Asia-Pacific
Economic Cooperation

APEC WORKSHOP ON SMALL HYDRO AND RENEWABLE GRID INTEGRATION

Final Report

APEC Energy Working Group

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Executive Summary

1. **Plenary Section:**

1.1 Mr. Le Tuan Phong, General Deputy Director the General Directorate of Energy Viet Nam (GDE) warmly welcomed all delegates to the Workshop on Small Hydro and Renewable Grid Integration. He emphasized the importance of diversification of energy resources and supply sources as a high policy agenda should be pursued. Therefore, small hydro and renewable energy have become important sources of energy to integrate into the grid in the APEC member economies. He encourage everyone to actively participate in the discussion in order to achieve the objectives of the Workshop, share experiences on the issues related to diversification of energy sources, sustainable development and green growth and suggest road map for addressing current grid integration problems and suggested future APEC projects.

1.2 Mr. Pham Thanh Tung, representative of the General Directorate of Energy of Viet Nam presented a brief review of the Workshop which highlighted the background, objectives and results of the Workshop. The main objectives of the Workshop are: To share experiences on an important clean energy resource; To develop a road map on the way forward to address problems; To support the policy makers at the central and local governments among APEC economies in promotion of the small scale hydro power and renewable electricity integrated into national grid; and To strengthen ties with member economy

1.3 Dr. Tom Lee, Chair of APEC Expert Group on New and Renewable Energy Technologies presented the overview of EGNRET projects which focused on the history of establishment and development of APEC and some key features of APEC membership are briefly introduced and APEC operating systems. APEC operates at two levels: the policy level and the working level. APEC established 7 energy working groups (EGCFE, EGEE&C, EGEDA, EGNRET, BTF, ETITF, LCMT TF) for addressing energy issues. He highlighted the 7 recent Renewable Grid Integration Projects, 3 Completed Projects, and 11 On-going Projects which have been and are being carried out in various member countries.

1.4 Mr. Nguyen Duc Cuong, Director of Renewable Energy & CDM Center presented current status and future plans on renewable electricity sources in Vietnam. He shared the potential of renewable energy development in Viet Nam, highlighted the progress of the new and renewable energy development especially policies/mechanisms for renewable energy development such as small hydro power, wind, solar and solid waste power.

1.5 Mr. Jeff Skeer, representative of the International Renewable Energy Agency presented the Small Hydro as part of a clean energy portfolio. He shared the Renewable Generation Costs Study. The major following information were shared:

- Rapid deployment and high learning rates are leading to significant cost declines that encourage further capacity additions
- While the smallest hydropower facilities have somewhat higher operation and maintenance costs per kilowatt, the overall burden of O&M costs is modest – ranging from 1 to 6 percent of installed capacity costs per year of operation. Around 3 percent of capacity costs per year is typical for small hydro, 2 percent for large.

- The busbar cost of small hydro averages around 4 cents per kilowatt-hour in China, with a range of 2 to 7 cents, and 5 cents per kilowatt-hour in the rest of Asia, with a range of 3 to 13 cents. So for APEC in general an Viet Nam in particular, small hydro is an attractive option.

1.7 Dr. Tran Thanh Lien, Team Leader, Asia Pacific Energy Research Center (APERC) presented the Renewable Energy Electricity Generation Outlook in the APEC Region. He also analyzed some key drivers, opportunities and challenges for renewable energy development in Viet Nam. He emphasized on the phasing out fossil fuel subsidies for power generation; rapid declining RE technology costs; Viet Nam has experiences on the development of small hydropower plants in the past; Trends of reduction in RE technology costs for wind and PV in the world and APEC region.

1.8 Mr. Dan Ton, Program Manager, Smart grid R&D, U.S. Department of Energy presented the Smart Grid R&D Program in USA which focused on three areas: intelligent load management; distribution automation and micro grids. The area Micro grids" is where small hydro is integrated with the smart grid.

1.9 Trinh Quoc Vu, Director Power Market Development Research and Training Center presented the current problems faced in Vietnam associated with the Integration of Small Hydro into electric grid of Viet Nam with main points focusing on the following items: (1) Current situation and Potential for development of small HPP in Vietnam; (2) Benefit and Advantage; (3) Legal framework for development of small HPP; (3) Problems arising with small HPP: Technical issues and Social and environment; and Solutions.

2. Session 2: Current status and development plan for grid small hydropower in APEC economies

This Session chaired by Dr. Cary Bloyd Pacific Northwest National Laboratory USA . In this session, representatives of economies present issues related to small hydropower development and integration to the grid, including current status and future development plans, favorable conditions, problems, barriers, and proposed solutions.

The following is summary of presentations delivered in this session.

2.1 Mr. Duong Manh Cuong, Expert of Planning Dept., GDE Vietnam presented the current status & development plan for grid small hydropower in Vietnam which highlighted the barriers and measures to overcome barriers in the future. He continue sharing information on: (1) current status and future development plans for Small hydro power in Viet Nam: 361 small hydro projects with capacity of 1200MW have been completed and commissioning. They are mainly connected to medium voltage grid (22kV, 35kV) and partly to 110kV grid; (2) Incentive mechanism and policy to encourage the development of renewable energy including small hydro power such as: import tax exemption for imported equipment. EVN has obligation to purchase electricity from renewable energy sources; (3) Barriers that limit the development of small Hydro Power in Viet Nam; (4) highlights of solutions such as: Establishing regulations on safety management of hydropower dams, regulation on using surface water resource to ensure harmonizing water resource to irrigation and household use; Developing efficient connection network to optimize construction cost, transmitting capacity and land occupation.

2.2 Ms. Nurhafiza bt Mohamed Hasan, Head, Licensing Unit, Energy Commission Malaysia presented the current status and development plan for small hydropower in Malaysia which highlighted the national RE policy, RE strategies, implementation mechanism such as small committee on renewable energy, FIT mechanism, tax incentives, green technology, financial mechanism, eligibility criteria (zero or low gas emission, safe for use and promoted environment, conserve energy use and natural resources) and also major challenges such as: no rainfall reducing generation, heavy rain causing flood & overflow; regarding technology: water filter needed; regulatory requirements; financial support/approval from banks; water pollution during construction.

2.3 Mr. Winifredo W. Malabanan, Director of Renewable Energy Department Bureau, Department of Energy Philippines presented the Roadmap for Hydropower Development in the Philippines which focused on the following items: current status; challenges and barriers; mechanisms and policies.

2.4 Mr. Rida Mulyana, Director General of Renewable Energy and Conservation, Indonesia presented the progress of the Grid Small Hydro Power Development in Indonesia.

2.5 Ms. Krittiya Petsee Plan and Polisy Analyst Work Plan Devision presented the current status and development plan for Grid Small Hydro Power in Thailand which highlighted the lessons learned such as Micro-Pico Hydro considering as the cheapest RE Resource and simple and proven technology; Strong commitments of community to operate and maintenance; and Technical assistance and transfer to local people.

3. Section 3: Issues on grid integration of small scale *RE* electricity APEC Economies - Electric Utilities Perspective

This section chaired by Dr. Tom Lee, Industrial Technology Research Institute, Chinese Taipei, and Chair APEC Expert Group on New and Renewable Energy technologies. The discussions in this section are about status of small hydro and renewable energy and issues, solutions related to their grid integration in APEC economies.

3.1 Dr. Tran Nam Trung, Technical and Production Department, Electricity Vietnam Viet Nam presented the progress of the wind power study under cooperation between EVN and ICASEA. His presentation focused on the wind power development in Vietnam, analyzing wind power impacts on the power system and wind power in the electricity market. He also presented the future work on wind grid interconnection.

3.2 Mr. Do Thien Khoi, Global Government Affairs Manager, Product Safety UL LLC, USA presented the standards and technical considerations for small scale energy projects into the grid which focused on the following contents: technical considerations for small scale projects; Systems approach to safety and performance (Local vs. International); Installation (PID, Inspection, and Maintenance); Energy Storage and Integration Policy; and recommendations for engagement of international standards development; private sector; and SCSC project proposal – PV Integration into the Smart Grid.

3.3 Mr. Saharuddin Sulaiman, Principle Engineer, Asset Management Department Distribution Division, Tenaga Nasional Berhad, Malaysia shared the issues on grid integration of small scale RE electricity APEC Economies—Electric Utilities Perspective.

3.4 Mr. Suroso Isnandar, System Planning Engineer, Division of System Planning, PT PLN (Persero), Indonesia presented the issues on grid integration of small hydro in Indonesia – PLN's Perspective which highlighted the issues and solutions for the grid integration of small hydro.

3.5 Ms. Worajit Setthapun, Suchat Srikaew, Wattanapong Rakwichian, Asian Development Institute for Community Economy and Technology, Chiang Mai Rajabhat University, Chiang Mai, Thailand presented the progress of the Chiang Mai World Green City – Smart Community.

3.6 Mr. Wan Lin, Director Beijing Energy Innovation Ltd. China presented the current status and development for grid integration of small scale RE electricity in China. His presentation emphasized some cooperation proposals such as: roadmap, models, price setting models, tool kits …

3.7 Mr. Dan Ton, Program Manager, Smart grid R&D, U.S. Department of Energy presented a brief overview of renewable system integration in USA focusing on background, issues and solutions.

3.8 Dr. Bing Chwen Yang, Division Director, Green Energy and Environment Laboratories, Industrial Technology Research Institute, Chinese Taipei presented the progress of the smart grid master plan in Chinese Taipei that focused on power system in Chinese Taipei, hydro power system, target of renewable energy, smart grid & energy storage.

4. Session 4: Roundtable discussion on the development of a road map for small hydro integration

In the roundtable discussion of the workshop, participants made suggestions on common issues across the economies, although each economy has distinct hydro resources and natural conditions, different type of social-economic system and technical system (for example, the grid system).

Looking at different aspects, a consensus view among participants suggested that the most important areas were:

1. Research projects
- Optimal combination of small hydro and wind/solar in the grid and harmonization of all kinds of distributed energies of the grid system
- Technology and policy solutions for these combination and harmonization
- Promoting a micro grid concept
- Cost effectiveness
2. Conducting feasibility studies and pilot projects
    - To keep people to know how to get effectiveness before expanding installation/building RE energy system
    - To demonstrate these studies and projects in specific community or particular local conditions
3. Building system information exchange based on regional cooperation.
    - APEC will lead a joint study on the PV-hydro hybrid system.

- Proposal projects for best practices for areas: Hybrid system; assessment of latest technology, for example, micro grid and RE technology; interconnection of the hydro into the grid system; and financing models for RE projects.
- APEC will lead a project on clear definition on RE small scale, including small hydro power.

4. Standards for small hydro and other renewable energy system

   Workshop participants discussed a range of collaboration activities in the APEC region. In this regards, APEC could produce/propose some projects in this mentioned area.
5. Involvement of stakeholders, specifically local community in small hydro projects
   - Small hydro power plants normally can increase the life of local people. However, in several cases, it has negative impacts on environment in the area located plant. Therefore, their positive and negative influences to people living in around location of SHP should be addressed clearly so that local community can participate effectively in the involvement of the project and support to developers.
   - Increasing awareness and understanding to the community in the stage of study and implementation as well.
6. RE Integration grid code

   Participants considered APEC will assist making some guidelines for setting up distribution code.
7. Flexibility of the power system issues

   It is also an important thing for RE small scale should be addressed such as: Demand side responds via the smart grid; energy storage facilities and dispatch able power plant.
8. Financing issue

   Another suggestion from participants addressed to the financing issue is establishing the framework for the effective cost sharing among stakeholders for RE development: Local government, developers, power companies (transmission/distribution power companies) and producers/operators.

The chairman of the session, Dr. Cary Bloyd concluded that all kind essential comments from participants here are very helpful for Viet Nam to develop the Roadmap in the coming time.

Finally Mr. Nguyen Ninh Hai, on behalf of Mr. Pham Thanh Tung, the project overseer closed the workshop. He mentioned that the workshop achieved fruitful results as all expected. The workshop provided a lot with vitally useful information experience and opinion on both policy making and practicing activities for diversification of energy resources to meet the energy demand and sustainable development in our current complex. Especially, the issue of small hydropower and renewable energy integration into the grid is increasingly to pay attention in APEC economies. It is a chance for Viet Nam to learnt experience in this specific area from experts of APEC.

He also expressed thanks to EGRET, APERC, and all speakers, participants from APEC economies for great contribution to the successful workshop.

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Detail Report of the Workshop

The APEC Workshop on Small Hydro and Renewable Grid Integration was held on 3-5 April 2013 at Hotel Prestige Hanoi in Hanoi, Vietnam. The workshop organizer is General Directorate of Energy under the Ministry of Industry and Trade, Vietnam. The workshop brought together more than 45 participants from APEC economies APEC Economies, APERC, EGEDA, LCMT TF, IRENA, ICA

The workshop consisted of two day discussions organized in 4 following sessions:

- Session 1: Plenary session
- Session 2: Current status and development plan for grid small hydropower in APEC economies
- Session 3: Issues on grid integration of small scale *RE* electricity APEC Economies - Electric Utilities Perspective
- Session 4: Roundtable discussion on the development of a road map for small hydro Integration

and 1/2 day of technical visit to Nui Coc small HPP located in Thai Nguyen, a northern province of Vietnam, 100 km far from Hanoi.

1. Plenary Session

Chaired by Mr. Le Tuan Phong, Deputy Director General of General Directorate of Energy (GDE) Ministry of Industry and Trade Vietnam

Mr. Le Tuan Phong opened the workshop by speech with the following main contents:

The continuous and severe increase of energy demand has been creating global and regional challenges to ensure a secure and sustainable supply and environmental protection. Use of fossil fuels and continuous upward trends in the dynamic region's energy demand have momentum. Diversification of energy resources and supply sources as a high policy agenda should be pursued. Therefore, small hydro and renewable energy have become important sources of energy to integrate into the grid in the APEC Member economies. The purpose of the workshop is as a forum for representatives from APEC economies to discuss and share experiences on the issues related to diversification of energy sources, sustainable development and green growth.

This is the plenary session in which the relevant issues of general energy and renewable energy development opportunities and challenges in APEC economies are discussed.

The following is summary of presentations delivered in this session:

1.1 Workshop overview and expected outcomes

Mr. Pham Thanh Tung, Project Overseer (PO), General Directorate of Energy Vietnam

Background:

Small hydro-electric generation systems are being utilized as important part of the economy energy mix across APEC member economies. They are of special importance in developing member economies where they often provide the only firm power available in rural areas. However, as economy wide grids are established, small hydro and other small scale renewable energy systems pose unique technical problems to the economy grid operators.

This workshop will bring together both project developers, electric utility representatives, and government officials who are involved in small scale hydro and other small renewables development across the APEC economies to share experiences on best practices as well as identify current problems being faced in their economies associated with the integration of small hydro and other renewable energy systems into their electric grid.

APEC developing economies rely to a much greater extent than developed economies on the ability of small hydro power to bring the benefits of electricity to rural communities. For developing member economies, small hydro often provides the only firm power available in rural areas. It is therefore of critical importance that as the economies develop, there is the proper integration to the larger central power grid. The small hydro power roadmap developed in this project will thus be targeted to help developing member economies learn from developed economies to that prior mistake can be avoided.

To ensure a roadmap with highest possible quality, Viet Nam, host country will develop and circulate the draft roadmap to all member economies for further comments and suggestions. Feedback from most participants and reviewers will be incorporated into the final suggested roadmap and also indicate strong interest of the APEC member economies for the promotion of small scale hydro power and renewable electricity integrated into national grid.

Workshop objectives:

- To share experiences on an important clean energy resource that is available in rural areas across the APEC region.
- To develop a road map on the way forward to address problems that are arising with the integration of small scale hydro and other renewables into the modern electric grid.
- To support the policy makers at the central and local governments among APEC economies in promotion of the small scale hydro power and renewable electricity integrated into national grid.
- To strengthen ties with member economies, and encourage participation in other APERC related activities

Expected outcomes from the workshop:

- Report of the discussion during the Workshop
- Suggested road map for addressing current grid integration problems and suggested future APEC projects.

The Workshop Agenda is shown in Appendix 1

1.2 Overview of EGNRET Projects

Dr. Tom Lee

Industrial Technology Research Institute, Chinese Taipei, and Chair of APEC Expert Group on New and Renewable Energy Technologies

History of establishment and development of APEC and some key features of APEC membership are briefly introduced. The economic significance of the forum with the rest of the world is illustrated by figures such as APEC member economies account for 40% of the world's population or nearly 2.7 billion people, 44% of world trade or just over US$17 trillion and 55% of world GDP or US$32 trillion. APEC operates at two levels: the policy level and the working level. APEC established 7 energy working groups (EGCFE, EGEE&C, EGEDA, EGNRET, BTF, ETITF, LCMT TF) for addressing energy issues. Relating to renewable energy development and renewable energy grid integration, the APEC important initiatives and projects are presented such as APEC 21st Century Renewable Energy Development Initiative, Energy Smart Communities Initiative (ESCI), APEC Smart Grid Initiative (ASGI), 7 Recent Renewable Grid Integration Projects, 3 Completed Projects, and 11 On-going Projects which have been and are being carried out in various member countries.

The presentation of Dr. Tom Lee is shown in Appendix 2.

