



**Asia-Pacific  
Economic Cooperation**

**EWG 19/2011A:  
Best Practices in Energy Efficiency and  
Renewable Energy Technologies in the  
Industrial Sector in APEC Region**

**APEC EGEE&C 42<sup>nd</sup> Meeting**

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**Asia-Pacific  
Economic Cooperation**

## **Project Overseer**

Dr. Nuwong Chollacoop,  
Dr. Paritud Bhandhubanyong and Ms. Peesamai Jenvanitpanjakul  
National Metal and Materials Technology Center (MTEC)/  
National Science Technology Development Agency (NSTDA)  
Ministry of Science and Technology (MOST), THAILAND

## **Duration**

Jan 2012 - Mar 2013



**MTEC**  
a member of NSTDA

## **Contractor**

**Resource Development Ltd  
Hunterville, New Zealand**

## **Project Team**

Dr. David F. S. Natusch, Team Leader  
Dr. Garth S. Harris, Consultant  
Mrs. Pam Bradley, Researcher  
Mrs. Tam Hiscotte, Secretarial





### **Project Coverage and Tasks**

1. Assemble **Examples** of EE and RE in Industry,
2. Identify **Obstacles** to the introduction of EE & RE in industry,
3. Establish the **Lessons Learned** in APEC Economies
4. Formulate **Best Practices** for the introduction of EE & RE in industry throughout APEC,
5. Prepare a **Roadmap** for the introduction of EE and RE in Industry applicable to APEC economies.



### **EE & RE Examples Selected**

- **Bagasse Power in Sugar Mills – Australia**
- **Bagasse Fired Cogeneration – Thailand**
- **Bagasse Power and Fuel Production – USA**
- **Bagasse Cogeneration in an Edible Oil Refinery – India**
- **Biomass Gasification in Ethanol Production – USA**
- **Biogas to Heat and Power – Canada**
- **Large Scale Industrial Biogas – China**
- **Tallow Fuelled Boilers – New Zealand**
- **Sawmill Powered by Wood Waste – Australia**
- **Wood-waste in Different End Uses – Malaysia, New Zealand, Singapore**
  - ✓ **Timber Drying.**
  - ✓ **Cogeneration of Heat and Power for Waste Processing**
  - ✓ **Maximizing the End Use Efficiency of Wood Waste.**
  - ✓ **Production of Briquettes for Boiler Fuel.**
  - ✓ **Combined Application of Several Energy Efficiency Initiatives.**
  - ✓ **Sewage Sludge Disposal.**
- **Watermill Upgrading – Nepal**
- **Micro-Hydro Electricity Generation – Indonesia**
- **Solar Crop Drying – Indonesia**
- **Solar Thermal Process Heat – USA**
- **Concentrated Solar Thermal Power Plant – Thailand**
- **Hybrid Solar Thermal and PV for Process Heat and Power – USA**
- **Solar Cooling and Process Heat – Singapore**
- **Changbin and Taichung Wind Farms - Chinese Taipei**



Bagasse Fired Cogeneration (on-grid 29MW)  
– Phu Khieo Bio-Energy Co. Ltd. Thailand  
*Photo courtesy by COGEN 3 Info Sheet*

- For each EE & RE Example
  - ✓ Project Description
  - ✓ Coupling with Energy Efficiency
  - ✓ Project Highlights
  - ✓ Economics
  - ✓ Obstacles Encountered
  - ✓ Lessons Learned
  - ✓ Contact Information

- From all EE & RE Examples

- ✓ Identify obstacles
  - Generic
  - Technology specific
  - Industry specific
- ✓ Establish lessons learned
  - Generic
  - Financial and Economic
  - Institutional
  - Technology specific

- ✓ Formulate *Best Practices*
  - Financial incentives
  - Regulatory actions
  - Other measures
    - Funding, R/D, Demos
    - Recognition, awareness
    - Training/technical support
    - Benchmarking & labeling
    - Target setting
- ✓ Prepare *Roadmap*
  - Roadmap elements
  - Roadmap time sequence

