Asia-Pacific
Economic Cooperation

Policy Review for Low-Carbon Town Development Project in Koh Samui, Thailand

Final Report

June, 2013

Report for the APEC Energy Working Group

CONTENTS

PREFACE

The APEC Low-Carbon Model Town (LCMT) Project seeks to promote low-carbon technologies in city planning in order to manage rapidly growing energy consumption and greenhouse gas emissions in urban areas of the APEC region.

The key objectives of the project are;

1) To develop "The Concept of the Low-Carbon Town in the APEC Region", which is intended to be a guidebook to the principles and implementation of low-carbon design;

2) To assist in the implementation of the concepts in selected towns by providing feasibility studies and policy reviews of these planned urban development projects;

3) To share best practices and real-world experiences of low-carbon design with planners and policymakers throughout the APEC

This report presents the findings of Policy Review for Samui Island Development Project , Thailand.

The primary accountability of each policy review is shared by the economy being reviewed and the Review Team. The Policy Review in Koh Samui, Thailand was conducted by a team of seven experts (see Appendix A) who visited Koh Samui from 24 to 27 September 2012.

During the visit, the Review Team had comprehensive discussions with representatives and experts from government agencies, private and state companies (see Appendix B). The Review Team wishes to thank all the presenters and others that spent time with the team for discussions, especially The Thailand Ministry of Energy- Department of Alternative Energy Development and Efficiency (DEDE), and EEC Engineering Network (EEC) who organised the event.

EXECUTIVE SUMMARY

Koh Samui is a small island situated in the Gulf of Thailand and located in Suratthani Province, approximately 750 km to the south of Bangkok. Whilst the island's population is small at approximately 54 000 registered people and unregistered population of about 6 times of the registered population, tourists number up to 1.1 million annually. Given the islands main industry is tourism and the large number of visitors travelling to Koh Samui annually, the island is making great strides in achieving low-carbon status.

At the national and local economy level, targets on emissions reductions have been set, even at a sector by sector level. However, it is important that these targets are reviewed periodically and that accurate data, particularly on the demand side is collected so that valuable monitoring and target reviews can be made.

Great work is being carried out in developing a low-carbon compatible town structure. Ambitious plans are in place and are all inclusive, involving the local community. It is important however when undertaking ambitious plans that much thought goes into how it will affect the local community and at times assistance may be needed from the central government, close coordination between local and central authorities will prove fruitful in achieving a well functioning town and satisfied local population.

Eco lifestyle is a very important component in achieving a low-carbon town; it is thus highly commendable that it is being considered as part of Koh Samui's low-carbon strategy. The establishment of a low-carbon school, exposing the young population of Koh Samui to low-carbon measures that they themselves can implement at home such as recycling, is instrumental in creating and maintaining a low-carbon environment. Such knowledge can be passed on from children to parents and create a positive multiplier effect on the island. The review team encourages plans for an Eco Research Centre that in addition to low-carbon research involves the local community in low-carbon training programs and is able to provide them with a useful skill base and possible employment opportunities on the island.

Even though Samui island is small as is its population, because of the large number of tourists visiting annually, energy needs are relatively high for an island of its size. Given the energy requirements of the island, area energy planning management is very good. However there are other energy management options including the export of energy from the island that could be considered, one such option put forward by the review team is to possibly consider the use of cables to export renewable energy to mainland and/or other islands and to link to offshore wind farm(s).

The review team found environmental planning on Samui island to be well thought out. However it is important that relevant authorities build on the experience of successful waste management strategy to engage and empower business (including local tourism association) and community on other environmental issues and also include a wider range of environmental issues in their planning in order to achieve an all encompassing strategy.

Given the number of hotels and resorts on the island there is plenty of potential to develop or adopt a green building benchmark that identifies facilities that have achieved efficient use of energy and water, this will be beneficial to hotels and resorts as well as they look at marketing their respective properties

as eco-friendly. The option of retrofitting some of the old buildings on the island to make them low-carbon should also be considered.

The review team was pleased to see that low-carbon transport options are being considered in the development of Koh Samui as a low-carbon town; however it is vital that a thorough analysis of the access/transport requirements for freight, tourists and local residents is conducted, so that an appropriate mix of solutions can be developed and implemented. It would also be in the islands best interest to utilise current low-carbon vehicle technology such as smart cars to maximise benefits.

Utilisation of renewable energy is instrumental in the development of any low-carbon town, it is important that Koh Samui authorities build on existing research and analysis to clarify potential end uses. At the same time in order to encourage its use it is important that methods of reducing initial high capital costs are considered.

RECOMMENDATIONS

ECONOMY MEMBER LEVEL POLICY AND STRATEGY TO REDUCE CO2 EMISSIONS

Recommendation 1 *Enhance the coordination among the relevant Ministries, between the Central Government, business community and Local Government/Units working on educational activities.*

Recommendation 2 *Balance the coordination among "Three Values (Social and Human, Environment & Resource, Economic) for Koh Samui.*

Recommendation 3 *Revise flexibly and periodically CO2 emission reduction targets by nine sectors ("Nine Baskets").*

Recommendation 4 *Improve data collection.*

Recommendation 5 *Develop benchmarking measures or performance indicators.*

Recommendation 6 *Consider sharing information, best practice, products, and services amongst economies, an extension of this could even be electing low energy low-carbon buildings or structures as demonstrations for other cities in Asia.*

TOWN STRUCTURE

Recommendation 7 *Increase analysis on whether Koh Samui wants to increase tourism or sustain current tourism flows. It may be difficult to reconcile further development with re-forestation and gaining public acceptance.*

Recommendation 8 *Involve local community (residents and hotels) in tree planting.*

Recommendation 9 *Create view points and walking trails to maximise benefits, in increasing walk ability in tandem with increasing green areas.*

Recommendation 10 *Need long term maintenance plan for keeping green areas well managed.*

Recommendation 11 *Consider avoidance of, or swift resolution of complications surrounding the re-settling of local communities under the proposed 'Neighbouring Communities' concept, whilst their original living quarters are modified to eco-friendly sustainable living centres.*

Recommendation 12 *Conduct further surveys, consultation, monitoring and analysis to provide feedback to the project team on local responses to the trial urban centre development, as input to future development.*

Recommendation 13 *Explore innovative solutions to underpin ongoing development of areas with roadside commerce. Conflicts between pedestrians and different vehicle types reduce amenity and safety for commercial activity and tourism. At the same time, the small scale and diversity of activity provides an important part of the local economy and culture, and create important tourist attractions. These valuable aspects should not be lost.*

Recommendation 14 *Develop and use planning guidelines and incentives/requirements to engage the community, to influence future development towards compatibility with a low-carbon, sustainable future.*

ECO-LIFESTYLE

Recommendation 15 *Work closely on eco-tourism and eco-lifestyle as Eco-tourism is a big industry globally.*

Recommendation 16 *Focus on 'green' tourism under eco-tourism marketing campaigns, balancing opulence with holidaying for the environmentally conscious an example of this is Punta Islita Resort, Costa Rica.*

Recommendation 17 *Promote green volunteer programs.*

Recommendation 18 *Establish Eco-Research Centre and Eco-Tourism Centre.*

Recommendation 19 *Develop 'low/no guilt' but effective eco-lifestyle solutions at resorts and other tourism facilities, including 'locally beneficial' carbon offset schemes.*

AREA ENERGY PLANNING MANAGEMENT

Recommendation 20 *Much stronger focus on demand side: detailed data on time profiles of demand, uses, local data, consumer equipment efficiency, knowledge of energy efficiency, etc.*

Recommendation 21 *Focus on a demand side programme for large consumers.*

Recommendation 22 *Develop diagnostic techniques, tools, local skills to identify and implement energy efficiency/management opportunities – implement demonstrations, train local people.*

Recommendation 23 *Investigate strengths and weaknesses of district scale energy systems compared with individual options: district scale can be inflexible and have high energy losses.*

Recommendation 24 *Introduce smart demand side systems including energy storage, feedback to user and renewable energy – use grid to 'top up' local and on-site storage, at the same time ensure smart grid network design complements demand side smart systems and allows consumers to manage their demand.*

Recommendation 25 *Consider implications of Samui energy strategy for mainland energy use and supply.*

Recommendation 26 *Develop governance structures and contractual frameworks for energy management.*

Recommendation 27 *Make clear that a Combined Cycle gas generator will be needed if Energy Efficiency and renewable energy are effectively pursued, unless to manage risk of cable failure: storage may also be alternative to gas fired generation.*

Recommendation 28 *Pursue smart grids as an untapped energy option.*

ENVIRONMENTAL PLANNING

Recommendation 29 *Build on experience of successful waste management strategy to engage and empower business (including local tourism association) and community on other environmental issues.*

Recommendation 30 *Include wider range of environmental issues in planning.*

Recommendation 31 *Develop a plan for emergency accommodation in environmental events.*

Recommendation 32 *Incorporate low-carbon materials, permeable surfaces into built infrastructure.*

Recommendation 33 *Link climate change, transport and building strategies to broader environmental plan.*

Recommendation 34 *Develop infrastructure to protect/adapt to climate change.*

Recommendation 35 *Look at energy use of water supply and treatment and minimise (e.g. slower pumping to distributed storages, make high altitude development as water self-sufficient as possible).*

LOW-CARBON BUILDINGS

Recommendation 36 *Make key buildings (arrival points, high-visitor facilities) low-carbon centric.*

Recommendation 37 *Minimise electricity use in existing large buildings.*

Recommendation 38 *Develop or adopt a green building benchmark that identifies facilities that have achieved efficient use of energy and water.*

Recommendation 39 *Provide guidance to building owners and operators on energy efficient operating practices.*

Recommendation 40 *Emphasise ocean front building characteristics.*

Recommendation 41 *Consider Retrofitting on old buildings.*

Recommendation 42 *Complete the phase out of incandescent bulbs in hotels, shops and homes, including the replacement of halogen down lighting and track lighting in shops and hotels with LED lamps.*

Recommendation 43 *Introduce lighting controls in areas with good day lighting and intermittent occupancy.*

Recommendation 44 *Consider reducing electricity use by 60-70% by deploying solar or heat pump hot water heating, as many hot water systems use electric heating elements.*

Recommendation 45 *Shade indoor spaces with outdoor planting.*

Recommendation 46 *Encourage the use of units of air-conditioning with a high efficiency rating.*

Recommendation 47 *Develop design guidance for new construction and major refurbishments.*

Recommendation 48 *Consider professional training for local labour with the green building maintenance, construction, designing, and retrofitting skills.*

Recommendation 49 *Develop planned communities.*

TRANSPORTATION

Recommendation 50 *Continue to emphasise integrated local comprehensive urban planning.*

Recommendation 51 *Clearly define road or street systems.*

Recommendation 52 *Review accessibility and connectivity of an efficient comprehensive transportation planning system.*

Recommendation 53 *Design safe, equal and easy access and pleasant walk able areas.*

Recommendation 54 *Monitor energy use and transportation planning.*

Recommendation 55 *Design transit-oriented-development (TOD) transport strategies.*

Recommendation 56 *Seek financing mechanisms to purchase and maintain Electric vehicles on a large scale.*

Recommendation 57 *Utilise smart transport system.*

Recommendation 58 *Analyse the comprehensive costs and benefits of addressing a range of transport issues. This should include the benefits of improved road safety, enhanced tourist experience, reduced air and noise pollution, reduced freight costs, etc, as well as carbon abatement.*

Recommendation 59 *Analyse the access/transport requirements for freight, tourists and local residents, so that an appropriate mix of solutions can be developed and implemented.*

Recommendation 60 *Carry out trials of innovative access/transport solutions before full scale implementation.*

Recommendation 61 *Develop strategies to reduce vehicle speeds and provide transport alternatives for local residents, tourists and freight that reduce numbers of vehicles. Another key point that was not discussed in detail during the presentation was the role of freight demand. It is highly recommended that a detailed plan be put forth to deal with the role of freight and its impact on the overall traffic flow and carbon usage.*