1.3 Current Status and Future Plans on Renewable Electricity Sources in Vietnam

Mr. Nguyen Duc Cuong,

Director of Renewable Energy & CDM Center,

Institute of Energy, Ministry of Industry and Trade, Vietnam

Vietnam has high potential of renewable energy resources: Solar energy: 4-5kWh/m2 day; Biogas: >100MW; Wind energy: > 6200MW (7m/s); Geothermal: 340MW; Biomass: >100,000 ton (>2000MW); Tide, bio-fuels MSW: >320MW; Small Hydro:>7000MW. It set targets for increasing share of RE to 5**%** of total primary energy consumption in 2020, and about 11% in 2050. The share of RE electricity production will reach 4.5% of total electricity production in 2020, and 6% in 2030. The FIT mechanism is set up for grid connected wind power at purchase price equal to 7.8 US Cents/kWh. The establishment of RE development fund is being considered. The opportunities for RE development include high energy demand, high resource potential, RE development strategy and policy available. The challenges include price subsidy for energy from conventional sources (e.g. coal, electricity), lack of reliable data and planning of RE resources, technology costs, seasonable production, scattered project owners, low price of electricity.

The presentation of Mr. Nguyen Duc Cuong is shown in Appendix 3

1.4 Small Hydro as Part of a Clean Energy Portfolio, Small hydro : Big Potential

Mr. Jeff Skeer

Senior Program Manager

International Renewable Energy Agency

Abu Dhabi, United Arab Emirates

Introduction of International Renewable Energy Agency (IRENA):

- Established in April 2011
- Mission: Accelerate deployment of renewable energy
- Members: 158 countries engaged; 109 ratified member countries and EU
- Mandate: Sustainable deployment of the six RE resources (Biomass, Geothermal, Hydro, Ocean, Solar, Wind)
- Location: Headquarters in Abu Dhabi, United Arab Emirates Innovation and Technology Centre - IITC, Bonn, Germany

Focus of Presentation: Small Hydro Costs, Potential

- How do the costs of electricity from small hydro plants compare with the costs of other renewable power options?
- *Renewable Power Generation Costs in 2012: An Overview* (IRENA Innovation and Technology Centre)

Context for the Renewable Generation Costs Study

- Analysis of 8,000 projects shows that rapid deployment and high learning rates are leading to significant cost declines that encourage further capacity additions
- In China, small hydro capacity costs around 900 dollars per kilowatt on average, with a range of roughly 500 to 1700. In Southeast Asia, small hydro capacity costs around 1400 dollars per kilowatt on average, with a range from just under 1000 to over 3000. So the costs are site specific, requiring careful analysis in each case
- While the smallest hydropower facilities have somewhat higher operation and maintenance costs per kilowatt, the overall burden of O&M costs is modest – ranging from 1 to 6 percent of installed capacity costs per year of operation. Around 3 percent of capacity costs per year is typical for small hydro, 2 percent for large.
- The busbar cost of small hydro averages around 4 cents per kilowatt-hour in China, with a range of 2 to 7 cents, and 5 cents per kilowatt-hour in the rest of Asia, with a range of 3 to 13 cents. So for APEC in general an Viet Nam in particular, small hydro is an attractive option.
- Hydro on different scales has major potential for expansion, with 25 GW of new plants installed worldwide in 2011, as compared with 41 GW of wind, 30 GW of PV, 6 GW of bio-power, 0.5 GW of CSP, and 0.1 GW of geothermal power.

Hydropower Advantages

- Mature technology, flexible design in many cases
- Unrivalled ability to provide ancillary grid services
- Lowest cost electricity where good resources available
- Importance will grow with market penetration of variable renewable energy resources like wind and solar power

The presentation of Mr. Jeff Skeer is shown in Appendix 4

1.5 Renewable Energy Electricity Generation Outlook in the APEC Region and Related Issues for Viet Nam

Dr. Tran Thanh Lien

Team Leader, Asia Pacific Energy Research Center (APERC)

The APEC Energy Outlook 2013:

Projected Electricity Generation by Source; APEC Region Electricity Generation Mix (1990-2035); Key Finding: Strong Growth in Renewable Power but Modest in Hydro;

Key Drives:

Feed-in-tariffs *(*utilities are required to buy electricity from renewables at a guaranteed price)*;* Renewable portfolio standards (utilities are required to obtain a minimum fraction of their electricity from renewable sources); Carbon pricing (Tax on CO2 emissions, which discourages the use of fossil fuels); Regulations limiting greenhouse gas emissions (Laws which limit the level of GHG emissions on certain fossil generation); Phasing out fossil fuel subsidies for power generation (As a strategy for several APEC developing economies); Rapid Declining RE technology costs (Trend of module production costs for Solar PV declined sharply. USD 4.5/W in 2000 to USD1.00 /W in 2012 (LBNL) event less USD1.00/W; Wind turbine prices had *doubled* during 2002 - 2008 then have fallen ~20%-30% in recent years and continues down for the long-term).

Opportunities

High growing electricity demand; Supportive policies; Diversification of power generation based on energy security; Clear target on RE electricity: 4.5% by 2020 and 6% by 2030 (PDP7); A number of Decrees and Decisions approved by the Prime Minister to offer incentives to RE projects in recent years; Viet Nam has experience on the development of small hydropower plants in the past; Trend of reduction in RE technology costs for wind and PV in the world and the APEC region; APEC RE market stronger than expected: increasing over 6 folds from 139 GW to 816 GW between 2010-2035.

Challenges

- Institutions issues: Electricity Pricing Framework: FIT is just in the initial stage; low electricity price; Inadequate policy support in planning, financing, legal framework.
- Technical issues: Lack of infrastructures Lack of RE database system including RE potential maps (for wind, solar, biomass); Distribution network is weak, doesn't meet the higher amount of RE electricity introduced to the grid; Insufficient amount of operating reserves due to the RE resources are intermittent.
- None technical issues: Still much high capital costs of NRE compared to fossil fuel fired power plants in VN; Shortage of human resources especially technical expertise on NRE field; Lack of studies on assessment of impact on the grid taking into account the RE resources.

The presentation of Dr. Tran Thanh Lien is shown in Appendix 5

1.6 Small Hydro and Smart Grid Integration by the U.S. DOE

Mr. Dan Ton

Program Manager, Smart grid R&D

U.S. Department of Energy

The vision for the smart grid is a network of integrated micro grids that can monitor and heal itself. Integration of renewable and energy efficient generation plays a major role in the smart grid development. Within the Smart Grid R&D Program, there are three focus areas: intelligent load management; distribution automation and micro grids. The area Micro grids" is where small hydro is integrated with the smart grid.

Project overview:

It is a ~1MW micro grid test bed project involving a collaboration with the DOE Los Alamos National Laboratory, the Japanese NEDO, and a local utility in Los Alamos, New Mexico, in USA.

The micro grid test bed includes photovoltaic (PV) generation, battery-based electrical energy storage, and a micro grid controller (µEMS) that integrates the PV into the rest of the utility systems by reducing the inherent fluctuations of the PV generation. It is fully instrumented to capture technical and economic performance data. The run-of-river hydro, that is Abiquiu hydro (17MW), is already linked to the utility SCADA. Thus, this test bed offers a unique opportunity for evaluating small hydro generation in providing ancillary services and supporting renewable energy integration.

The work which has been done is presented in the following order:

First, available hydro resources that have been identified for providing ancillary services without impacting energy revenues is presented.

Next, using spinning reserve as an example of ancillary services, the desired windows of steady-state water flows for providing 1-3 MW in spinning reserve from run-of-river hydro have been identified, as well as how well these flows map with existing operations.

Then simulated results on impacts of downstream river flows from providing spinning reserve are shown.

Lastly, simulated results of using hydro to smooth PV output are presented under real-use conditions.

Opportunity for run-of-river hydro:

- Increasing grid stress demands more operational flexibility from generation (and load) assets. Valuable services include spinning reserves, balancing of intermittent generation (or related fluctuations) and other possibilities.
- Run-of-river hydro is an underused electrical grid asset that can provide these services while meeting other water stakeholder needs.
- Increases effectiveness of local planning for energy choices, such as locally-generated renewable.
- Enables development of lower-cost, firm renewable energy for rural communities with access to a RoR asset.
- Simulations and experiments/observations have identified: The impacts on daily flow scheduling to accommodate different levels of flexibility; The quality of the services that could be delivered by different levels of flexibility; The transient impacts that could be expected on intra-day river flows and stage; The optimal balance of flow (CFS) and discharge (acre-ft) flexibility.

The presentation of Mr. Dan Ton is shown in Appendix 6

1.7 Current Problems Faced in Vietnam Associated with the Integration of Small Hydro into Electric Grid of Vietnam

Trinh Quoc Vu

Director Power Market Development Research and Training Center

Electricity Regulatory Authority of Vietnam (ERAV)

Current situation and Potential for development of small HPP in Vietnam

- Definition of small hydro power plants: installed capacity less or equal to 30MW.
- Total installed capacity in 2012: 1,166MW (contributed 4.4% in whole system).
- Energy generation in 2012: 4,493 million kWh (contributed 3.73% in whole system)
- Operation and scheduling: depending on the season, weather and type of HPP, capacity of reservoir, etc.
- Potential by 2015: North: 345 projects, total capacity 3,800MW; Central, South and Highland: 329 projects, total capacity 3,500MW.

Benefit and Advantage

- Contributed to balance the power supply – demand of national power system.
- Ensure power supply at local province, increase electrification rate.

- Contributed to social-economic development: infrastructure system (transportation, water transport, etc); Increase the employment opportunities in the local; Reasonable cost.
- Supplement the green energy for power system.
- Contributed to prevent from flood.
- Reduce greenhouse gas emissions

Legal framework for development of small HPP

- Provincial People's Committee develop small HPP planning in their provincial and submit to MOIT for approval
- General Directorate of Energy develop the hydroelectric ladder planning and submit MOIT for approval
- Orientation of connection voltage level in planning: Less than 3MW: Connect to medium voltage at current local network; From 3MW to 10MW: Consider connect to medium bus bar of 110kV sub-station; From 10MW to 30MW: connect directly to 110kV network or medium voltage.
- Technical regulation: Distribution Code; Technical procedures, connection procedures to be specified for each kind of renewable energy (Wind, small HPP,..).
- Scheduling and dispatching of PCs: depending on ability of small HPP (reservoir, ability of daily, weekly,.. water regulation) and be consistent with the provisions in the SPPA.
- Generation pricing: Complied with Avoided Cost regulation: issued the avoided cost tariff for small renewable energy power plants and Standard PPA.
- Participation in to Vietnam Competitive Generation Market: Small and medium HPPs are not obligated to participate in VCGM.
- Average price of small HPPs: 2011: 804 VND/kWh; 2012: 910 VND/kWh.

Problems arising with small HPP

Technical issues:

- Connection planning issues: In some case the investment boundary of network connection to power system was not clear, and it depend on the planning process.
- Power flow management: Sometime (wet season or off-peak of system), the power flow turn back to China in the Northern (Lao Cai, Yen Bai, Ha Giang province,..)
- Grid congestion: Capacity of transmission and distribution network are not enough to transfer all the power of small HPP in some area to national power system (the Northern and Highland).
- Quality of voltage normally do not meet the requirement in Technical code.
- Communication and information (SCADA/EMS/DMS) do not meet the requirements or can not operate.
- The operation cooperation was not good, still exist contradiction
- Lacking the benefit sharing mechanism between stakeholder to invest connection network.
- The avoided cost tariff may not enough interested to attract investors

- The avoided cost tariff do not reflect all the cost of project (example: cost to invest the network connection,..)

Social and environment:

- Change the natural flow on the river (downstream).
- Deforestation.
- Impact to ecosystem
- Migration and resettlement.
- Impact on the agriculture in dry season.
- There is not the benefit sharing mechanism for affected people

Solutions:

Development perspective:

- Potential development as ensuring the balance between energy resources type (Hydro, thermal, Gas, nuclear, other RE,…)
- Focus on: Optimization of the social, economic, and environment aspects; Development of place/area that have the low rate of Electrification or off-grid

Solutions:

- Enhance IT/automation infrastructure of small HPPs i.e. SCADA, communication system to support the optimization of operation and communication between dispatch centers and HPPs
- Develop technical requirements customized for embedded generators including small HPPs to improve the quality of voltage, energy losses
- Enhance and enforce the process of reservoir operation cooperation between HPPs/stakeholders
- Review small HPP plan, eliminate projects are not efficient and feasible (technical, economic, social and environmental aspects)
- Issue specific mechanism for development of small HPP: Pricing mechanism should be reviewed to achieve the attraction of investors; The benefit sharing mechanism for affected peoples by HPP should be considered

The presentation of Mr. Trinh Quoc Vu is shown in Appendix 7

2. Session 2: Current status and development plan for grid small hydropower in APEC economies

Chaired by Dr. Cary Bloyd Pacific Northwest National Laboratory USA

In this session, representatives of economies present issues related to small hydropower development and integration to the grid, including current status and future development plans, favorable conditions, problems, barriers, and proposed solutions.

The following is summary of presentations delivered in this session.

2.1 Current Status & Development Plan for Grid small hydropower in Vietnam – Barriers & Measures to overcome Barriers in the Future

Mr. Duong Manh Cuong

Expert of Planning Dept., GDE

Vietnam

Current status and future development plans:

361 small hydro projects with capacity of 1200MW have been completed and commissioning. They are mainly connected to medium voltage grid (22kV, 35kV) and partly to 110kV grid. These projects account for 36% of planned projects with total capacity of 4300MW.

Favorable conditions:

There are incentive mechanism and policy to encourage the development of renewable energy including small hydro power such as: import tax exemption for imported equipment, EVN has obligation to purchase electricity from renewable energy sources, avoided cost tariff for SHPs, FIT for grid connected wind farms.

Barriers:

Investors have limitation of capability and experience in management and monitoring construction works. They are difficult to access bank's loan with reasonable interest rate. Grid connection: big investment is required to transmit all capacity of hydro power plants in one big area and there is local congestion on transmission network due to many hydro power projects centralized in one area. Electricity tariff applied for small HPPs is low and unchangeable for long-time because PPA is for period of 20 years.

Solutions:

Establish regulations on safety management of hydropower dams, regulation on using surface water resource to ensure harmonizing water resource to irrigation and household use; develop efficient connection network to optimize construction cost, transmitting capacity and land occupation.

The presentation of Mr. Duong Manh Cuong is shown in Appendix 8

2.2 Current Status and Development plan for Small Hydropower in Malaysia

Ms. Nurhafiza bt Mohamed Hasan

Head, Licensing Unit, Energy Commission Malaysia

Malaysia has the national RE policy, RE strategies, implementation mechanism (small committee on renewable energy, FIT mechanism), tax incentives, green technology, financial mechanism (Government bears 2% of interest rate, provides guarantee of 60% on financing amount), eligibility criteria (zero or low gas emission, safe for use and promoted environment, conserve energy use and natural resources).

Development of minihydro: permanent license 627.7MW; provisional license 6,42.25MW, FIT 17FIAH-115.05MW)

Generation mix in Peninsula Malaysia: 382.7GWh (MD 15,286MW), in Sabah: 15860MWh (MD 828MW).

Challenges: no rainfall reducing generation, heavy rain causing flood & overflow; regarding technology: water filter needed; regulatory requirements; financial support/approval from banks; water pollution during construction.

The presentation of Ms. Nurhafiza bt Mohamed Hasan is shown in Appendix 9

2.3 Roadmap for Hydropower Development in the Philippines

Mr. Winifredo W. Malabanan
Director of Renewable Energy Department Bureau, Department of Energy
Philippines

Current status:

Hydropower classification: Micro-Hydro - Up to 100 kW; Mini-Hydro - 101 kW - 10,000 kW; Small Hydro - 10,001kW - 50 MW; Large Hydro - Above 50 MW; Total existing hydro generating capacity: 3,104.435MW, of which: Micro-hydro 0.15MW; Mini-hydropower 99.785 MW; Small hydropower 280.40MW; Large Hydropower 2,724.10MW.

Challenges and barriers:

High upfront and technology costs; Non-competitiveness; Non-viable markets; Inaccessible Financial Packages; Social Acceptability

Policy implementation:

Establishment of the Renewable Energy Management Bureau; Creation of the National Renewable Energy Board.

Policy Mechanisms:

Lowering of investment costs; Enhanced Competitiveness; Renewable Portfolio Standard (RPS); ERC Approved Feed-in-Tariff (Solar P9.68/kWh, Wind P8.53/kWh, Biomass P6.63/kWh, Hydro P5.90/kWh).

Hydropower sector roadmap for period 2011-2030.

The presentation of Mr. Winifredo W. Malabanan is shown in Appendix 10

2.4 Grid Small Hydro Power Development in Indonesia

Mr. Rida Mulyana,
Director General of Renewable Energy and Conservation
Ministry of Energy and Mineral Resources
Indonesia

Current status:

- Total installed capacity: 44,216 MW (PLN 73%, IPP 23%, and PPU 4%); Current electrification ratio: 76.56%; Energy mix in power generation: Coal 51%, Gas 23%, Oil 15%, Hydro 6%, Geothermal 5%; Total investment in Power Sector: USD 10.7 Billion/year.

- Renewable energy (hydro: potential 75000MW, installed 6848,46MW; geothermal: potential 29164MW, installed 1341MW; biomass: potential 49810MW, 1644MW; solar: potential: 4.80kWh/m2/day, installed 22.45MW; wind: potential 3-6m/s, installed 1.87MW; ocean: potential 49GW, installed 0,,01MW).
- Small hydropower development: There are 375 IPP projects with total installed capacity of 1692.340 KW (operation: 29 projects with 61265kW) and 163 project of PLN with total installed capacity of 246633 kW (operation: 163 project with capacity of 140680kW).
- Distributed generation (embedded small capacity power generations such as hydro, PV, wind, biomass etc. with installed capacity <10MW): may be connected to the 20 kV distribution lines; FIT applied for energy transaction.

