sources or buy green certificate in the market. In March 2011, the Italian government announced its adoption of the Renewable Energy Law. Under this law, a feed-in-tariff system is planned to replace the green certificate system by the year 2015. Following the newly introduced law, feed-in-tariff will be applied to wind farms operated after 2012 and involves an auction process for larger projects. Incentive tariffs for solar energy have been applied since 2007 and will continue to be applied according the Renewable Energy Law. Italian citizens are also eligible to receive tax incentives in regards to renewable energy. According to the Renewable Energy Law, investors putting their money in renewable energy sector may take off 55 percent of the total investment costs from their tax bill.[59] Overall, the government is putting efforts to encourage both the renewable energy industry and the investors.

The Increasing Interest of SMEs for Eco-Innovation Products and Services

Italy's economy centers on SMEs. Approximately 99 percent of companies in Italy account for SMEs, and they are responsible for 75 percent of all workforce and 60 percent of total production and exports.[60] In the recent years, there have been clear evidences of growing interest among SMEs to develop and produce 'eco-sustainable' products and services. In spite of the country's on-going economic crisis, there is a steady growth in SMEs' green investments mainly focused on increasing energy efficiency. Italian SMEs are quick to respond to changes in the industry based on its agile characteristic, and they have experienced a rapid growth through strong collaboration and partnership via SME-based industrial districts called 'clusters.' The Ministry for Economic Development grants funds to SMEs with focus on innovation and renewable energy. This is active especially in Southern Italy. Italian regional agencies also manage regional guarantee funds for specific industry, e.g. Agency "Veneto Sviluppo" provides available funds to specific industry. Italian SMEs are among active participants of European project, EcoSMEs. EcoSMEs was set up with the purpose of providing information and raising awareness of eco-innovation among SMEs in Europe. Through EcoSMEs, SMEs can receive information and training on starting eco-innovation interventions including related policies and regulations. Growing involvement of SMEs in eco-innovation hopes to further develop the eco-business in Italy.

Industry Specific Cluster Effort to Eco-innovate

In 2009, the country set up a new law on "network contracts," (NET) which aims at supporting collaboration among SMEs to increase their potential for innovation, research, and development. This policy instrument supports the establishment and emergence of clusters or networks designed to be particularly suited for SMEs.

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[58] *European Commission (2007), Renewable Energy Road Map*

[59] *Library of Congress, Italy: Renewable Energy Law Adopted http://www.loc.gov/lawweb/servlet/lloc_news?disp3_l205402587_text*

[60] *Eurostat (2011)*

This action is being undertaken within the framework of the Small Business Act. It is stated that eco-innovation in the country is mainly understood as "environmental performance improvement, and not innovation in the cleantech sector". [61] Thus, eco-innovation activities in clusters are implemented in a way to improve environmental performance of different industries. Clusters in textile show high interests and voluntary efforts in promoting eco-innovation with relatively large number of patent applications filed for green technologies in the textile sector, and 'sustainable fashion' shows high potential of development. Cluster-level eco-innovation activities in the textile industry have been implemented in different regions of Italy. In leather and textile clusters in the region Prato, members within the clusters cooperate to be EMAS certified and reduce costs by sharing related sources and knowledge.[62] The Pratese Industrial Union, founded in 1912, identifies environmental challenges within the cluster and tries to increase energy efficiency, reduce industrial emissions, and lower water consumption intensity. Confartigianato Prato is another public organization initiated to support services of SMEs with 5000 members. The organization identifies key environmental challenges for local textile industry such as waste water dumping and challenges water quality management and water supply issues.[63]

Eco-Innovation Case Studies

CASE STUDY 1

Prada

Prada, founded in 1913, is an Italian fashion label specializing in luxury goods for men and women such as ready-to wear, leather accessories, shoes, luggage and hats. Prada introduces merging of both sustainability and cradle2cradle (C2C) into the Prada value chain. Prada's C2C products start with using alternative materials for their products in the future. For example, nylon is replaced with eco-intelligent polyester, and leather with salmons' skin. Prada eyewear is another good example of C2C production as frames and hinges made with bio-plastics or polymer derived from castor oil and lenses are recyclable to be re-used for cameras or binoculars. In addition, Prada's flagship stores are to be built within the C2C philosophy using Carbon Negative Cement, air-purifying wall papers, and construction panels made from cow manure and other recycled content. Prada is proactively setting a good example in the fashion industry as an eco-innovative company through successful environmental management system and marketing. To successfully apply the concept of sustainability and C2C, the company plans to make both financial and social investment.

Source: Leesmetn, Fahey, Fordham, Domokosch, Negahbani, Introducing sustainability into High fashion through PRADA

[61] *Greenovate! Europe EEIG (2011), Eco-Innovation and National Cluster Policies in Europe*

[62] *Greenovate! Europe EEIG (2011), Eco-Innovation and National Cluster Policies in Europe*

[63] *Greenovate! Europe EEIG (2011), Eco-Innovation in Cluster Organisations in the Chemical and Textile-Clothing-Leather Sectors*

CASE STUDY 2

Piaggio

Piaggio is a SME manufacturing two-wheeled motor vehicles and is among leaders in its sector. The Piaggio Group aims to "meet the most progressive needs for mobility while reducing the environmental impact and consumption of its vehicles, ensuring customers excellent levels of performance." The company seeks to be an environmentally friendly company not only by producing eco-friendly products but also by making eco-innovative efforts in production, distribution and management process. Piaggio started developing eco-innovative vehicles since 1978. In 2009, Piaggio started commercializing the first hybrid scooter in the world. This hybrid scooter reduces the emission of pollutant gases and CO2 in urban areas by making greater use of renewable and sustainable sources of energy. The group visions to grow further in two business sectors: the two-wheeler business (scooters and motorcycles) and Commercial Vehicles business. These two business sectors aim to accomplish eco-technological innovation and sustainable mobility.

Source: http://www.piaggiogroup.com/en

CASE STUDY 3

SOLWA Srl

SOLWA Srl (SOLWA), Solar Water, provides service for depuration of water. SOLWA was founded by various experts from industry and academia in hopes to provide its service targeting global regions. SOLWA's product enables depuration and desalinization of water from polluted and salt-rich resources to drinkable and agriculturally suitable quality of water using only solar power. SOLWA's product not only solves problem of water pollution and water scarcity but also provides a solution to the usage of low quality water irrigation in many barren areas. SOLWA's solar still can easily be constructed with materials which are easily accessible in any country and territory. The company's solar still generates maximum efficiency in solar energy rich areas such as tropical regions. The basic structure of SOLWA's solar still starts with converting the solar beams into heat. The heat heats up the salt water inside an isolated structure, green house, until it evaporates. Then, the water vapor from evaporation is collected inside the green house. SOLWA's eco-innovation solution aims to protect the environment and save energy. The system is still in the experiment stage, but recently, SOLWA successfully implemented its service in Peru as a pilot in collaboration with the National University of Trujillo and the University of Venice.

Source: http://www.ideassonline.org/public/pdf/br_48_01.pdf, http://www.solwa.it/index.php?lang=en

JAPAN

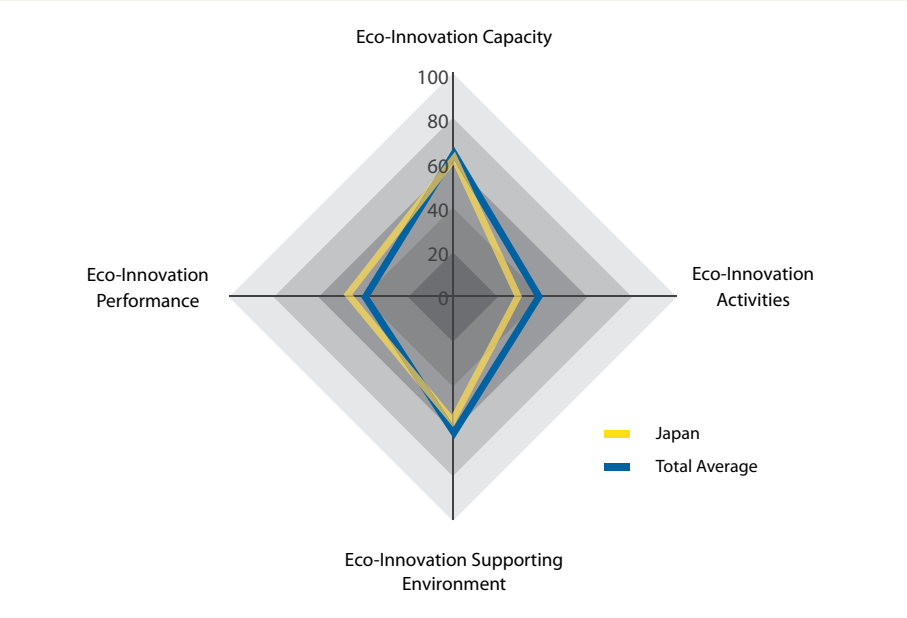

Fig. 15 Result analysis of Japan

Country Result & Analysis

Based on 20 indicators, which are aggregated into four criteria, Japan scores about the average (50/100) in ASEI. It is noteworthy that Japan scores higher than all other Asian ASEM member countries and even some lagging countries in Europe. In regards to the country's level "of eco-innovation capacity", the country demonstrates around the average score in "level of economic competitiveness" and "general innovation capacity". However the country scores well above the average in the "level of awareness on sustainability management" and "number of jobs in green technology industry". Japan's "eco-innovation activities" described by the "number of green patents", "number of commercialized green technology SMEs", "number of green technology SMEs at Early Stage", "level of environmental management", renewable energy utilization level", and "turnover of environmentally friendly companies" falls below the average. However, Japan scores above the average regarding to the "level of environmental management" and "turnover of environmentally friendly companies". In the area of "eco-innovation supporting environment", Japan scores slightly below the average, but the country has high "level of environmental laws" and good "level of commitment towards international environmental agreed goals". "Eco-innovation performance" appears to be the strongest among all four criteria. The criteria measure is well supported with high score in "green industry market size", "CO2 intensity level", "energy sustainability" and "environmental impact on society". Overall, Japan ranks just below the average on the ASEI index.

Japan's Key Eco-Innovation Environment

According to the Ministry of Environment of Japan, Japan's green industry experienced decrease in size with the global economic crisis in 2008, but the industry has recovered and improved its market size reaching 69 trillion yen in 2010. The current number of employees in green industry in Japan is approximately 1.85 million which has grown from 1.80 million in 2009.[64] In 2007, the Japanese government's Industrial Science

[64] *Ministry of Environment (2012), Estimated Market Size of Japan's Environmental Industries of 2010, and Report of Japan's Environmental Industry Growth Engines*

Technology Policy Committee introduced the term "eco-innovation" for the first time at national level. With the introduction of this term, the Japanese government provided vision of transiting towards green growth. Following on, as part of the "New Growth Strategy"[65] adopted in 2009-2010, innovation in environmental sector was promoted. With global economic downturn in 2008 and national disaster of earthquake in March 2011, Japan has been experiencing economic, social and environmental difficulties. It is noteworthy that Japan is putting eco-innovation and green growth as a major pillar in the revitalization of Japan.