## Identify **obstacles** from all EE & RE Examples

### ✓ Generic obstacles

- Information access & Implementation capacity
  - Access to information
  - Information transfer and personnel training
  - Implementation capacity
- Project ownership issues
  - Management and worker perceptions
  - Championship
  - Stakeholder engagement
- Technical issues
- Financial & Economic issues
  - Establishment costs
  - Economic viability
  - Access to capital
- Institutional obstacles
  - Incentives
  - Standards and regulations
  - Administrative barriers

### ✓ Technology specific obstacles

- Solar thermal: conservative nature of building and architecture
- Bioenergy: availability of feedstock/land/stockpiling

### ✓ Industry specific obstacles

- Availability of suitable land for large-scale installation
- Cost to accommodate RE & EE infrastructure
- Availability and effective utilization of waste heat



### **Establish lesson learned from all EE & RE Examples**

#### ✓ Generic lessons

- Benefits of Renewable Energy and Energy Efficiency
- Early Industrial Adopters of Renewable Energy and Energy Efficiency
- Information Availability and Capacity Building
- Technical Lessons

#### ✓ Financial and Economic Lessons

#### ✓ Institutional Lessons

- Availability of Incentives
- Standards and Regulations

#### ✓ Technology specific lessons

- Solar thermal/PV/concentrating solar
- Wind electric power
- Bioenergy: power generation, process heating, CHP, biogas production, MSW, landfill gas capture, liquid biofuels
- Hydropower: hydro electricity, hydro shaft power

## Formulate **best practices** from all EE & RE Examples

### ✓ Financial Incentives

- Feed In Tariffs
- Net Metering
- Grants, Rebates and Loans
- Tax Incentives and Benefits
  - Excise Taxes
  - Tax Credits and Deductions
  - Sales Taxes and Import Duties
  - Energy End Use Taxes

### ✓ Regulatory Actions

- Mandates
- Renewable Portfolio Standards
- Tradable Renewable Energy Certificates (RECs)
- Regulations, Standards and Codes of Practice

### ✓ Other Measures

- Funding, Research, Development and Demonstrations
- Recognition Programs and Awareness Building
- Training and Technical Support
- Benchmarking and Labelling
- Target Setting
- Energy Audits
- Encouraging OEM Participation



## Develop **roadmap** from all EE & RE Examples

## ✓ Roadmap Elements

- Industry-wide Review
- Government Commitment
- Formulation of Policies
- Promulgation of Standards and Regulations
- Access to Technology and Equipment
- Industry Information and Education Campaigns
- Technical Capacity Building
- Development of Financing Packages
- Leadership by Example
- Program Management and Monitoring

- ✓ Roadmap time sequence

ROADMAP ACTIVITIES		YEAR 1				YEAR 2				YEAR 3				YEAR 4				YEAR 5			
1	Industry-wide Review																				
2	Government commitment																				
3	Formulation of policies																				
4	Promulgation of Standards and Regulations																				
5	Access to Technology and Equipment																				
6	Industry Information and Education Campaigns																				
7	Technical Capacity Building																				
8	Development of Financing Packages																				
9	Leadership by example																				
10	Program Management and Monitoring																				



## Conclusion

### ✓ Overall conclusion

- RE and EE are the “twin pillars” of a sustainable energy future → their combined application can result in the outcome exceeding the sum of the parts<sup>1</sup>
- Already many successful applications of RE combined with EE throughout APEC and their numbers are increasing.
- Governments can create regulatory and business environments that promote development of RE and EE in industry → industry will develop responding business models by extracting maximum value from the opportunity available.
- No universal business model that can be used to introduce and sustain all different forms of RE and EE in industry.
- Successful introduction of RE coupled with EE improvement in industry often depends upon the people involved and the partnerships established.