Barriers: Lack of viability; Lack of Equity;

Countermeasures:

- Indonesia seeks to enhance contribution of grid small hydro power generation to the electricity supply provision.
- Regulation of Feed-in Tariff for Renewable Energy especially on Small Hydro Power Generation has developed progressively to facilitate investor in Hydro Power Generation business.
- Financial mechanism will be simplified by the intervention of Reserved Bank

The presentation of Mr. Rida Mulyana is shown in Appendix 11

2.5 Current status and Development plan for Grid Small Hydro Power in Thailand

Ms. Krittiya Petsee
Plan and Polisy Analyst
Work Plan Devision
Department of Alternative Energy Development and Efficiency
Thailand

Current status:

EGAT: Large dam 21 projects 3,400 MW; Pumped Storage 2 projects 500 MW; Small Hydro 2 projects (irrigation dam) 36 MW; DEDE: Small Hydro 22 projects 43.3 MW; Micro-Pico Hydro: 48 projects 1.8 MW; PEA: Small Hydro 8 projects 19.8 MW; 2 projects 0.5 MW

Alternative Energy Development Plan (AEDP:

10 years Alternative Energy-Development Plan (AEDP-Master Plan 2012-2021): hydro 1,608MW (101.75MW small – micro- pico; 500MW pumped storage); Government

Funding On R & D Activities; Private-Led Investment; Target 25 % of RE in total energy consumption by 2021 (Current RE Share of 9.9% (March 2013)

Lesson Learned

Micro-Pico Hydro = Cheapest RE Resource; Technology => Simple & Proven; Needs Strong Community to operate, maintenance; Technical assistance and transfer to local people is still necessary for continuity of the projects.

The presentation of Ms. Krittiya Petsee is shown in Appendix 12

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3. Section 3: Issues on grid integration of small scale *RE* electricity APEC Economies - Electric Utilities Perspective

Chaired by Chairman: Dr. Tom Lee, Industrial Technology Research Institute, Chinese Taipei, and Chair APEC Expert Group on New and Renewable Energy technologies

The discussions in this section are about status of small hydro and renewable energy and issues, solutions related to their grid integration in APEC economies.

The following is summary of presentations delivered in this session.

3.1 Interconnection of wind power onto the Vietnamese power grid

Dr. Tran Nam Trung

Technical and Production Department

Electricity Vietnam

Vietnam

This is the presentation of wind power study under cooperation between EVN and ICASEA.

Current status:

- Installed generation capacity: 26,926 MW; Peak demand in 2012: 18,649 MW; Energy sales in 2012: 120 bil. kWh.
- Wind power: in operation: Tuy Phong wind farm – 30 MW (20 x 1.5 MW); Phu Quy hybrid system – 6 MW (3 x 2 MW); in construction: Phuong Mai wind farm – 30 MW (6 x 2.5 MW by 2012; 6 x 2.5 MW by 2015); Bac Lieu wind farm – 99.2 MW (10 x 1.6 MW by 2012).

Wind power development in Vietnam:

- - Installed capacity (2011: capacity 30 MW,; 2020: 1000MW, 2.31TWh; 2030: 6200MW, 16.68TWh).

Components of study:

- Wind power impacts on the power system;
- Interconnecting wind power to the power system;
- Wind power in the electricity market.

Future work on wind grid interconnection:

- Impact studies of wind power in two high wind potential regions: Binh Thuan and Bac Lieu provinces; Conduct detailed simulations to complete the wind grid code

The presentation of Dr. Tran Nam Trung is shown in Appendix 13

3.2 Standards and Technical Considerations for Small Scale Energy Projects into the Grid

Mr. Do Thien Khoi

Global Government Affairs Manager

Product Safety UL LLC, USA

The presentation contains following contents: Technical Considerations for Small Scale Projects; Systems Approach to Safety and Performance (Local vs. International); Installation (PID, Inspection, and Maintenance); Energy Storage and Integration Policy; and Recommendations for Engagement of International Standards Development; Private Sector; and SCSC Project Proposal – PV Integration into the Smart Grid.

The presentation of Mr. Do Thien Khoi is shown in Appendix 14

3.3 Issues on grid integration of small scale RE electricity APEC Economies—Electric Utilities Perspective

Mr. Saharuddin Sulaiman

Principle Engineer

Asset Management Department

Distribution Division, Tenaga Nasional Berhad

Malaysia

Status:

Small Renewable Energy scenario in TNB: Mini hydro (TNB: 20 sites - 97MW; RE developers: 4 sites - 29.2MW); solar PV (developers: 20 sites - 25.5MW); biomass (developers: 3 sites -20MW); biogas (developers: 6 sites (7MW); Feed-in Tariff in 2011 (up to 30MW); Regulators : Electricity Commission Malaysia, SEDA Malaysia

Connection point is based on RE output capacity

TNB green policy:

Support the national green agenda and minimize the environmental impacts by applying sustainable, efficient operations and delivering green energy through the application of appropriate technologies and investments.

The presentation of Mr. Saharuddin Sulaiman is shown in Appendix 15

3.4 Issues on grid integration of small hydro in Indonesia – PLN's Perspective

Mr. Suroso Isnandar

System Planning Engineer

Division of System Planning, PT PLN (Persero)

Indonesia

Profile of PLN (as of 2011)

- Installed Capacity 29,268 MW; Peak Load 26,665 MW; Energy Production 184 TWh; Energy Consumption 160 TWh.
- Electricity demand is predicted to grow at a average rate of 9,7% per year
- Approx New Capacity 55 GW: Coal 38 GW; Geothermal 6.4 GW; Comb. Cycle 2.5 GW; GT/Gas Eng. 4 GW; Hydro/Mini Hydro: 5.3 GW (Mini hydro is about 1,500 MW);
- Others: 0.25 GW.
- Hydro potential: 5 GW; after strict screening 26.3 GW 167 locations; and further narrow to 12,9 GW 89 locations.
- MEMR Ministerial Decree No. 04/2012 FIT Small Hydro < 10 MW (1 USD = Rp 9,700).

Issues:

- Expanding the Grid to reach small hydro
- Hydro locations will greatly affect project viability
- Site overlapping between PLN and other developers
- Operational aspect of small hydro integration
- Metering point, coordination of outage schedule, automation/SCADA/telecom, SOP, etc.

Solutions:

- Mini hydro improve fuel mix, reduce losses, improve voltage profile on distribution network
- FIT generates positive response from IPP developer

- Developers and PLN needs to work out on several issues such as site overlapping or connection issues
- PLN needs to adjust its network expansion plan to accommodate small hydro

The presentation of Mr. Suroso Isnandar is shown in Appendix 16

3.5 Community PV-DC Micro grid

Worajit Setthapun, Suchat Srikaew
Wattanapong Rakwichian
Asian Development Institute for Community Economy and Technology
Chiang Mai Rajabhat University, Chiang Mai, Thailand

Project "Chiang Mai World Green City – Smart Community" is introduced with beautiful pictures.

PV - DC Micro grid Pilot Project (Community DC power grid system) with low voltage from PV has following parameters:

- *Phase 1 – PV DC Hybrid Micro grid*
  - 25.5 kWp PV Generator with DC Grid to each load
  - 24 VDC Lighting; converter 240 VDC /24 VDC
  - Online monitoring & data acquisition system
  - Main loads: 1 office, 1 minimart, 1 restaurant, 1 coffee shop, 1 farm, 6 houses, farm pump.
  - 240 VDC for household appliances
    - Lighting, TV, Computer, Refrigerator
    - Rice cooker, Water heater, Microwave, Air Conditioner
  - Low energy consumption more than 80% saving
- *PV DC compared to PV AC:*
  - Higher efficiency by eliminating DC/AC/DC conversion
  - Lower cost from eliminating inverter

The presentation of Worajit Setthapun, Suchat Srikaew Wattanapong Rakwichian is shown in Appendix 17

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3. Session 3: Issues on grid integration of small scale *RE* electricity APEC Economies - Electric Utilities Perspective *(cont'd)*

Chaired by Mr. Nguyen Ninh Hai, Deputy Director, New and Renewable Energy Department, General Directorate of Energy, Vietnam

3.6 Current status and development for grid integration of small scale RE electricity in China

Mr. Wan Lin, Director Beijing Energy Innovation Ltd. China

China's Renewable Energy Development

- Power Source Structure in China, 2011 [coal: 765.46GW (72.5%), 3897.5 TWh (82.54%); Hydro: 230.51 GW (21.83%), 662.6 TWh (14.03%); Nuclear: 15.65GW (1.48 %), 87.4 TWh (1.85%); Wind: 42GW (3.98%), 73.2TWh (1.55%); PV: 2.14GW (0.2%), 1TWh (0.02%)].
- Power Source Structure in China, 2020 [coal: 1170GW (60.47%), 6100 TWh (72.27%); Hydro: 360 GW (18.6%), 1200 TWh (14.22%); Nuclear: 130GW (6.71 %), 590 TWh (6.99%); Wind: 180GW (9.3%), 360TWh (4.27%); PV: 50.00GW (2.58%), 75TWh (0.89%); others: 45GW (2.33%), 115TWh (1.36%)].

Opportunity: Resources; Laboratory; Market

Challenge:

- Technology: Reliability of PV System
- Economy: Safety, Profitability, Liquidity of PV Investment
- Social: Mature Industry?

Cooperation Proposal:

- Roadmap: sustainable development; choosing kind of technology, solution; lessons learnt from other industries, real estate, automobile, clean development mechanism; what learnt: mature industry & mature market, risk management, technology & innovation; financing, insurance, marketing & service.
- Models: Business & Financing Model; Low Carbon Model Town (LCMT); Industrial Real Estate Developer; LSPV; Residential.
- Price setting models: Electricity Price; Power Consumption; Grid Connection & Transmission Cost; Stakeholders' credit; Liquidity & Bankability; Carbon Asset Value & Financing Cost; Net Cash Flow & Reasonable Price
- Tool Kits: Due diligence; Resource evaluation; Design evaluation; Equipment manufacturing supervision; Construction supervision; Complete acceptance check; Operation & maintenance; Ex-post evaluation; Life cycle yield prediction; Financing and insurance related service.
- Pilot Project New District of Turpan: "Local unique clean energy and suitable ecological technology will be used in New District of Turpan, which will become a distinctive, residential, and harmonious ecological demonstration urban." - Planning of New District of Turpan (2009-2020)

The presentation of Mr. Wan Lin is shown in Appendix 18

3.7 Renewable System Integration Overview

Dan Ton
Program Manager, Smart grid R&D
U.S. Department of Energy

- *Background*
  - U.S. PV potential growth due to:
    - Renewable Portfolio Standards (RPS)
    - Technology improvements
    - Government programs
  - RSI Study started in 2006, completed in 2008*

- *Issues*
  - Reverse power flows
  - Power quality
  - Codes & Standards
  - System protection
  - * http://www.nrel.gov/docs/fy08osti/42292.pdf
- *Solutions*
  - Smart inverter development for PV solar system to be connected to the grid, micro grid for households
  - Grid control
  - Integrated DMS-EMS, OMS, Forecasting
  - Dynamic volt/var control
  - Modeling/simulation in GridLAB-D
  - Demonstrations: 10 demonstrations around the countries
  - Micro grid R&D

The presentation of Mr. Dan Ton is shown in Appendix 19

3.8 Smart Grid Master Plan in Chinese Taipei

Dr. Bing Chwen Yang
Division Director
Green Energy and Environment Laboratories

Industrial Technology Research Institute, Chinese Taipei

- *Power System in Chinese Taipei*
  - Power Capacity 48,750 MW
  - Power Generation 252,173 GWh
- *Hydro Power System*
  - Total 15 HPPs contribute 9.52% of total installed capacity and 2.74% of power generation in 2011.
  - One pump hydro contributes 36.4% of total hydro power capacity.
  - 2 conventional HPPs with capacity > 1 GW; 3 conventional HPPs with capacity between 100 ~ 200 MW, other 9 less than 100 MW.
- *Target of Renewable Energy*
  - The installed capacity of renewable energy was 3,683 MW in Dec 2012.
  - Targeted renewable power generation capacity is 12.5 GW by 2030.
- *Why Smart Grid & Energy Storage?*
  - Ensure Reliable Power Supply:
    - The SAIDI (System Average Interruption Duration Index) should be maintained on the top five of the world in 2030. (2030:15.5min./year)
    - Reducing the power transmission loss from 4.8% to 4.4% in 2030.
  - Encourage Energy Conservation and Emission Reduction:
    - Reducing 100 million ton CO_2 emission per year in 2030.
  - Enhance the use of green energy:
    - Improving the renewable power interconnection capability to 30% in 2030.
  - Develop Low-carbon Industry:
    - Driving smart grid industry to create NTD 700 billion value in 2030.
  - The expectations of Smart Grid Master Plan are not only to upgrade existing power grids, but also to enhance the supplementary schemes including regulations and policies.

The presentation of Dr. Bing Chwen Yang is shown in Appendix 20

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4. Session 4: Roundtable discussion on the development of a road map for small hydro Integration

Chaired by Dr. Cary Bloyd, Senior Staff Scientist, Pacific Northwest National Laboratory USA

Chairman explained the purpose and way of conducting roundtable discussion:

The purpose of roundtable discussion is to help in development of the final report and roadmap. Through good presentations across economies, prepared by utilities, governmental officials, researchers, a lot of things we want to look at over. The speakers and participants will express their ideas, comments and suggestions on the points we have seen as common issues across the APEC economies and we would like to put them as a part of report in terms of how it would be findings of roadmap for hydropower and renewable integration into power grid. A roadmap shall be in kind of steps forwards important in development of small hydro across the APEC economies, that respect the existing development plans, existing grids, existing infrastructures, and identify the way to solve challenges for hydropower and renewable integration into power grid.

The following is the summary of comments, suggestions from participants:

Mr. Dan Ton

Program Manager, Smart grid R&D

U.S. Department of Energy

It is seem the economies already have own roadmap with specific micro hydro planning. My specific comment would be certainly from our experience we have from energy global integrations study and so basically through this study you can look at from different prospective how much wind solar and hydro can play together and what technologies will be best in what locations. It is easy to say from national goal at 5 % of renewable energy but may be from local prospective that 5 % can be 40 % based on grid integration and other aspects. And then from there decide whether technologies can be developable. For hydro I would like to see opportunities to identify through it hybrid study on where is hydro resources available and what kind of grid conditions there, how can we use hydro to support other global project like solar and wind and then do some type of demonstration for specific community or specific local conditions because may be some thing in hydro development in Indonesia may not be similar to US or in Vietnam conditions and then I would like to also promote micro grid concepts and I think that at their presentations it is something that has been developed worldwide and that the developing economies can follow without going through the same experience we have with grid.

Mr. Jeff Skeer

Senior Program Manager, International Renewable Energy Agency

Abu Dhabi Arab Emirates

I work in International Renewable Energy Agency so I see very useful workshop to our work and also how the expertise can be honest because many interesting presentations, from many economy profiles, professionals so our research is to maximize the cost effectiveness, renewable power share over time, to accelerate adoption by way to get a higher share on the grid swaying powerful different parts of the world that is practical. So I am surely interested to hear about presented issues that we concern. And today we heard many packages of solutions from Dan Ton and also many other valuable suggestions of which some of policy solutions, some of the technology solutions. You may know that you have pages of explanations how certain technology solutions are helping to solve certain problems we concern. I think it should be very helpful way of organizing the conclusions of readings and you might want keep in mind that which one would be really applied to all various renewables including wind and solar and with the concern of apply mainly with hydro, it may be some specific roadmap for hydro and other technologies.

And also you may know experts of grid here so I should have two requests for the people here, first to know we have project on smart grid and power grid I learned in Africa may be later in Asia so we can really the expertise of that and we are hearing of smart grid roadmap and a storage roadmap and experts advice on this roadmap. I think it would very helpful and I think a lot of experts in this room would have the advice so the overall report from this meeting could be very useful contribution. I believe in global roadmap on smart grid and storage because a lot of information here is not yet published so they are very current developments and so I hope that in the terms of that conclusions of and also please officials to introduce them like a part of renewable energy policies by steps forwards or help with the roadmap of renewables.

Dr. Tom Lee

Industrial Technology Research Institute, Chinese Taipei, and Chair APEC Expert Group on New and Renewable Energy technologies

First of all I would like to congratulate hosting economy to hold this successful workshop. And once again initiative shows how external project can benefit all economies. I'd like to add some of points based on studies of models for some community bases. My suggestion is that if it is possible we can have a feasibility study to keep people to know how to get effectiveness before they put hundred thousands installations in place. Now we call the governments to pay for the study. And before we have hydropower tool kits we can contact with the local governments for the first preliminary study to make and address issues how we can combine renewable energies and by doing so we can get more benefits in terms of power supply.

Dr. Bing Chwen Yang

Division Director

Green Energy and Environment Laboratories

Industrial Technology Research Institute, Chinese Taipei

First of all I would like to thank speakers for their contribution to this workshop. It is essential for me to learn from all of you, especially from Thailand. We also begin from green campus and try to modify model of all components in the green campus. It is the second year so probably two years later you can come and we can show you our campus.

Then I need this kind of system information exchange. It is quite important for the region because we need it to exchange our experience and we also try to our each economic demonstration site to show how we integrate more and more renewable energies into grid system. So I initiated one way that covers about energy conservation and we also be keen of demand side. APEC is a region with high potential of hydro. In order to fully use resources of hydro, not only regular hydro but mini hydro, small hydro, any kind of hydro it should be one of initiatives for our region. I think if we want to corporate all these kinds of hydro or even other renewable energies into grid systems, I think harmonization of things that for grid system or smart system is very important thing. So I hope after this meeting, either coordinator or experts can put some work or network on how to harmonize all smart grid systems. So it needs to cooperate all kinds of distributed energies into grid systems more useful or we can spread from each economy to other economies so it can be benefit to all technology exchanges. This is my suggestion, thank you.