Recommendation 62 *Consider air travel to and from Koh Samui which is probably the biggest contributor to a tourist's holiday carbon footprint. Measures to reduce emissions and impacts of aircraft including; alternative mode options, offset emissions, and encouraging longer stays, can all help to cut emissions per baht of revenue and/or per tourist. There is potential to encourage visitors to offset their travel emissions through purchase (and surrender) of Carbon Emission Reduction permits created through local renewable energy and energy efficiency projects.*

RENEWABLE ENERGY

Recommendation 63 *Promote roof top solar heating system and heat pump hot water heating on the island. Hotels and resorts account for a large percent of the total buildings on the island, and a lot of domestic hot water is used daily.*

Recommendation 64 *Encourage use of grid connected solar PV technology.*

Recommendation 65 *Consider use of sea water and lake water as a good cooling source for the air conditioning system.*

Recommendation 66 *Consider small scale hydro power and wind power uptake in remote areas.*

Recommendation 67 *Build on existing research and analysis to clarify potential end uses.*

Recommendation 68 *Consider ways of reducing high capital costs.*

Recommendation 69 *Establish a program of demonstration projects for the renewable energy options with best potential and install demonstration projects at schools and facilities where they can be used for education and training. Demonstration projects could be linked to zones where smart grid technology is in place, and should also offer smart user features such as monitoring and reporting of output.*

Recommendation 70 *Monitor and survey user and local community attitudes to existing renewable energy systems, and to new installations to ensure they operate properly, and to support learning from experience.*

Recommendation 71 *Review the adequacy of the existing wind speed records, including evaluation of offshore wind resources.*

Recommendation 72 *Collect data and modelling of the wind power resource.*

UNTAPPED ENERGY PLANNING

Recommendation 73 *Pursue known cost-effective or beneficial energy solutions to their full extent.*

Recommendation 74 *Consider investing in backup power generators. Backup power generators in many hotels and other businesses are run frequently when electricity supply disruptions and demand peaks occur. Capital has already been invested in these generators, so optimising their efficiency, use of renewable fuel and their role in minimising overall energy costs potentially offers low cost options.*

Recommendation 75 *Identify and use lower temperature heat sinks to improve cooling efficiency. Refrigerative cooling is a dominant consumer of electricity, and the efficiency of air conditioning is sensitive to the temperature of the condenser.*

Recommendation 76 *Upgrade the incinerators which provide an opportunity to install a plant to generate electricity or combined heat and power (CHP) fuelled by the combustible solid waste which accounts for 25% of solid waste.*

Recommendation 77 *Measure ground temperature and temperatures of any underground aquifers to allow analysis of potential role of ground source heat pumps or use of aquifers as heat sinks.*

Recommendation 78 *Advance a proposal to install an electricity generator or CHP plant, if a process heat requirement exists, to produce energy from the combustion of municipal solid waste.*

Recommendation 79 *Consider woody biomass from agricultural wastes for use as an additional resource for energy production either as a heat source at the Municipal Solid Waste (MSW) plant (if the electricity generation option is implemented) or for production of second generation bio-fuels for transport.*

Recommendation 80 *Consider green kitchen waste and used cooking oil for biogas generation and as a diesel substitute respectively.*

Recommendation 81 *Consider the production and use of biogas in the design of the central waste water treatment plant, possibly supplemented with kitchen waste.*

Recommendation 82 *Make provision for new low-carbon energy resources, both centralised and decentralised, to be incorporated on the Koh Samui energy system under regional planning policies.*

PART 1: BACKGOUND INFORMATION

The background information contained in this report has been contributed by Thailand. This information is intended to provide some context to the recommendations of the Policy Review Team. It covers the policy of the central and local government. The detail design concern and law/regulations for the low-carbon town development is also included. The monitoring and reporting mechanism is also specified.

Background Information

1. Overview

Samui Island, which is in the Gulf of Thailand, is located in Suratthani Province, approximately 750 km to the south from Bangkok. Samui Island or Koh Samui is located 84 km northeast of Suratthani or about 20 km east of mainland. The closest harbour is Donsak Harbour, which is 35 km away from Samui.

Figure 1 : Koh Samui

Koh Samui has a population in the region of 53,769 people with latent population, which is about six times of registered population, and tourists, both Thai and foreign tourists, travelling about 3,000 people per day, resulting in a rapid evolution and change due to growth of the tourism industry. Each year, 1,059,642 tourists visit Koh Samui; of which 429,917 people travel by plane. The remainder of the tourists reach the island by ferry, with modes of transport to reach the ferry being used as follows: 175,604 people by train, 221,803 people by bus, 212,772 people by private cars, and 19,546 people by other transportation modes, bringing money into the island totalling more than 15,000 million baht per year. More than 400 hotels have been built to provide hospitality, holding more than 16,000 rooms. Fresh water demand is approximately 18,000 – 22,000 m^3/day while almost 6,000 m^3/day wastewater is going to the wastewater treatment system. The remaining wastewater is discharged directly to river and canals, such as Chaweng and Lamai canals. Every day, 120 tonnes of municipal waste are sent to waste disposal plant, which is capable of removing only 130 tonnes of garbage per day.

Koh Pa-Ngan, to the north of Koh Samui, has a total area of 193 km^2, 168 and 25 km^2 for Pa-Ngan and Tao islands respectively. More than half of the islands are mountains or plateaus. Officially, there are about 6,000 people living in Pa-Ngan. However, there are more than 10,000 that are considered part of the unregistered population, such as workers or employees in tourism business. Also, there are about 1,500 tourists on average coming to Pa-Ngan daily; the number is higher during the famous full moon party nights.

Figure 2 : Koh Pa-Ngan

The first Koh Samui's Urban Plan had been announced and enforced in 1995 – 2005, the second Urban Planning has been announced since 2006 and was valid until July, 26th 2011. The first Koh Pa-Ngan's Urban Planning had been announced and enforced in between 1983 – 2008, the second Urban Planning is currently under preparation. The areas have been classified according to the density of the population, commercial area with dense population, industry and warehouse areas, rural and agricultural areas, etc. as shown in the following figures. High skyscraper with the height beyond 12 meters is prohibited in these Koh Samui and Koh Pa-Ngan areas.

Koh Samui is located in tropical weather. The average temperature is 29 °C the highest and lowest temperature ranges from 37 °C (April and May) to 21 °C (December and January). The area of Koh Samui accounts for 227 square kilometres. More than 70% of the land is used for agriculture, mostly coconut and durian plantations. In order to preserve the forest and wildlife, the Department of Forestry has set up two National Parks in the area of Hin Lad and Na Muang waterfalls. The residential and commercial areas are well spread along the shoreline. The crowded areas are located in the north and south-east of the island.

2. Natural Resources

Soil Resource: soil resource is distributed along the hillside, agricultural and communities' areas and coastline.

Water Resource: surface water is vital for consumption on the island. The important canals are Klong Li Pa Yai, Klong Lung Pai, Klong Li Pa Noi, Klong Sra Ket, Klong Lad War Norn, Klong La Mai etc. Apart from these, there are two swamp areas of Pru Na Muang and Pru Chaweng which are major water storages for Chaweng community.

The growth of Koh Samui in terms of tourist attractions has not been planned properly and has , therefore, exceeded far beyond the capacity of public utility and the use of natural resources to be able to support the amount of tourists who travel to the island. Today, Koh Samui is facing the problem of environmental degradation and pollution, irremovable chemical waste, underground contaminated water and shortage, surface water degradation and shortage, coastal and marine resources were destroyed and natural attractions degraded. Moreover the traditional art, culture and way of life of the locals have been devoured by the foreign culture as well as lack of environmental protection awareness.

We hope, the Low-Carbon Town Development Project – Koh Samui will find means of cooperation between the government sectors, business people, tourists, and the local Samui community to restore the island's beautiful natural environment and its traditional ways of life. The effort will also include finding ways to develop and improve the quality of the tourism business, improve energy efficient, introduce renewable energy, and introduce the utilization of natural gas to replace oil, so that Samui remains attractive and becomes low-carbon town for tourism destination for many years to come.

3. Town Structure and Infrastructure

3.1 Commercial Buildings

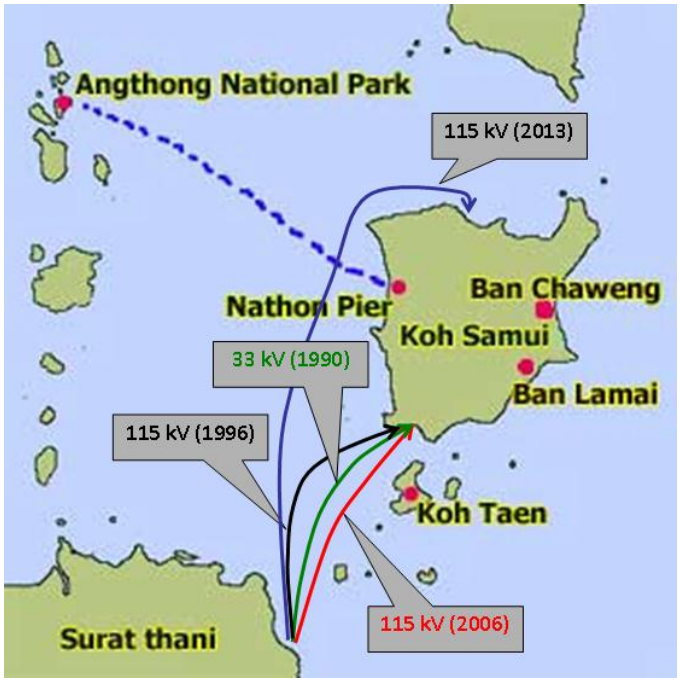
In 2010, there was a record on the number of service rooms in hotels and resorts as many as 15,012 rooms from 425 hotels, with approximate floor areas of 240,192 m^2 and average occupancy rate of 33.59%.

A significant proportion of commercial activity occurs in road-side and small businesses, many of which are registered as residential buildings.

3.2 Electricity Supplies

Primary energy use in Koh Samui is electricity purchased from Provincial Electricity Authority (PEA), generated on the main land from gas, ... and transmitted through submarine feeder cables. The energy demand recorded historically increases from 28.4 MW in 2000 to 95 MW in 2012 and expected to be 127 MW in 2020 and 200 MW in 2030. Most of the electricity consumption is in commercial and residential buildings. The energy-consuming equipment includes air conditioning system, lighting system, hot water, water treatment system and others. Two most electricity consumers are Business/Industry and Household Sector (which includes some small business) with the portion of 71% and 24 % respectively.

However, it is expected the shortage of the electricity supplying to Koh Samui will be overcome in the near future. New submarine cable is under construction at present. The vulnerability of the island to failure of cables was demonstrated in December 2012, when one failed, causing serious disruption in the peak tourism period.



3.3 Fuel Supplies

Koh Samui consumes more than 40 million litters of petroleum fuel per year. These petroleum fuels have to be imported from the main land. With the introduction of biofuel such as ethanol and biodiesel under the Thailand Alternative Energy and Development Plan, biofuel shares account for a share of the total amount of fuel used.

4. Forestation

The reforestation, especially coconut plantations will act as a carbon sink, as well as the beautifulness and fertility of the forest to support the eco-system and eco-tourism. Rising public awareness on the importance of the forest, as well as proper garbage dumping and no direct discharge of waste water into the sea, must be carried out. However these actions will require the local people and tourists to have better awareness of the importance of nature.

The encouragement and regulation enforcement will help all sectors involved in the area of Koh Samui and Pa-Ngan to develop the low-carbon town. The social and market mechanisms are use as measures to help stimulate the awareness and the cooperation in the development of low-carbon town.

Incentives to encourage business owners to cooperate, such as rewarding those who conduct their business, in consideration of reducing environmental impact, with promotion in the media and by the Tourism Authority of Thailand (TAT).

One type of information could be done in the future is "The Low-Carbon Samui Island Handbook", which should include environment-friendly advice to tourists, encouraging people to use fewer plastic bags, decrease municipal waste quantity, conserve energy and to patronize hotels (named on a checklist) that have policies aimed at conserving the environment.