Push for Renewable Energy after Fukushima Disaster

Following the Fukushima nuclear disaster, in July 2011, the Japanese government set up the Energy and Environment Council and disclosed its plan to reach 0 percent nuclear energy target by 2030 including alternative targets of 15 percent and 25 percent. To reach the national goal, the government aims to strictly apply no longer than 40-year operation rule to all of its nuclear reactors throughout Japan and not grant permission to build any more reactor plants. Japan's rather extreme plan to reduce national nuclear power production brings a concern of increase in energy prices. In regards to the target rate of 0 percent, 15 percent, and 25 percent of energy supply from nuclear power, the corresponding rate of increase in energy price is projected to be around 21-27 percent, 15-20 percent, and 12-15 percent respectively.[66] Therefore, it is essential for Japan to improve energy efficiency and develop alternative energy sources via eco-innovation. In the late 2011, Renewable Energy Act was put in action, and significant growth is expected in the renewable energy market especially in the solar sector. From July 2012, the new feed-in tariff law has put into effect which approves generous feed-in tariffs for renewable energy projects. It is stated that the change in direction on energy system and the new feed-in tariff law expect to promote the development of new green technologies that can be practically applied. This change will also increase revenue from renewable energy industry to more than $30 billion by 2016.[67] In the next ten years, eco-innovation is expected to appear in the renewable energy sector more rapidly than other areas in Japan.

Public Support to R&D on Green Technologies

As Japan is known as a strong technology advanced country, there is a great amount of both public and private R&D efforts. In fact, the Japan's expenditure on R&D is among the highest in the world. Therefore, the proportion of R&D spending on environmental technology may seem small, but the amount itself stands for a very large amount.[68] As a result, Japan is one of the countries with highest number of patents with relatively large share of patents in environmental technology. As part of the government's plan for New Growth Strategy, 1.9 billion Euros has been allocated with specific emphasis on low carbon energy supply, highly efficient, smart use of energy and greening of social infrastructure. Environment Research and Technology Development Fund (ERDF) is a main R&D program related to eco-innovation. Another supporting program for eco-innovative R&D activities is the Global Environment Research Fund (GERF), which is a grant scheme for global environment research and calls for proposals. Since the launch of this fund in 1990, the GERF played a significant role in researching environmental issues. Advanced technological knowledge and such R&D supporting schemes related to environmental issues have continuously enhanced the eco-innovation activities of the country. With the change of energy policy and direction towards green growth, more practical eco-innovation solutions are expected to appear with the background of such government supported R&D funding.

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[65] *The government outlined the green growth strategy in July 2012 which included five key policies "(1) establishment of Japan's presence in global markets through next-generation vehicles; (2) development of energy systems and their expansion to overseas; (3) creation of storage battery markets and strengthening of Japan's competitiveness in such markets; (4) achievement of industrial growth through green materials; and (5) strategic development and use of the ocean environment."*

[66] *KEMRI (2012), the 36th Weekly Report*

[67] *http://www.reuters.com/article/2012/06/18/us-energy-renewables-japan-idUSBRE85H00Z20120618*

[68] *OECD (2008), Eco-Innovation Policies in Japan*

Setting a High Environmental Performance Targets for Business

To promote green growth, several legislative[69] (e.g. Top runner Program) and voluntary (e.g. Keidanren Voluntary Action Plan) environmental targets, mostly related to energy efficiency, have been set up to stimulate such efforts. In 2008, the Energy Conservation Law was partly revised mainly to prevent the increase in energy consumption of consumer sector. The standard gives guidance to increase the energy efficiency by 1 percent annually. In 1999, under the Agency for Natural Resources and Energy as an element of the Energy Conservation Law, a regulatory scheme named Top Runner Program was set up as an effort to target energy efficiency for products within selected segments of markets. The primary purpose of the program involves pushing not only manufactures but also importers of energy consuming products and equipments. Currently, 23 product groups are targeted by the program, and the set energy efficiency level should be met within four to eight years. Japan's Top Runner Program scheme interacts with the Energy Label Program (2000) to grant Top Runner Label to the products that satisfied the standards. Legislative environmental targets such as the Top Runner program allow more energy efficient products to enter the market.

Eco-Innovation Case Studies

CASE STUDY 1

ENAX

ENAX manufactures rechargeable lithium ion batteries (LIB) which can be used for a variety of uses. ENAX's product features high energy density, high power and large size. The product demonstrates high energy per unit mass which suits a use in mobile electronics for its portability. ENAX's LIB is good for industry use for its high power-to-mass ratio. Electric vehicles are seen as eco-friendly alternative to conventional gas-fueled cars because it generates no exhaust gases. The ENAX's Li-ion rechargeable batteries contribute to reduction of environmental impacts since the battery is used as an energy source to electric vehicles. Furthermore, ENAX's know-how skill makes it possible to provide its products at cheaper price. ENAX's LIBs offer both environmental and economic advantages to its customers. In 2004, the company was named the winner of Excellence Prize for Tokyo Venture Technology Awards for development of specific LIB for vehicles as an alternative to lead secondary batteries. In addition, in 2011, ENAX was introduced at the German-Japanese Energy Symposium 2011 under the theme of "Research & Development and Business Opportunities for Optimal Sustainable Energy Allocation".

Source: http://www.enax.jp, http://www.dr-kiehl.net/programs/ENAX%20Presentation.pdf

[69] *Other Japanese legislative actions on environmental targets include: Packaging Law (1990), Air Pollution Control Law (2006); Energy Conservation Law (amended in 2010); Reinforcement of Energy Saving for plants, buildings & transportation (2005); Law for Enhancing Motivation on Environmental Conservation and promoting of environmental education (2003)*

CASE STUDY 2

Mitsubishi Materials Corporation

Mitsubishi Materials Corporation (Mitsubishi) is a subsidiary of a multinational enterprise, Mitsubishi Group, and has been involved in the field of cement, metals, advanced materials &tools, aluminum, electronic materials & components, energy, precious metals and recycling business. As a country of advanced technology, use of metal and mineral resources in Japan is high. Unfortunately, Japan is also known to be a country with few natural resources, thus brings the nation's high dependency on imports of raw material. In the 1980s, urban mining was introduced in Japan to resolve the country's shortage on mineral resources and to reduce the cost of imports. The concept of urban mining is basically recycling of rare earth minerals from used electronic devices. Urban mining not only reduces environmental impact but also conserves natural resources. Among a number of companies in the field of urban mining, Mitsubishi proactively leads the field. Mitsubishi has put good amount of efforts to increase the recycled content of their materials. Over half of the aluminum sold by Mitsubishi comes from recovered and recycled drinks cans. Mitsubishi runs Naoshima Smelter and Refinery where the company recycles metals from household appliances. The size of urban mining in Japan is about 68,000 tons of gold, 60,000 tons of silver, and 1,700 tons of indium, which is even more than the amount in South Africa, the country with the most reserves.

Source: http://www.mitsubishicarbide.com/mmus/ca/index.html
http://www.icmm.com/page/9004/mitsubishisurban-mines-recycling-for-production

CASE STUDY 3

Laminate Industry Co., Ltd.

Laminate Industry Co., Ltd. (Laminate Industry), is a developer of processing technology of metal plate and plastic film. Laminate Industry has developed its own solution breaking the traditional way of using laminating paper and became the world's only company with environment-friendly laminating technology. The company holds a patented technology solution for glue-free and solvent-free laminate, and its can products are proven to release less environmental hormones and minimize sources for volatile organic compounds. Laminate Industry's technology can be used for variety of two piece cans, three piece cans of canning and manufacturing lid, household appliances, building materials, car and train compartment exterior and a wide range of areas.

Source: http://www.laminate.co.jp/us/index.html
http://www.chipf.com.cn/qyyd/E2en/e2s076/e2s076_en.html

KOREA

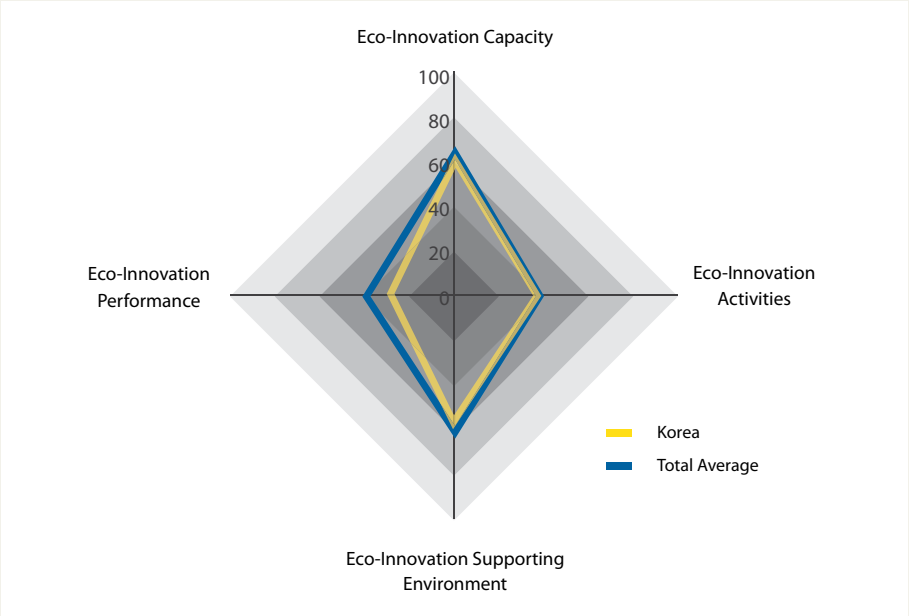

Fig. 16 Result analysis of Korea

Country Result & Analysis

The overall score of Korea in ASEI falls slightly below the average (47/100). As Korea is an emerging country in eco-innovation, the country shows more strength in "eco-innovation capacity" and "eco-innovation supporting environment" but scores far below the average in "eco-innovation performance". Korea demonstrates average "level of country's economic competitiveness", "general innovation capacity", "awareness level on sustainability management". Korea's score on "investment capital flow towards green technology" may be low, but "number of jobs in green technology industry" is high. In terms of "eco-innovation activities", Korea shows high score in the "number of green patents", "turnover of environmentally friendly companies", and "level of environmental management". However, Korea's overall score for "eco-innovation activities" is below the average pulled down by low "number of green technology SMEs at early stage" and low "level of renewable energy utilization". The "government's R&D expenditure in green industry" and the "level of environmental laws" is analyzed to be high in ASEI. Yet, the country still lags behind in the level of investment maturity of green technology industry and commitment to international environmental agreements. In regards to "eco-innovation performance", the country shows small "size of green industry market" and low score in "water consumption intensity", "CO2 emission intensity", and "energy sustainability". However, Korea performs respectively well regarding the "level of environmental impact on society". Overall, Korea ranks just below average on the ASEI index.

Korea's Key Eco-Innovation Environment

Korea's policy measures for eco-innovation is included as a part of the Korean government's green growth strategy (2009-2050) focusing on mitigation of GHGs emissions, development and diffusion of renewable energy, improvement of capability to respond to climate change, and other sustainable goals. Since the launch of the Low Carbon Green Growth Strategy, eco-innovation has been promoted as the central tool to achieve green growth. Eco-innovation strategies are implemented by various governmental bodies and research institutes; Ministry of Environment (MOE), Ministry of Knowledge Economy (MKE), Ministry of Education, Science and Technology (MEST), The Korea Eco-Products Institute (KOECO), Korean Agency for Technology and

Standards (KATS), Korea Institute of Environmental Science & Technology (KIEST). Under the Low Carbon Green Growth Strategy launched in 2010, Korea plans to invest 2 percent of its GDP, approximately KRW 107 trillion in transiting towards green growth.[70] Although it has been only two years since the adoption of the green growth strategy, Korea's eco-innovation strategy is setting a roadmap or model for developing countries to follow.