Dr. Keng Tung Wu

I think about one of technologies to be used in a small hydro system not in large rural areas but it take place in urban area. On urban area, there is always lot of energy wasted to treat water. Therefore some times, for piping or location of waste drainage they also have some water outstretch so we can install some water tanks inside waste treatment plant. They can recover some power which is connected with other economies where hydro may be available. This can be a kind of system to provide some use in waste treatment plants that we can take into account for the future development.

Dr. Chung H'sien Chen

In development of renewable energies, hydropower is the best source of electricity generation. However, local site may also have other sources such as PV or wind power so smart grid can help us to integrate other renewable energies

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Mr. Wan Lin

Beijing Energy Innovation Ltd., China

I am thinking about perspective to the best practice side of PV-hydro hybrid system. We can see in China, especially in a lot of rural areas it is very hard to build grids but there exist small hydro projects, a lot of them. We have very good grid bases and kinds of support for future development. Our three reports have just come out. The first is to development of policy on PV hydro hybrid system and to deliver proper solutions such as those to different economies. Secondly may be you can find some pilot projects in China such as PV and hydro and storage projects. The third is may be in future some economies can kick off concept notes because we would have to carry out a joint research.

Mr. Ho Wan Yip + 2 participants

I come from Hong Kong, as you know that is a small place so renewable energy source is very limited. Actually we have very little renewable energy projects in Hong Kong so I am glad to attend this workshop because I keep my thoughts on renewable energy. I have one suggestion. Because Hong Kong has little renewable resource if APEC can produce some standards for hydro projects or other renewable energies such as wind power, hydropower and some PV and also if APEC can produce some standards for these or codes for other renewable energy resources, I think this can help some little places such as Hong Kong to came from this.

I think successful implementation of hydro power is really the subject of this agenda focus. I think one point we need to address is that implementation or construction of small hydro expected in Vietnam or in other economies can have the support of local people, especially on the users. From the user's point of view, they may have some improvement on the defect environment in practice where they have pipe extended. They have better or secure power supply but in some projects during implementation stage they may have some so called environmental base usually to be future concerns on their influence on environment that increase negative impacts on environment but actually they may have or they may have not. This point needs to address because it actually has been changed after installation of hydro power. Positive type and negative type can be addressed. Those environmental issues may not be paid attention by the local people in those areas and the report may address, from user's point of view, how such small hydro can have influence on their environment and life.

I came here from Hong Kong and I appreciate the host provide us opportunity to know minimum energy. I am engineer now working on water supply and utilization and as so you may know that in Hong Kong water supply is one of top utility consumption because we use lot of energy for pumping water from China or from reservoirs to our consumers. So our focus is try to tap those energies which have been already used or to connect to some reservoirs and to make this energy to be applicable to our system. So that why we are interesting on hydropower plant to make use of added potential energy from reservoirs which have been wasted so I think that it is opportunity for those researchers or for those countries because every country or every economy also has ordinary plants or water works installation there and certainly there are rooms for going to tap energy from water that why it is not exactly what were those hydropower plants most you concerned about. Coming to this workshop I have chance to know that kind of hydro power plant, mini hydropower plant. So I think every economy can also work with those water facilities and think how we can tap energy from the system.

Mr. Abdi

From my point of view as regulator, small hydro have been playing an important role as renewable energy especially in Asia but we have two points, first is FIT and the next other is making scheme that will stand more fit to the sites.

Mr. Suruso + one Indonesia participant

I have three things that APEC needs to help us in making some guidelines for APEC members to set up green push for renewable energy grid integration, guidelines to set up green push or distribution code, because the existing distribution code normally deals with the ordinary distribution network. When we have renewable energy connection then we need to reify them. Malaysia has very good renewable energy integration grid code and we could share among other APEC members and it may be very good. The second one is I would like to see some source of objective assessment or technology brief or the latest archives on renewable energy, for example, for micro grid technology and wind farm technologies. From small hydro, there is quite matured technology but for other renewable energies we don't really note there are latest of technology. The third one is need for some source of fund model, for PV or small hydro and also for large hydro ones, because for small renewable energy fund is straight forward where utilities pay the developers as the generator. For large scale of renewable energy developers such as large wind farms, or large PV cells more than ten MW we need to pay initial some capacity charge for them so we really to look at, it will be very different standard in PV and model from the existing thermal power plant and there is a good information for us. So I just have three requests.

I would like express my appreciation to Mr. Chairman, all economies' delegates. For us, we can have opportunity to share experience, information and especially practices. We evidence so many things from Philippines now is the big show and also some from China with PV production we know that appropriate because we have import from China products in our PV projects as well as many experience from others and also from China Taipei in the way they delivered their roadmaps. I may say that there is many things I can suggest for assembly the roadmap, what source of roadmap we can get, it is development or technology, is there any APEC economy has experience with regard to the roadmap technology especially I don't get it from Australia and no details we can share on how can we develop, how can the effort of the workshop informal so that big documents to be shared instead the only roadmap on energy development because now we talk on renewable energy development in form of technology and because a small hydro we some times confuse what we talk about, micro hydro, mini hydro or small hydro. If we talk about small hydro it is some times like about all power plants. I may suggest that at least the APEC has definition so we could get what small hydropower means to people so that we understand what to prepare for roadmap in more details.

Mr. Saharuddin Su

My appreciation to the host MOIT for this event at that we get much new knowledge. My suggestion is that the all economies to look into developing a master plan or interconnection of the hydro projects because in our experience it is quite practicing when we try to connect as much as possible hydro but due to interconnection problems we could not. There should be a central effort for economies to look into and develop them. My suggestion is to collect all these small hydro and generate power to the grids.

Dr. Worajit Setthaoun

I'd like to thank organizer again for giving us opportunity to come and meeting you in the workshop. From academic side, I have learned a lot from policy makers, utilities and I get expectation on how APEC economies road the roadmap so for academic from my point of view like that I have a goal to reach to 2030 or 2021 in case of Thailand and so for us how can universities, academy help. In order to reach that goal the government needs policy but does some one to have to help implement and so I think with help by two ways. In one way university can help with evaluation of information of making power project work. Should it be included into the kind of master plan or roadmap, universities can help in that. The second way is that university can help regarding to the users. The academy university can help increase awareness and understanding to the community and how to implement to make the roadmap success as well as give information and help implement it.

Ms. Krittiya Petsee (38.5)

First of all I would like to thank organizers and the host country. This workshop is very helpful and there is informative things to learn and I learn about the common problems which our community tries to meet the people expectation and environmental benefit from renewable energy installation in all our countries and I think we need some kind of set our goals to meet in medium term or period of fifteen years and the goal can set up some of strategies or business strategy, community strategy, environmental strategy or how can share some best practices or information towards our economies that may be the good way to move forward our roadmap.

Ms. Viray – APERC

I am going with our papers myself with economies or with agencies. I try to say something that is not politically or sensitive or there is compromised both economy and APEC so what ever I would say is from my opinion and things can help Philippines government or APEC any way. I am just allowed to attend this seminar because I learn a lot from here. As you may know Philippines has very rich renewable energy resources potential but also they have lot of barriers and issues. Because 70 % of these barriers is in the islands. You may know that Philippines has more than 7 thousand islands meanwhile Indonesia has fifteen thousand islands and they are able to address most these barriers within islands. So Philippines has to learn from other economies with this number of islands and also from IRENA which has good projects for island economies and also Philippines has involvement with universities. From Thailand presentation, they have very good coordination with government of Thailand to implement all these projects so Philippines have just learned how to integrate all these projects to achieve the targets of the Government, including RE strategy 2020. There is RE goal of all economies and hearing also from EGAT that they have also projects and they have achieved support. As APERC, I would try my best go back to our agency to be a good team network of all these agencies and economies so that the Philippines Government's RE targets be met or achieved in the future.

Mr. Nguyen Duc Cuong, Vietnam

We are now discussing on how to make and have the useful roadmap for grid renewable power integration. I heard from presentations of each economy and knew that large potential of renewable energy especially small hydropower but have not yet been exploited because there are many challenges, issues and problems. As my college Vietnam mentioned forms of challenges and problems such as policy, regulation. Now there are some conflicts in the water management, resource management and conflicts between river protection and environmental protection and technology is not yet in proper innovation. The tariff is very low. In order to have useful roadmap for economies we need information of the good practices, database. For roadmap I suggest some actions we need to do such as collect more information from each economy. The best way is to provide table template to economies for collecting more information, for example, the existing and future plans regarding renewable energy in general and small hydro power in particular. For future plans, we need targets on shares of renewable energy, main challenges and suggested solutions. I propose that we need to provide successful case studies from grid hydropower integration and each economy can send their guidelines for other economies in the construction, operation management, control.

Dr. Tran Thanh Lien, APERC

From my point of view on this workshop, I think I have learned many things from presentations by different economies, by speakers and as you know that the nature of small scale of renewable energy especially hydro are highly depending on weather conditions. They are far from the load centers and also far from population centers. So that why the high share of renewable energy in power system causes some problems. In case of Vietnam, I think beside the matter on the need for upgrading the existing grid we also should look at the power system flexibility. I think it is very important thing for putting the renewable energy, especially hydropower on the grids. For example, such kind of system flexibility like demand side response via smart grid or energy storage facilities or dispatchable power plants. Other thing regarding studies that our researchers start on this issue, the assessment of invest on the grid is taking into account the renewable energy resources and combination with their integration in the hybrid system. The important thing is combination of operation between hydro, small hydro and PV because normally small hydropower plants run on the base load and PV on the peak load. This matter can be solved by the most effective way to combine between among kinds of renewable energies, especially small hydro. The last my point is that we should consider effective and practical cost sharing framework for the connection of renewables to the grids. Because the distribution or transmission from the small hydropower plants to the grid is very far and so in this case how to establish framework for cost sharing among developers or operators is also important. For example who pays for distribution network in connection to the grid or who pays for upgrading grid if necessary. As I listened to Indonesia presentation, almost cost of investment on the distribution network from the hydropower plant to the grid is born by PLN. But in some cases, if private sector wants to build small hydropower plants, the investment cost for transmission, connection to the grid and then it made increased total investment cost of power plants and private sector could not agree. So this is not attractive to the private sector. That why we should establish the framework for the effective cost sharing. This is the last my point.

Chairman

I really do think all you put very kind essential speaking and it very good help the report development or the roadmap. I hope the most major identified factors will be shown in our final report.

Closing remarks delivered by Mr. Nguyen Ninh Hai on behalf of Mr. Pham Thanh Tung

Distinguished participants ladies and gentlemen,

After two days of discussing and exchanging the views and experience, one of the most important issues of the both global and regional network is sustainable energy development and we have now come to the last day of the workshop on small hydropower and renewable energy grid integration. It is great pleasure for me to deliver the closing remarks. I do believe that our workshop achieved fruitful results and partners' expectation. The workshop has provided a lot vitally useful information, experience and opinion on both policy making and practicing activities for diversification of energy resources to meet the energy demand and sustainable development. In our current complex it is no doubt for the importance of small hydropower and renewable energy integration into grid in the arm of APEC economies, a dynamic region for the successful workshop. On behalf of our General Directorate of Energy, I would like to express our sincere thanks for honorable chairs, the distinguished participants and guests and speakers for the workshop and special thanks to APEC Expert Group on New and Renewable Energy and Technology (EGNRET) and Asian Pacific Energy Research Center for its continuous and effective activities and contribution to our energy issues. I would like to thank to provide myself this opportunity to express our sincere thanks for the active cooperation and support from APEC economies for our nation development in general and energy utilities in particular. We do hope that our cooperation will be enhanced and operated effectively for green and sustainable development for our region

May I wish you all best in your carrier and your life. Thank you very much for your attention.

Appendix 1

FINAL AGENDA

APEC Workshop on Small Hydro and Renewable Grid Integration
Ha Noi, Viet Nam
April 3-5, 2013
Meeting Venue: Prestige Hotel, 17 Pham Dinh Ho, Ha Noi - Vietnam

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April 3, 2013

13:30-14:00 Registration

Session 1: Plenary session;

Chairman: Mr. Le Tuan Phong,
Deputy Director Genaral of General Directorate of Energy, Viet Nam

14:00-14:15 Official Welcome
Mr. Le Tuan Phong
Deputy Director General of General Directorate of Energy, Viet Nam

14:15-14:30 Workshop overview and expected outcomes
Pham Thanh Tung, Project Overseer (PO)
General Directorate of Energy, Viet Nam

14:30-14:50 Overview of EGNRET projects
Dr. Tom Lee
Industrial Technology Research Institute, Chinese Taipei, and Chair
APEC Expert Group on New and Renewable Energy Technologies

14:50-15:10 Current status and future plans on renewable energy electricity sources in Viet Nam
Mr. Nguyen Duc Cuong, Institute of Energy

15:10-15:30 Small hydro as part of a clean energy portfolio
Jeff Skeer
Senior Program Manager
International Renewable Energy Agency

	Abu Dhabi, United Arab Emirates
15:30-16:00	Break
16:00-16:20	Renewable energy electricity generation outlook in the APEC region and related issues on Viet Nam Dr. Tran Thanh Lien, Team leader, Asia Pacific Energy Research Centre (APERC)
16:20-16:40	Small hydro and smart grid integration Dan Ton Program Manager, Smart Grid Research & Development Office of Electricity Delivery and Energy Reliability U.S. Department of Energy
16:40-17:00	Current problems faced in Viet Nam associated with the integration of small hydro into electric grid Viet Nam Trinh Quoc Vu, Electric Regulatory and Authority of Viet Nam

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April 4, 2013

Session2: Current status and development plan for grid small hydro power in APEC Economies

Identify potential, barriers and measures to overcome barriers in the future

Chairman: Dr. Cary Bloyd
Pacific Northwest National Laboratory USA

9:20-9:40	Viet Nam Mr. Duong Manh Cuong Expert of Planning Dept. GDE
9:40-10:00	Malaysia Ms. Nurhafiza bt Mohamed Hasan Head, Licencing Unit, Energy Commission Malaysia
10:00-10:20	Philippines Mr. Winifredo W. Malabanan Director of Renewable Energy Management Bureau, Department of Energy

10:20-11:00 Break

11:00-11:20: Indonesia
Mr. Rida Mulyana,
Director General of New Renewable Energy and Energy Conservation,
Ministry of Energy and Mineral Resources

11:20-11:40 Thailand
Ms. Krittiya Petsee
Plan and Policy Analyst, Work Plan Division
Department of Alternative Energy Development and Efficiency (DEDE)

12:20-14:00 Lunch

Session 3: Issues on grid integration of small scale *RE* electricity APEC Economies—Electric Utilities Perspective

Chairman: Dr. Tom Lee
Industrial Technology Research Institute, Chinese Taipei, and Chair
APEC Expert Group on New and Renewable Energy Technologies

14:00-14:30 Viet Nam
Dr. Tran Nam Trung, Technical and Productional Dept.
Electricity of Viet Nam

14:30-15:00 USA
Mr. Do Thien-Khoi
Global Government Affairs Manager - Product Safety UL LLC, USA

15:00-15:30 Break

15:30-16:00 Malaysia
Mr. Saharuddin Sulaiman
Principal Engineer,
Asset Management Department,
Distribution Division, Tenaga Nasional Berhad,

16:00-16:30 Indonesia
Mr. Suroso Isnandar
System Planning Engineer

Division of System Planning, PT PLN (Persero)

16:30-17:00 Thailand
Dr. Worajit Setthapun
Chiang Mai Rajabhat University

April 5, 2013

Session 3: Issues on grid integration of small scale *RE* electricity APEC Economies—Electric Utilities Perspective (continued)

Chairman: Mr. Nguyen Ninh Hai

9:20-9:40 China
Mr. Wan Lin, Director
Beijing Energy Innovation Ltd., China

9:40-10:00 USA
Dan Ton
Program Manager, Smart Grid Research & Development
Office of Electricity Delivery and Energy Reliability
U.S. Department of Energy

10:00-10:20 Chinese Taipei
Dr. Bing Chwen Yang
Division Director
Green Energy and Environment Laboratories
Industrial Technology Research Institute, Chinese Taipei

10:20 – 10:40 Break

Session 4: Roundtables on the development of a road map for small hydro Integration

Chairman: Dr. Cary Bloyd

10:20-11:20 All participants

11:20-11:30 Closing remark by Mr. Nguyen Ninh Hai on behalf of Mr. Pham Thanh Tung, Project Overseer

13:30-19:00 Technical site visit (TBD)

Appendix 2

Overview of EGNRET Projects

Dr. Tom Lee

Industrial Technology Research Institute, Chinese Taipei, and Chair of APEC Expert Group on New and Renewable Energy Technologies

- *Introduction of APEC:*
  - APEC was the brainchild of former Australian Prime Minister Bob Hawke.
  - It first met in Canberra in 1989 with 12 members.
  - In 1991, China; Hong Kong, China; and Chinese Taipei joined.
  - In 1993, Mexico and Papua New Guinea came onboard.
  - Next came Chile in 1994.
  - And lastly, Peru, Russia and Viet Nam joined in 1998, taking the total membership to 21.
  - APEC also has three official observers. They are:
    - The Association of Southeast Asian Nations (ASEAN),
    - The Pacific Economic Cooperation Council (PECC), and
    - The Pacific Islands Forum (PIF).

- *Some key features of APEC membership include the following:*
  - APEC Members are referred to as 'Member Economies'. Members cooperate as economic entities.
  - Leaders of Member Economies meet at an informal annual Leaders' meeting rather than a Leaders' Summit.
  - APEC is an inter-governmental grouping that operates on the basis of non-binding commitments, consensus and open dialogue.
  - APEC member economies account for:
    - 40% of the world's population or nearly 2.7 billion people
    - 44% of world trade or just over US$17 trillion and 55% of world GDP or US$32 trillion.