5. Transportation, Traffic and Urban Planning

Ministry of Transportation had conducted the study to set out master plan of transportation and traffic in the centre of civilization in Suratthani region (Koh Samui). They have set out six plans for transportation and traffic development in the area of Koh Samui; the plan includes Traffic Management Plan, Transportation Safety Plan, Sustainable Transportation Plan, Infrastructure Development Plan, Traffic Knowledge & Discipline Plan, and Information Provision Plan. Projects in these plans are, for example, improving efficiency of public transport on Koh Samui, study on the construction of bicycle lanes, bicycle riding campaign, and the construction of the pedestrian walkway along Chaweng beach.

Beyond the scope of the mentioned projects in developing low-carbon town, there are other projects that should be considered driving the development of low-carbon society for this island such as encouraging the use of natural gas (NGV) in boats, buses and personal vehicles, encouraging the use of biodiesel in ferries and fishing boats, considering the construction of the local monorail, introducing of the electrical vehicles for transportation and logistics system management.

Also if the use of NGV and electrical vehicles are promoted in the area of Koh Samui and Pa-Ngan, these will reduce the risk of oil leakage into sea during shipment.

6. Energy Status of Koh Samui and Koh Pa-Ngan

Energy consumption, especially the use of electricity, on Koh Samui and Koh Pa-Ngan increased continuously and rapidly. Due to the development of the tourism industry that has been growing rapidly since 1986, has resulted in the increasing number of trips, tourists, hotel accommodations, and foreign currencies that circulate in Koh Samui and Koh Pa-Ngan. This has been the main economy of Koh Samui and Koh Pa-Ngan in the last few years, even though the political situation and the monsoon that has caused severe flooding in the past caused the economic slowdown and difficulties in travelling. But when the situation returned to normal, number of tourists arriving in Koh Samui and Koh Pa-Ngan were found to increase. The income from the tourism industry increased accordingly, resulting in the continued growth of the economies of Koh Samui and Koh Pa-Ngan.

6.1 Energy Efficiency

According to general information on the proportion of energy consumption in Thailand, it can be concluded that the proportion of electricity consumption associated with air conditioning systems is around 55-60% of total energy consumption in the country. This figure also falls in line with electricity consumption for air conditioning in Koh Samui. Measures involved regarding energy conservation in air conditioning systems should be considered in order to reduce electricity use in these areas. Besides that the introduction of energy management and high efficiency electric appliances must be commenced as well.

6.2 Renewable Energy

According to the feasibility study for the Sustainable Development of Samui island carried out in 2006, it has been found that the composition of the solid waste in the area of Koh Samui were as follows;

40% incombustible and plastic

25% dry combustible

30% food waste with high moisture

5% others

Koh Samui has generated municipal solid waste about 120 tons daily. Now the only one waste disposal plant in Koh Samui is capable of burning dumped waste up to 140 tons/day (2 x 70 tons/day incinerator), which almost reached its limit to burn waste already.

Waste separation prior to combustion, reducing the amount of burned solid waste, can extend the service capacity of the incinerator, therefore the construction of additional waste disposal plant can be retarded for some years. With waste separation process, there is only 25% of dry combustible and 5% of other waste to be burned. This will eliminate 40% incombustible and plastic to recycle, while the 30% food waste with high moisture can be used in producing biogas to be utilized as a renewable energy source,

which is expected to be able to generate power of approximately 1 MW. The waste heat from solid waste burning process can also be used in producing fresh water from sea water, which is expected to be able to produce 70 m^3 of fresh water per day, reducing the amount of fresh water required to provide for consumption on the island. However, to develop a sustainable reduction of waste for better environment, the concept of 1A3R (Avoid, Reduce, Reuse, Recycle) should be used to seriously encourage practical results.

Apart from the development of renewable energy being utilized in Koh Samui area, there are many possible renewable energy related projects that would be considered using in the islands such as the production of electricity from solar PV, solar hot water on rooftops of hospitals, hotels, resorts or other government buildings, fresh water production using solar energy, biomass fuel for households, introduce a smart grid etc.

7. Operational Steps

At present, Thailand is now implementing the 11th National Economic and Social Development Plan (2012-2016). This National Master Plan consists of six strategies for sustainable development. Within these strategies, there are two strategies related to a low-carbon society, which is the strategy for stabilizing and balancing of food and energy, and the strategy for sustainable management of natural resources and environment. This means the government has recognized the importance of natural resources and environmental management to adapt and ready to move forwards to low-carbon society.

8. Relevant Agencies

List of the relevant organizations and their responsibilities, but not limited to, are briefly listed here:

1. Units working on educational activities – to promote the establishment of low-carbon activity groups, which may include activities such as the establishment of youth camps, learning centres, campaign, etc.

2. Regional administrative bodies – activities will include setting up a working group composed of all relevant sectors/organizations to set policy, provide budget, prescribe procedures to penalize or encourage relevant sectors to ensure that they follow the framework set for low-carbon town, evaluate the outcomes, monitor and revise the project.

3. Government – relevant ministries such as Ministry of Natural Resources and Environment, Ministry of Tourism and Sports, Ministry of Interior, Ministry of Transportation, Ministry of Energy, etc. may cooperate in policies driving, giving financial support to carry out projects in both the short and long term.

4. Business sector – the department and convenient stores, hotels, resorts, guesthouses, transportation and shipping companies, restaurants, the island community and media may join campaigns in various related activities such as 1A3R, waste separation, low-carbon fuel and renewable energy uses, energy conservation, and public relation campaign.

Another and very important cluster that will enhance the sustainability of the low-carbon project is the involvement of tourists in all these activities.

9. Outputs/Outcomes

1. Creating increased public awareness regarding the present status of environmental degradation and pollution issues of Koh Samui and the way forward.

2. Reviewed and updated guidelines in the development of a sustainable low-carbon island model for a tourism destination by all sectors involved.

3. Sustainable development in combination with environment and energy utilisation in Koh Samui.

4. A very successful case in low-carbon town demonstration site and learning centre.

9.1 Impact on People

Consideration and planning of the Low-Carbon Town Development Project for Koh Samui and Koh Pa-Ngan must have public participation at all stages such as public hearings, project planning, energy knowledge management, environment and nature, as well as project monitoring and evaluation. Therefore the development of low-carbon town has no negative impact to the public and communities, but will have positive influences on Samui and Pa-Ngan communities in the light of better environment and healthcare, by having officers from many sectors involved in energy management, waste management, renewable energy utilisation, and proper transportation management.

10. Related Studies and Research Paper in Koh Samui area

1. Koh Samui Tourism Development Master Plan (1985)
2. Study the Ability to Support the Development of Tourism and Attractions in Koh Samui (1988)
3. Koh Samui Tourism Development Action Plan, under Bearable Capacity (1990)
4. Preparation of Environment and Nature Conservation Plan in Koh Samui Area, Suratthani Province (1995)
5. Feasibility Study for the Sustainable Development of Samui Island (2006)
6. Integrated Ecotourism for Planning Sustainable Tourism Development on Koh Pa-Ngan, Suratthani Province (2008)
7. Traffic and Transportation Survey for Regional Master Plan, Suratthani Province (2010) under the Traffic and Transportation Remedial Master Plan.
8. Policy on low-carbon development

PART 2: REVIEW TEAM REPORT

This part of the report presents the Policy Review Team's conclusions and recommendations about the low-carbon town development in Koh Samui, Thailand.

ECONOMY MEMBER LEVEL POLICY AND STRATEGY TO REDUCE CO2 EMISSIONS

1.1. Findings

(Economy level)

The 11th National Economic and Social Development Plan of Thailand (2012-2016)

Thailand has "The 11th National Economic and Social Development Plan of Thailand (2012-2016)". The Vision of the 11th National Economic and Social Development Plan is "Peaceful society under equitability, justice, and resilience toward changes." The 11th Development Plan has the following five objectives.

(1) An improvement in Wellbeing of Thai people and Peace for Thai society, with reduced inequality and improved corruption perception.
(2) A lifelong learning and improved health for Thai people, with strong social institutions.
(3) Appropriate economic growth rate given the country's potential

An improvement of productivity no lower than 3% per year

An improved competitiveness of the country's economy

Improved values of small and medium sized enterprises' products per GDP to be no lower than 40%

(4) A more prominent role of Science, Technology, Innovation and R&D in contributing to economy, society and environment, with the target of investment per GDP no lower than 1% by 2016.
(5) To maintain Quality of Environment within standards, by improving efficiency in reducing green house gas emission and by increasing forest area to maintain the ecosystem.

The 11th Development Plan has the following six Strategies in the three fields in accordance with the above-mentioned objectives.

<u>Creation of quality human capital and society</u>

Strategy 1 Promoting Social Justice

Strategy 2 Human Development toward a Sustainable Lifelong Learning Society

<u>Economic restructuring</u>

Strategy 3 Strengthening of the agriculture sector and food & energy security

Strategy 4 Restructuring of the economy toward quality growth and sustainability

Strategy 5 Regional connectivity

<u>Management of natural resources</u>

Strategy 6 Managing Natural Resources and the Environment to Achieve Sustainability

Strategies 4 and 6 are related to the energy field. Thailand aims at (1) generating energy security and developing renewable energy, (2) restoring, conserving and creating security for the natural resource base and environment, (3) moving toward a low-carbon economy and society, and (4) addressing climate change more rigorously.

Alternative Energy Development Plan (AEDP)

Thailand has the "Alternative Energy Development Plan (AEDP) (2012-2021)"; AEDP has a target of 25% of renewable energy accounting for total energy consumption by 2021. AEDP is Thailand's clear commitment to the development of a low-carbon society. The Thai Government will make the best use of government funding on research and development (R &D) and also utilize and encourage private-led investment.

Thailand has current power generation capacity of 2,316.53MW by renewable energy (Wind, solar, hydro, biomass, biogas, municipal solid waste and tidal & geothermal). AEDP has set the target of achieving power generation capacity of 9,201MW by 2021 compared to the previous target of 5,607.5MW.

AEDP has the following six strategies.

(1) Promote renewable energy on a community scale
(2) Encouraging private investment
(3) Improve relevant infrastructure
(4) Promote research and development as a tool for the renewable industry
(5) Promote better understanding
(6) Modifying outdated rules and regulations

AEDP also has the following strategies for each kind of renewable energy;

<u>Solar</u>

- Promote solar photovoltaic rooftop
- Develop "Smart-grid" system

<u>Wind</u>

- Small-wind for community
- Promote wind for water-pumping in the agricultural sector

<u>Hydro</u>

- Promotion of Pico & Micro hydro turbine

- New pumped storage facilities by EGAT

Municipal solid waste

- Focusing on household and community waste
- Promoting Refuse Derived Fuel (RDF) and Pyrolysis Oil

Biomass

- Dedicated energy crops
- From agricultural wastes to focusing on "Bagasse" from sugar mills

Biogas

- Waste-water and animal farms
- Biogas network
- Compressed Biomethane Gas (CBG)-compressed gas-for transportation

(Koh Samui)

Koh Samui has the "Index and target: Moving **SAMUI to Low-Carbon"** strategy. Koh Samui has a high level vision "People Oriented" and aims at "the First Low-Carbon Island in the Asia-Pacific".

The high level vision consists of the three following values.

(1) Social & Human Value

- Local culture and life-style well mixed with modern life-style
- Improve quality of life with eco-lifestyle
- Low-carbon lifestyle integrated successfully with tourism on the island

(2) Environment & Resource Value

- Natural resources well preserved and undamaged
- Green environment enhancement (green products)
- Low-carbon emission for hotels, resorts, schools, houses and transports, etc.

(3) Economic Value.

- High value of land and economy
- Investment attraction

The total targets for reduction of CO2 emission intensity (tCO2e/GDP) on the island are 20% by 2020 and 40% by 2030. CO2 emissions in Koh Samui are expected to reach 509,229 CO2e ton in 2020 and 806,192 CO2e ton in 2030 under the Business-As-Usual (BAU) Case. Koh Samui has a target for CO2 emission reduction of 32.7% in 2020 and 30.8% in 2030 compared to the BAU Case.

The target has been set by nine sectors (some in progress). EEC has identified nine focus areas, that they call "Nine Baskets", that is to say, (1) Town planning, (2) Transportation, (3) Area energy planning, (4) Area energy management, (5) Renewable energy, (6) Untapped energy planning, (7) Low-carbon building, (8) Eco-life style and (9) Environmental planning.