<sup>1</sup><http://www.ren21.net/REN21Activities/GlobalStatusReport.aspx>



# Thank You

## Best Practices in Energy Efficiency and Renewable Energy Technologies in the Industrial Sector in APEC Region



Report to the

APEC Energy Working Group

[http://www.apec.org/Press/Features/2013/9/903\\_future.aspx](http://www.apec.org/Press/Features/2013/9/903_future.aspx)



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5 Sep 2013

### Mapping out a renewable energy future



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Crushed sugarcane stalks, once regarded as trash, are fed into boilers and burned to generate fuel at a mill in northeast Thailand. The burned sugarcane waste generates enough electric power to support the Mitr Phol Bio-Power mill's daily operations and even provides surplus power to Thailand's electricity grid.

An APEC project on best practices in energy efficiency and renewable energy in industry recently highlighted the activities of the Mitr Phol Bio-Power's mill. Renewable energy, if used efficiently, has the potential to supply 23 percent of final energy use in the global manufacturing industry and up to 14 percent of fossil feedstock can be replaced by biomass like sugarcane waste, also known as bagasse. Together, this equates up to 21 percent of final energy use, according to the APEC project report.

Taking advantage of incentives by the Thai government to promote renewable energy, Mitr Phol Bio-Power installed new high-efficiency boilers and turbines to generate electrical power and steam to run the mill's manufacturing processes. The new cogeneration plant was especially designed to export excess power to the grid by a contract with the Electricity Generating Authority of Thailand (EGAT), a new concept for the sugar industry.

"The project was beneficial in terms of both financial return and plant efficiency," said Mr. Suwat Kamolpanus, Managing Director of Mitr Phol Bio-Power Co. Ltd.

"Before, the used sugarcane or bagasse was merely agricultural waste to be rid of. But with the government incentives, the bagasse has become a valuable asset to be well taken care of."

At the mill, the waste is fed into a boiler that heats a mixture of water and oil, which is used to generate electricity. The electricity is then sold to the grid. The mill is now regarded as a Small Power Producer.

"The agricultural processing industry is a good model for combining renewable energy and energy efficiency," said Dr. Nuwong Chollacoop, APEC project overseer and Head of the Renewable Energy Laboratory, National Metal and Materials Technology Center (MTEC) in Thailand.

"Instead of investing to properly dispose unused agricultural waste, additional

Instead of investing to properly dispose unused agricultural waste, additional investment can convert this waste into a renewable energy source to provide energy back into the process plant for better overall energy efficiency.

Dr. Nuwong Chollacoop, APEC project overseer and Head of the Renewable Energy Laboratory, National Metal and Materials Technology Center (MTEC), Thailand.

APEC Bulletin Issue 34, September 2013

[http://publications.apec.org/publication-detail.php?pub\\_id=1404](http://publications.apec.org/publication-detail.php?pub_id=1404)



## Conclusion

### ✓ Combination of RE & EE

- Combined application of RE & EE in industry is a natural marriage
  - industry operators who have the foresight to convert their plants from fossil fuels to renewable fuels are very likely to maximize the value of the renewable fuel by maximizing the efficiency of its use in their plants.
- A need to broaden our thinking to include the efficient use of renewable energy in industry to achieve maximum value for **ALL** (industrial end user, community, economy and planet with its inhabitants.)
- Combined use of RE & EE in industry needs to focus on how such combination can maximize the benefits that can be achieved, e.g.
  - minimizing the specific energy consumption (SEC) required for production,
  - maximizing revenues and economic value for an industrial company,
  - minimizing the use of fossil fuels,
  - reducing GHG emissions,
  - managing waste disposal,
  - minimizing environmental impacts,
  - job creation,
  - improvement of industrial working conditions and safety.
- Combined RE & EE initiatives may be quite different depending on which is targeted by a particular industry or industrial plant.



## Conclusion

### ✓ RE & EE in industry

- Many examples of the combined application of RE & EE in industry, their penetration to date has not been extensive.
- Applications considered most likely to achieve significant penetration in the middle term are:
  - biomass for process heat,
  - biomass as a petrochemical feedstock,
  - solar thermal systems for process heat,
  - heat pumps for process heat.
- It has been suggested that RE has the potential to supply 23% of final energy use in the global manufacturing industry and up to 14% of fossil feedstock can be replaced by biomass. Together, this equates to 21% of total final energy use.