Encouraging Eco-Innovation via National Greenhouse Gas (GHGs) Target Management System

In 2009, being the world's ninth-largest carbon emitter, the Korean government declared its target to reduce GHGs emission by 30 percent by the year 2020 at the United Nations Climate Change Conference in Copenhagen (CCCC). This declaration puts the country on a tight schedule to make eco-innovative efforts to meet such target, speeding up the growth of eco-innovation practices. The Korean government has enforced a national level management system, GHG & Energy Target Management System since April 2010. The GHG & Energy Target Management System requires heavy emitters of GHGs and largest energy consumers to set targets for GHGs emission reduction, energy saving and energy efficiency. As a result, 490 companies, 80 percent of them in industrial fields, were designated to meet the set environmental targets.[71] Target Setting and GHG & Energy Target System Committee was initiated to set the allowance level for each business type and targets for individual companies. The companies that have successfully achieved the reduction level beyond the set targets will be able to take the advantage of GHG emission reduction in line with Carbon Emission Trading beginning in 2015. Several companies, especially companies with huge energy consumption and GHGs emission intensity in heavy industries and construction, have already implemented GHGs management system and made eco-innovative improvements in process and products to meet their targets. Such system is moving companies in Korea to act as drivers of eco-innovation by following strict environmental regulations.

Promoting SMEs' Eco-innovation

Under the national plan for green growth, several governmental programs and funding schemes were set up to support green SMEs. Small & Medium Business Corporation (SBC) provides SMEs green growth support developing both green technologies and green management system to increase their level of green competitiveness in the global market and to go further to establish a new market. To enhance the level of environmental management of SMEs, a group of experts make visits to production sites and help implement systematic environmental management strategies to respond to legal mandates and climate change. The project also helps SMEs develop more enhanced green technology solutions by offering services such as product performance evaluation, testing and certification, consulting and on-site facilities diagnostics. In 2010, Small Business Association (SMBA) of Korea made an announcement to foster 1,000 green SMEs by the year 2013.[72] The plan includes support measures to increase domestic production and exports of greener components and materials. SMBA's project encourages the establishment of green technology ventures via close collaboration with universities and research institutions and aims to build 'green clusters' in Korea. SMBA announced that it would invest in green growth related sectors with approximately 1.1 trillion KRW by the year 2013.[73] Such support for green SMEs' R&D activities will bring more green jobs and increase exports within eco-industry market.

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[70] *Presidential Committee on Green Growth (PCGG), http://www.greengrowth.go.kr/*

[71] *Presidential Committee on Green Growth (PCGG), http://www.greengrowth.go.kr/*

[72] *Small Business Association (SMBA), http://www.smba.go.kr/*

[73] *Small Business Association (SMBA), http://www.smba.go.kr/*

Financial Support for Development and Commercialization of Eco-innovative Technology

In 2009, the Korean Government set the 'Roadmap for Core Green Technology and Commercialization' to foster green R&D efforts and investments in the related field. Korean Government increased investment in green technology and R&D for related industries from 1,400 billion KRW in 2008 to 2,800 billion KRW in 2011, and chose 27 key green technologies for further promotion.[74] Following the government's green growth vision, the Ministry of Environment started the Next-generation Eco-Innovation Project in 2011. As part of this project, the Ministry of Environment disclosed its plan to commit KRW 15 trillion for the next ten years in fostering development of green technologies.[75] The Korean Ministry of Environment also launched Environmental Venture Funds to support promising environment-related start-ups in collaboration with investment banking institutes. Korea's green industry may still be at the early stage, but national effort to expand financial support for green R&D and technologies is expected to work as a great tool in fostering eco-innovation in Korea.

Eco-Innovation Case Studies

CASE STUDY 1

Kaon Media

Kaon Media (Kaon) is a set-top box manufacturing SME established in 2001. The company has been proactively responding to national and international environmental regulations as large share of its revenue is brought from exports to European regions. Stricter international regulations increasingly set barriers in exporting its products. The company puts effort to meet strict regulations on products such as RoHS, WEEE, and ERP. And to overcome this challenge, the company participated in SMEs' Green Supply Chain Management System project supported by the Small Business Association and Small & Medium Business Corporation. As a result of the project, Kaon, its business partners and suppliers were able take precautionary actions against environmental risks and meet the environment related international standards. Finally, the company's eco-innovative effort to overcome trading barriers via collaborating with supporting governmental organization has placed the company in a good position to expand its market share abroad.

Source: http://nbiz.heraldcorp.com/view.php?ud=20111220000658,
http://www.kaonmedia.com/main_new/index.htm

[74] *Presidential Committee on Green Growth (PCGG), http://www.greengrowth.go.kr/*
[75] *http://www.keiti.re.kr/action.do?mid=1010101010*

CASE STUDY 2

Kyungdong Ceratech

Kyungdong Ceratech manufactures ceramics used for semiconductor components, machine parts, heat-resistant parts, and electrical insulation parts. In 2011, the company's high-efficiency thermal insulator was named the winner of the National Green Technology Award. The National Green Technology Award is given to outstanding green technology developing companies, universities, or research institutions that have solutions with high technical performance and economic benefits. Kyungdong Ceratech was the first SME to receive such award. The award winning product of Kyungdong Ceratech demonstrates enhanced insulation performance by 14 percent and will enable the GHGs emissions reduction of 8.45 percent by the year of 2020.

Source: http://www.koita.or.kr/kfile/guide/ebook/12/ebook/EBook.htm, http://en.kdceratec.com/main

CASE STUDY 3

Energy Solutions Company

Energy Solutions Company (Energy Solutions) is an energy service company (ESCO) established in 1998. The company makes investment to build energy-saving system for organizations and companies and collects saved energy costs as the company's profits. It is actually a 'win-win strategy' for both Energy Solutions and its customers, because Energy Solutions can earn profits from its successful projects and its customers can reduce energy consumption without any upfront expenses. The annual saved energy cost through Energy Solutions' projects is summed to be approximately 1.9 billion KRW. Since 2009, the company has expanded its business in waste heavy metal incineration, and with a strong interest in alternative energy field, the company is also expanding its business into the renewable energy sector. Energy Solutions holds the second largest market share in the ESCO business and was named an excellent ESCO company for two consecutive years in 2009. ESCO is a business that receives governmental support for its business features. As the Korean government announced to increase its current financial support by 300 percent in 2011, the future of Energy Solutions seems more promising than ever.

Source: http://www.ecoroko.com/603

MALAYSIA

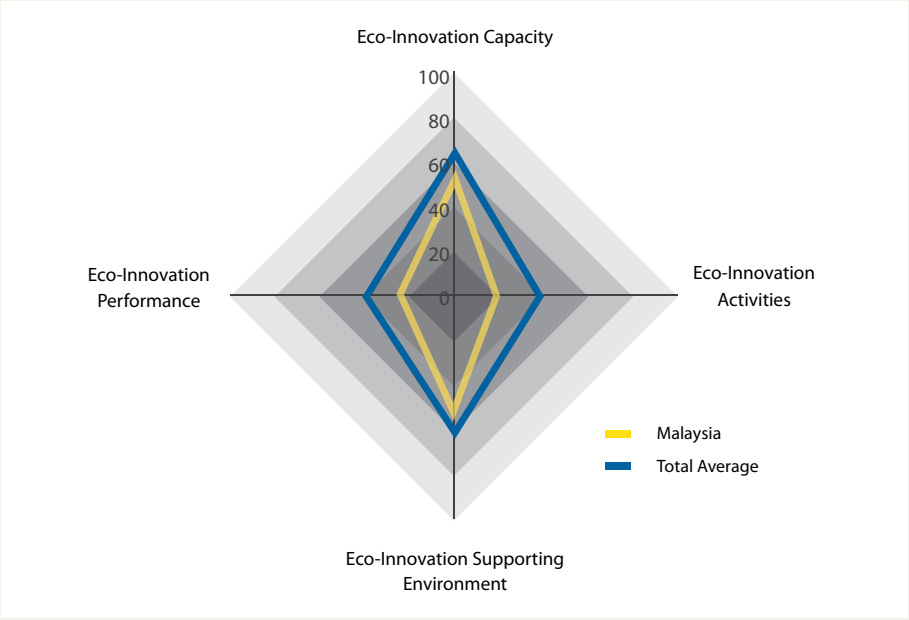

Fig. 17 Result analysis of Malaysia

Country Result & Analysis

With an overall score of 38/100, Malaysia falls below the average of ASEI. In regards to "eco-innovation capacity", Malaysia shows average scores in "general innovation capacity" level and country's "overall economic competitiveness" but low scores in the value of investment capital flow and jobs in green technology industry. For the indicator, "awareness level on sustainability management" Malaysia positions higher than most of the Asian ASEM member countries examined. In the area of "eco-innovation activities", Malaysia positions below the average in all six indicators behind the measuring criteria; "number of green patents", "turnover of environmentally friendly companies", "renewable energy utilization level", "number of green technology SMEs at early stage", "level of environmental management" and "level of commercialized green technology SMEs". For "eco-innovation supporting environment", the country shows below average scores in the "level of investment maturity of green technology industry", "level of government's R&D expenditure in green industry", and "level of participation in international environmental treaties" however, the country scores high for having a good "level of environmental laws". In the area of "eco-innovation performance", the country shows low scores in water consumption and CO2 emission intensity levels. However, for the size of the economy and GDP, the country performs respectively well in the "size of the green industry market" and the "level of environmental impact on society". Overall, Malaysia ranks below average on the ASEI index.

Malaysia's Key Eco-Innovation Environment

There are signs that the Malaysian government is just beginning to understand the concept of eco-innovation. National programs and policies promoting eco-innovation are just beginning to emerge in the recent years. Two years ago, the Malaysian government started the Green Technology Financing Scheme (GTFS) that provides loans with two percent subsidy in interest rates and 60 percent guarantee to green companies. With a fund of 1.5 billion RM, this governmental project has offered loans and investment for 6 projects as of 2012 with the support of 20 financial institutions. Such national scheme will enhance the development and performance of green technology companies, accelerating the expected outcomes and activities of eco-innovation.

Launch of National Policy for Green Technology

In 2009, the Malaysian Government launched the National Green Technology Policy to actively promote green technology as a driver of eco-innovation. To enact this policy, the government restructured the Malaysian Energy Center to GreenTech Malaysia (Malaysian Green Technology Corporation) to support the Ministry of Energy, Green Technology and Water (KeTTHA). The National Green Technology Policy has five objectives; 1) to minimize growth of energy consumption while enhancing economic development, 2) to facilitate the growth of the Green Technology industry and enhance its contribution to the national economy, 3) to increase national capacity for innovation in Green Technology development and enhance Malaysia in Green Technology globally, 4) to ensure sustainable development and conserve the environment for future generation, and 5) to enhance public education and awareness on green technology and encourage its widespread use. Under this policy, the government has also established the Green Technology Financing Scheme (GTFS) to improve the supply and utilization of green technology. With a budget of 1.5 billion RM, the scheme is supporting more than 100 companies.[76] The Malaysian government is further working in collaboration with the EU to create and develop green technology market in Malaysia. In the recent 3rd International Greentech and Eco-products Exhibition launched in October 2012, a seminar was launched under the theme of "Financing Solutions for the Future of Green Growth in Malaysia". Such seminar was hosted by the European Union-Malaysia Chamber of Commerce and Industry (EUMCCI) in collaboration with Malaysian Green Technology Corp and the Ministry of Energy, Green Technology and Water (KeTTHA).