(Relevant Ministries and Organisations)

The following Ministries and Organisations are involved with trying to achieve the target of CO2 emission reduction in Koh Samui: Ministry of Energy, Ministry of Natural Resources and Environment, Ministry of Tourism and Sport, Ministry of Interior, Ministry of Transportation; Local Administrative Bodies, and Units working on educational activities.

1.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of Economy member level policy and strategy to reduce CO2 emissions.

(1) Enhance the coordination among the relevant Ministries, between the Central Government, business community and Local Government/Units working on educational activities.

There are several relevant Ministries of the Central Government, the Organisations of Koh Samui and other entities committed to achieving the reduction of CO2 emissions on Koh Samui. Thailand authorities know the importance of cooperation and coordination among them. Enhancement of the cooperation and coordination is desirable.

(2) Balance the coordination among "Three Values (Social and Human, Environment & Resource, Economic) for Samui Island.

In some cases, you may face a "trade-off" among the "Three Values". If you put too much emphasis on Social and Human Values or Environment & Resource Values, you may lose out on economic values and vice versa.

(3) Revise flexibly and periodically CO2 emission reduction targets by nine sectors ("Nine Baskets").

To take necessary measures involves investment and time. Each of the nine sectors has a different cost for reducing CO2 emissions and such costs will change over time. The most cost-effective way to reduce CO2 emissions should be pursued, where costs and benefits include all relevant factors, such as creation of employment, protection of natural environment to support future tourism, etc. In addition, prioritisation of measures among the nine sectors should be pursued in view of cost-efficiency.

(4) Improve data collection.

To achieve the CO2 emission reduction target would require monitoring and evaluation. It is vital that precise and detailed data collection on energy is undertaken which is important for monitoring and evaluation. In general it is easy to get data on the supply side especially from big suppliers such as established hotels –aren't these both big suppliers via their generators and big consumers?, but difficult to get data on the demand side. Efforts to establish a data collection system on the demand side (consumers), such as questionnaires for consumers (tourists and locals), metering system, etc., should be pursued.

(5) Develop benchmarking measures or performance indicators.

This should be done so that progress can be monitored and evaluated. Principles of measuring indicators should be: Specific, Measurable, Achievable, Realistic, Time bound – or +SMART.

(6) Consider sharing information, best practice, products, and services amongst economies, an extension of this could even be erecting low energy low-carbon buildings or structures as demonstrations for other cities in Asia.

Given the amount of work being conducted on low-carbon communities including low-carbon buildings it is a very good idea to share experiences and learn from other economies. A sharing platform that will be suitable is http://esci-ksp.org/, an APEC Knowledge sharing Platform.

2. TOWN STRUCTURE

2.1. Findings

It was clearly seen through EEC plans and the work of the Koh Samui Tourism Association that many basic plans for increasing the walk ability, therefore reducing the reliance on motor transportation, and increasing the ratio of green to development in the island were in place. Some such plans include the planting of greenery and orchards as well as the removal of trash on walk ways to make it easier to get around the island by foot. The increasing of greenery not only for aesthetic reasons but also the inclusion of plants that absorb CO2 emissions to reduce carbon emissions is a very valuable concept. In addition to this to make the island more pedestrian friendly it was seen that there were plans to make certain heavy foot traffic areas (tourist and shopping hotspots) closed to motor transportation for short periods of time during pedestrian peak hours to increase pedestrian safety.

Exciting concepts such as the development of neighbouring communities were also discussed. The 'Neighbouring Communities' is an admirable idea considering the development of eco-friendly and sustainable and neighbourhoods for locals. A major hurdle for this concept however is the movement of

communities from their living quarters to temporary accommodations for an indefinite period of time until their original living quarters are transformed to sustainable and green communities. There may be some objection and resistance from the local community due to the inconvenience such a move will cause in their lives unless this is carefully managed.

2.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of town structure.

(7) Increase analysis on whether Koh Samui wants to increase tourism or sustain current tourism flows. It may be difficult to reconcile further development with re-forestation and gaining public acceptance.

Currently Koh Samui has a large number of visitors annually (1 million tourists). Given the size of the island and the desire to improve the green to development ratio it is important to undertake an in-depth study and analysis on the merits of increasing tourism or sustaining current numbers while building revenue through 'value adding'. A challenge that could be faced in choosing to increase greenery may be the local's hesitation to use land for reforestation over further tourism development due to the perceived monetary benefits of such development, therefore public acceptance maybe difficult to be obtained. During the workshop, a strong message was received that local businesses-Koh Samui Tourism Association wanted to limit growth in numbers of visitors, and to focus on quality experience instead of scale: this needs to be tested and discussed more widely, and the consequences of various future scenarios analysed and explored. This will all need to be analysed in an in-depth study as discussed above.

(8) Involve local community (residents and hotels) in tree planting.

Given the benefits of increasing the greenery for the local community and business operators in the region (mainly hotels and resorts) it would be a good idea to involve their participation in the re-forestation process. It would be a good learning opportunity for the local community and hotels may be able to provide the economies of scale and financial resources for the project.

(9) Create view points and waking trails to maximise benefits in increasing walk ability in tandem with increasing green areas.

Whilst increasing the walk ability of the island as well as increasing greenery are highly commendable ideas separately, it is important that they are coordinated. Creating clear walking trails and paths through areas of greenery or around them would work well with the tourism industry on the island as well as providing locals with a healthy lifestyle and pleasant living environment.

(10) Need long term maintenance plan for keeping green areas well managed.

There is a lot of effort involved in re-forestation of land especially if there are plans for the introduction of various species of plant life, including those that absorb CO2. Therefore it is highly recommended that a long term maintenance plan is in place including the hire of specialists in agronomy so that they are able to contribute to the maintenance of the greenery on the island smoothly.

(11) Consider avoidance of, or swift resolution of complications surrounding the re-settling of local communities under the proposed 'Neighbouring Communities' concept, whilst their original living quarters are modified to eco-friendly sustainable living centres.

There is much sensitivity surrounding the re-settlement of communities whilst their original living quarters are modified to eco-friendly, sustainable living centres. It is important that there are very good educational programs in place for the young and old so that they are educated on the reason for the need for the move and the benefits that will come from the temporary re-settlement and then re-adjustment to new modified living quarters. Temporary accommodation also needs to have minimum standards and at least meet the specifications of previous living quarters. Modified living quarters also need to have strict minimum standards and at least meet the maximum level of comfort previously enjoyed by those living there. This needs to be monitored strictly and overseen by some sort of regulatory body. There need to be clear explanations and strong initiative from government of all levels, including the possibilities of incentives being offered in order to entice people to move to temporary accommodation voluntarily. It may be useful to involve local people in the reconstruction process through planning, employment and purchasing of goods and services through local sources so they can appreciate the progress and understand the future benefits they will gain.

(12) Conduct further surveys, consultation, monitoring and analysis to provide feedback to the project team on local responses to the trial urban centre development, as input to future development.

It is critically important to maximise learning from experience, and to respond to community reactions to trials and demonstrations. This may include applying improved approaches to design and construction, and/or dialogue and education to influence community and business attitudes to recognise broader and longer term benefits. The risk of negative reactions, often based on preconceptions or problems with early implementation, can lead to polarisation and must be carefully managed.

(13) Explore innovative solutions to underpin ongoing development of areas with roadside commerce. Conflicts between pedestrians and different vehicle types reduce amenity and safety for commercial activity and tourism. At the same time, the small scale and diversity of activity provides an important part of the local economy and culture, and create important tourist attractions. These valuable aspects should not be lost.

Roadside commerce provides an important source of employment for local residents and a way of maintaining local culture, while also offering a variety of services and experiences to tourists. At the same time, this business sector creates a significant amount of road traffic through sub-optimal freight

activity (e.g. large numbers of light vans and utilities with small loads) and individual tourist vehicles. Some roadside commerce, such as motorcycle mechanics, may be adversely affected by a shift towards a low-carbon economy unless they are assisted to shift to other activities. Roadside commerce also places limits on the amount of space available to widen roads, establish separate low speed vehicle lanes and pedestrian-oriented spaces. Innovative consultation processes and creative solutions will be needed to resolve these issues. For example, if buses running on the main road around Koh Samui can also carry light freight, bicycles and motorcycles, the amount of traffic on the main road may be reduced, so conflicts can be reduced.

(14) Develop and use planning guidelines and incentives/requirements to engage the community, to influence future development towards compatibility with a low-carbon, sustainable future.

Redevelopment of existing facilities and infrastructure, as well as some expansion into undeveloped areas is likely to continue. Yet local representatives who spoke at the workshop seemed to prefer a future of no or low growth. This will require individual decisions regarding development to be influenced by community level perspectives, which may limit or change outcomes from individual preferences. Given the limited governance frameworks and resources of public agencies, it will be important to use mechanisms such as peer pressure, cultural values, incentives and public funding to influence the direction of development. Development controls and other forms of regulation require a basic level of community support and adequate resources to manage compliance, which are likely to take time to evolve.

3. ECO LIFESTYLE

3.1. Findings

Many interesting ideas regarding the establishment and promotion of an eco lifestyle on Koh Samui were presented to the review team. Some such concepts included; the low-carbon school initiative, hotels and resorts working with the local community, a solid eco-tourism strategy, development and promotion of eco-branding of products and eco-centres on the island, and the possible introduction of an eco points system on the island.

The low-carbon school initiative is a particularly commendable initiative. Involving experts from prestigious organisations such as big name hotels and resorts to impart their knowledge on low-carbon initiatives and principles simple or complex is a step in the right direction. It is important that the young generation of Samui are familiar with low-carbon practices, even basic principles such as recycling and proper garbage disposal so that they can incorporate these measures in their day-today life. By children learning these concepts they are able to impart this knowledge to their parents when they go home and adapt such measures in their households, a significant positive multiplier effect can therefore be seen through this initiative.

The 7 Greens Eco-tourism plan presented by the Koh Samui Municipal Council is also a great effort in moving Koh Samui to a low-carbon town. The development of eco-centres is a highly commendable idea and platform for the development of green ideas and implementation of such ideas within the town.

Such centres would also bring additional employment and learning opportunities for the local community.

Eco-branding is an exciting concept and provided that products are subject to strict green certification processes consistent with international standards, would well work in Samui, edging it closer to a low-carbon town. Eco-branding in conjunction with an eco points system would work well in promoting green products on the island as tourists and eco tourists alike have an extra incentive to buy green apart from the obvious environmental benefits.

The hands on approach undertaken by the Koh Samui Tourism Association is also highly commendable. Clear evidence of the benefits of such grass root level campaigns was seen in the cleanup of the Chaweng channel. Such efforts should be continued and supported by other organisations on the island.

3.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of the Eco lifestyle concept.

(15) Work closely on eco-tourism and eco-lifestyle as Eco-tourism is a big industry globally.

The eco-tourism concept is gaining momentum globally and Koh Samui is a prime candidate to pursue this type of 'green' tourism. It is important that eco-tourism continues to play a prominent role under eco lifestyle on the island. Given the potential for eco tourism on the island, Samui should position itself as a world leader through the introduction of global green events such as 'Green Fashion Week', etc.

(16) Focus on 'green' tourism under Eco-tourism marketing campaigns, balancing opulence with holidaying for the environmentally conscious: an example of this is Punta Islita Resort, Costa Rica.

By promoting eco-tourism through large scale marketing campaigns, Samui can solidify its position as not only a leading tourist destination but a leading 'green' tourism destination. Given the large wave of environmentally conscious travellers, Samui can attract a different demographic to the island who are willing to substitute large scale opulence for (or combine with) environmentally conscious resorts and hotels that also offer seclusion and privacy. Given the environmental consciousness of such travellers they are less likely to litter and treat their surrounding environment with care which will have positive environmental effects for the island not only monetary benefits.

(17) Promote green volunteer programs.

A way to extend the benefits of tourism to Samui Island past monetary gains is the introduction of green volunteer programs. Such programs could get tourists involved with re-forestation (tree planting) as well as helping with recycling and other green efforts. Tourists could volunteer some of their time with low-carbon schools, teaching children eco-concepts, such interaction would prove enriching to all those involved.