- *APEC operates at two levels – the policy level and the working level.*
  - Policy level:
    - Economic Leaders' Meetings are held once a year in the APEC host economy.
    - Leaders receive reports from Senior Officials, Ministerial Meetings and the APEC Business Advisory Council, about what has been done during the year and recommendations for future action.
    - The Leaders then make a Declaration setting the policy agenda going forward.
    - Sectoral Ministerial meetings are also held regularly – covering areas such as Finance, Trade, Health and Tourism. Ministers take stock of the year's activities and provide recommendations for Leaders' consideration.

- Annual Ministerial Meetings of Foreign and Economic/Trade Ministers are held immediately prior to every Leaders' Meeting.
- The APEC Business Advisory Council (ABAC) provides Leaders with a business perspective on APEC issues through an annual meeting and report to Leaders. The annual report contains recommendations to improve the business and investment environment in the APEC region. ABAC meets four times a year and ABAC representatives attends the majority of APEC meetings.

◦ Working level:
  - SOM meetings are held three to four times a year with the Chair coming from the host economy.
  - Taking direction from Ministers, Senior Officials guide the activities of the four Committees, Working Groups and Task Forces at the working level.
  - Senior Officials also develop recommendations for Ministers and Economic Leaders.

◦ The four Committees: the Committee on Trade and Investment, the Economic Committee, Senior Officials' Committee on Economic and Technical Cooperation and the Budget and Management Committee all report to Senior Officials. They also guide the work of the sectoral Working Groups, Task Forces and CTI sub-committees under their purview.

◦ Energy (Energy Working Group, EWG)
  - Expert Group on Clean Fossil Energy (EGCFE)
  - Expert Group on Energy Efficiency & Conservation (EGEE&C)
  - Expert Group on Energy Data & Analysis (EGEDA)
  - <u>Expert Group on New & Renewable Energy Technologies (EGNRET)</u>
  - Biofuels Task Force (BTF) (2005-2011)
  - Energy Trade and Investment Task Force (ETITF) (2009-)
  - Low-Carbon Model Town Task Force (LCMT TF) (2010-)

◦ EGNRET Mission
  - The APEC Expert Group on New and Renewable Energy Technologies (EGNRET) has been established by - and reports to - the APEC Energy Working Group (EWG).
  - The mission of the EGNRET is to facilitate an increase in the use of new and renewable energy technologies in the APEC region.
  - The activities of the EGNRET will be directed towards meeting the energy challenges identified by APEC Leaders and Energy Ministers

◦ EGNRET Activities:
  - Meeting twice annually
  - Conducting research projects
  - Organizing workshops
  - Supporting major Initiatives
    · APEC 21st Century Renewable Energy Development Initiative

        - Energy Smart Communities Initiative (ESCI)
        - APEC Smart Grid Initiative (ASGI)
- APEC Smart Grid Initiative (ASGI)
    - Launched in June 2010 (EMM 9)
    - EMM 9 instructed the Energy Working Group (EWG) "to start an APEC Smart Grid Initiative (ASGI) to evaluate the potential of smart grids to support the integration of intermittent renewable energies and energy management approaches in buildings and industry."
- Recent Renewable Grid Integration Projects
    - Addressing Challenges of AMI Deployment in APEC (Chinese Taipei)
    - Stock-take of Electric Vehicle Interface with Electricity and Smart Grids Across APEC Economies and the Potential for Harmonization (New Zealand)
    - Piloting smart/micro grid projects for insular and remote localities in APEC economies (Russia)
    - Combined heat and power (CHP) technologies for distributed energy systems (Russia)
    - Small Hydro and Renewables Grid Integration Workshop (Vietnam)
    - Study of Demand Response's Effect in Accommodating Renewable Energy Penetration in the Smart Grid (China)
    - Christchurch Smart Energy Grids: Earthquake Recovery Project (New Zealand)
- Completed Projects
    - Addressing Challenges of Advanced Metering Infrastructure (AMI) Deployment in APEC (EWG 07/2011A) (Chinese Taipei)
    - Stock-take of Electric Vehicle Interface with Electricity and Smart Grids Across APEC Economies and the Potential for Harmonization (EWG 11/2011) (New Zealand)
    - Piloting Smart/micro Grid Projects for Insular and Remote Localities in APEC Economies (S EWG 15 11A) (Russia)
- 11 EGNRET On-going Projects:
    - Prospects for Marine Current Energy Generation in APEC Region (S EWG 23 11A) (Russia)
    - Best Practices in Energy Efficiency and Renewable Energy Technologies in the Industrial Sector in APEC Region (S EWG 19 11A) (Cooperated with EGEE&C) (Thailand)
    - Urban Development Smart Grid Roadmap: Christchurch Recovery Project (EWG 08 2012) (Cooperated with EGEE&C) (New Zealand)
    - Research on the Application of Physical Energy Storage Technology to Enhance the Deployment of Renewable Energy in an APEC Low Carbon Town (EWG 16 2012A) (China)
    - The Comprehensive Analysis and Research of Key Technologies and Commercial Model of Low Carbon Model Town Applied in Yujiapu CBD EWG (EWG 11/2012A) (China)

- APEC Peer Review on Low-carbon Energy Policies (PRLCE) Phase 2 (EWG 18 2012A) (Japan)
- APEC Workshop on Best Practices on Financing Renewable Energy (EWG 21 2012A) (Viet Nam) (Approval in Session 3, 2012)
- Promoting Stable and Consistent Renewable Energy Supply by Utilizing Suitable Energy Storage Systems (EWG 22 2012A) (China)
- Operation Technology of Solar Photovoltaic Power Station Roof and Policy Framework (EWG 24 2012A) (China)
- Study on Measures to Reduce Energy Intensity in APEC Low Carbon Town (EWG 23/2012A) (China)
- 2013 APEC Workshop on Geothermal Technology (SF EWG 01/2013) (Chinese Taipei)

Appendix 3

Current Status and Future Plans on Renewable Electricity Sources in Vietnam

Nguyen Duc Cuong,
Director of Renewable Energy & CDM Center,
Institute of Energy, Ministry of Industry and Trade
Vietnam

- *Potential and current status of renewable energies*
  - Small hydro power and electricity generation from RE (grid-connected)
    - Total national electricity generation mix:108.725 TWh
    - Total electricity generation from RE: 3.65 TWh, accounts for 3.6% only. Dominated by electricity from small hydro-power (97% of total RE).
    - Electricity generation and development trend of renewable electricity during past 10 years from 2001 to 2011: Wind Power just emerged from 22/08/2009, and municipal solid waste from 2005.

- *Strategy and policy for RE development in VN*
  - Increasing share of RE to 5% of total primary energy consumption in 2020, and about 11% in 2050.
  - Completing rural-mountainous energy program, by 2020 about 100% households will access to electricity
    - 2015: production of ethanol and vegetable oil will reach 250 thousand tons, accounting for 1% of whole country's gasoline, oil demand;
    - 2025: production of ethanol and vegetable oil reaches 1.8 mill. Tons, accounting for 5% of whole country's gasoline, oil demand
  - Price subsidy for products of CDM projects:
    - Subsidy/kWh = cost/kWh + reasonable profit /kWh – selling price/kWh – CDM selling price
    - To purchase whole electricity via standard power purchase agreement (20 years).
    - Grid connected electricity price subsidy: Purchase price is equal to 7.8 US Cents/kWh
  - Priority given to development of RE for electricity production: reaches 4.5% of total electricity production in 2030, and 6% in 2050
  - Applicable for organizations, individuals purchasing electricity from RE small power plants
  - To purchase whole electricity via standard power purchase agreement (20 years).
  - Priority given to investment capital, tax, fees, land use
  - Grid connected electricity price subsidy: Purchase price is equal to 7.8 Uscents/kWh

- Applied for CDM
- Priority given to development of RE for electricity production: reaches 4.5% of total electricity production in 2030, 6% in 2030
- In planned period: new installation of about 13,000MW from RE
- Electrification – by 2020 most households will have electricity: 600 thousand households will be supplied with electricity from RE
- Solutions of electricity price (ensuring cost recovery + reasonable profit).

- *RE electricity for off grid electrification*
  - Status of electrification
    - About 800 thousand households without electricity
    - Power network expansion consideration
    - Assessment of RE resources in 8 zones and provinces
  - RE resources for electrification
    - Anticipated plan for supplying electricity to 800 thousand households without electricity
    - Solar PV power systems: 18%
    - SHP, mini system: 25%
    - Biogas: 4%
    - Wind + Diesel: 4%
    - PV + Diesel: 9%
    - Wind + PV + Diesel: 4%
    - National power grid: 37%

- *Investment opportunities*
  - By 2030, VN's energy demand will be increased 4 times compared to 2005. It is anticipated to import coal for electricity production (after 2015)
  - By 2030 electricity demand of VN will increase nearly 7 times compared to 2010.
  - At present, electricity must be imported from China to meet electricity shortage
  - Vietnam has available RE resources, including wind, SHP, biomass, solar, geothermal …
  - Government and ministries paid attention on important of renewable energy and implementation RE projects
  - Preparation of RE development strategy and master plan for VN: completed and submitted to the Government for approval
  - Strategy on adaptation to climate change has been promulgated RE is one of strategic tasks in reduction of green house gas emission
  - Strategy on green growth: being prepared for promotion of green industry/energy, low carbon technologies

Conclusions:

- *Vietnam has potential for development of RE power and other RE*
  - Grid connected wind power (including offshore/Semi-offshore –Bac Lieu wind power project)
  - Off grid wind power/ mini projects (rural electrification – huge program of Vietnamese government with target 100% household access electricity in 2020)
  - Other RE sources: biomass, biogas, municipal solid wastes, PV etc.
- *Legal framework for wind power development and renewable energies*
  - Government goals for development of wind and renewable energy (PDP VII)
  - National Strategic Program to Respond to Climate Change (2011) and Green Growth Strategy (2012)
  - Renewable Energy/ Wind Power Development Planning on provincial and national level are being developed
  - MoIT's program "Support to the development of renewable energy" is being implemented
  - Vietnam is a leading country among ASEAN in terms of installed capacity of wind power

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Appendix 4

Small Hydro as Part of a Clean Energy Portfolio, Small hydro : Big Potential

Jeff Skeer, Senior Program Manager
International Renewable Energy Agency
Abu Dhabi, United Arab Emirates

- *International Renewable Energy Agency (IRENA)*
  - Established: April 2011
  - Mission: Accelerate deployment of renewable energy
  - Mid-term strategy: Hub, voice and objective information source for renewable energy
  - Members: 158 countries engaged; 109 ratified member countries and EU
  - Mandate: Sustainable deployment of the six RE resources (Biomass, Geothermal, Hydro, Ocean, Solar, Wind)
  - Location: Headquarters in Abu Dhabi, United Arab Emirates
  - Innovation and Technology Centre - IITC, Bonn, Germany

- *Focus of Presentation: Small Hydro Costs, Potential*
  - How do the costs of electricity from small hydro plants compare with the costs of other renewable power options?
  - Renewable Power Generation Costs in 2012: An Overview (IRENA Innovation and Technology Centre)

- *Context for the Renewable Generation Costs Study*
  - Renewables now account for roughly half of all new electricity capacity installed around the world each year.
  - Analysis of 8,000 projects shows that rapid deployment and high learning rates are leading to significant cost declines that encourage further capacity additions.
  - In China, small hydro capacity costs around 900 dollars per kilowatt on average, with a range of roughly 500 to 1700. In Southeast Asia, small hydro capacity costs around 1400 dollars per kilowatt on average, with a range from just under 1000 to over 3000. So the costs are site specific, requiring careful analysis in each case.
  - While the smallest hydropower facilities have somewhat higher operation and maintenance costs per kilowatt, the overall burden of O&M costs is modest – ranging from 1 to 6 percent of installed capacity costs per year of operation. Around 3 percent of capacity costs per year is typical for small hydro, 2 percent for large
  - The busbar cost of small hydro averages around 4 cents per kilowatt-hour in China, with a range of 2 to 7 cents, and 5 cents per kilowatt-hour in the rest of

Asia, with a range of 3 to 13 cents. So for APEC in general an Viet Nam in particular, small hydro is an attractive option

- Hydro on different scales has major potential for expansion, with 25 GW of new plants installed worldwide in 2011, as compared with 41 GW of wind, 30 GW of PV, 6 GW of bio-power,   0.5 GW of CSP, and 0.1 GW of geothermal power
- Mature technology, flexible design in many cases
- Unrivalled ability to provide ancillary grid services
- Lowest cost electricity where good resources available
- Importance will grow with market penetration of variable renewable energy resources like wind and solar power

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Appendix 5

Renewable Energy Electricity Generation Outlook in the APEC Region and Related Issues for Viet Nam

Dr. Tran Thanh Lien, Team Leader,
Asia Pacific Energy Research Center

- APERC has historically produced an *APEC Energy Demand and Supply Outlook* every 2 or 3 years
- *The 5th Edition was published in February 2013: APEC Energy Outlook 2013*
  - Projected Electricity Generation by Source
  - APEC Region Electricity Generation Mix (1990-2035)
  - Key Finding: Strong Growth in Renewable Power but Modest in Hydro
  - Key Drivers for the strong NRE growth
    - Supportive government policy
    - Advancements of RE technology
    - Supportive government policy
    - Advancements of RE technology

  - Key Drive: APEC Renewable Energy Policy Support is Robust
    - Feed-in-tariffs – utilities required to buy electricity from renewables at a guaranteed price
    - Renewable portfolio standards – Requirement of utilities to obtain a minimum fraction of their electricity from renewable sources
    - Carbon pricing – Tax on CO_2 emissions, which discourages the use of fossil fuels
    - Regulations limiting greenhouse gas emissions – Laws which limit the level of GHG emissions on certain fossil generation
    - Phasing out fossil fuel subsidies for power generation – As a strategy for several APEC developing economies

  - Key Drive: Rapid Declining RE technology costs
    - Trend of module production costs for Solar PV declined sharply. USD 4.5/W in 2000 to USD1.00 /W in 2012 (LBNL) event less USD1.00/W
    - Wind turbine prices had doubled during 2002 - 2008 then have fallen ~20%-30% in recent years and continues down for the long-term (LBNL)

  - Key finding: Significant wind power addition expected in APEC Region

- *Related Issues for Viet Nam*
  - Opportunities
    - High growing electricity demand

- Supportive policies
  - Diversification of power generation based on energy security
  - Clear target on RE electricity: 4.5% by 2020 and 6% by 2030 (PDP7)
  - A number of Decrees and Decisions approved by the Prime Minister to offer incentives to RE projects in recent years
  - Viet Nam has experience on the development of small hydropower plants in the past
- Global aspect
  - Trend of reduction in RE technology costs for wind and PV in the world and the APEC region
  - APEC RE market stronger than expected: increasing over 6 folds from 139 GW to 816 GW between 2010-2035 (APEC outlook 2013)

◦ Challenges

- Institutions issue
  - Electricity Pricing Framework: FIT is just in the initial stage; low electricity price
  - Inadequate policy support in planning, financing, legal framework.
- Technical issue
  - Lack of infrastructures
  - Lack of RE database system including RE potential maps (for wind, solar, biomass)
  - Distribution network is weak, doesn't meet the higher amount of RE electricity introduced to the grid
  - Insufficient amount of operating reserves due to the RE resources are intermittent
- None technical issue
  - Still much high capital costs of NRE compared to fossil fuel fired power plants in VN
  - Shortage of human resources especially technical expertise on NRE field
  - Lack of studies on assessment of impact on the grid taking into account the RE resources

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Appendix 6

Small Hydro and Smart Grid Integration by the U.S. DOE

Dan Ton, Program Manager, Smart grid R&D
U.S. Department of Energy

- Vision: Smart Grid
- DOE's Smart Grid R&D Program: Focusing on distribution systems and customer solutions, including interfaces and integration with T&G systems

- *Microgrid Testbed - Los Alamos, New Mexico, USA*
  - ~ 1 MW electrical microgrid in collaboration with the local utility, the Japanese NEDO, and LANL
    - Microgrid includes photovoltaic (PV) generation, battery-based electrical energy storage, and a microgrid controller (µEMS) that integrates the PV into the rest of the utility systems by reducing the inherent fluctuations of the PV generation
    - Fully instrumented to capture system performance—technical and economic
    - Local SCADA link to Abiquiu hydro
    - Microgrid operation already coordinated with local utility electrical dispatch
  - Unique testbed for evaluating small run-of-river (RoR) hydro generation vis-a-vis battery storage in supporting renewable energy integration, while potentially providing other valuable grid services

- *Run-of-River Hydro*
  - Identified available resource
    - How much flexibility (in MW) Abiquiu can provide without impacting energy revenues
  - Identified desired windows of "steady-state" water flows and compared them to existing operations
  - Estimated transient impacts on river flows from providing spinning reserve
  - Performed simulation studies of real-time operations
    - Estimated PV-smoothing capability of the hydro under a range of operating assumptions
      - Allowable deviation from water flow schedule
      - PV forecast quality
    - Estimated impact on instantaneous water flow and daily discharge accounting
  - Abiquiu is a 17 MW hydro station including 3 turbines: two 7-MW units; one 3-MW unit
  - Leveraged Low-Flow Turbine acceptance testing to simulate spinning reserve event

- 135 CFS increase X 1 hour
- 2 MW up regulation X 1 hour

◦ Impact is minimal for 2 MW changes
  - Expected to decrease proportionally for smaller MW changes
  - Expected to smooth out for more frequent changes
  - Impact of Flexibility - Frequency of Transients Spinning Reserve

◦ 1-2 events per week

◦ One hour duration

◦ Year-round operation

◦ Benefit/Impact is clear from measurements

◦ Up/Down Following for PV Smoothing Demonstration Project
  - Generation change every 15 minutes
  - Requesting ~ 2 week demonstration
  - Transient impacts not obvious - requires simulations to assess effects on river flows and stage