Government's Effort to Activate Eco-industry Market

The Malaysian government has put efforts in establishing various programs to activate eco-industry market. As one of them, the GreenTAG Endorse Program was established with the objective to encourage more producers, manufacturers, importers, service providers, wholesalers and retailers to produce green products and services. The GreenTAG Endorse program provides information to consumers to help them make sustainable purchasing decision and at the same time encourages producers to create sustainable products through eco-innovation. Government is also using the Economic Transformation Program (ETP), an initiative to encourage green products and renewable energy. Through ETP, it has been reported that Malaysia is expected to create 53 billion RM of GNI by 2020 through green industries. Moreover, it has been reported that Malaysian green industry market already sized 67 billion RM and grew 6 percent between 2010 and 2011.[77] ETP along with The Malaysian government is putting effort to increase awareness of eco-innovation in the market mechanism through programs such as ETP, GreenTAG and feed-in tariff-system towards renewable energy solutions.

Industry Specific Eco-innovation: Automotive Industry

The Malaysian government is stimulating eco-innovation in specific industries by integrating the concept into industry specific policies and sub-policies. Malaysia is well known to be the global automotive hub, offering opportunities for global automotive and component manufacturers to set up manufacturing and distribution operations in the country. The automotive industry has been developed further by the establishment of national car projects such as Proton and Perodua. In 2009, the Malaysian Government reviewed the National Automotive Policy (NAP) and introduced several sub-policies related to energy efficiency and the use of green technologies. The new NAP promotes hybrid and electric vehicles to make Malaysia a regional and global hub for energy efficient vehicles (EEVs). This is encouraging a shift from fuel efficient vehicles to hybrid, electric and alternatively fuelled vehicles such as compressed natural gas (CNG), liquefied petroleum gas (LPG), biodiesel, ethanol, hydrogen and fuel cell. The newly revised policy also promotes automotive recycling to ensure the

[76] *Ministry of International Trade and Industry, www.miti.gov.my/*

[77] *http://www.aseanaffairs.com/malaysia_news/environment/pm_malaysia_electric_cars_on_the_roads_soon*

sustainability of the industry. The government is encouraging the increase of sales and production of hybrid vehicles through tax incentives, new model launches, consumer education and funding for hybrid vehicle projects. Malaysia is promoting industry specific policies and providing necessary funding to activate eco-innovation in targeted industries.

Eco-Innovation Case Studies

CASE STUDY 1

Proton

Proton is a national car manufacturing company established in 1983. Proton's hybrid feasibility study started in 2004 and hit its stride through government's large-scale grant funding given for research and development of hybrid cars in accordance with National Automotive Policy (NAP) Review. Patron is currently collaborating with UK-based electric & hybrid vehicle technology company, Frazer-Nash Research, and South Korea-based LG. A large support from the government and cooperation between industry and universities have enabled Proton to go further in developing and researching in green technology in the automotive industry. Proton received large amount of grants from the government; 270 million MYR (89 million USD) in 2010, and 100 million MYR (33million USD) in 2012. In 2011, Proton's electric car model 'Saga EV' and extended range electric car model 'Exora REEV' had been subjected to the fleet testing program. Malaysia government is still very positive on the possibility of commercialization of hybrid cars and promised to offer 120 million MYR grants to Proton in 2013. In recent Proton Green Mobility Challenge 2012, it has been announced that the company is expected to gain profits after commercializing EVs in 2014.

Source: http://corporate.proton.com

CASE STUDY 2

Return2Green Sdn. Bhd.

Return2Green (R2G), established in 2009, is an SME which develops and manufactures 100 percent degradable packaging products using biomass. R2B's bio-degradable eco-packaging products are disposable plates, bowl, medical disposal packaging products and AV/IT disposable packing made of polystyrene or plastic. The main material of the products is sugar-cane waste (husk) that degrades and returns to nature within 45-180 days of composting. In 2010, R2B commenced mass production at its new factory attached to a research center. The production process complied with the international quality system such as FDA, HACCP, ISO 9001 and LCA & GMP standards to prepare for exportation of products to foreign countries. As a starting point, R2G is carrying forward Green Technology Park Project which involves the construction of a Bio Tech Center to process agricultural waste into eco-packaging products with the government of Ghana and Africa2Green.
R2G is one of the 217 SMEs which awarded Bio-Nexus status from the Government and the SME Innovation Award 2012 in green technology sector. The Bio-Nexus companies were provided with fiscal supports including Seed Fund, R&D Matching Fund and International Business Development (IBD) Matching Fund as well as tax incentives. They were also provided with non-fiscal support such as corporate management education, accessibility to local laboratories and infrastructure for product testing and research and networking opportunities with other Bio-Nexus companies.

Source: http://return2green.com.my

CASE STUDY 3

Exis Tech Sdn. Bhd.

Exis Tech Sdn. Bhd. (Exis Tech), founded in 2002, is an original equipment manufacturer testing segments for semiconductor and automation industries. As the company seeks sustainability, Exis Tech demonstrates its dedication to introduce green process activities for production. Such effort is well shown in its 'green factory,' a newly constructed facility to target reduction in environmental burden and production costs. Main criteria to be considered and targeted in establishment of the green factory include high energy & resource efficiency, GHGs emission reduction, renewable energy use, environmental certificates, compliance with environmental regulations and etc. Through application of green processes such as water resources with rainwater harvesting, fluorescent lights with LED lights, and etc, Exis Tech is expected to reach not only transition to green process but also great economic benefits. The projected advantages include reduced GHGs emission of 79 tons of CO2 and reduced annual electricity consumption of up to 114,411 kWh which leads to saved cost of approximately 10,000 USD.

Source: ASEIC (2011), ASEM Eco-Innovation Consulting Projects for SMEs Best Practices in Malaysia

SWEDEN

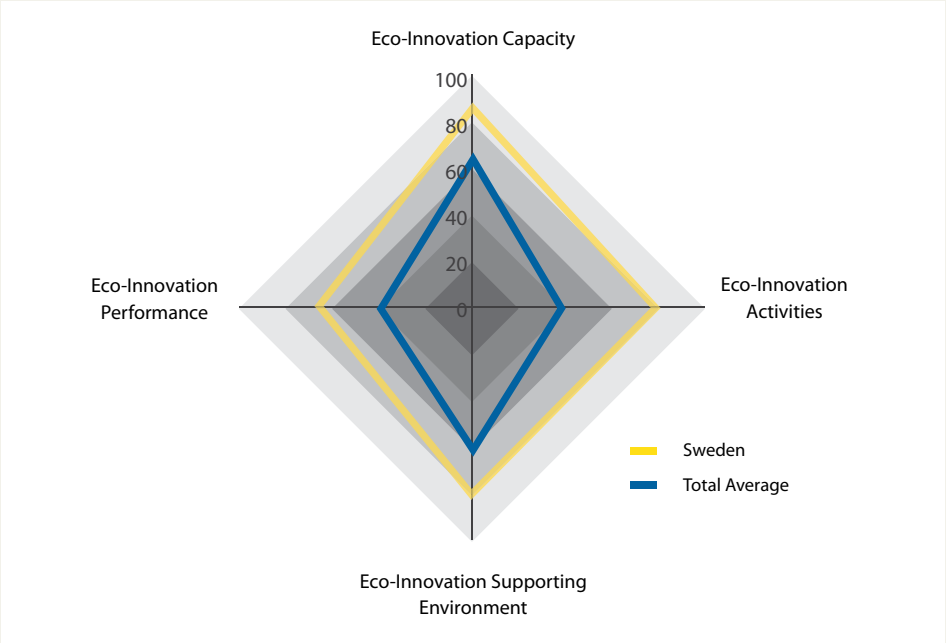

Fig. 18 Result analysis of Sweden

Country Result & Analysis

Based on 20 indicators, which are aggregated into four criteria, Sweden positions high (77/100) in ASEI. Sweden's high score in "eco-innovation capacity" is backed with high "general innovation capacity level", strong country's "economic competitiveness", high "awareness level on sustainability management", a relatively "large amount of investment capital flow in green technology" and "employees in green technology industry". In regards to "eco-innovation activities", the country scores average in "number of green patents" and "turnover of environmentally friendly companies". However, the "number of green technology SMEs at early stage" is much higher than the average. In Sweden, a large number of companies have been successful in commercializing green technology solutions. In the area of "eco-innovation supporting environment", the country scores high in the "level of systematic environmental laws" and "government's R&D expenditure in green industry". Furthermore, amongst the leaders of sustainability, the country is ratified to many international environmental treaties. As an early starter of eco-innovation, there is significant evidence of high performance in "eco-innovation performance" described by the country's high score in "energy sustainability level", "CO2 emission intensity", "water consumption intensity", "environmental impact on society" and "green market size". In regards to "energy sustainability" and "CO2 emission intensity", the country performs well above the average. Overall, Sweden ranks high on the ASEI index.

Sweden's Key Eco-Innovation Environment

Sweden is known for a strong eco-innovation reputation. Based Harmonization of liberal economic policies and strict environmental regulations provide a wider and flexible ground to implement eco-innovation in Sweden. The Swedish Ministry of the Environment set the national Environmental Quality Objectives in 1999;

most of them are to be achieved by 2020. In basis with the 16 set national objectives,[78] active environmental policies and programs have been introduced to address environmental challenges, and eco-innovation has been largely integrated in these policies and programs. The Swedish government built various bodies and institutions to achieve environmental improvement such as the Environmental Protection Agency, The Environmental Objectives Council, Swedish Environmental Technology Council, Foundation for Strategic Environmental Research, The National Environmental Management Authority and Swedish Energy Agency. Eco-innovation in Sweden has long been supported by the government's pro-active push for environmental protection, and it is clear that the government has a holistic view on eco-innovation. Sweden is seen as one of the national best practices in the field of eco-innovation.

Pro-active Government Support towards SMEs

Previously, Swedish government focused on supporting R&D activities to promote eco-innovation. However, realizing that SMEs had the greatest potential to be the drivers and creators of eco-innovation, the government started supporting SMEs in this area. The Swedish Agency for Economic and Regional Growth (NUTEK) implemented the Environment-Driven Business Development program since 2003. This program was set up with an aim to strengthen the competitiveness of Swedish SMEs in the "Environment-driven Markets". The Environment-Driven Business Development program supports projects that are based on cooperation between companies and projects that enhance knowledge about environmentally driven growth. As of 2007, it is reported that the program has provided 40 million SEK in funding for projects.[79] As a pioneer for stimulating SMEs for eco-innovation, Sweden enabled SMEs to develop their business accordingly and strengthen their competitive advantage as eco-innovative companies in the global market.