(18) Establish Eco-Research Centre and Eco-Tourism Centre.

The establishment of an Eco-Research centre would further cement the efforts carried out by the organisations previously mentioned. Such a centre would provide a foundation for sound research to be conducted and at the same time offer eco-centred education programs for the local population. An Eco-Tourism centre would complement such a set up, with small scale centres being set up across the island and offering tourists information about the eco programmes carried out across the island and encouraging them to participate in programmes such as the volunteer programme discussed above as well as other eco events. An eco-tourism centre can also be a useful location to gather useful information from tourists i.e. data on how varying types of tourists react to different approaches.

(19) Develop 'low/no guilt' but effective eco-lifestyle solutions at resorts and other tourism facilities, including 'locally beneficial' carbon offset schemes.

Many tourists expect tourism operators to address environmental issues, and are not inclined to compromise on the level of service. However, there is scope to provide positive feedback and rewards for those who engage in eco activities- an extension of the proposed eco-points program. Offering options for tourists to voluntarily buy and retire carbon offsets associated with local projects, is potentially an important way of addressing this issue. Tourism operators could also offer to retire offsets for free as a reward for those who engage in eco-friendly activities. Ensuring the qualification of projects to Certification of Emission Reduction (CER) requirements and creation and sale of locally sourced CERs on a voluntary basis to environmentally concerned tourists can generate revenue for local carbon abatement projects, while site visits and other related activities can be integrated into a positive tourism experience. Indeed, some tourism operators may be interested in buying and retiring CERs from local projects to reward clients who act to reduce environmental impacts during their stay.

4. AREA ENERGY PLANNING MANAGEMENT

4.1. Findings

A new undersea cable is almost complete to secure reliable electricity supply to 2025+ under BAU growth – there is potential to export renewable electricity. On one hand, the new cable may reduce local focus on measures to limit peak demand because it should overcome existing overarching power capacity problems. But many power failures are caused by failures in the distribution system on Koh Samui, so these will continue, maintaining community focus on supply reliability and leaving open opportunities for energy efficiency improvement, local generation and storage. On the other hand, it provides more potential for export of renewable electricity to the mainland, with many associated benefits. Also, recent shortages and the failure of one cable have raised awareness of the risks of excessive reliance on power supplied from the mainland.

Major hotels have their own back-up generators. These generators provide significant (but possibly unquantified) generation capacity. If they ran on renewable fuels, and could be operated at specified times to support the overall electricity system as well as providing hot water for their hosts (with savings relative to use of electricity), and were able to capture waste heat for hot water and possibly cooling,

they could provide useful, flexible and low emission energy. Given that the generators are already in place, or would be seen as essential equipment for any new hotel, they will be valuable even if they only run for short times each day, with usage influenced by hot water production and potentially higher export or offset prices for electricity or lower peak demand charges at critical times. While these small generators may be relatively low efficiency (maybe 30%), when providing useful hot water (or cooling/dehumidification via absorption or desiccant cooling), overall efficiency may reach 70% or so.

One thousand three hundred large consumers pay demand charges. The existence of this pricing framework provides an incentive for large consumers to manage peak demand and utilise on-site generation (potentially helping reduce peaks if pricing is well-designed). It also provides a base for further development of peak and time based pricing and financial reward for demand management and energy efficiency measures that cut peak demand for these key consumers. It is likely that education of these consumers to understand the tariffs and recognise the financial and other benefits of managing demand/generation would increase response to this pricing signal. Redesign of the peak charges so that reduction of load at critical times leads to bonus payments, which to consumers is important psychologically: businesses often respond better to incentives than penalties.

The Koh Samui community is stabilising solid waste production and improving management through community and business programs, there is a real opportunity to 'ride on' these successes. This successful program has built links to key community groups and businesses, as well as providing an example of what can be achieved by cooperative action. The networks and empowerment could support low-carbon activities.

It is highly commendable that major studies have been undertaken, EEC and DEDE have invested substantial effort in data collection and analysis of energy use and low/zero emission supply potential for transport on Koh Samui. This not only provides a valuable basis for project development, but the gaps it has identified can help to focus future data collection and analysis.

4.2 Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of area energy planning management.

(20) Much stronger focus on demand side: detailed data on time profiles of demand, uses, local data, consumer equipment efficiency, knowledge of energy efficiency, etc.

Demand for services, moderated by the efficiency and forms of energy used by the methods of delivering those services, drives demand for each type of energy. In the past, the 'lumpy' nature, long construction timeframes, capital intensity of energy supply infrastructure and desire to avoid power shortages has meant that energy policy has been driven by construction of supply-side capacity: this has now changed, as a wide variety of demand side and supply side options can now be implemented quickly. Traditionally, the level of energy use has been linked to demand for energy, but rapid

technological change and redefinition of the services required by businesses and communities means that there is much greater scope to decouple the level (and timing) of energy use from economic and social development. So it is critically important to build understanding of why, how and when consumers use energy to deliver services as a matter of urgency.

(21) Focus on a demand side programme for large consumers.

To realise the best return on investment and capture the interest of larger hotels, a demand-side programme could initially focus on larger energy consumers.

(22) Develop diagnostic techniques, tools, local skills to identify and implement energy efficiency/management opportunities – implement demonstrations, train local people.

If businesses and community are to take cost-effective and socially/environmentally preferable demand-side action, they need techniques, tools and skills, as well as awareness and confidence to identify the potential and implement them. Of course, the financial dimension is also important, but these factors help to reduce implementation costs, perceptions of financial risk and encourage private sector activity to provide products, services and finance.

(23) Investigate strengths and weaknesses of district scale energy systems compared with individual options: district scale can be inflexible and have high energy losses.

As noted in the recommendation, the energy savings from district scale energy solutions can be sensitive to a variety of factors. At the workshop, EEC commented that further analysis since their first draft report had indicated that district solutions were unlikely to be suited to most situations in Koh Samui. Also, district solutions rely on coordination of building owners in a precinct, and this is more difficult in developing economies, where regulation and long term cooperative models for buildings are less common and more difficult to enforce.

(24) Introduce smart demand side systems including energy storage, feedback to user and renewable energy (e.g. Home Energy Management System) – use grid to 'top up' local and on-site storage, at the same time ensure smart grid network design complements demand side smart systems and allows consumers to manage their demand.

Such systems involve monitoring energy supply and use factors and use of smart control systems to vary or shift demand and/or supply. These grids are better suited to a large number of electricity generators distributed around the grid, and can include storage capacity to help balance supply and demand. Smart grids can be complemented by 'smart consumers'. Information fed to consumers (or their smart control systems) on energy use at a site, and availability and cost of electricity can lead to manual or automated management of demand, onsite storage and onsite electricity generation to manage the consumer's interaction with the electricity grid. Smart grids can also be used to remotely manage consumer energy use and production. Many electricity policy makers have focused on investment in making grids 'smart' but many ICT companies are developing innovative consumer-side systems. These can benefit from

economies of scale, technology development and marketing activities more quickly than supply side investment, so it is important to take a balanced approach that includes both supply side and demand side innovations.

(25) Consider implications of Samui energy strategy for mainland energy use and supply.

There was no discussion at the workshop on the challenges facing the mainland and other nearby island electricity and transport fuel supply systems. However, taking into account circumstances when developing carbon abatement strategies, including renewable energy projects, community engagement and education programs, etc. may provide opportunities to offer services and energy to others on the mainland as well. It may also provide a justification for funding from regional, national or international agencies or organisations, on the basis that Koh Samui is developing and trialling measures that could be applied more widely.

(26) Develop governance structures and contractual frameworks for energy management.

Energy efficiency projects often cross traditional boundaries within and between organisations. Success is therefore often dependent on good communication, shared objectives, opportunities and risk, and confidence that each party will play its appropriate role over what can be an extended period during which staff, management and even ownership may change. Factors such as coordination, formal agreements and joint management may be important. So skills and resources must be made available for these kinds of activities.

(27) Make clear that a Combined Cycle gas generator will be needed if energy efficiency and renewable energy are effectively pursued, unless to manage risk of cable failure: storage may also be alternative to gas fired generation.

There is clearly concern about the dependence of Koh Samui on electricity imported via undersea cables, especially as development progresses and dependence on high reliability electricity increases. One proposal is for a 45 MW combined cycle gas fired power station to be installed in southern Koh Samui, near existing electricity infrastructure. This technology is efficient and relatively low in carbon emission intensity (approximately 100 grams CO2/MJ or 0.36 kg CO2/kilowatt-hour) – about half the Thai grid average. However, this would require either an undersea gas pipeline or gas delivery and local storage capacity. On one hand, this might facilitate use on Koh Samui of natural gas for other activities such as cooking. On the other hand, it is a steep change that may require careful negotiation with the community and access to substantial capital. Thailand is also reaching its limits in local gas production. At present, imported gas is quite expensive. Further, climate science is increasingly suggesting that we have to cut carbon emissions further and faster than expected. Unless this generator could be converted to run on biofuel in the future, and suitable sources were available, its future role may be limited.

(28) Pursue smart grids as an untapped energy option.

Since many existing opportunities for energy efficiency, demand management, smart grids and renewable energy involving the existing building stock have not yet been widely adopted on Koh Samui, these could be pursued more strongly as untapped energy options.

5. ENVIRONMENTAL PLANNING

5.1. Findings

Many achievements with regards to environmental planning in Samui were witnessed, some such achievements include:

- Solid waste volume stabilised through strong community and business projects, plans for energy from waste.
- Recent water shortage has increased community awareness and support for efficiency.
- Plans for more desalination plants could be deferred, avoided by efficiency, local storage, rain water, recycled water, etc.
- Several existing waste water treatment plants may be converted to biogas/energy production.
- Waste water plan developed.
- Major studies have been or are in the process of being undertaken.

5.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of environmental planning.

The recommendations in this study are concentrated on a low-carbon future; the review team recognise many other environmental and social issues should be considered through appropriate mechanisms as part of a comprehensive environmental strategy.

(29) Build on experience of successful waste management strategy to engage and empower business (including local tourism association) and community on other environmental issues.

From presentations made to the workshop, it seems that the waste management strategy pursued on the island over the past few years has been an outstanding model of an effective approach tailored to local conditions and engaging all key groups. It makes sense to learn from this experience. Also, there is value in using communications and measures that have visible similarities to the existing program, so that they are familiar to local people and easier to adopt based on their past experience. Failure to do this can also lead to criticism of lack of integration and greater needs for education and infrastructure.

For example, in Australia the first water efficiency label used A, AA and AAA as the ratings. After some years, this was replaced by a star rating label designed to work in the same way as the much more successful appliance energy label. The design of information materials, interactive website etc has all been based on the experience of the energy rating label. This has worked well to integrate consideration of water efficiency into purchasing behaviour.

(30) Include wider range of environmental issues in planning, e.g.:

- Biodiversity
- Toxic materials, e.g. asbestos, fuel spills, lead paints

This recommendation relates to the fact that energy and carbon strategies inevitably involve other environmental and social issues. Also, communities often confront major non-energy issues. There can be benefits from linking carbon/energy activities to other factors that people may be more familiar with. Also, an action that solves multiple problems is more likely to be valued and adopted. There are also real risks for low-carbon projects if they conflict with other environmental or social issues. This can cause a backlash against the low-carbon strategy. For example, strong opposition has been seen against hydro-electricity projects (due to factors such as impacts of dams on biodiversity, aesthetics and displacement of communities), wind energy (visual and noise issues), biomass (air pollution, 'food versus fuel', land clearing). The community tends to judge programs and projects that claim environmental benefits, such as reducing carbon emissions, more harshly if they fail to meet other environmental and social criteria. On the other hand, when they complement and enhance other outcomes, they can become much more popular and successful.

(31) Develop a plan for emergency accommodation in environmental events.

This is an example of linking low-carbon projects to other high value community priorities. Distributed energy infrastructure, upgrading existing buildings and building new facilities provides an opportunity to incorporate features that support the community at times of crisis at relatively low incremental cost. Also, inclusion of such features can support access to funding from sources other than energy and carbon budgets. For example, a distributed energy facility with energy storage could be attached to an emergency accommodation facility and, instead of it being used rarely; it could provide ongoing energy and a multi-purpose building for the local community. For example, in southern Australia, community facilities and homes being replaced after major bushfires include energy efficiency and renewable energy features, as well as improved fire resistance.