◦ PV Smoothing - Simulations of Operations Abiquiu hydro resides within existing utility operations - operational simulations should mimic these operations
  - Bulk energy exchange is scheduled 90 minutes before the top of the current operator hour
  - Once committed, the scheduled bulk energy exchange cannot be altered
  - Within the current hour, the hydro can be adjusted every 15 minutes to help maintain schedule
  - PV Smoothing - Simulations of Operations

◦ PV Smoothing—Simulations of Operations

◦ Summary—
  The Opportunity for Run-of-River Hydro

◦ Increasing grid stress demands more operational flexibility from generation (and load) assets. Valuable services include:
  - Spinning reserves
  - Balancing of intermittent generation (or related fluctuations)
  - …..others are possible

◦ Run-of-river hydro is an underused electrical grid asset that can provide these services while meeting other water stakeholder needs

◦ Increases effectiveness of local planning for energy choices, such as locally-generated renewables

◦ Enables development of lower-cost, firm renewable energy for rural communities with access to a RoR asset

◦ Simulations and experiments/observations have identified
  - The impacts on daily flow scheduling to accommodate different levels of flexibility
  - The quality of the services that could be delivered by different levels of flexibility

- The transient impacts that could be expected on intra-day river flows and stage
- The optimal balance of flow (CFS) and discharge (acre-ft) flexibility

◦ Next step is to plan for a RoR hydro/PV demonstration during two weeks of the summer of 2013 (TBD)

Appendix 7

Current Problems Faced in Vietnam Associated with the Integration of Small Hydro into Electric Grid of Vietnam

Trinh Quoc Vu, Director

Power Market Development Research and Training Center

Electricity Regulatory Authority of Vietnam (ERAV)

- *Vietnam Power Sector Overview*
  - Average electricity consumption growth rate in 1997-2012: 12,2%
  - Energy Consumption in 2012: 119.033 Billion kWh
  - Installed Capacity (2012): Total: 26,475 MW, of which: Hydro 12,009 MW; Coal fired thermal 4,900 MW; Oil fired thermal 550 MW; Gas turbine 7,446 MW; Gas thermal 468 MW; Diesel & Small hydro 1,170 MW; and Other 110 MW.
  - Electricity generation (2012): Total: 120,257 mill. kWh, of which: Hydro 52,795 mill. kWh; Coal fired thermal 22,716 mill. kWh; Oil fired thermal 43 mill. kWh; Gas turbine 41,250 mill. kWh; Gas thermal 311 mill. kWh; Import from China 2,676 mill. kWh; Export to Cambodia 1,224 mill. kWh and Other 467 mill. kWh.
  - Network: 500kV: Spine line, 3 region link; 220kV: Transmission line in each region, 2 region link; 110kV: Connected to 220kV Substations or power plans; Electrification: 96.1%.
  - National Power Development Plan VII – in period of 2011-2020, vision to 2030: Renewable Energy : 2010: 3.5%. 2020: 4.5%; 2030: 6.5%; Energy efficiency: 2015: 5-8%; 2020: 8-10%.

- *Current situation and Potential for development of small HPP in Vietnam*
  - Definition of small hydro power plants: installed capacity less or equal to 30MW.
  - Total installed capacity in 2012: 1,166MW (contributed 4.4% in whole system).
  - Energy generation in 2012: 4,493 million kWh (contributed 3.73% in whole system)
  - Operation and scheduling: depending on the season, weather and type of HPP, capacity of reservoir, etc.
  - Potential by 2015: North: 345 projects, total capacity 3,800MW; Central, South and Highland: 329 projects, total capacity 3,500MW.

- *Benefit and Advantage*
  - Contributed to balance the power supply – demand of national power system.
  - Ensure power supply at local province, increase electrification rate.
  - Contributed to social-economic development: infrastructure system (transportation, water transport, etc); Increase the employment opportunities in the local; Reasonable cost.
  - Supplement the green energy for power system.
  - Contributed to prevent from flood.
  - Reduce greenhouse gas emissions

- *Legal framework for development of small HPP*
  - Provincial People's Committee develop small HPP planning in their provincial and submit to MOIT for approval
  - General Directorate of Energy develop the hydroelectric ladder planning and submit MOIT for approval
  - Orientation of connection voltage level in planning: Less than 3MW: Connect to medium voltage at current local network; From 3MW to 10MW: Consider connect to medium bus bar of 110kV sub-station; From 10MW to 30MW: connect directly to 110kV network or medium voltage.
  - Technical regulation: Distribution Code; Technical procedures, connection procedures to be specified for each kind of renewable energy (Wind, small HPP,..).
  - Scheduling and dispatching of PCs: depending on ability of small HPP (reservoir, ability of daily, weekly,.. Regulation) and be consistent with the provisions in the SPPA.
  - Generation pricing: Complied with Avoided Cost regulation: issued the avoided cost tariff for small renewable energy power plants and Standard PPA.
  - Participation in to Vietnam Competitive Generation Market: Small and medium HPPs are not obligated to participate in VCGM.
  - Average price of small HPPs: 2011: 804 VND/kWh; 2012: 910 VND/kWh.

- *Problems arising with small HPP*

  Technical issues:
  - Connection planning issues: In some case the investment boundary of network connection to power system was not clear, and it depend on the planning process.
  - Power flow management: Sometime (wet season or off-peak of system), the power flow turn back to China in the Northern (Lao Cai, Yen Bai, Ha Giang province,..)
  - Grid congestion: Capacity of transmission and distribution network are not enough to transfer all the power of small HPP in some area to national power system (the Northern and Highland).
  - Quality of voltage normally was not meet the requirement in Technical code.

- Communication and information (SCADA/EMS/DMS) do not meet the requirements or can not operate.
- The operation cooperation was not good, still exist contradiction
- Lacking the benefit sharing mechanism between stakeholder to invest connection network.
- The avoided cost tariff may not enough interested to attract investors
- The avoided cost tariff do not reflect all the cost of project (example: cost to invest the network connection,..)

Social and environment:

- Change the natural flow on the river (downstream).
- Deforestation.
- Impact to ecosystem
- Migration and resettlement.
- Impact on the agriculture in dry season.
- There is not the benefit sharing mechanism for affected people

- *Solutions:*

  Development perspective:

  - Potential development as ensuring the balance between energy resources type (Hydro, thermal, Gas, nuclear, other RE,…)
  - Focus on: Optimization of the social, economic, and environment aspects; Development of place/area that have the low rate of Electrification or off-grid

  Solutions:

  - Enhance IT/automation infrastructure of small HPPs i.e. SCADA, communication system to support the optimization of operation and communication between dispatch centers and HPPs
  - Develop technical requirements customized for embedded generators including small HPPs to improve the quality of voltage, energy losses
  - Enhance and enforce the process of reservoir operation cooperation between HPPs/stakeholders
  - Review small HPP plan, eliminate projects are not efficient and feasible (technical, economic, social and environmental aspects)
  - Issue specific mechanism for development of small HPP: Pricing mechanism should be reviewed to achieve the attraction of investors; The benefit sharing mechanism for affected peoples by HPP should be considered.

Appendix 8

Current Status & Development Plan for Grid small hydropower in Vietnam – Barriers & Measures to overcome Barriers in the Future

Mr. Duong Manh Cuong
Expert of Planning Dept., GDE
Vietnam

- *Current status and development plan for grid small hydro power plants*
  - 2012: Total installed capacity: 24,278MW; Hydropower capacity: 10,73MW (40%); Capacity of small hydro: 1,200MW
  - Total generation: 117.6TWh; Total consumption: 106.3TWh

  - Hydro Power Plants (Large, Medium, Small):
    - Potential: 35,000 MW, 300TWh/year
    - Exploitable: 20-25 GW, 80-85TWh/year.
    - Planned: 1,097 Projects, of which:
      - Completed and commissioning project: 195 Projects with total installed capacity 10,733MW.
      - Under construction projects: 245 Projects with total installed capacity 7,101 MW.
      - Not yet constructed: 657 Projects.

  - Small Hydro Power Plant (Installed Capacity <30MW)

    - Planned 990 Projects with 4,300MW of installed capacity of which 361 Projects has been completed and commissioning (36% of total) with total installed capacity of 1,200 MW.
    - Connect to Grid: Mainly by middle voltage at 22kV, 35kV (existing for installed capacity <10MW if compatible to network capacity or brand new) & partly at 110kV.
    - Average forestland use: 3ha/MW (3,98ha/MW for large and medium hydro power project).
    - Most of small hydro power plan do not have to arrange resettlement

- *Incentive mechanism and policy to encourage the development of Renewable energy including small hydro power*

  - General incentives:

- Import tax exemption for equipments which can not be produced domestically.
- Corporate tax exemption for the first four years and reduce to 50% in the next 9 years.
- Obligation to purchase electricity: EVN must purchase all electricity generated from renewable energy sources.
- Tax and land use fee exemption for renewable energy projects.
- Free Environmental protection fee.

◦ Specific policy: Tariff mechanism
  - Decision No.18/2008/QD-BCT dated 18th July 2008 on avoided cost tariffs for small hydro projects
    · The avoided costs of the national power system is calculated when there is a (01) kWh power from small power plants using renewable energy is emitted into the distribution grid;
    · Production costs of 1kWh have the highest cost in the national electricity system, these costs can be avoided if buyers purchase 1kWh from a small power plants using renewable energy replacement.

▪ *Barriers & measures to overcome barriers in the future*
  ◦ Investors:
    - Limited capacity and experience of the investors in management and monitoring construction.
    - Lack of financial resources. Difficulty to access bank's loan with reasonable interest rate. Especially in crisis period when bank's interest rate reach 30%/year.

      Which leads to:
      · Low quality project's construction, affect safety of downstream community.
      · Project's progress slower than committed.
  ◦ Connection grid
    - Difficulty and uncertainty in the system connection due to big investment required to transmit all capacity of hydro power plants in one big area.
    - Locally congestion on transmission network due to many hydro power project centralized in 1 area
  ◦ Electricity Tariff
    - Unchangeable long-term tariff: Only small hydro power projects start operation since 2010 may be applied The avoided cost (Decision 18) and most of small hydro power projects have to sign a Long-term contract normally effective for 20 years. While average electric price may change regularly due to input indicators (e.g. Fuel price, current exchange, inflation…). It means in some case, the tariff is lower than average price
  ◦ Local State bodies:

- Inaccurate planning due to out-of-date basic material (hydrology, topography, geology, etc…).
- Insufficient management, inspection, monitoring of registered project.

  Which leads:

  · Unstable Planning, uncertain projects;

  · Several projects negatively affect the natural environment and society

◦ Solutions:

- Strengthening capability of management and planning for Local state bodies;
- Evaluate Investor ability (Experience, Finance): Exclude the project has low socio-economic efficiency such as projects has major influence on the environment, large reservoir flooded large land area, especially paddy, forestland; Withdrawn the investment certificate of No-go projects;
- Develop efficient connection network to optimize construction cost, transmitting capacity and land occupation.
- Establish regulations on safety management of hydropower dams;
- Strengthening of the management, inspection capacity to ensure the safety of hydroelectric production, flood control, dealing with rain, storms, floods ...
- Establish regulation on using surface water resource to ensure harmonize water resource to irrigation and household in dry season and the flood season

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Appendix 9

Current Status and Development plan for Small Hydropower in Malaysia

Ms. Nurhafiza bt Mohamed Hasan
Head, Licensing Unit, Energy Commission Malaysia

- *Government initiatives in promoting Renewable Energies (RE)*
  - The policies / Acts / Regulations
  - Stakeholders Involvement
  - Incentives
  - Government Support

- *Development of Minihydro*
  - Current Status
  - Future Projects

Appendix 10

Roadmap for Hydropower Development in the Philippines

Mr. Winifredo W. Malabanan
Director of Renewable Energy Department Bureau, Department of Energy
Philippines

Brief History of Hydropower Development in the Philippines

- *Hydropower Development*
  - Started in the early 1900's for electricity generation and non-power applications (e.g., millings), in rural communities
  - Government initiated commercial development of hydropower resources thru the National Power Corporation and the National Electrification Administration
  - Promulgation of Republic Act No. 7156 which provided full private sector development of mini-hydropower resources (up to 10 MW) in 1991
  - Private Sector participation through Build-Operate-Transfer Scheme of large hydropower projects in mid 1990's

- *Current status:*
  - Hydropower classification: Micro-Hydro - Up to 100 kW; Mini-Hydro - 101 kW - 10,000 kW; Small Hydro - 10,001kW - 50 MW; Large Hydro - Above 50 MW
  - Total existing hydro generating capacity: 3,104.435MW, of which: Micro-hydro 0.15MW; Mini-hydropower 99.785 MW; Small hydropower 280.40MW; Large Hydropower 2,724.10MW

- *Challenges and Barriers*
  - High upfront and technology costs
  - Non-competitiveness
  - Non-viable markets
  - Inaccessible Financial Packages
  - Social Acceptability
  - To address these barriers, the Government promulgated landmark Laws to accelerate development of renewable energy resources

- *Enactment of Landmark Law*
  - The Renewable Energy Act of 2008: Accelerate the development of the country's renewable energy resources by providing fiscal and non-fiscal incentives to private sector investors and equipment manufacturers / suppliers

- *Policy Implementation*
  - Establishment of the Renewable Energy Management Bureau
    - DOE's lead unit in the implementation of the Acts
    - Put in operation on 14 July 2009
    - Creation of the Interim Negotiating Panel for RE Service / Operating Contracts on 09 September 2009
  - Creation of the National Renewable Energy Board
    - Created Sub-committees and working groups to facilitate the formulation of mechanisms, rules and guidelines on the ff.:
    - Renewable Portfolio Standard / Feed In Tariff
    - Net Metering
    - Green Energy Option
    - Renewable Energy Trust Fund

- *Policy Directions and Mechanisms*
  - Accelerate the exploration and development of renewable energy resources
    - achieve energy self-reliance to reduce the country's dependence on fossil fuels, minimize the country's exposure to price fluctuations
    - adoption of clean energy to mitigate climate change
    - promote socio-economic development in rural areas
  - Increase the utilization of renewable energy by providing fiscal and non fiscal incentives

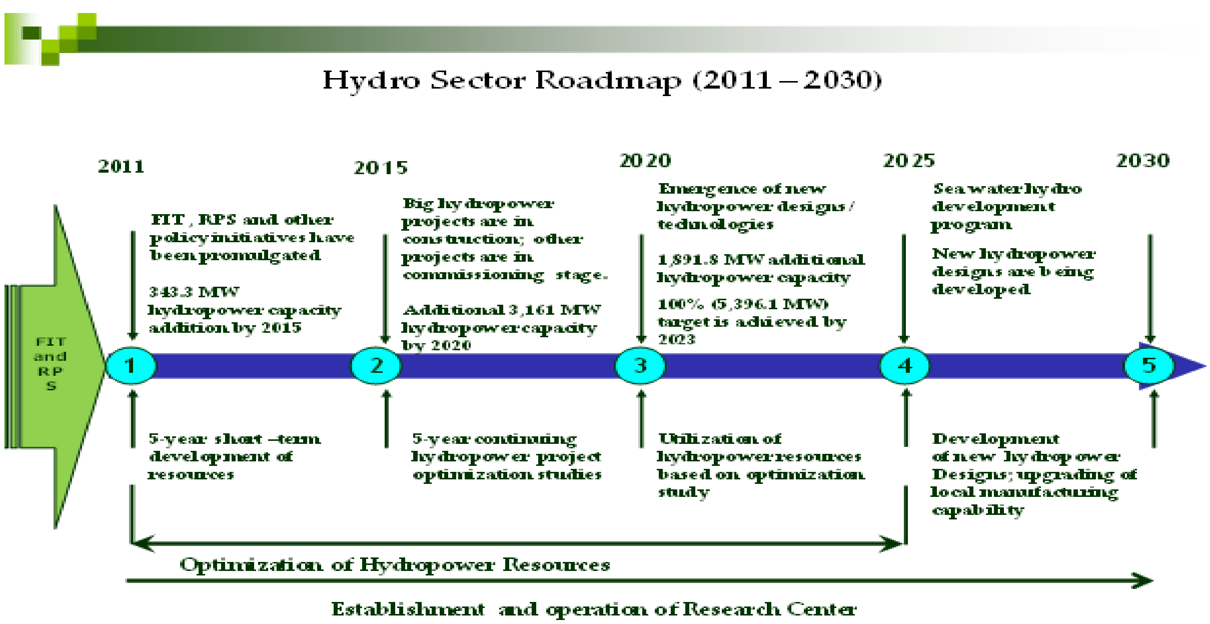
- *Policy Mechanisms*
  - Lowering of investment costs
    - Fiscal Incentives
      - Income Tax Holiday and Low Income Tax Rate
      - Reduced Government Share
      - Duty-free Importation of Equipment and VAT-zero Rating
      - Tax Credit on Domestic Capital Equipment
      - Special Realty Tax Rate on Equipment and Machinery
      - Cash Incentive for Missionary Electrification
      - Exemption from Universal Charge
      - Payment of Transmission Charges
      - Tax Exemption on Carbon Credits

  - Enhanced Competitiveness
    - Mandatory Utilization of RE Resources: Biofuels Mandate; Renewable Portfolio Standard (RPS); Feed-In Tariff (FIT)
    - Provision of Interconnection / Ancillary Services

- Other Market Options: Net Metering Concept; Green Energy Option

- *Where are we now?*
  - Renewable Portfolio Standard (RPS)
    - Conducted seven (7) Regional Public Consultations (Luzon, Visayas, Mindanao) and Plenary Public Consultation at PICC on 14 November 2011
    - RPS Rules for final review
  - ERC Approved Feed-in-Tariff (FiT) on 27 July 2012
    - Solar P9.68/kWh
    - Wind P8.53/kWh
    - Biomass P6.63/kWh
    - Hydro P5.90/kWh
  - FIT-ALL Payment and Collection Guidelines
    - Guidelines were submitted by NREB to ERC on 18 April 2012.
  - Net-Metering
    - The Rules Enabling the Net Metering Program for Renewable Energy was endorsed by NREB to ERC on 20 April 2012

- *Hydropower Sector Roadmap*



- *Summary of Renewable Energy Projects (as of February 2013)*

- *Renewable Energy Targets: 2011 - 2030*

Sector	Short Term	Medium Term	Long Term	Total
	2011-2015	**2016-2020**	**2021-2030**	
Geothermal	220 MW	1,100 MW	175 MW	1,495 MW
Hydropower	341.3 MW	3,161 MW	1,891.8 MW	5,394.1 MW
Biomass	276.7 MW	0	0	276.7 MW
Biofuels	•DC on E10 in 2011 •Mandatory E10 to all Gasoline by 2012 •PNS for B5 by 2014 •DC on B5 by 2015 •Mandatory B5 to all Diesel by 2015	•PNS for B20 & E85 by 2020 •DC on B10 and E20 by 2020	•DC on B20 and E85 by 2025	
Wind	200 MW	700 MW	1,445 MW	2,345 MW
Solar	50 MW	100 MW	200 MW	350 MW
Ocean Power	0	35.5	35	70.5
Total	**1,088 MW**	**5,096.5 MW**	**3,746.80 MW**	**9,931.3 MW**

Appendix 11

Grid Small Hydro Power Development in Indonesia

Mr. Rida Mulyana,
Director General of Renewable Energy and Conservation
Ministry of Energy and Mineral Resources
Indonesia

- *Introduction*
  - Overview of Indonesian Electricity Condition
  - Electrification Ratio
  - Indonesia Electricity Infrastructure
  - Target of Energy Mix for Power Generation

- *Overview of Indonesian Electricity Condition*
  - Total installed capacity: 44,216 MW (PLN 73%, IPP 23%, and PPU 4%)
  - Current electrification ratio: 76.56%
  - Energy mix in power generation: Coal 51%, Gas 23%, Oil 15%, Hydro 6%, Geothermal 5%.
  - Total investment in Power Sector : USD 10.7 Billion/year

- *Target of Energy Mix for Power Generation*
  - Electricity efficiency effort is conducted through diversification of primary energy in power generation (supply side) by optimizing utilization of gas, replacement of HSD to MFO, increasing coal utilization, and developing renewable energy power generation.
  - Gas and coal are given priority to reduce dependence on oil in power generation.