Green Technology Readiness

The Swedish eco-innovation approach seems to be technology focused. The country's innovative business climate, rapid technology adoption skill, highly conducive environment for R&D and innovation, promising green technology companies and close collaborating setting between universities, industry and governmental bodies allow Sweden to be a global laboratory and test bed for green technologies. The recent figures regarding the green technology sector show that the sector´s turnover increased by 11 percent between 2005 and 2006, to almost SEK 97 billion and exports increased by almost 20 per cent, to just over 25 billion SEK.[80] Due to advanced green technology, currently 45 percent of Sweden's energy supply comes from renewable energy, and the country aims to increase this share to 50 percent by 2020. These advanced figures are supported by the government's initiative and funding to develop Swedish green technology since the mid 2000s. The Swedish Environmental Technology Council (SWENTEC) established in 2008 provides an effective environment to support Swedish green technology companies, while the Swedish Trade Council works to accelerate the globalization of the green technology companies increasing their exports by means of global project collaboration. In addition, VINNOVA, the Swedish Agency for Innovation Systems, funds and supports eco-innovation projects through the "Innovations for a Sustainable Future" program. The agency aims to promote sustainable growth by financing research and development of technology and effective innovation solutions. The Government's environmental technology strategy was further introduced in 2011 to facilitate the development and trade of Swedish green technology solutions. Swedish government has a good

[78] *The 16 Environmental Quality Objectives set by the government are: Reduced Climate Impact, Clean Air, Natural Acidification Only, A Non-Toxic Environment, A Protective Ozone Layer, A Safe Radiation Environment, Zero Eutrophication, Flourishing Lakes and Streams, Good-Quality Groundwater, A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos, Thriving Wetlands, Sustainable Forests, A Varied Agricultural Landscape, A Magnificent Mountain Landscape, A Good Built Environment, A Rich Diversity of Plant and Animal Life*

[79] *Sweden's report to the European Commission (2007), Implementation of the EU Sustainable Development Strategy*

[80] *Invest Sweden, Cleantech report: a country that fully embraces green technologies, http://www.investsweden.se/*

understanding of the role of companies to eco-innovate to act as an engine for green growth. As a leader of technology readiness, the Swedish government recognizes the importance of not only developing new green technology but also diffusing and spreading existing green technology solutions into local, regional and global markets. Furthermore, the country takes forefront approach in searching for the right pricing mechanism in the green market. The Swedish government announced that it aims to invest 400 million SEK in green technology between 2011 and 2014 based on its Strategy for Environmental Technology.[81]

Global Reach through Delivering Eco-innovation Solutions

The Swedish Government considers environmental problems as transboundary challenges that need global solutions that can be applied in various regions and countries. Sweden realizes that environmental problems go hand in hand with poverty, security and health problems that need solving based on holistic thinking. The Swedish International Development Cooperation Agency (Sida)'s Innovation Against Poverty program invites private companies to develop projects, services and business models that contributes to both fighting poverty and climate change. Each year, Sida's IAP program encourages companies to create innovative sustainable business solutions that can be delivered to the international community. In 2011, Sida launched the Green Solutions and Sustainable Development Conference in Kenya to encourage local authorities of Kenya to identify green solutions suitable in the context of Kenya. In the same year, Sida financed the establishment of an environmental technology center at the Swedish Embassy in Beijing called the Center of Environmental Technology (CENTEC). CENTEC promotes the introduction and doing business of Swedish eco-innovative companies in China. More recently, VINNOVA, the Swedish Agency for Innovation Systems, launched a new program called the International Cooperation for Eco-innovations in July 2012. This program aims at strengthening international research and development cooperation for eco-innovation in the field of sustainable urban development, information and communication technology and environmental engineering. Through such programs and initiatives introduced above, Sweden is working on delivering and exporting eco-innovation ideas, solutions and products to emerging countries to support in tackling local challenges while it benefits Swedish companies too.

[81] *Government Offices of Sweden (2011), Environmental Technology – 13 Swedish Solutions*

Eco-Innovation Case Studies

CASE STUDY 1

Solvatten AB

Solvatten AB (Solvatten) is a company that has developed a solar energy water purifier that uses ultraviolet light in sunshine to kill microorganisms in water. The name of the product is Solvatten meaning sun water. This product's design includes two 5 liter compartments with two transparent faces which heat up water to 130 Celsius degrees. This temperature is high enough to kill off disease-causing pathogens. When the water is safe to drink, an indicator light turns from green to red. With this purifier, 11 liters of water is purified in 2 to 6 hours and can be used two to three times a day. The Solvatten water purifiers are distributed to 130,000 people in Kenya. According to Global Autmaning's report, this will enable Nairobi families to save around $150 to $250 per year. This purifier has made some people to do small business by selling purified water to others at an affordable price. Solvatten is now involved in larger scale climate change, clean water and deforestation reduction projects in twenty countries.

Source: http://www.solvatten.se/

CASE STUDY 2

ClimateWell

ClimateWell is most known for its technology that uses solar power for cooling, heating and domestic hot water. The company is one of the most successful green technology start-ups that received a funding support and show rapid growth. This technology is only available technology on the market to provide powered cooling and hot water with embedded solar and waste energy storage. This company's vision slogan is "One billion tons less CO2". The company aims to make a "global sustainable energy supply" through its heating and cooling technology. ClimateWell had been selected as one of the GE's Eco-imagination Challenge awarded firms in 2010. Since then, the company is working on the application of this technology in GE appliances as well as commercial buildings. Due to its rapid growth, this company has been selected as one of the 100 cleantech companies selected by the Cleantech Group. Now the company's green technology is reaching out to other European countries and the Middle East with heat pumps and air conditioning that need zero electricity. ClimateWell promotes that an average family can reduce their CO2 emissions with up to 15 tons per year. Now, ClimateWell is receiving Swedish government support for developing green truck cooling system which reduces fuel consumption. ClimateWell's technology is contributing towards energy efficient society disseminating its technology into various appliances and buildings to reduce power consumption and carbon emission.

Source: http://www.climatewell.com/

CASE STUDY 3

Biorecro

Biorecro is a recognized company that offers Carbon Cleanup service using Bio Energy with Carbon Capture and Storage (BECCS) technology. Carbon Cleanup is a service that captures carbon dioxide from the atmosphere and compress and stores it permanently below the ground to reduce ocean acidification and global warming. BECCS can capture carbon dioxide from biomass which encompasses any type of vegetation and thus can store negative emission. Negative emission is known as a process of removing greenhouse gas from the Earth's atmosphere and is considered the opposite of carbon dioxide emission. It is estimated that 3.5 billion tons of CO2 can be removed from the atmosphere annually by 2050 for a cost of less than 50 Euros per tones. Biorecro is involved in three major projects in the US; Illinois, North Dakota and Kansas. Biorecro has been selected as one of the Climate Solver by WWF in 2010. Biorecro's innovative service and technology have a large potential in mitigating climate change and is attracting new investors and influencing policy makers.

Source: http://www.biorecro.com

THAILAND

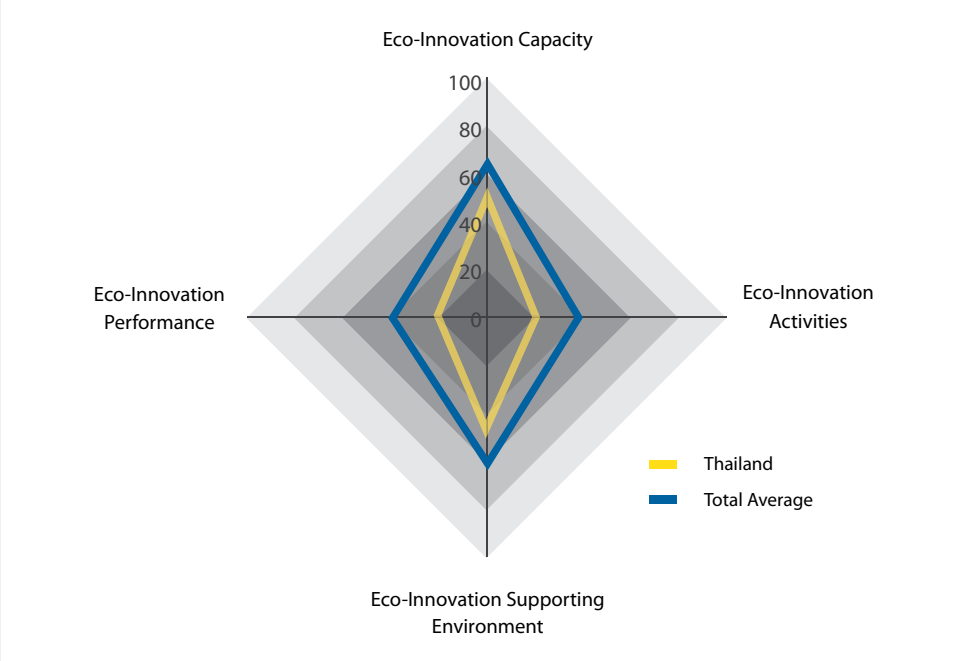

Fig. 19 Result analysis of Thailand

Country Result & Analysis

With an overall score of 33/100, Thailand falls below the average of ASEI. In terms of "eco-innovation capacity", Thailand shows an average level of "awareness on sustainability management", "general innovation capacity" and "country's overall economic competitiveness" but relatively low score on the "size of investment capital flow and number of employees in green technology industry". Regarding "eco-innovation activities", Thailand positions itself below the average in all six indicators behind the measuring criteria; "number of green patents", "turnover of environmentally friendly companies", "green technology SMEs at early stage", "renewable energy utilization level", the "level of environmental management" and the "level of commercialized green technology SMEs". In regards to "eco-innovation supporting environment," the country scores below the average in all of the indicators in the measuring criteria; low "level of environmental laws", small "size of government's R&D expenditure in green industry", low "commitment to international environmental agreements" and low "level of investment maturity of green technology industry". In the area of "eco-innovation performance", the country shows low score in "water consumption intensity", "CO2 emission intensity", "energy sustainability level", and "level of environmental impact on society". However, for the size of the economy and GDP, the country performs respectively well in the "size of the green market". Overall, Thailand ranks below average on the ASEI index.

Thailand's Key Eco-Innovation Environment

Eco-innovation is a less familiar term in Thailand. However, Thailand is placing multi-faceted environmental policy packages that eventually stimulate eco-innovation activities and initiatives. More than twenty government bodies are involved to overcome environmental concerns implementing various incentives, law and regulations and to promote eco-innovation at national level.

Building National Foundation for Eco-innovation to Emerge

Thailand has showed rapid industrial development and urbanization in the past decades, but as the country developed, more environmental concerns have emerged. Although Thailand has enacted its first national level law, the Improvement and Conservation of National Environmental Quality Act in 1975, the country took some time to set up implementable environmental policies until it was replaced by the Enhancement and Conservation of National Environmental Quality Act in 1992. Under this new act, Pollution Control Committee, Environmental Fund, National Committee on Climate Change and the Ministry of Science, Technology and Environment (MOSTE) were established in the 1990s. Recently, the government announced the Eleventh Five-year National Economic and Social Development plan (2012-2016), and under this plan, the government has included an environmental master plan. The Ministry of Natural Resources and Environment and the Ministry of Energy and National Innovation Agency (NIA) established during early 2000 are recently starting to rethink the ways to protect the environment. For example, NIA states that it currently focuses on three strategic areas related to eco-innovation such as Bio-Business and Eco-industry. NIA supports SMEs with "Good Innovation projects" offering incentives. Recently, the Royal Thai Government selected alternative energy as a national agenda, 15-year Renewable Energy Development (REDP) 2008-2022, to enhance energy security. Such active national agenda will encourage companies to research, develop and promote eco-innovative solutions that reduce environmental impact and enhance energy efficiency. Rethinking the emergency of environmental protection, the Thai government, is slowly forming a firm foundation for eco-innovation activities to evolve and accelerate. Gradual recognition of the urgent importance of protecting the environment by the Thai government will eventually provide a larger room for companies to find multi-faceted eco-innovation solutions.