(32) Incorporate low-carbon materials, permeable surfaces into built infrastructure.

Large amounts of energy and resources are incorporated into traditional infrastructure, this infrastructure can exacerbate other environmental and social problems, such as high water runoff after rain. An increasing variety of new materials combine multiple environmental benefits. For example, some durable paving materials are now made from permeable or recycled materials.

(33) Link climate change, transport and building strategies to broader environmental plan.

This recommendation reinforces a broad approach to low-carbon strategies that is linked in appropriate ways to other environmental issues. As noted earlier, such an approach can enhance effectiveness or avoid conflict.

(34) Develop infrastructure to protect/adapt to climate change.

When building low emission infrastructure and upgrading existing facilities, it is important to ensure that they will not be adversely affected by climate change. Also, in Australia it has been found that people involved in adaptation projects often become more active in carbon abatement activity as they begin to understand the practical local implications of allowing climate change to progress. These links can be emphasised in education, training and communication.

(35) Look at energy use of water supply and treatment and minimise (e.g. slower pumping to distributed storages, make high altitude development as water self-sufficient as possible).

Water supply and treatment, including desalination, sewage treatment and pumping water in buildings can use large amounts of energy. Small scale distributed water and sewage processing plants can use surprisingly large amounts of energy. For example, one small sewage plant in a Melbourne (Australia) green building was found to be using four times as much energy per kilolitre of water produced as a large desalination plant. One Victorian water retailer found that the pumping energy required to supply water to consumers in high altitude areas was much greater than in lower areas, it therefore focused water efficiency and rainwater collection programs in high altitude areas. Pumping energy increases rapidly as the flow rate in a given pipe increases, so pumping slower over a longer period can save a large proportion of pumping energy. There is also significant potential to generate hydro-electric power as water and sewage flow downhill. Indeed, delaying flows to local storages can allow higher flows and electricity production at times of peak electricity demand.

6. LOW-CARBON BUILDING

6.1. Findings

Many achievements with regards to environmental planning in Samui were witnessed, some such achievements include:

- A number of businesses, in particular within the tourism sector, have developed low-carbon buildings that incorporate passive design techniques and energy efficient solutions including:
    - cooling buildings with shading elements and vegetation
    - natural ventilation and day lighting of common spaces
    - installation of high efficiency appliances including refrigerators, air conditioners and lighting systems
    - use of card control to switch off equipment in unoccupied hotel rooms

- In most commercial buildings and many homes, efficient light sources in particular compact fluorescent lamps have largely replaced incandescent bulbs.
- The analysis properly identified various types of buildings (resorts, hotels, etc.) and addressed the adequate technologies used in these buildings.
- Energy improvements and CO2 emissions were analysed and measured which were helpful for needs assessment as well as future monitoring.
- Larger standby generators for hotels and commercial buildings are being used to help manage peak demands on Koh Samui.
- A number of hotels participate in the Green Leaf programme that assesses their efficiency in environmental management and awards a Green Leaf Certificate ranging from 1 to 5 leaves.

6.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of implementation of low-carbon buildings.

(36) Make key buildings (arrival points, high-visitor facilities) low-carbon centric.

The low energy design and performance of a number of key facilities can play a major role in raising awareness, demonstrating energy efficiency in practice and showcasing Samui's low-carbon development direction to both locals and tourists. An example of this is the airport and ferry terminal. The review team noted the low energy design of the airport building including the use of natural lighting, ventilation and passive cooling techniques. As this facility is refurbished and extended there is a major opportunity to demonstrate leading low energy design and show case Samui's development direction to visitors. Public buildings and high-visitor facilities provide an opportunity to achieve major energy savings and provide highly visible showcases.

(37) Minimise electricity use in existing large buildings.

Most of Samui's electricity is used in buildings for air conditioning, lighting, hot water supply and appliances. There are opportunities to reduce electricity use and a demand side energy efficiency programme initially targeting larger buildings would be an effective way to make energy savings, reduce energy costs, create jobs and manage energy demand growth.

(38) Develop or adopt a green building benchmark / rating that identifies facilities that have achieved efficient use of energy and water.

This reiterates the point that energy and water saving is a good thing and providing a benchmark or awards (star) system encourages building managers to create and maintain savings.

This can be done initially on a voluntary basis with the potential to form part of a mandatory disclosure requirement. These can be either design-based ratings or performance-based ratings.

(39) Provide guidance to building owners and operators on energy efficient operating practices.

The guidance would cover best practice in energy management and maintenance including technical opportunities, staff and guest education relating to all energy end uses.

(40) Emphasise ocean front building characteristics.

Continue to take advantages of these characteristics such as natural air-conditioning from the sea breeze, collect and reuse rainwater, hot water pipes beneath the solar panels on the roof, waste water filtered and recycled, and use of local materials (renewable timber and reclaimed stone, for examples.)

(41) Consider Retrofitting on old buildings.

Retrofitting usually proves the most cost effective measure when wanting to achieve energy efficiency in older buildings.

(42) Complete the phase out of incandescent bulbs in hotels, shops and homes, including the replacement of halogen down lighting and track lighting in shops and hotels with LED lamps.

Such measures can usually be done quite cost effectively and simply and also bring about substantial energy savings.

(43) Introduce lighting controls in areas with good day lighting and intermittent occupancy.

This is also a cost-effective measure to use in energy conservation.

(44) Consider reducing electricity use by 60-70% by deploying solar or heat pump hot water heating, as many hot water systems use electric heating elements.

As an interim measure, larger storage hot water systems could be controlled at times of peak demand to better manage the capacity of the electricity system.

(45) Shade indoor spaces with outdoor planting.

By sharing indoor spaces with outdoor planting a cooler environment can be created thus providing a cost-effective and energy efficient cooling measure.

(46) Encourage the use of units of air-conditioning with a high efficiency rating.

The most common type of room air conditioners appear to be split system air-to-air units. These also have high maintenance requirements in the humid and salty marine environment. Electricity savings can be made by encouraging the use of units with a high efficiency rating; using central systems where appropriate; and rejecting heat to swimming pools and other water bodies rather than to air.

(47) Develop design guidance for new construction and major refurbishments. Contents would include:

- Passive design with naturally ventilated communal spaces and circulation areas where practical, limit need for air conditioning.
- Use of cool roofs and eaves to minimise heat transfer to indoor spaces.
- Effective cross flow natural ventilation.
- Heat pump and solar water heating.
- High efficiency equipment and lighting.

Such design guidance would prove very useful to architects and builders not just on the island but across Thailand and would significantly assist in efforts for reaching a low-carbon island and country.

(48) Consider professional training for local labor with the green building maintenance, construction, designing, and retrofitting skills.

This has obvious benefits as it provides skills and employs the local community whilst at the same time creates an easily accessible workforce for the creation of and maintenance of a sustainable green community.

(49) Develop planned communities.

This can be done through a cluster development or compact development concept where groups of green building structures can be integrated with a smart electricity distribution system.

7. TRANSPORTATION

7.1. Findings

The review team was very impressed to see the following achievements regarding a low-carbon transportation sector in Koh Samui:

- The transportation planning report has addressed the use of public transportation and high efficiency vehicles.
- Urban planning has an integrated land use and transportation plan that includes non-green area development.

- Innovative transportation technology such as Electric Vehicles (EV) have been evaluated. Related planning and EV facilities have also been considered.
- The analysis of CO2 reductions through transportation planning and different transport modes can provide critical information for future planning and selecting transportation options.

In addition to this there is:

1. A widespread awareness of the need for change, driven by various factors including high accident rates, noise, intermittent traffic congestion, air pollution, fuel spillages, carbon emissions and so on.
2. A variety of electric vehicles, mopeds and bicycles are already in use on Koh Samui, so there is a base of experience. For example, at the Intercontinental Resort on Koh Samui, small electric carts shift people and goods around a hilly site with low noise and environmental impact. The newer vehicles have regenerative braking, so their batteries can be recharged while they roll downhill.
3. At least 60 percent of visitors to Koh Samui travel by ferry from the mainland, having used trains, buses or cars instead of higher climate impact aircraft to travel from their points of origin. This offers a base for growing low emission travel to Koh Samui.
4. There seems to be strong community support for maintaining a single airport, not building more. This reflects the desire to move tourism towards 'quality not quantity'. If this approach is adopted, it will create opportunities for other lower emission modes of transport to and from Koh Samui.
5. Koh Samui seems to have widespread access to relatively high speed internet services. This underpins the development of 'smart' alternatives to transport, including improved logistics management for people and freight.
6. Substantial work has been done to collect statistical transport data and integrate low-carbon transport solutions into demonstration developments on Koh Samui, while low emission transport solutions have been proposed in the DEDE/EEC studies.

7.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of the transportation system on the island.

(50) Continue to emphasise integrated local comprehensive urban planning.

This is so that transportation, land use, land conservation and tourism can be assessed and coordinated.

(51) Clearly define road or street systems.

This can be done by separating the functions of major corridor, community streets, bike ways, and pedestrian walkways. With clear functional definitions, transportation efficiency and low-carbon

strategies can be implemented through better transportation mode distribution, planning, traffic regulations, signaling, monitoring and enforcement, and safety.

(52) Review accessibility and connectivity of an efficient comprehensive transportation planning system.

Factors that should be considered include safety, signs, multi-mode connecting points (airport, electric trolleys, corridor, mopeds, ferry, mini buses, and hotel vehicles). Walkable areas should connect public transportation and hotel, shops, attractions etc.

(53) Design safe, equal and easy access and pleasant walk able areas.

It is important that handicap and disabilities should be considered as should a night time lighting system for pedestrian safety. Walk able areas should connect public transportation, hotel, shops, attractions etc.

(54) Monitor energy use and transportation planning.

The Samui authorities should set current use and consider forecasting on a regular basis, future transportation demands and needs, energy saving strategies, measurable indicators, benchmarking.

(55) Design transit-oriented-development (TOD) transport strategies.

This would significantly enhance the transportation system of the island and provide locals and tourists with a convenient transport system that is also low-carbon.

(56) Seek financing mechanisms to purchase and maintain Electric vehicles on a large scale.

For example, develop a rebate program and consider providing grants to individuals, businesses, government organisations, non-governmental organisations, hotels and resorts, etc. Such involvement from these different players is likely to provide an efficient way of acquiring and maintaining electric vehicles, thus assisting in creating a low-carbon transportation system.

(57) Utilise smart transport system.

An example of this is the integration of cell phones, geo-mapping, and applications etc., in the running of the transportation system on the island (locals and vehicles hired by tourists).

(58) Analyse the comprehensive costs and benefits of addressing a range of transport issues. This should include the benefits of improved road safety, enhanced tourist experience, reduced air and noise pollution, reduced freight costs, etc, as well as carbon abatement.

Carbon abatement is a relatively small part of the benefit from reducing transport fossil fuel use. This recommendation proposes evaluation of a range of benefits that improve the economics, social and environmental benefits of low-carbon transport solutions. Although the focus of this project is carbon abatement, we need to use all available arguments to increase the likelihood of implementation. In Koh Samui, economics, tourism benefits and quality of life are major motivating factors.

(59) Analyse the access/transport requirements for freight, tourists and local residents, so that an appropriate mix of solutions can be developed and implemented.

To develop appropriate measures and policies, it is critically important to understand the diversity and scale of services required. It should also be emphasised that transport activity often reflects a failure to provide easy access to services near where people are: reducing the need for transport is the first priority option. Technology in this area is changing rapidly, so 'virtual' travel (using communications technologies, sensors and smart controls) can replace, optimise or enhance the value and reduce risks of travel. Given that it is likely that higher quality local public transport services will first be provided on the main 'ring' road, it will be important to investigate appropriate operational frequencies and capabilities of the vehicles selected. Vehicles that can carry people (in comfort), light freight (to and from roadside businesses), bicycles and even motorcycles could significantly reduce traffic. For example, tourists could use this service to reduce the effort involved in using bicycles, so they could just use them off the main road for shorter trips to local features and destinations. It seems that many light vans and utilities (and even motorcycles) are used for freight, but they are not fully loaded: a shared service could avoid significant amounts of traffic. Children and the elderly would also have safer and more independent travel options, which would also reduce time spent by parents and carers transporting them around.