- *Hydro Power Generation*
  - Renewable Energy Potency

NO	RENEWABLE ENERGY	SOURCES	INSTALLED CAPACITY	RATIO
1	**2**	**3**	**4**	**5 = 4/3**
1	Hydro	75.000 MW	6.848,46 MW	9,13%
2	Geothermal	29.164 MW	1.341 MW	4,6 %
3	Biomass	49.810 MW	1.644,1 MW	3,3%

4	Solar	4,80 kWh/m2/day	22,45 MW	-
5	Wind	3 – 6 m/s	1,87 MW	-
6	Ocean	49 GW	0,01 MW	0%

- *Ownership*
  - Private: Independent power producer (IPP);
  - State owned company: Perusahaan Listrik Negara (PLN)

- *Current Progress of Small Hydro Power Development*

Status	IPP	
	Number	Installed Capacity (kW)
Operation	29	61.265
Construction	36	160.738
PPA	53	280.610
Permit Process	52	209.232
Proposal	65	327.573
Potential	140	653.340
Total	**375**	**1.692.758**

Status	PLN	
	Number	Installed Capacity (kW)
Operation	113	140.680
Construction	3	5.500
Study, Funding & Procurement	34	70.343
Total	**163**	**246.633**

- *Scope of Distributed Generation*
  - Distributed generation also known as embedded generation is a small capacity power generation installation that generates electricity from many small energy sources, which can be renewable or thermal energy.

- It may be connected to the 20 kV distribution lines which is part of a larger grid, or supplying an isolated MV/LV grid.
- Sources of primary energy may come from renewables such as hydro, PV, wind, biomass, etc or thermal energy such as micro gas engines or other type of captive power.
- Installed capacity < 10 MW, and must confirm with Distribution Code when connecting to the grid
- Feed-in tariff is applied for energy transaction

- *Benefit of Distributed Generation*
  - When DG installed in remote areas, they will ease the logistic issue of supplying fuel to the remote locations
  - When installed in larger interconnected networks, they will help reduce distribution losses
  - Improve voltage regulation and reliability of supply when the output of DG is not intermittent such as small hydro

- *Barriers and Countermeasures*
  - Barriers: Lack of viability; Lack of Equity
  - Countermeasures: Direct appointment; FIT; Improvement on financial mechanism

- *Past FIT regulation*
  - **Ministry of Energy and Mineral Resources Decree No. 112K/30/MEM/2002**
    - Small Scale of Renewable Energy and Excess Power Less Than 1 MW.
    - Only for Small Enterprise.
    - Feed-in Tariff:
      - 0,8 x Production Cost of Electricity (Connected to MV)
      - 0,6 x Production Cost of Electricity (Connected to LV)
  - **Ministry of Energy and Mineral Resources Decree No. 002 Year 2006**
    - Medium Scale of Renewable Energy and Excess Power from 1 up to 10 MW.
    - Only for Regional Owned Company, Coperative and Private Enterprise.
    - Feed-in Tariff:
      - 0,8 x Production Cost of Electricity (Connected to MV)
      - 0,6 x Production Cost of Electricity (Connected to LV)

- *Ministry of Energy and Mineral Resources Decree No. 31 Year 2009*
  - Small and Medium Scale of Renewable Energy and Excess Power up to 10 MW.
  - Only for Regional Owned Company, Coperative and Private Enterprise.
  - Feed-in Tariff based on Region:

	Price in IDR	Remark	Price in USD Cent			
Renewable Energy	9.200		Java/Bali	Sumatera/ Sulawesi	Kalimantan, NTB/NTT	Maluku & Papua
		F	1	1,2	1,3	1,5
	656	MV	7,13	8,56	9,27	10,70
	1.004	LV	10,91	13,10	14,19	16,37

Current FIT Regulation

- *Ministry of Energy and Mineral Resources Decree No. 04 Year 2012*
  - Small and Medium Scale of Renewable Energy and Excess Power up to 10 MW.
  - Only for Regional Owned Company, Cooperative and Private Enterprise.
  - PLN (State-Owned Electricity Company) has obligation to buy the electricity form renewable energy sources.
  - The tariff was set-up based on the avoided cost level of utility's electricity delivery cost (cost of good sold) regionally.
  - New fixed floor and un-negotiated tariff from all kind of renewable energies (can be the excess power from it) up to 10 MW.

	Price in IDR	Remark	Price in USD Cent							
Renewable Energy	9.200		Java/Bali	Sumatera/ Sulawesi	Kalimantan, NTB/NTT	Maluku & Papua	Jawa, Madura, Bali & Sumatera	Sulawesi, Kalimantan, NTT/NTB	Maluku & Papua	all over Indonesia
		F	1	1,2	1,3	1,5	1	1,2	1,3	
Renewable energy	656	MV	7,13	8,56	9,27	10,70				
	1.004	LV	10,91	13,10	14,19	16,37				
Biomass/BioGas	975	MV					10,60	12,72	13,78	
	1.325	LV					14,40	17,28	18,72	
Zero Waste	1.050	MV								11,41
	1.395	LV								15,16
Sanitary Landfill	850	MV								9,24
	1.198	LV								13,02

- *Future FIT Regulation*
  - Currently the FIT regulation for Small Hydro Power is under preparation.
  - It is expected the FIT will be increased in order to attract investor.
  - Green Banking Scheme is currently under assessment of Reserved Bank to accommodate the funding for Renewable Energy Project

- *Summary*
  - Indonesia seeks to enhance contribution of grid small hydro power generation to the electricity supply provision.
  - Regulation of Feed-in Tariff for Renewable Energy especially on Small Hydro Power Generation has developed progressively to facilitate investor in Hydro Power Generation business.
  - Financial mechanism will be simplified by the intervention of Reserved Bank

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Appendix 12

Current status and Development plan for Grid Small Hydro Power in Thailand

Ms. Krittiya Petsee, Plan and Policy Analyst
Work Plan Devision
Department of Alternative Energy Development and Efficiency Thailand

- *Current Capacity of Small Hydro Power*
  - EGAT: Large dam 21 projects 3,400 MW; Pumped Storage 2 projects 500 MW; Small Hydro 2 projects (irrigation dam) 36 MW.
  - DEDE: Small Hydro 22 projects 43.3 MW; Micro-Pico Hydro: 48 projects 1.8 MW.
  - PEA: Small Hydro 8 projects 19.8 MW; 2 projects 0.5 MW

- *Alternative Energy & Traditional RE*
  - Power Generation 1.3 % (Solar/Wind/Biomass /MSW/Biogas)
  - Alternative & Renewable Energy 9.9 %
  - Traditional RE 10.5%
  - Small Hydro Power 0.1%
  - Biofuels 1.6%
  - Final Energy consumption: Fossil 77.40%; Alternative Energy & Traditional RE 20.40%; Imported Hydro power 1.20%; Large hydropower 1.00%.
  - Comprising total capacity (Dec.2011): 32,395MW; Total added capacity 55,130 MW; Deduction of the retired capacity 16,839 MW; Grand total capacity 70,686MW
  - Classification of added capacity during 2012-2030: 55,130MW: Renewable energy power plants 14,580MW; Cogeneration: 6,476MW; Combined cycle power plants: 25,451; Thermal power plants: 8,623MW.

- *Alternative Energy Development Plan (AEDP)*
  - Committed to the development of low-carbon society
  - 10 years Alternative Energy-Development Plan (AEDP-Master Plan 2012-2021): hydro 1,608MW (101.75MW small – micro- pico; 500MW pumped storage); Government Funding On R & D Activities; Private-Led Investment
  - Target 25 % of RE in total energy consumption by 2021 (Current RE Share of 9.9% (March 2013)

- *RE power plants:*
  - North: Total 1,458 MW (Large Hydro = 1,279 MW; Biomass = 110 MW; Mini hydro = 40 MW; Solar = 24 MW; Geothermal = 0.3 MW; Biogas = 5 MW).

- Northeast: Total 1,377 MW (Large Hydro = 737 MW; Biomass = 352 MW; Mini hydro = 24MW; Solar = 120 MW; Biogas = 51 MW; Wind = 93 MW).
- Central: Total 1,606 MW (Large Hydro = 1,078 MW; Biomass = 241 MW; Mini hydro = 3 MW; Solar = 230 MW; Biogas = 43 MW; Wind = 0.1 MW; MSW = 1 MW).
- South: Total 430 MW (Large Hydro = 312 MW; Biomass = 48 MW; Mini hydro = 4 MW; Solar = 0.1 MW; Biogas = 47 MW; Wind = 2 MW; MSW = 17 MW)

- *DEDE Strategy for Hydro Power:*
  - Focus on " Micro+Pico Hydro+Pumped Storage"
  - Targeted 1,608 MW with measurements

    1. Electricity from Small Hydro Power at village level, for non-electrified households
       - Off grid / isolated system
    2. DEDE supports Small Hydro Project in community
       - Owned by Local Administrative organization / People
       - Managed by Community
    3. Solve the barrier
       - Site located in conserved area / restricted area
    4. Research & Study Micro Hydro Turbine of Run-of-River
    5. Develop hydro turbine of low-head type
  - Community Participation

- *Current Capacity of Small Hydro Power*
  - EGAT: Large dam 21 projects 3,400 MW; Pumped Storage 2 projects 500 MW; Small Hydro 2 projects (irrigation dam) 36 MW.
  - DEDE: Small Hydro 22 projects 43.3 MW; Micro-Pico Hydro: 48 projects 1.8 MW.
  - PEA: Small Hydro 8 projects 19.8 MW; 2 projects 0.5 MW.

- *Lesson Learned*
  - Micro-Pico Hydro = Cheapest RE Resource
  - Technology => Simple & Proven
  - Needs Strong Community to
    - operate
    - maintenance
  - Technical assistance and transfer to local people is still necessary for continuity of the projects.

Session 3: Issues on grid integration of small scale RE electricity APEC Economies – Electricity Utilities Perspective

Chairman: Dr. Tom Lee

Industrial Technology Research Institute, Chinese Taipei, and Chair APEC Expert Group on New and Renewable Energy technologies

Appendix 13

Interconnection of wind power onto the Vietnamese power grid

Dr. Tran Nam Trung

Technical and Production Department

Electricity Vietnam

Vietnam

- *Vietnamese Power System*
  - Installed generation capacity: 26,926 MW
  - Peak demand in 2012: 18,649 MW
  - Energy sales in 2012: 120 bil. kWh

	Length (km)	Capacity (MVA)
500 kV	4,437	13,950
220 kV	10,999	25,839
110 kV	13,141	30,284
Medium Vol.	138,971	-
Low Vol.	230,437	-

- *Existing wind power installations*
  - In operation: Tuy Phong wind farm – 30 MW (20 x 1.5 MW); Phu Quy hybrid system – 6 MW (3 x 2 MW);
  - In construction: Phuong Mai wind farm – 30 MW (6 x 2.5 MW by 2012; 6 x 2.5 MW by 2015); Bac Lieu wind farm – 99.2 MW (10 x 1.6 MW by 2012)

- *Wind power development in Vietnam*

Year	**2011**	**2020**	**2030**
Wind power installed capacity (MW)	30	1,000	6,200
Wind power from Binh Thuan province (MW)		700	2500

System capacity (MW)	21,000	66,979	137,000
Total wind power ratio	**0.14%**	**1.5%**	**4.5%**
Wind power energy (TWh)		2.31	16.68
Wind energy from Binh Thuan province (TWh)		1.5	5.475
System energy (TWh)		329	695
Total wind energy ratio		**0.7%**	**2.4%**

- *Collaborative research studies*
  - Cooperation between EVN and ICASEA
  - Component 1: study on wind power impacts on the power system
  - Component 2: study on interconnecting wind power to the power system
  - Component 3: study on wind power in the electricity market

- *Wind power impacts*
  - Issues of wind power
    - Availability of Resource
    - Poor Stability Support
    - Voltage Regulation
    - Change in System Fault Levels
    - Power Quality Issues

  - Assessing impacts of wind power to the power system
    - Constituents of a Wind Integration Study
    - Software Tools for Wind Integration Studies
    - Data Required for Wind Integration Studies

  - Remedies to minimize impacts of wind power
    - Measures to reduce the impacts of wind variability
    - Improving fault performance of wind turbines
    - Reactive power support from wind power plants
    - Meeting transmission capacity needs
  - Recommendations
    - Firm up the master plan for wind power development for a certain planning window and make it an integral part of other planning activities.
    - If not already available, commence on-site wind measurements for areas earmarked by the wind power master plan.
      - Compile all necessary element and operational data of the power system in order to carry out the dynamic simulations of the wind integration study.

- Specify the capabilities and operational conditions that need to be met by new wind power plants, based on grid codes and experience of other countries, until such time own wind integration studies are conducted.