New Incentives to Create Eco-innovation Solutions

New policies for Investment for Sustainable Development 2010-2012 have been introduced by the Thailand Board of Investment (BOI) which is operated under the Ministry of Industry. The BOI is the principal government agency for encouraging investment. BOI supported by the Ministry of Industry and the Ministry of Energy introduces special incentives for companies manufacturing eco-friendly materials and products, energy saving and alternative energy, and high technologies e.g. biotech and nano-tech. These are part of activities to support eco-innovation activities within the country. In 2007, the Thai government decided to grant tax incentives to auto manufacturers that produce energy efficient eco-cars. Companies producing eco-cars may receive the incentive of excise tax rate set at 17 percent compared with the typical 30-50 percent and eight years of exemption from corporate income tax payments and machinery import duties. In 2012, the BOI launched an industrial fair under the theme of "Going Green for the Future" to promote green industry and encourage investment in eco-innovative products while offering "maximum" tax breaks for investors. Increasing government initiated incentives aims to grow the green market, increase awareness of environmental concerns to customers and to reduce environmental impact during manufacturing, consumption, utilization and disposal stage of products. At the same time, while increasing incentives to promote the development of eco-innovation solutions, the government is increasing fines for any environmental damages.

Green Public Procurement Policy to Stimulate Eco-innovative Products

In 2008, Thailand introduced green public procurement policy in collaboration between the Ministry of Natural Resources and Environment, Green Labor Program and Green Leaf Program. This policy encourages all governmental agencies to purchase green products within four years. This policy is significant as public procurement covers about 20 percent of consumption in Thailand. This policy can act as a powerful driver of green purchasing, greening of supply chain and promoting sustainable production and consumption

in Thailand. The Thai government is creating an enabling environment and market for eco-innovation and encouraging eco-labeling products to emerge and get commercialized through government oriented mandatory green procurement. In 2012, the Thailand's Pollution Control Department and German International Cooperation worked together to launch the "Sustainable Consumption and Production for Low Carbon Economy – Low Emissions Public Procurement and Eco-Labeling" (SCP4LCE) project that will run until June 2015 to further promote eco-labeling and eco-innovative products. This project is financed by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and executed by German International Cooperation and key partners including the Pollution Control Department (PCD), the Thailand Environment Institute (TEI), The Federal of Thai Industries (FTI) and the Thailand Greenhouse Gas Management Organization (TGO). This project expects to influence the private sector in Thailand, encouraging companies to produce more eco-innovative products. Furthermore, it is expected that green consumption and production patterns will emerge in Thailand. Such international cooperation represents an encouraging sign that the government intends to work collaboratively with countries advanced in this area.

Eco-Innovation Case Studies

CASE STUDY 1

Mitr Phol Sugar Corporation Limited

Since 1994, the government of Thailand has put efforts to promote small power producers (SPPs) to employ biomass as fuel in the energy generation process through Renewable Energy Promotion project. Under this project, one of the largest sugar producers in Thailand, **Mitr Phol Sugar Corporation Limited (Mitrphol)** started the project of new boilers installation at Dan Chang Mill in 2002. It is common for a company with large sugar mills to operate its own steam and power generation plants by using their by-product, bagasse, as a main source of fuel, but Mitrphol was able to enjoy a lot more benefits along with the implementation of a new generator. Through this project, Mitrphol received pricing subsidies via Electricity Generating Authority of Thailand (EGAT) as the government's Energy Conservation Promotion Fund. EGAT also allows SPPs to sell any excessive power demand to the country's power grid through a contractual agreement. The new generator's efficiency is four times better than the old one, and it provides more reliable electricity supply. Since the power is generated by recycling of by-products and waste from sugarcane, its production process promises zero waste with the recycling of power and water. Mitrphol received the carbon label for its natural mineral sugar products from Thailand Greenhouse Gas Management Organization. The award was granted for its ability to reduce carbon emission and global warming. Mitrphol's syrup was also awarded for the Best Creative Food Product of the Year, and it was praised for saving time, energy and cost. In addition, the company won the Project of the Year Thailand ICT Excellence Awards in 2009 for the second time in a row.

Source: http://enviroscope.iges.or.jp/contents/APEIS/RISPO/inventory/db/pdf/0136.pdf
http://enviroscope.iges.or.jp/contents/APEIS/RISPO/inventory/db/pdf/0136.pdf
http://www.thaipr.net/products/296645

CASE STUDY 2

Thai Num Choke Textile Co., Ltd.

Thai Num Choke Textile Co., Ltd. (Thai Num Choke) is a textile company that produces fabrics for apparels, home textile, shoes, bags and packaging. Thai Num Choke takes an eco-innovative approach to produce eco-friendly fabrics by blending with banana fiber, galangal fiber and pineapple fiber. In addition, Thai Num Choke dyes its fabrics in a natural way using tea, betel nut, lac and tropical walnut, and it uses natural color cotton. The supporting institutes behind the company's eco-innovation products are National Innovation Agency (NIA), Thailand Textile Institute (THTI), and National Science & Technology Development Agency (NSTDA). Thai Num Choke's eco-friendly fabric is sold in domestic and international market such as ASEAN countries, Japan and EU, and its future potential market includes North America. Thai Num Choke has been recognized for its creativity and environmentally friendly products. The company was named the winner of the Design Innovation Contest, DIC 2011 in Eco-Friendly Design category, Thai Creative awards from the Office of Knowledge Management & Development (OKMD) and DeMark award from the Ministry of Commerce.

Source: http://www.thailand-innovativecompanies.com/ttd_bizenterprise/companyFeaturesTTIC.aspx?dirid=97&cocode=20111046, http://fabricwoven.com/about.php

CASE STUDY 3

Thai Motor Chain Co., Ltd

Thai Motor Chain Co., Ltd (TMC) is a leading motorcycle chain manufacturer which has been in the business for over 30 years. A problem that TMC faced in its production process was its high energy cost brought by the cooling system of heat treatment for its products. The company's eco-innovative effort started with eliminating a factor of 'waste of unnecessary processing,' which involved simplifying its cooling system. TMC's cooling system runs with water using two water pumps, and one of the two pumps was removed to prevent the excessive use of water. In addition, the load on the electric heater for heating of the washing water was reduced through recycling of waste heat from the heat treatment. This kind of systematic changes in its production line brought successful outcomes to TMC. Through elimination of a pump, the company is able to save 2,557 USD from saved energy consumption and reduce GHGs emissions by 11.1 tons of CO2. Furthermore, the recycling of waste heat brings saved annual cost of 9,673 USD and reduction of GHGs emissions by 35.6 tons of CO2.

Source: ASEIC (2011), ASEM Eco-Innovation Consulting Projects for SMEs Best Practices in Thailand

UNITED KINGDOM

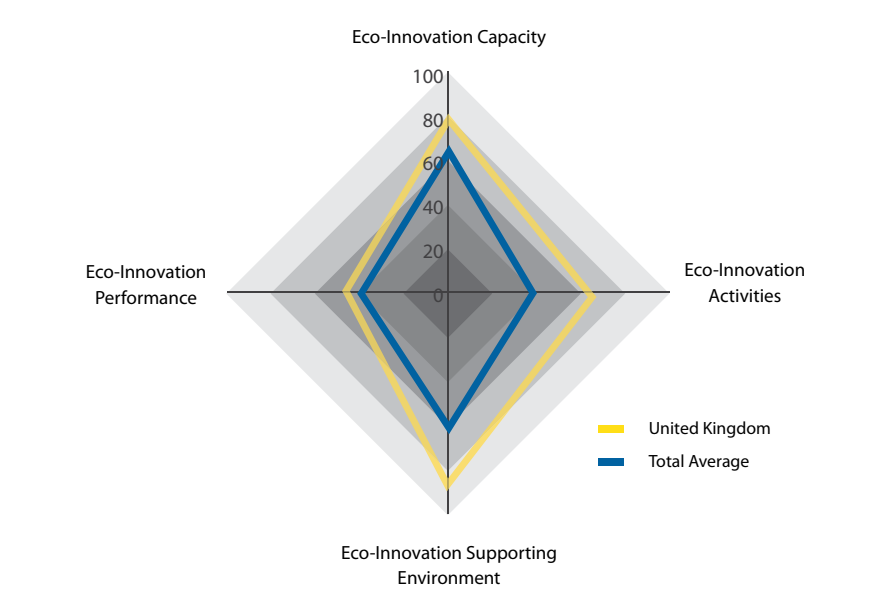

Fig. 20 Result analysis of United Kingdom

Country Result & Analysis

Based on 20 indicators, which are aggregated into four criteria, the result shows overall high score (71/100) in ASEI. The UK's relatively high "eco-innovation capacity" is supported by the country's strong "economic competitiveness", high "level of general innovation capacity" and large "amount of investment capital flow in green technology industry". The UK's "eco-innovation activities" are measured with six indicators; "renewable energy utilization level", "number of green patents", "level of commercialized green technology SMEs", "green technology SMEs at early stage", "level of environmental management" and "turnover of environmentally friendly companies". The country shows high "level of commercialization of green technology SMEs" backed with large number of green technology related companies. According to the Department of Business, Innovation and Skills, there are currently around 51,600 companies in the field of green technology with respectively large number of number of employees involved, and both figures have increased in the last three years. The enterprises also take part in the country's eco-innovation activities by maintaining environmental management system. The UK scores the highest in its "eco-innovation supporting environment" which is based on "investment maturity of green technology industry", "government's R&D expenditure in green industry", "level of environmental laws" and "country's commitment to international environmental agreements". The level of UK's "eco-innovation performance" is higher than ASEM member countries assessed. The country shows relatively high scores in "green industry market size", "water consumption intensity" and "CO2 emission intensity". Overall, UK ranks well above the average on the ASEI index.

UK's Key Eco-Innovation Environment

With the formation of coalition government in 2010, the UK government claimed "the Greenest Government Ever" in hopes to make transition to a green economy. Under the promotion of this campaign, the UK coalition government published the Roadmap to a Green Economy in 2011 supported by Department of Environment, Food and Rural Affairs (DEFRA), Department for Business, Innovation, and Skills (BIS) and Department for Energy and Climate change (DECCS). This roadmap set various policy tools to support the transition to a

greener economy and provides guidelines of how business should react to such implications. DEFRA, BIS and DECC are working together to ensure that there are consistent policy framework to encourage eco-innovation under this set roadmap at national level. Although there have been some setbacks due to the economic downturn, it is expected that the government will consistently promote eco-innovation through green business.