(60) Carry out trials of innovative access/transport solutions before full scale implementation.

Implementation of change is often more complex and difficult than expected. It may also be easier if people value the new approach or the introduction is well-managed. So trials are important ways of learning, raising awareness, and building local skills and capacity (such as maintenance, recharging facilities, rental services etc).

(61) Develop strategies to reduce vehicle speeds and provide transport alternatives for local residents, tourists and freight that reduce numbers of vehicles. Possibilities might include:

a. A frequent service on the main ring road that uses vehicles capable of carrying people, light freight, bicycles and motorcycles. This should have 'smart' features so that users can estimate when the next vehicle will arrive, alert drivers to pick up and drop off freight to roadside businesses, and allow users to register calls for service.

b. High visibility screens/radar units that publicly display the speed of each vehicle relative to the speed limit.

c. Traffic calming strategies to slow traffic in areas of high pedestrian density.

d. Provision of safer paths/lanes for low speed vehicles.

e. Installation of speed limiting devices on all new vehicles brought onto the island.

f. Combinations of the above that may be phased in over time and as community attitudes change.

This recommendation is overarching for the transport sector on the island and reflects the view that successful change in transport to reduce emissions offers multiple benefits but may require some changes to existing practices to gain acceptance and support. The above gives an idea of the kinds of issues that might be involved.

(62) Consider air travel to and from Koh Samui which is probably the biggest contributor to a tourist's holiday carbon footprint. Measures to reduce emissions and impacts of aircraft including; alternative mode options, offset emissions, and encouraging longer stays, can all help to cut emissions per baht of revenue and/or per tourist. There is potential to encourage visitors to offset their travel emissions through purchase (and surrender) of Carbon Emission Reduction permits created through local renewable energy and energy efficiency projects.

Upgrading alternatives to air travel, developing tourism packages that integrate travel through Thailand with visits to Koh Samui, encouraging longer stays and development of attractive 'offset' packages can be addressed without engagement with air lines. Increasing aircraft occupancy, using more fuel-efficient aircrafts, and encouraging lower flight altitudes (to reduce creation of contrails and cirrus clouds, which create substantial climate effects but are not yet included in international climate agreements) could be cooperatively introduced with airlines. A carbon price could be applied to air travel to and from Koh Samui, as is being done in the European Union. Air lines that support these approaches could be favourably promoted and supported with special accommodation and activity packages.

8. RENEWABLE ENERGY

8.1. Findings

The review team was very impressed to see the following achievements regarding renewable energy use and development in Koh Samui:

- DEDE have made a detailed renewable energy development plan and accelerated program for the economy, including the current renewable energy source and target of total power generation by renewable energy.
- Development and promotion of solar, wind, hydro, biomass, etc, is a strategy of the Ministry of Energy Alternative Energy Development Plan (AEDP) that attracts a feed-in premium for a supporting period of 10 years.
- New renewable technologies are under research and development, including geo-thermal, tidal energy and hydrogen & fuel cell energy in Koh Samui and supported by government funding.

- Gasohol and biodiesel are used in fuel blends on Koh Samui, although at low fractions in the fuels.
- Renewable energy technologies have improved in both performance and cost in recent years.
- Service providers operating on Koh Samui provide Photo Voltaic (PV) systems and other energy efficient products.
- Existing height restrictions (all the buildings on Koh Samui with a height beyond 12 meters are prohibited) on building developments will help maintain solar access as the use of PV technology increases.
- PV power is used on Koh Samui in some off-grid locations where it replaces diesel generators and there appears to be a small number of grid-connected installations used by hotels and other businesses.

Globally by 2011 the price of PV modules per MW fell by 60% compared with 2008. Although there is debate about the rate of future price reductions most analysts consider installed PV capacity will continue to grow rapidly with further price reductions.[1] Historically a doubling of installed global capacity has resulted in a 20% reduction in price. From a user's perspective, in the absence of subsidies the economics of grid connected PV is dependent on annual sunshine hours and the level of electricity tariffs and is already competitive without subsidies in some countries.[2]

Samui has a good solar resource and the opportunities for its use as a grid connected source fall into three distinct markets:

- residential roof tops (<5kW),
- commercial building roof tops (< 50kW), and
- utility scale installations (>50 kW).

It is expected that the first two markets will be the first to compete with grid supplied electricity because they substitute for higher cost power that includes generation, transmission and distribution charges. Continued protection of solar access to roof tops will permit this technology to be fully utilised as it becomes competitive.

WIND POWER

Achievements

Small community scale wind power generation is a strategy in the AEDP and is supported by feed-in premiums.

Challenges

[1] http://www.mckinseyquarterly.com/The_economics_of_solar_power_2161
[2] https://www.bnef.com/PressReleases/view/216

Onshore wind generation seems to lack support from the local community, and would contravene the 12 metre height limit for structures on the island. Also the available wind speed information, presented to the Study group, appeared to be from monitoring close to the ground and onshore, so resource estimates are likely to be well below those measured at turbine hub height offshore.

Publically available information at Koh Samui airport (elevation 17m) indicates monthly average wind speeds for 2012 of between 9 and 15 km/h.[3] Other data from NASA Langley Research Centre indicates monthly average wind speeds (elevation 50m) vary between 12.3 and 22.4 km/h.[4] These latter average speeds suggest wind power could make a contribution and it would be worth clarifying what is known about this resource, and if justified, conduct a wind resource survey covering Koh Samui and the surrounding sea area.

Should a sufficient wind resource be established, broad options for location of wind turbines are:

Turbine option	**Location**	**Issues**
Small turbines (<100 kW)	Many locations on the island particularly as part of standalone power systems in remote locations.	High capital cost and low capacity factors. Vertical axis turbines may have some advantages.
Utility scale turbines (0.5 -3 MW)	At elevated sites	Typical 2010 installed costs range from US$1300 to US$2200 per kW. Landscape impacts.
Large turbines (>3 MW)	Offshore locations	Currently about twice the cost of onshore wind power, generally located in shallow water (< 30m).

There is also insufficient information available to the Study group to indicate whether off shore wind power is a future possibility although evidence suggests the ocean is sufficiently shallow to allow wind farm construction.[5] Offshore wind energy production is capital intensive, so it is essential that projects have high quality data on wind energy resources and other factors such as site factors affecting design and construction, and access to transmission lines. Without such information, financiers will be unlikely to provide the capital.

Generally offshore wind installations can have electricity outputs 50% larger than equivalent onshore wind farms because of the higher sustained wind speeds at sea. Key information to assess the viability of off shore wind is the nature of the resource in the Koh Samui region, possible wind farm locations,

[3] www.wunderground.com
[4] reported at www.gaisma.com
[5] There is a 20m depth contour close to the east side of Samui and Pangan Islands in the following reference suggesting that between Samui and the mainland depths are < 20m
http://www.thaiscience.info/Article%20for%20ThaiScience/Article/4/Ts-4%20coastal%20erosion%20in%20the%20gulf%20of%20thailand.pdf

and the sea bed depth at these locations.[6] If offshore wind farms are a possibility the existing submarine cable may be able to be utilised for power transmission.

Unlike other islands with standalone power systems, the existing electricity supply to Koh Samui would provide backup and grid stabilisation to support the intermittent wind resource without the need for diesel generation.

8.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of the development and implementation of renewable energy.

(63) Promote roof top solar heating system and heat pump hot water heating on the island. Hotels and resorts account for a large percent of the total buildings on the island, and a lot of domestic hot water is used daily.

Increased introduction of such systems will assist significantly in reducing CO2 on the island.

(64) Encourage use of grid connected solar PV technology.

It is important that the Municipal authority and the Provincial Electricity Authority of Thailand work to support the uptake of grid connected solar PV technology as it becomes more price-competitive.

(65) Consider use of sea water and lake water as a good cooling source for the air conditioning system.

The impact on the eco-system should be considered.

(66) Consider small scale hydro power and wind power uptake in remote areas.

This could decrease the initial cost of installing transformer substations.

(67) Build on existing research and analysis to clarify potential end uses.

Analysis should include scale, costs and benefits for renewable energy associated with buildings, business/industry and transport for electricity, heat, cooling and vehicles. Take into account potential for energy efficiency improvement and energy storage to reduce capacity required and enhance reliability and resilience. Since renewable energy technologies and costs are changing rapidly, and more data will be collected in relation to installation opportunities, this should be an ongoing process linked to other energy monitoring and analysis.

[6] There is a 20m depth contour close to the east side of Samui and Pangan Islands in the following reference suggesting that between Samui and the mainland depths are < 20m
http://www.thaiscience.info/Article%20for%20ThaiScience/Article/4/Ts-4%20coastal%20erosion%20in%20the%20gulf%20of%20thailand.pdf

(68) Consider ways of reducing high capital costs.

This can be done through large scale purchasing, streamlined installation, access to government funding and loans, etc. Also evaluate avoided costs of energy at estimated future prices (including a carbon price), and taking into account deferral of capital investment for alternative supply and other benefits. Capital costs are usually the biggest component of renewable energy costs. They often act as a major barrier to adoption. So minimising these costs through economies of scale, standardisation of systems and use of funding from external sources is very important. It is also important to recognise in full the value of the savings renewable energy systems will provide over their operating lives, by considering the savings on infrastructure and energy that would otherwise have been required. Renewable energy projects offer potential to create additional local employment.

(69) Establish a program of demonstration projects for the renewable energy options with best potential and install demonstration projects at schools and facilities where they can be used for education and training. Demonstration projects could be linked to zones where smart grid technology is in place, and should also offer smart user features such as monitoring and reporting of output.

Many people and businesses are inclined to see change as high risk, especially if it involves high capital costs. So practical demonstrations, and their use to educate local people, are critical to successful application of renewable energy. It is also important to ensure that any problems experienced by demonstration projects are promptly addressed, and the reasons for the problems (and how they were fixed) explained to local business and community.

(70) Monitor and survey user and local community attitudes to existing renewable energy systems, and to new installations to ensure they operate properly, and to support learning from experience.

Monitoring of both renewable energy system performance and attitudes is critical. Many renewable energy systems provide little feedback to users as to whether they are operating correctly, so failures can go undetected for long periods. This can undermine support for further installations. Ideally, monitoring should provide information both on-site and to a central point where program managers can track performance of all systems.

(71) Review the adequacy of the existing wind speed records.

This is to establish if the wind resource is sufficiently understood to determine the economic viability of wind power.

(72) Collect data and modelling of the wind power resource.

This is to assess the wind resource potential. This should include wind data for 60-80 metre heights offshore.

9. UNTAPPED ENERGY PLANNING

9.1. Findings

This section covers the possible use of a range of low-carbon resources including energy efficiency to reduce Koh Samui's reliance on imported electricity and fossil fuels. These options would also reduce the dependence on energy imports, help build a more diverse and resilient energy supply system, and contribute to the 'green brand' of the island.

The submarine power supply to the island is likely to remain an essential back bone of the supply system even if the proposed combined cycle power plant is developed. By providing a backup supply, it can usefully support the development of a number of renewable energy sources that are intermittent (e.g. solar, wind, waves). It could also provide a possible connection point for offshore energy generation.

Energy storage on the island could offer security in the event of supply disruptions as well as low-carbon benefits. For example, energy storage for electricity generation could help optimise the use of renewable energy resources mentioned above, provide improved energy regulation and operation of the supply grid and improve electricity security by reducing dependence on the submarine cables.

Substantial work related to identification of potential for a range of renewable energy options has been carried out at the central government level, and through studies focused on Koh Samui. Along with this, at a central government level, there is capability for research, development, demonstration and commercialisation of a range of energy technologies, as well as funding for such activities.

Energy efficiency of existing buildings

Much has already been achieved in this sector as is discussed in the Low-Carbon Building sector. However challenges still exist. There is little demand side data on energy end uses and how these are influenced by ambient temperature and tourist volumes. Many opportunities are available to improve energy efficiency in existing commercial buildings and hotels. Implementation of these would help reduce energy use and maximum electricity demands and take pressure off the electricity supply. Air conditioning, lighting, hot water generation and appliances are the main end uses and provide the largest opportunities for energy savings.