## Conclusion

### ✓ Barrier & Obstacles

- Obstacles encountered in industry are very much the same as those involving the introduction of new and unconventional technologies.
- No particular obstacles unique for the introduction of RE & EE initiatives in industry other than those applicable to specific technologies.
- Individual industries, technologies and locations have their own characteristics and obstacles that may be of major importance in one situation can be quite minor in another.
- Obstacles that can be addressed by Governments include:
  - lack of information about how the introduction of RE & EE can benefit specific industries,
  - insufficient capacity to implement the technology in a timely and cost effective manner,
  - high project establishment costs,
  - reduced economic viability due to competition with subsidized fossil fuels,
  - difficulties in accessing capital,
  - institutional obstacles such as:
    - » lack, or inadequacy, of appropriate incentives,
    - » ineffective regulatory regimes that are not supportive,
    - » inadequate administrative structures and performance.
- These issues have been addressed successfully in a number of APEC economies and industries and are diminishing with time as experience is gained, capacity built and costs reduced.





## Conclusion

### ✓ Lessons learned

- Many RE & EE technologies are now commercially competitive in a number of different industrial applications throughout APEC.
- Several EE improvements can be implemented together to provide a high level of energy end use efficiency and reduce GHG emissions.
- Combined production of heat and power (CHP) is probably the most important way in which the efficient use of RE in industry can be maximized.
- Efficiency gains can also be achieved through:
  - use of high efficiency boilers, steam turbines and captive power gensets,
  - use of a smart (microprocessor) system controller to match load requirements to available energy supply profiles,
  - improvement of such items as air leakage, controller efficiency, compressor efficiency, installation of variable speed drives, system pressure control and control of off load running of mechanical and electrical equipment.
- Opportunities for improving industrial EE extend beyond technology to include maximizing the value of the energy products and streamlining process and plant management practices. These can be identified by pursuing market research and energy audits that include a review of management protocols and practices.



## Conclusion

### ✓ Best practices

- Many APEC economies **already have policies and measures** in place to promote the development of **RE & EE** in industry although their **effectiveness differs considerably** and most are still evolving.
- **Tax incentives and benefits are the most common** measures used by governments to promote the introduction of **RE & EE** improvement in industry.
- There are **considerable variations** between the incentive policies and **measures employed throughout APEC**. Differences are apparent between:
  - developed and transition economies,
  - Asian, Australasian and North American economies,
  - industrialized and agrarian economies.





## Conclusion

### ✓ Roadmap (1)

- Intended to **outline the steps** that are required to **plan and implement** an **RE & EE** program in industry.
- Steps and actions required are **largely generic and are applicable** in all APEC economies; however, there are **considerable differences** between both economies and their industries,
  - so the actual implementation plan adopted, and mechanisms employed, will be different in each economy.
- Most APEC economies have **already embarked on implementation programs** so are currently at different points along the road.



## Conclusion

### ✓ Roadmap (2)

- The role of governments is to **create and manage an implementation program** that will **foster and support** the development of **RE & EE** in industry, and should include the following 10 elements:
  - Initial industry-wide review to **identify opportunities** for the development of **RE & EE** in industry.
  - Commit to support these initiatives and **develop an action plan**.
  - **Formulate policies to promote** the introduction of **RE & EE** by the industries.
  - Promulgate **standards and regulations**.
  - Facilitate **access to technology** and equipment.
  - Establish campaigns to **inform industry and the public** about Government objectives and policies and the actions that are being taken.
  - Build **local technical capacity**.
  - Develop **appropriate financing packages** and encourage the provision of **private sector financing**.
  - Lead by example by introducing **RE & EE** improvements in **government owned industrial plants**.
  - **Maintain ongoing program** management and monitoring.



## **Progress to Date**

All research has been completed,

Findings have been analysed,

Outcomes have been categorised and evaluated,

Roadmap has been formulated,

The Final Report already got comments from EGEE&C and EGNRET

APEC publication APEC#213-RE-01.7

[http://publications.apec.org/publication-detail.php?pub\\_id=1404](http://publications.apec.org/publication-detail.php?pub_id=1404)