National Low-Carbon Strategy Promotes Eco-innovation Activities

In November 2008, the UK has adopted a new Climate Change Act which put the government in position to set objectives and changes as needed. The government's low carbon strategy aims to reduce the carbon emission rate by 80 percent in relative to the 1990 level by 2050. Under the Climate Change Act, the UK created the Carbon Reduction Commitment Energy Efficiency Scheme which regulates companies with more than 6,000MW of electricity use to meet mandatory emission reduction rate. Another noteworthy policy seeking improvements in energy efficiency is the Green Deal, proposed in hopes to revolutionize the energy efficiency of British buildings. Green Deal is an innovative financial mechanism which allows the companies to provide consumers improvements in energy efficiency without upfront costs and let the consumers pay back through their energy bills. As for renewable energy, the UK is committed to supplying 15 percent of its energy consumption from renewable sources by 2020 with interim biannual targets.[82] To reach such target, the government has implemented a regulatory policy to support renewable electricity projects in the UK. With numerous carbon reduction scheme and policies, the country promotes low carbon technology development and the renewable energy field. This leads to increasing room for eco-innovation activities to emerge focused on energy efficiency.

Maturing Eco-Industry Market

The UK's eco-innovative solutions and products are well commercialized in the UK. Due to flexible business environment and support from the government, eco-innovative solutions and products enter the market more easily than other countries. The UK government's supportive approach to promote eco-innovation within the industry includes programs and financial incentives focused on low carbon technology, electric vehicles and alternative fuel. In 2012, the UK government disclosed new funding program to support and promote development of low-carbon technologies among SMEs, including 35 million GBP for Energy Entrepreneurs Fund, 3 million GBP for heat storage innovation, and the launch of online funding navigator. In the same year, the government announced the launch of UKH2Mobility project to facilitate commercialization of hydrogen fueled cell electric vehicles. The main content of the project concerns evaluation of the potential of hydrogen fuel to be introduced in 2014-2015 including financial support of 400 million GBP. As the UK government understands the role of companies to stimulate eco-innovation activities, eco-innovation is expected to be further promoted at company, industrial and national level in the UK.

Plan to Foster Green Investment Bank

As a result of the government's legal commitment following Climate Change Act, the government projected the size of necessary investments available for the next two decades ranging from 200 billion GBP to 1 trillion GBP. The UK government announced a plan to launch the first green investment bank to attract private funds

[82] *UK Department of Energy and Climate Change (2011), UK Renewable Energy Roadmap*

for the financing of the private sector's investments related to environmental preservation and improvement in 2010. The world's first green investment bank is to capitalize GBP 3 billion. Prior to expected approval of GIB in the late 2012, known as the 'incubation' phase, the government has made direct green investment through UK Green Investment team under the Department of Business, Innovation and Skills. The UK government disclosed its commitment to invest GBP 180 million on fully commercial term in waste and non domestic energy efficiency infrastructure projects. Now the government expects to obtain the European Commission's approval for state aid to the Bank by early 2013. If this Green Investment Bank successfully launches as an official body, more companies would benefit from getting involved in eco-innovation projects and more money or funding would go to companies that have the ability to produce eco-innovation products and technology solutions in the UK.

Eco-Innovation Case Studies

CASE STUDY 1

Unilever

Unilever has more than 400 brands, and its products include foods, beverages, cleaning agents and personal care products. In 2004, Unilever introduced laundry detergent, Surf Excel, targeting regions with water scarcity problems such as southern states of India, Andhra Pradesh and Tamil Nadu. By adding a number of anti-foam ingredients and yet preventing significant suppression of lather during the main wash, the company was able to create the rebalanced formulation that reduced the number of rinsing using less water. With the product's launch in India, Surf Excel has allowed to save approximately 14 billion liters of water each year. From its successful experience of creating more environmentally friendly product in developing markets, Unilever plans to use its know-how skill to expand its market in Europe and other emerging markets.

Source: http://www.unilever.co.uk/innovation/productinnovations/default/index.aspx

CASE STUDY 2

Green Biologics

Green Biologics Ltd (GBL) is an industrial biotechnology SME which develops microbial, fermentation and process technology to turn readily available and low-cost waste and agricultural by-products into high-quality chemicals and fuels. GBL was listed in the 2011 Global Cleantech 100 making in the top ten cleantech companies. GBL produces butanol using the company's own fermentation process and distillation technology with industrial proven microbial strains. Through such process, the company was able to provide cost-competitive biofuels further reducing the cost. GBL does not only target the biofuels and biochemicals market in the UK but also plans to target opportunities in China, India, Brazil and US. The company has already established a strong base in China by joining partnerships with several Chinese clean technology companies in energy and biochemicals such as China New Energy, Guangxi Jinyuan Biochemical Company and Lianyungang Union of Chemicals Company. With the establishment of partnerships in China, GBL seeks support of its commercial operation in the emerging market.

Source: http://research.cleantech.com/company/green-biologics

CASE STUDY 3

Carbon Trust

Carbon Trust is a not-for-dividend private company, founded in 2011 in hopes to make a sustainable and low-carbon economy by helping and providing services to organizations. Carbon Trust provides advisory services to promote sustainable challenges and environmental management of companies. In addition, its Carbon Trust Standard measures the environmental footprint of organizations, products and services. With this measurement, carbon certifications and carbon labeling are issued to best practiced companies. Carbon Trust supports organizations by providing funding and loans to aid development and deployment of low carbon technology. With help of Carbon Trust's services, Dyson, a British manufacturer of vacuum cleaners, hand dryers, bladeless fans and heaters, was able to develop one of the most energy-efficient hand dryers in the world. There are around 37 organizations of which Carbon Trust is carrying out case studies.

CARBON TRUST

Making business sense of climate change

Source: http://www.carbontrust.com

Conclusion

The ASEM Eco-Innovation index (ASEI) represents the first effort to measure eco-innovation status of both Asian and European countries. This report provides a measurement framework and metric for eco-innovation, one of the most central ideas in catalyzing green growth and elevating competitiveness in green economy of a country.

The first ASEI reveals a wide range of results and findings on the regional and global trends of eco-innovation. In this report, we were able to explain the variation of eco-innovation potentials of the two regions, Europe and Asia. The distinct approaches to eco-innovation taken by fifteen countries have been specified in this report, in addition to case studies that provide valuable information that sheds light on how eco-innovation is emerging through business practices.

Based on our in-depth analysis of eco-innovation, the report's findings show that Europe and Asia are at different development stages of eco-innovation. There are countries that have been successful in promoting and implementing eco-innovation and countries that are merely beginning to understand the concept. Most European countries, being the pioneers of eco-innovation, have built a firm foundation to foster eco-innovation activities with strong government support. Such insight is apparent and proven to be effective in the result of ASEI; higher ranks of the ASEI are dominated by the European countries, followed by economically advanced Asian countries such as Japan, China and Korea.

As late starters of eco-innovation, Asian countries lag behind in all four criteria of eco-innovation and are positioned at the bottom of the ASEI ranking. However, ASEI reports show that Asian countries have high eco-innovation capacity to catch up to the frontrunners. To do this, it is vital for Asian countries to transfer this eco-innovation capacity to eco-innovation activities. In this process, we found that the role of government is crucial. Our analysis from case studies reveals that eco-innovation activities are slowly emerging at the company and industrial level in Asia. We have analyzed that this emergence considerably correlates with the government's increasing push towards resource efficient or green economy. In case of China, government support towards renewable energy is moving Chinese companies to develop new green technologies and solutions to take the advantage of receiving additional funding or incentives. It is clear that government support towards eco-innovation matters highly in terms of driving companies to eco-innovate. Increasing levels of government support towards green growth in Asia with increasing more vibrant eco-innovation activities, are expected to influence the overall rankings of ASEI in the future. There are significant signs that some Asian countries like China, India and Korea are striving their way to catch up the rankings of the eco-innovation advanced countries.

It is imperative that Asian companies need to increase their awareness on eco-innovation and of its positive implication on their business. From the case study analysis, we have discovered the capability of Asian companies to be the creators, providers and exporters of eco-innovation solutions within the next ten years. Here, we point out that government's public-private partnership programmes may be one of the methods to assist these companies to explore the opportunity of entering the global green market.

The potential of eco-innovation potential of each country varies with country specific circumstances and level of industry development and our analysis demonstrates that there is no blueprint for successful eco-innovation model. Consequently, it is crucial for governments to find where each country's eco-innovation capacity and resources lie and increase government funding, research programnmes and networking platforms accordingly. Various eco-innovation approaches can be effective in stimulating the green market and facilitate green revolution in a country.

To take a range of diverse approaches towards eco-innovation, it is vital that countries should have more comprehensive understanding, eco-innovation. Currently, Asian countries seem to understand eco-innovation simply as a mean to develop new green technologies. Most government support in Asian countries of eco-innovation is focused on stimulating innovation through technology. Meanwhile, European countries appear to understand eco-innovation from a broader perspective. As mentioned in the beginning of this report, eco-innovation involves both technical and non-technical innovation that brings positive value to the environment. Integration of innovation and environment focused policies, national strategies, business models, products, designs, services and technologies can be any starting point of stimulating eco-innovation at the company, industry and national levels. European countries need to take the lead in promoting eco-innovation, so that Asian countries can gradually comprehend the meaning of both non-technical and technical approaches towards eco-innovation. As the definition of eco-innovation is getting more generalized, it provides space for eco-innovation activities to emerge in different sectors in various ways.

The Way Forward

We have taken the first step towards providing a measurement framework and metric for eco-innovation beyond Europe. ASEI 2012 offers policy makers a comprehensive accounting tool for measuring eco-innovation. The main objective of this research is to encourage eco-innovation outside Europe and highlight the need for eco-innovation targeted policy based on analytical data. This research is expected to be used by governments in the process of developing research and funding programmes or networking platforms to promote eco-innovation. Additionally, we hope that this report can be an aid towards building a foundation that can form stronger rigid partnerships between European and Asian countries in the future. In the long run, ASEI aims to become an important reference that monitors the progress of green growth of ASEM member countries. Increasing awareness of eco-innovation and development of eco-innovation activities over time will have important implications for green growth in the future.

ASEI 2012 has been challenged with lack of available internationally comparative data in the field of eco-innovation. Considering such daunting challenges, current ranking of ASEI 2012 should carry less weight or significance in overall research. Rather, as mentioned before, we hope to have highlighted various types of eco-innovation approaches that can be taken at the national level. Better data to measure eco-innovation is urgently needed to make a noteworthy improvement in ASEI 2013. We stress that ASEI will enhance its framework by replacing some indicators as more rigid data and analysis appear in the near future. Over time, ASEI expects to present new insights and data on eco-innovation.