Municipal Solid Waste

The study team was advised that solid waste generation has grown steadily from about 50 tonnes per day in 2000 to 135 tonnes per day in 2012.

Achievements

1. The Municipal authority has stabilised waste at 135 tonnes per day by running education programmes and initiatives to manage waste at source including:

    a. Expansion of pilot to 200 hotels

    b. Twenty six low-carbon schools includes recycling composting of green waste and organic gardening

    c. Community pilots

Challenges

It is evident that some combustible and recyclable waste on the island is not being collected. The collected waste is currently going to landfill because of operational problems with the two incinerators. To the extent this practice is resulting in stray methane release it is contributing to global warming emissions.

Biomass

Thailand has developed a wealth of experience in using biomass for energy production especially in households and small industries in rural areas.

More than 70% of Koh Samui's land is used for agriculture and significant quantities of waste such as coconut husks are produced. The Study group was told that there is a drive to improve the viability of coconut farming by producing added value products rather than exporting whole coconuts. This could substantially increase the amount of waste material on the island that could be utilised for energy production.

Kitchen waste

Solid kitchen waste can be used for animal feed, composting for fertiliser or biogas production. Food waste with high moisture comprises 30% of municipal solid waste. EEC has identified the potential for over 600 kW of biogas production which could be used for heating or cooking. Further work is required to identify the best value uses of this waste, including how biogas could be utilised at the point of production or reticulated.

Waste Water Treatment Plant

Wastewater volumes exceed 16,000 m^3 per day with the main sources on the eastern side of the island at Bo Phut, Lamai, Chaweng and Bo Phut, and on the west at Nathon. Local treatment facilities exist at the last three centres but it is understood seawater near high population areas was found to be contaminated in 2005.[7]

[7] Feasibility study for the Sustainable Development of Samui Island Chapter4, 2006

EEC suggested short term actions to repair the waste water system; offer incentives to the public to reduce the amount of waste water produced; and application of advanced waste water service charges and strict control over the amount of waste water released by households and commercial buildings. The Study Group supports these recommendations.

In the long term EEC recommends collection of all wastewater and construction of a central treatment plant. The development of this plant is strongly supported by the Study group as it would reduce the environmental impact of local effluent discharges and provide the opportunity for local energy generation.

Such a plant could be designed to generate biogas for electricity generation or a CHP plant or upgraded to bio-methane for use as a transport fuel. There may be a case for using kitchen waste at such a facility to create scale economies. Also treated water could be recycled for irrigation and other uses.

9.2. Recommendations

Based on the above observations and findings, the following suggestions and recommendations can be applied for further improvement of untapped energy planning.

(73) Pursue known cost-effective or beneficial energy solutions to their full extent.

These use more reliable and commercially available technologies that have usually been demonstrated in other places and are likely to involve less training and education for local people. So they can be rolled out more quickly and can deliver large energy savings and generation.

(74) Consider investing in backup power generators. Backup power generators in many hotels and other businesses are run frequently when electricity supply disruptions and demand peaks occur. Capital has already been invested in these generators, so optimising their efficiency, use of renewable fuel and their role in minimising overall energy costs potentially offers low cost options.

They could run on high percentage blends of biodiesel or biogas, and capture waste heat for water heating and cooling. This equipment could run for minimum periods each day to offset importation of high priced electricity, as well as avoiding electricity use for water heating and space cooling. It may be that high performance heat pumps or solar hot water could be more economical in some circumstances, so comparisons are needed.

(75) Identify and use lower temperature heat sinks to improve cooling efficiency. Refrigerative cooling is a dominant consumer of electricity, and the efficiency of air conditioning is sensitive to the temperature of the condenser.

This is particularly true in hot and humid periods. Sea temperature is estimated at 27-29C, which may be lower than wet bulb temperature for significant periods, so sea may also offer a useful heat sink for cooling equipment.

(76) Upgrade the incinerators which provide an opportunity to install a plant to generate electricity or combined heat and power (CHP) fuelled by the combustible solid waste which accounts for 25% of solid waste.

By putting a value on solid waste such a plant would help to increase waste collection and reduce wild dumping. Besides reducing the requirement for landfill, this project would also help reduce reliance on the submarine electricity supply. The choice of plant will depend on the extent to which the heat could be utilised locally. The feedstock for the plant could be supplemented with woody biomass from agricultural waste.

(77) Measure ground temperature and temperatures of any underground aquifers to allow analysis of potential role of ground source heat pumps or use of aquifers as heat sinks.

(78) Advance a proposal to install an electricity generator or CHP plant, if a process heat requirement exists, to produce energy from the combustion of municipal solid waste.

In the long term EEC recommends collection of all wastewater and construction of a central treatment plant. The development of this plant is strongly supported by the Study group as it would reduce the environmental impact of local effluent discharges and provide the opportunity for local energy generation. Such a plant could be designed to generate biogas for electricity generation or a CHP plant or upgraded to bio-methane for use as a transport fuel. There may be a case for using kitchen waste at such a facility to create scale economies. Also treated water could be recycled for irrigation and other uses.

(79) Consider woody biomass from agricultural wastes for use as an additional resource for energy production either as a heat source at the MSW plant (if the electricity generation option is implemented) or for production of second generation bio-fuels for transport.

Currently, use of biofuels is subject to conflict over ‘food or fuel’. There is potential value for many communities of a demonstration that manages this issue in a more sophisticated and constructive way. At present, coconut growers on the island make very little money from their product, and there are derelict plantations because of the poor economics. Development of a bio fuel industry that sources its inputs from a variety of sources, including some that do not compete with food production, offers an opportunity to establish a minimum price or ‘floor’ for local coconut producers by utilising excess. By setting an upper limit on the price that would be paid by the bio fuel producers and ensuring they have other alternative inputs, they would not compete for food at prices that provide a reasonable return for coconut growers.

At present, the sale price of coconuts is very low: there may be potential to utilise a proportion of coconuts for biomass energy with the proviso that, if prices exceed a specified upper limit, use for energy should be reduced or stopped. This could provide a means of increasing and stabilising income of local palm plantations while avoiding the 'food versus fuel' problem. For example, the coconuts could be used as a fuel input to the MSW electricity generator, or to produce bio fuel for vehicles and/or hotel generators and/or export to the mainland.

(80) Consider green kitchen waste and used cooking oil for biogas generation and as a diesel substitute respectively.

Used cooking oil could be collected and prepared for use as a transport bio fuel to displace diesel or for operation of standby generators. This procedure could also become an interim step to local production of bio fuel. As quantities of used cooking oil are limited this source may best be reserved for high profile applications such as a public transport which provide an education opportunity and visibly reinforce the Koh Samui low-carbon goal.

(81) Consider the production and use of biogas in the design of the central waste water treatment plant, possibly supplemented with kitchen waste.

(82) Make provision for new low-carbon energy resources, both centralised and decentralised, to be incorporated on the Koh Samui energy system under regional planning policies.

OTHER ENERGY SUPPLY OPTIONS

Micro hydro

The elevations and rainfall indicate that micro hydro generation (kW scale) could make a contribution either in on-grid or off-grid applications. Elevated water storage would increase their potential contribution and resilience to periods of low rainfall.

Algal Bio fuels

Among algal fuels attractive characteristics are that they can be grown with low impact in fresh water; can be produced using sea water or waste water; and are estimated to have a per unit area yield of oil many times that of land oil crops. Technical issues are being addressed but high investment costs for algae-to-bio fuel facilities remain an obstacle. Subject to further development, this technology could fit with Koh Samui's resources and climate.

Marine energy

The study team also notes that tidal energy has also been identified as a technology for research and development for the Phuket and Koh Samui regions[8]. The development of an international marine energy demonstration centre in the vicinity of Koh Samui may be worth exploring to help build Koh Samui's international low-carbon profile and would align with EEC's proposal for an Eco-Centre.

Energy Storage

Energy storage on the island will be a key factor in enhancing supply reliability and resilience, increasing use of local renewable energy sources, and supporting export of power to the mainland at times of high prices. Pumped storage for electricity generation provides a fairly simple way of doing this for locations where there are large variations in altitude and suitable sites for storage. Given the rapid rate of development of many other storage options, both at the network and consumer scale, any pumped storage solution should be compared with other options regarding economics and suitability to local conditions and community attitudes. Some energy storage options include:

Energy storage options	Comment
Pump water storage for electricity generation	Largest capacity form of grid energy storage. Koh Samui has land over 200m elevation for an upper level reservoir. Sea water or fresh water could be used as storage medium. Efficiency of the pump/generation cycle can be 70-80%.
Electric vehicle batteries connected to a smart grid	Will require a significant fleet of electric vehicles to provide significant storage, primarily of use for peak load supply.
Biomass storage at the municipal solid waste incinerators	Could potentially provide long term backup power for emergency services in the event of loss of grid supply.
Biogas storage	Located at points of production such as the waste treatment plant, potentially for electricity generation, transport fuel, or reticulation as a heat source.

[8] Dr Twarath Sutabutr, 2012. Presentation on Renewable Energy and Energy Efficiency Development Plan and Accelerated Program to APEC LCMT Phase 2 (Study Group B).

APPENDIX A: POLICY REVIEW TEAM MEMBER

Mr. Takato Ojimi, Policy Review Team Leader, President, Asia Pacific Energy Research Centre (APERC)

Mr. Alan Kenneth Pears, Adjunct Professor, RMIT University, Australia

Dr. Li Kuishan, Team Leader, Green Building Consulting, China

Mr. Bill Brander, Energy Efficiency and Conservation Authority, New Zealand

Mr. Alven H. Lam, US Dept. of Housing and Urban Planning, United States of America

Mr. Goichi Komori, Senior Researcher, Asia Pacific Energy Research Centre (APERC)

Miss. Gayathiri Bragatheswaran, Researcher, Asia Pacific Energy Research Centre (APERC)

Appendix B: Organisations, Officials and Experts Consulted

Thailand Ministry of Energy –Department of Alternative Energy Development and Efficiency

Dr. Twarath Sutabutr , Deputy Director General

Mr. Somchai Stakulcharoen, Energy expert

Dr. Sorawit Nunt-Jaruwong, Senior Scientist

Ms. Charoensri Huadmai, Consultant

Ms. Sujit Khemmee, Expert Analyst on Energy Planning

Mrs. Kamontip Suttaksam, General Service Officer

Ms. Chidchanok Choompanee, Foreign Relation Officer

Dr. Weerawat Chantanokome, Councillor to the Ministry of Energy

EEC Engineering Network

Mr. Kecha Thirakomen , CEO

Mr. Unnop Kinkajee, Assistant Managing Director

Ms. Chaviwan Samart, Engineer

Ms. Suwichaya Metamanorom, Engineer

Mr. Kamol Tanpipat, Project Manager

Ms. Korapin Thirakomen, Project Coordinator

Royal Thai Naval Dockyard Department

Captain Dr. Samai Jai-In, RTN, Energy

Provincial Energy Authority-Samui

Mr. Pipop Jantmanee, Assistant Technical Manager

Tourism Association of Koh Samui

Mr. Tanongsak Somwong , President

Mr. Vichavin Wichaidit, Vice President

The Office of National Economic and Social Development Board

Dr. Witaya Pintong, Expert on Macroeconomic Model

Surat Thani Energy Office

Mr. Rohya Chantaratana, Head of Energy Office

Mr. Chaiya Siyacheheep, Senior Techinician, Energy Office

Mr. Uisarut Kamyindee, Officer, Energy Office

Provincial Waterworks Authority of Koh Samui

Mr. Teerapol Chokkana, Head of Production

Mr. Nattakit Kwuaysu, Officer

Kasetsart University

Mr. Tanapon Panthasen

Mr. Supanita Mancharen

Agaligo

Mr. Sitt Therakomen

Bangkok Airways

Ms. Pannaphorn Oreechachan

NIKKEN SEKKEI Research Institute, Japan

Dr. Shinji Yamamura, Executive General Manager, Principal Consultant

Dr. Ken Kodama, Executive General Manager, Principal Consultant