APPENDIX I: INDICATOR DETAILS

Indicator	Detail	Weight
Eco-Innovation Capacity		
Country's Economic Competitiveness	• **Definition** Factors that enhances country's economic competitiveness such as higher education and training, goods market efficiency, labour market efficiency, financial market sophistication, technological readiness, and market size • **Source** WEF, Global Competitive Index	20%
General Innovation Capacity	• **Definition** Factors that facilitate country's level of general innovation capacity including institutions, human capital & research, infrastructure, market sophistication and business sophistication. • **Source** INSEAD, Global Innovation Index	20%
Level of Awareness on Sustainability Management	• **Definition** Social responsibility of business leaders • **Source** IMD, World Competitive Yearbook	20%
Value of Investment in Green Technology SMEs	• **Definition** Total amount of investment made in green technology industry in proportion to GDP • **Source** Cleantech Group	20%
Jobs in Green Technology Industry	• **Definition** Total number of jobs in green technology industry in proportion to total workforce • **Source** Cleantech Group	20%
Eco-Innovation Activities		
Renewable Energy Utilization Level	• **Definition** Share of renewable energy in total energy consumption • **Source** International Energy Agency	17%
Green Patents	• **Definition** Share of green patents in total number of patents • **Source** World Intellectual Property Organisation	17%
Level of Commercialised Green Technology SMEs	• **Definition** Number of firms with widely-commercialised green technology in proportion to the country's economy size • **Source** Cleantech Group	17%
Green Technology SMEs at Early Stage	• **Definition** Number of firms with 'early stage' green technology in proportion to the country's economy size • **Source** Cleantech Group	17%
Level of Environment Management	• **Definition** Number of organisations with ISO 14001 certification per billion PPP$ GDP • **Source** INSEAD, Global Innovation Index	17%
Turnover of Environmentally Friendly Companies	• **Definition** Total amount of revenue of companies listed in Global Green Ranking 500 • **Source** Sustinvest/ Sustainalytics	17%

Indicator	Detail	Weight
Eco-Innovation Supporting Environment		
Investment Maturity of Green Technology Industry	• **Definition** Number of local green investors and number of successful investment deals made in green technology industry • **Source** Cleantech Group	25%
Government's R&D Expenditure in Green Industry	• **Definition** Total amount of government's expenditure on R&D in green industry per GDP • **Source** International Energy Agency	25%
Level of Environmental Laws	• **Definition** Environmental laws and compliance fostering the competitiveness of business • **Source** IMD, World Competitive Yearbook	25%
Country's Commitment to International Environmental Agreements	• **Definition** Number of international environmental treaties that the country is committed to • **Source** WEF, Sustainable Competitiveness Index	25%
Eco-Innovation Performance		
Green Industry Market Size	• **Definition** Market size of low carbon and environmental goods and services in proportion to country's total market size • **Source** UK Department for Business, Innovation & Skills	20%
Water Consumption Intensity	• **Definition** Country's water consumption level per GDP in 1,000 USD • **Source** IMD, World Competitive Yearbook	20%
CO2 Emission Intensity	• **Definition** Country's level of CO2 emission per GDP in million USD • **Source** IMD, World Competitive Yearbook	20%
Energy Sustainability Level	• **Definition** Factor that affect country's level of energy sustainability including energy security, social equity, environmental impact mitigation, and political, societal & economic strength • **Source** World Energy Council	20%
Level of Environmental Impact on Society	• **Definition** Environmental impact on quality of life based on environmental burden of disease, adequate sanitation of water, drinking water, indoor air pollution, urban air pollutant particulates, and level of local ozone • **Source** Yale University/ Columbia University, Environmental Performance Index	20%

APPENDIX II: ANALYTIC HIERARCHY PROCESS (AHP)

Analytic hierarchy process (AHP), developed by Thomas L. Saaty, is a method that is widely used for decision making in a complex situation and can be easily applied in various fields. AHP is based on the mathematical structure of consistent matrices and their Eigen-values' ability to generate true or approximate weights[83] AHP method can be explained in four steps:

1. The decision making process starts with forming the problem into hierarchy of sub-problems. Options are paired up within criteria, and each pairs are considered independently.
2. Decision factors are compared, and the results are collected in a matrix form.
3. Using the Eigen-value method, the relative weights are calculated.
4. The final synthesised result provides the ranking/priority of all decision factors.

AHP provides information to help decision situations such as ranking, prioritisation, resource allocation, benchmarking, quality management, and conflict resolution. In our case, AHP was used to process selecting most important indicators of ASEI framework among all candidate indicators. In order to select indicators that best suit the indicators for ASEI, opinions of experts in the related field were taken into consideration. As a result of the experts' survey, among candidate indicators, the following indicators were pointed out as more important factors when measuring a country's eco-innovation:

(The order of the list does not imply the ranking of importance)

- CO2 Emission Intensity
- Country's Commitment to International Environmental Agreement
- Country's Economic Competitiveness
- Energy Sustainability Level
- General Innovation Capacity
- Government's R&D Expenditure in Green Industry
- Green Industry Market Size
- Green Patents
- Green Technology SMEs at Early Stage
- Investment Maturity of Green Technology Industry
- Jobs in Green Technology Industry
- Level of Awareness on Sustainability Management
- Level of Commercialized Green Technology SMEs
- Level of Environmental Impact on Society
- Level of Environmental Laws
- Level of Environmental Management
- Renewable Energy Utilization Level
- Turnover of Environmentally Friendly Companies
- Value of Investment in Green Technology SMEs
- Water Consumption Intensity

[83] *E. Forman and S. Gass (2001), The Analytic Hierarchy Process – An Exposition*

INDICATOR REFERENCE

Indicator	Reference
Country's Economic Competitiveness	Efficiency enhancers are the key for efficiency-driven economies. Countries will then move into the efficiency-driven stage of development, when they must begin to develop more efficient production processes and increase product quality because wages have risen and they cannot increase prices. At this point, competitiveness is increasingly driven by higher education and training, efficient goods markets, well-functioning labour markets, developed financial markets, the ability to harness the benefits of existing technologies, and a large domestic or foreign market. - *WEF(2008), Global Competitiveness Report 2008-2009*
Level of Awareness on Sustainability Management	CSR can be defined as the overall contribution of business towards achieving sustainable development goals. –*UN (2007)* CSR holds many direct benefits for businesses and society as a whole. In the case of promoting the greening of industries, businesses benefit from reductions in energy and waste bills and lower input costs. Employees also benefit from safer working conditions and increased training and capacity building. - *UNIDO (2010), UNIDO Green Industry: A policy framework for supporting the greening of industries*
Renewable Energy Utilization Level	Greenhouse gas (GHG) emissions resulting from the provision of energy services have contributed significantly to the historic increase in atmospheric GHG concentrations. Renewable energy sources have a large potential to displace emissions of greenhouse gases from the combustion of fossil fuels and thereby to mitigate climate change. - *IPCC SRREN (2012), Summary for Policy Makers*
Green Patents	Relatively limited evidence is currently available on patterns of green innovation. The available indicators of green patenting, an indicator of the rate of invention, show that renewable energy and air pollution control are the most dynamic groups of environmental technologies among patent applications filed under the Patent Cooperation Treaty. - *OECD(2011), Towards Green Growth*
Level of Environment Management	Disseminating and demonstrating the benefits of environmentally sustainable and resource-efficient industries (e.g. lower energy inputs, raw material usage) is an effective way of fostering the adoption of new production methods.- *UNIDO (2010), UNIDO Green Industry: A policy framework for supporting the greening of industries*
Government's R&D expenditure in Green Industry	Science and technology are central to transforming manufacturing industries towards sustainable patterns of production and economic growth. Enterprises and industries are becoming increasingly aware of the prospects that environmental technologies hold – not just in terms of improved environmental outcomes, but also the potential to reap economic rewards from increased efficiencies and new business opportunities. - *UNIDO (2010), UNIDO Green Industry: A policy framework for supporting the greening of industries*
Level of Environmental Laws	Governmental support has long been central in moving forward next-generation technologies and in promoting radical innovation and systemic changes – *OECD (2011), Fostering Innovation For Green Growth: The Role of Business Models in Green Transformation*

Country's Commitment to International Environmental Agreements	Vertical integration involves integration between international, national, state, and local tiers of government. Once an MEA enters into force, it takes legal effect and implementation begins. - *UNIDO (2010), UNIDO Green Industry: A policy framework for supporting the greening of industries*
Green Industry Market Size	As demand for environmental services, equipment and technologies has been increasing, mainly pushed by regulatory demands in developed countries, the environmental industry has become a dynamic growth pole in OECD countries. Sustainable lifestyles and consumption patterns are key agenda items addressed by United Nations agencies such as WHO, UNEP, UNDP, the World Food Programme, ITU and UN-HABITAT insofar as they are closely related both to trends in health and quality of life as well as to human and sustainable development overall. - *UN (2011), Working towards a Balanced and Inclusive Green Economy: A United Nations System-wide Perspective*
Water Consumption Intensity / CO2 Emission Intensity	The resource efficiency aims to measure the extent to which countries are using existing resources in an efficient manner, thus directly supporting higher productivity and competitiveness. the water intensity of agriculture in an economy, which considers the extent to which the agriculture sector is efficient in its use of water; the efficiency of energy use as measured by the economy's energy output as a percentage of GDP; and the CO2 intensity of energy use at the national level, which measures the emissions of CO2 that result from the consumption of solid fuel in an economy. - *WEF(2011), Global Competitiveness Report*
Level of Environmental Impact on Society	A high-quality natural environment supports a healthy workforce, avoiding damaging effects on human capital (such as illness and lower human capital productivity) that can be brought about by pollution and other environmental degradation. Environmental degradation can also directly reduce the productivity of sectors such as agriculture, which in turn lowers output and potentially the ability for a country to meet the food needs of the population. - *WEF(2011), Global Competitiveness Report*

DEFINITIONS

Green Growth
Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. (OECD, 2011)

Green Competitiveness
Applying strategy to achieve productivity and overall performance of socio-economic development while reaching the goal of sustainable development (OECD, 2012)

Eco-efficiency
Eco-efficiency is producing more goods and services with less energy and fewer natural resources (OECD, 2012)

Resource efficiency
Resource efficiency means reducing the environmental impact of the consumption and production of goods and services over their full life cycle. The 'doing more with less' slogan indicates the focus on more outputs with fewer impacts (fewer resources, less pollution, fewer impacts on the conditions of poor people). (UNEP, 2008)

Green Business
Green business means innovative products to decrease environmental impacts and use fewer resources, as well as services that facilitate a better match between supply and demand of eco-innovative solutions and help eco-innovation into the market (European Union, 2011)

Eco-industry
The core eco-industries are "those [identifiable] sectors within which the main – or a substantial part of – activities are undertaken with the primary purpose of the production of goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems." (Ecorys, 2009)

Environmental Technology
Environmental Technology is a technology that advances sustainable development by reducing risk enhancing cost effectiveness, improving process efficiency and creating products and processes that are environmentally beneficial or benign. (EcoAP, 2012)

Sustainable Development
Sustainable development means integrating the economic, social and environmental objectives of society, in order to maximise human well-being in the present without compromising the ability of future generations to meet their needs. (OECD, 2001)

Green Economy
In a green economy, growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. (UNESC, 2011)

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ASEAN - Association of Southeast Asian Nations *www.aseansec.org*

EEA - European Environment Agency *www.eea.europa.eu*

EPO - European Patent Office *www.epo.org*

European commission *ec.europa.eu*

ICTSD - International Center for Trade and Sustainable Development *ictsd.org*

IEA - International Energy Agency *www.iea.org*

ILO - International Labor Organization *www.ilo.org*

IMF - International Monetary Fund *www.imf.org*

IPCC - Interovernmental Panel on Climate Change *www.ipcc.ch*

OECD - Organisation for Economic Co-operation and Development *www.oecd.org*

OECD Statistics *stats.oecd.org*

SERI- Sustainable Europe Research Institute *seri.at*

UN - United Nations *unstats.un.org*

UN ESCAP - Economic and Social Commission for Asia and the Pacific *www.unescap.org*

UNEP -United Nations Environment Programme *www.unep.org*

WBCSD - World Business Council for Sustainable Development *www.wbcsd.org*

World Bank *www.worldbank.org*

WEF - World Economic Forum *www.weforum.org*

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WWF - World Wide Fund for Nature wwf.panda.org