- *Wind power interconnection criteria*
  - Wind connection criteria is only valid up to 5% of wind penetration with respect to system capacity.
  - National regulatory circulars of Vietnam
    - Circular No 12/2010/TT-BCT by MOIT dated 15 April 2010 on transmission system
    - Circular No 32/2010/TT-BCT by MOIT dated 30 July 2010 on distribution system
  - Best international practice reviewed here are:
    - Ireland – Distribution code and Grid code
    - Indian Grid code
    - UK – G59, G75 & Grid code
    - Denmark - Generating facilities that are connected below 100 kV and that are connected above 100 kV
    - Germany - Guideline for generating plants' connection to and parallel operation with the medium-voltage network and Grid code
    - Parts of Chinese grid code

  - Grounding arrangements
    - Neutral grounding of the DNO distribution systems vary from isolated, Peterson coil to direct grounding depending on the voltage levels of the distribution systems.
    - To ensure that earth fault protection schemes of the existing distribution systems are not disturbed, a WPGF shall be connected to such distribution systems through a transformer with a suitable vector group to:
      - prevent distribution system earth faults appearing as earth faults on the WPGF side and
      - enable the total earth fault current to flow through DNO's distribution system neutrals

  - Protection schemes
    - All WPGFs are required to install protection schemes to:
      - protect the distribution system from faults originating in the WPGF, which include but not limited to wind turbine, generator, WTG step-up transformer, collector facilities and equipment used to interconnect the WPGF and the distribution system
      - protect the distribution system from the abnormal operating conditions of the WPGF
      - disconnect WPGFs during distribution system faults, and

- · disconnect WPGF when islanding occurs
- All protection schemes of the WPGF shall be fully discriminative with the upstream (DNO) protection schemes

◦ SCADA

- To ensure reliable and secure operation of distribution networks, WPGFs are required to comply with the SCADA requirements as outlined in Circular 32, Clauses 40 and 41.
- It is recommended that WPGFs exceeding 10MW shall provide information related to the wind speeds in addition to those specified in the preceding paragraph

◦ Communication

- WPGF communications systems shall comply with the Article 40 of Circular 32:
    - · Customer using distribution network owns power plants that have capacity not less than 10MW and all 110kV transformer have responsibility for installation Data/Information System in range management and connect to Distributor's data/Information System for data/information communication and transmission proposes in operation system. Customer's devices must be compatible with existing system of distributor.
    - · In case of customers out of scope that is stipulated in clause 1 this Article shall has the right to get agreement for installation data/information System that clarify in connection agreement.
    - · The Distributors have responsible for investment, management network in own area for power distribution system operation.
    - · The Distributors have responsible for providing for Customer using distribution network the requirement on data/information, communication protocol and interface and co-ordination with Customer in testing, verifying and connected information system of customer to their existing data/information system

◦ Requirements of data made available

- Forecast of wind power production in every month
- Key technical characteristics of the wind generator
- Technical data for electrical equipment in connection points (Switching equipment, Transformers, Reactive compensation equipment, Voltage Transformer (VT)/ Current Transformer (CT), Protection and Control system, Transmission lines and cables related to power connection point)
- Single line diagram of the connection point
- Equipment and their ownership at the connection point
- Authorized officers for operation and safety
- Operational procedures and the parties responsible for operation
- Names of Officers who provided the above information and the dates

- Future work on wind grid interconnection
    - Impact studies of wind power in two high wind potential regions: Binh Thuan and Bac Lieu provinces.
    - Conduct detailed simulations to complete the wind grid code
    - Submit to MOIT for approval and promulgation

Appendix 14
Standards and Technical Considerations for Small Scale Energy Projects into the Grid

Mr. Do Thien Khoi
Global Government Affairs Manager
Product Safety UL LLC, USA

- *Agenda*
  - Update on Standards Development Activity
  - Technical Considerations for Small Scale Projects
    - Systems Approach to Safety and Performance (Local vs. International)
    - Installation
    - PID, Inspection, and Maintenance
  - Energy Storage and Integration Policy
  - Recommendations for Engagement of International Standards Development and Private Sector
  - SCSC Project Proposal – PV Integration into the Smart Grid
  - Questions and Feedback

- *Standards Development: UL and IEC*
  - UL is active in IEC Harmonization Efforts in key renewable energy technologies:
    - IEC/UL 61730, IEC/UL 61215, IEC/UL 61646, IEC/UL 62108 for PV
    - IEC/UL 62109 for inverters
    - UL also active in IEC committees with an eye toward future harmonization in areas like batteries, wind power, and electric vehicle equipment
  - Call for more APEC economy and regional representation and involvement
  - Key considerations for future standards development will include safety, performance, reliability, bankability, grid connectivity, interoperability, and security
  - System level standards development will be an increasing priority to address safe and reliable operation of renewable energy systems

- *Systems Level Approach – International Considerations and Local Application*
  - Coordinating the balance of global product deployment and local compatibility is an ongoing challenge
  - For example, inverters may be expected to comply with:
    - Product standards for safety (e.g. IEC 62109, UL 1741, etc.)
    - Code requirements for installation (e.g. NEC)
    - General Utility interconnection requirements (e.g. IEEE 1547)

    - Special Utility performance requirements (e.g. low-voltage ride-through), depending on the specific distributed resource & grid characteristics
  - UL is achieving efficiency through a systems level approach, where basic aspects are addressed and optional aspects are clearly defined to support proper selection, approval and use in the system

- *Installation Considerations*
  - Safe and suitable installation is essential to support appropriate deployment; this is accomplished through:
    - Suitably qualified installers, verified by means such as Certification or other credentialing to promote workmanship and code compliance
    - Approval by regulators for safety, energy performance, etc.
    - Approval by utilities for suitability of grid connectivity & performance
  - Various documents and programs have been developed or initiated to address these issues – for example UL's PV installer certification and installation guidebook development through IEC
  - Residential safety implications – UL/Solar ABCs research on flammability of roofing materials under installed PV panels indicated that consideration is needed to coordinate safety

- *Technology In-Use*
  - Assessing safety and performance attributes of the systems in use are critical – for example:
    - Potential Induced Degradation (PID) is a phenomenon that can greatly reduce operation of PV modules, especially in damp environments; UL's test method identifies PID susceptibility
    - Ongoing performance and safety are addressed in PV Park programs to promote assurance of proper operation

- *PV Safety Research*

Research in 3 general areas of PV fire safety

  - Effect of a PV installation on roof fire classification ratings:
    - Changes to fire test procedure have been proposed to the UL 1703 Standards Technical Panel
    - Reports of the work can be accessed at http://www.solarabcs.org/current-issues/fire_class_rating.html
  - Use of screens to prevent ignition of debris under a PV installation:
    - Screen found to be ineffective in prevention of debris ignition
    - Caused an increase in module operating temperature

  - Fire Fighter Safety and Installation
    - Shock hazard due to presence of water and PV power during suppression activities

- Shock hazard due to direct contact with energized components during firefighting operations
- Emergency disconnect and disruption techniques
- Severing of conductors
- Assessment of PV power during low light ambient light,, artificial light and illumination from fire
- Assessment of potential shock hazard from damaged PV modules and systems.
- Reports of the work can be accessed at http://www.ul.com/global/eng/pages/offerings/industries/buildingmaterials/fire/fireservice/pvsystems/

▪ *Energy Storage and Smart Grid*
  ◦ Energy storage standards and balancing systems will be increasingly critical to assure safety and establish realistic expectations about performance and reliability
  ◦ How will different economies handle energy storage policy and when power can feed back into the grid will become increasingly important
  ◦ Transition to Smart Grid systems leads to new implications for safety, performance, interoperability, and security

▪ *Considerations for APEC and ASEAN Economies*
  ◦ Engagement in standards development
  ◦ Climate and Environment Implications
  ◦ Small-Scale Projects and Residential Application – safety and efficiency
  ◦ Engaging Private Sector in projects and services

▪ *APEC Project Proposal: PV Integration into the Smart Grid*

  ◦ "The project will focus on standards, regulations, and best practices that facilitate solar technology deployment and smart grid integration in smart communities across APEC economies."
  ◦ Study of different Smart Communities across APEC and workshop around SOM 1 2014 in China
  ◦ Submitted through Subcommittee on Standards and Conformance (SCSC) under the Committee on Trade and Investment (CTI)
  ◦ Co-sponsoring Economies: Indonesia, Japan, Malaysia, Chinese Taipei, and expressed support for hosting in 2014 by China
  ◦ Build up collaborative work in SCSC, EGNRET, and EWG

Appendix 15

Issues on grid integration of small scale RE electricity APEC Economies - Electric Utilities Perspective

Mr. Saharuddin Sulaiman
Principle Engineer, Asset Management Department
Distribution Division, Tenaga Nasional Berhad Malaysia

- *INTRODUCTION*

  - Small Renewable Energy scenario in TNB

Types	TNB	RE developer
Mini hydro	20 sites (97MW)	4 sites (29.2MW)
Solar PV	-	20 sites (25.5MW)
Biomass	-	3 sites (20MW)
Biogas	-	6 sites (7MW)

  - Feed-in Tariff in 2011 (up to 30MW)
  - Regulators : Electricity Commission Malaysia, SEDA Malaysia
  - Connection point is based on RE output capacity

- *REFERENCES*

  - Renewable Energy Act, 2011 (SEDA Malaysia)
  - Distribution Code (Energy Commission Malaysia)
  - Connection of PV Generation (TNB)
  - DG Generation Guidebook (TNB)

- *TNB GREEN ENERGY POLICY*
  - "TNB is committed to support the national green agenda and minimize the environmental impact of our business by applying sustainable, efficient operations and delivering green energy through the application of appropriate technologies and investments"

- *ISSUES*

a) Voltage regulation

i- MV

- Proposed RE sites are away from load centre : low load, smaller cables
- High generation results in out-of-range voltage (±5%)
  - Reduce generator pf
  - Install reactor
  - Install larger cable
  - Reduce capacity
  - Connect to higher voltage
  - Upgrade utility cable/line

ii- LV

- Voltage increase during low load causing inverter to trip

b) Nearest connection point is a “weak” system

- Low load
- Small cable, bottleneck
- Long interconnection cable/line required to connect to suitable substation
  - Reduced generation capacity

c) Network losses due to reversed power flow & supply of Var

- Higher current flow results in higher losses

d) High system fault level

- Addition of RE generators exacerbate
  - 33kV 25kA
  - 11kV 20kA, 25kA
    - Unparallel transformers
  - Reduce fault contribution from RE

e) Penetration limit

- Based on capacity
- Based on existing trough load
- Based on expected voltage rise

>>> Prevailing limit is 85% of trough load, TNB is currently reviewing the limit

f) Favourite sites

- Some sites are favoured by RE developers resulting in high number of proposals due to:
  - Cluster of potential rivers
  - State government support
  - “Cheaper” land

- Penetration limit
- Insufficient space for additional switchgears at Main Intake Substation

g) Upgrading at existing substation/feeder
- ◦ Existing small substation
- ◦ Connection from multiple developers
- ◦ No nearby existing substation
- ◦ RE site nearest to worst performing feeder

h) Numerous connection schemes
- ◦ Multiple feed causing difficulty to isolate fault during operation
- ◦ Standardized for FiT connections
  - Single connection point
  - Standardized connection point based on connected capacity
    - · Standardised interconnection feeder
- ◦ Interlocking scheme to ensure TNB equipments not used to sync
- ◦ Interfacing with TNB
  - Cable – Unit Protection and OCEF
- ◦ Interlocking facilities
  - A trip – B to trip
  - B close position – A cannot close
  - A open position – B cannot close
  - Earth switch B ON – A cannot close

i) Boundary of ownership/operation
- ◦ Energy meter installed at connection point i.e. TNB substation. Energy meter reading by Remote Metering
- ◦ Ownership of RE developer until connection point
- ◦ Interconnection Operation Manual (IOM) for every site

j) Inconsistent energy output (steady state)
- ◦ Solar : due to varying solar irradiance
- ◦ Biomass : due to unavailability of biomass, fuel
- ◦ Biogas : due to inconsistency of gas – sanitary landfill, anaerobic digestor
- ◦ Hydro : due to reduced water flow

k) Reduced Main Intake Substation capacity utilization

l) Change in Main Intake Substation power factor
- ◦ Reduced substation power factor due to reduced P, increased Q

m) Exact machine data not available during power system study
- ◦ Use of typical parameters

n) Increase maintenance of substation equipment
- ◦ Use of VCB switchgears at connection points

- ▪ *CONCERNS*

i) Safety of workmen during operation
ii) Harmonic contribution to distribution network
iii) Yo-yo like energy output complicates load forecast, capacity planning
iv) Local industry technical support - skilled

Appendix 16

Issues on grid integration of small hydro in Indonesia – PLN's Perspective

Mr. Suroso Isnandar
System Planning Engineer, Division of System Planning,
PT PLN (Persero) Indonesia

- *Profile of PLN (Statistic 2011)*

No	Description	
1.	Installed Capacity	29.268 MW
2.	Peak Load	26.665 MW
3.	Energy Production	184 TWh
4.	Energy Consumption	160 TWh
5.	Number of Customers	45,9 m
6.	Transmission Line	36.720 kmc
7.	Distribution Line	679.424 kmc
8.	Revenue	21 b USD
9.	Electrification Ratio	74%

- *Demand of electricity is expected to grow fast (2012-2021)*
  - Electricity demand is predicted to grow at a average rate of 9,7% per year.

- *Need to build 55 GW new power plant to serve the demand growth*
  - Approx New Capacity: 55 GW
    - Coal : 38 GW
    - Geothermal: 6.4 GW
    - Comb. Cycle: 2.5 GW
    - GT/Gas Eng.: 4 GW
    - Hydro/Mini Hydro: 5.3 GW (Mini hydro is about 1,500 MW)
    - Others: 0.25 GW

- *The hydro potential is promising*
  - 5 GW hydro potential, after strict screening (environmental & social) is about 26.3 GW 167 locations,
  - and further narrow to 12,9 GW 89 locations

- *MEMR Ministerial Decree No. 04/2012 FIT Small Hydro < 10 MW (1 USD = Rp 9,700)*

- *More Small Hydro and Other RE is planned*

ISSUES:

- *Issue 1. Expanding the Grid to reach them*
  - Connection issues due to remote location
    - Too remote : islanding operation for local load and doesn't connect to PLN's grid, forming micro grids
    - Connecting to 150/20 kV substation
    - Connecting to nearest 20 kV distribution network
    - In some cases, PLN needs to build section of 150 kV T/L and 150/20 kV substation, revising on-going transmission expansion plan
  - Economic issues : location will greatly affect project viability
  - In some areas, PLN needs to build 150 kV Substation and extend T/L, revising the on-going power development plan
  - New 150 kV SS specially built for mini hydro :
    - Dolok Sanggul: 30 MVA, Ongoing, COD 2013
    - Salak: 2x30 MVA, Ongoing, COD 2014
    - Negeri Dolok : 2x30 MVA, Ongoing, COD 2014
    - Parlilitan: 2x30 MVA, Planned, COD 2016
    - Pakkat: 2x30 MVA, Planned, COD 2016

- *Issue 2. Site overlapping between PLN and developers*
  - No single authoritative agency :
    - Principal permit, location permit, environment assesment issued by local governments
    - Approval to proceed to PPA and operation-worthy certificate is given by central government c.q Ministry of Energy and Mineral Resources
    - Pre-qualification, direct appointment process and PPA is processed by PLN, FIT is used for PPA periods 2x15 years
  - Need coordinated approach/one gate processing centre.
  - New proposals need to consult with the prevailing power development plan (RUPTL 2012-2021)

- *Issue 3. Operational aspect of small hydro integration*
  - Distribution code : MEMR Ministerial Decree No 4/2009
  - Need to ensure that the distribution system working properly after small hydro connected, as distribution system is mostly designed, operated and protected with a single voltage source on each distribution feeder, and the connection alter this existing operation pattern.
  - Conditions to be maintained in the system are:
    - voltage regulation;
    - thermal ratings of equipment being not exceeded;
    - fault ratings of switchgear and cables being not exceeded;
    - fault current contribution;
    - Power quality, voltage disturbance affected in terms of step changes, flicker and harmonics being kept to a minimum and within accepted limits;
    - reverse power flow
    - protection coordination, fault clearance
    - etc.

- *Concluding Notes*
  - There are other issues : metering point, coordination of outage schedule, automation/SCADA/telecom, SOP, etc
  - Mini hydro improve fuel mix, reduce losses, improve voltage profile on distribution network
  - FIT generates positive response from IPP developer
  - Developers and PLN needs to work out on several issues such as site overlapping or connection issues
  - PLN needs to adjust its network expansion plan to accommodate small hydro

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Appendix 17

Community PV-DC Microgrid

Worajit Setthapun, Suchat Srikaew
Wattanapong Rakwichian
Asian Development Institute for Community Economy and Technology
Chiang Mai Rajabhat University, Chiang Mai, Thailand

- *Phase 1 – PV DC Hybrid Microgrid*
  - 25.5 kWp PV Generator with DC grid to each load
  - 24 VDC lighting; converter 240 VDC /24 VDC
  - Online monitoring & data acquisition system
  - Main loads: 1 office, 1 minimart, 1 restaurant, 1 coffee shop, 1 farm, 6 houses, farm pump.
  - 240 VDC for household appliances
    - Lighting, TV, computer, refrigerator
    - Rice cooker, water heater, microwave, air conditioner
  - Low energy consumption more than 80% saving
- *PV DC compared to PV AC:*
    - Higher efficiency by eliminating DC/AC/DC conversion
    - Lower cost from eliminating inverter

Appendix 18

Current status and development for grid integration of small scale RE electricity in China

Mr. Wan Lin, Director Beijing Energy Innovation Ltd. China

Summary of presentation:

- *Power Source Structure in China, 2011*

2011 年电力装机和发电量 Power Source Structure in 2011				
类 型 Type	装机容量（GW） Capacity		发电量（TWh） Generation	
	容 量	比例	发电量	比例
	（GW）	（%）	（TWh）	（%）
煤 电 Coal	765.46	72.5	3897.5	82.54
水 电 Hydro	230.51	21.83	662.6	14.03
核电等 Nuclear etc	15.65	1.48	87.4	1.85
风电 Wind	42	3.98	73.2	1.55
光伏 PV	2.14	0.2	1	0.02
合 计 Total	1055.76	100.00	4721.7	100.0

- *Power Source Structure in China, 2020*

2020 年电力装机和发电量 Power Structure by 2020				
类 型 Type	装机容量 Capacity （GW）		发电量 Generation （TWh）	
	容 量	比例	发电量	比例
	（GW）	（%）	（TWh）	（%）

煤 电 Coal	1170	60.47	6100	72.27
水 电 Hydro	360	18.6	1200	14.22
核电等 Nuclear etc	130	6.71	590	6.99
风电 Wind	180	9.3	360	4.27
太阳能 PV	50.00	2.58	75	0.89
其它 Others	45	2.33	115	1.36
合 计 Total	1935	100	8440	100

- *Government Sponsored PV Projects*

Large Scale PV		
Phases	**Approved Capacity**	**Feed-in Tariff**
2011 FIT	2000MW	FIT = 1.15 元/kWh
2012 FIT	2000MW	FIT = 1.0 元/kWh
Total（2009 - 2012）	4300MW	800MW waiting for grid connection
Financial Source	Renewable Energy Surcharge	
PV Building Project		
Phases	**Approved Capacity**	**Subsidy to Capital（Yuan/W)**
3rd phase, 2011	106 projects, 120MW	BIPV 12 元/W
4th phase, 2012	250MW	BIPV 9, BAPV 7.5
Total（2009 - 2012）	500MW	
Financial Source	Special Fund for Renewable Energy	
Gonden Sun Demonstration		
Phases	**Approved Capacity**	**Subsidy to Capital（Yuan/W)**

3rd Phase 2011	140 projects, 690MW	C-Si 9.0, a-Si 8.5
4th Phase 2012	167 projects, 1709MW	PV Building 5.5, off-grid >7.0
Total (2009 - 2012)	2870MW	
Financial Source	Special Fund for Renewable Energy	
Additional PV Building Project and Golden-Sun Demonstration		
Nov. 2012	2830MW	BIPV 7, BAPV 5.5
Financial Source	Special Fund for Renewable Energy	
Total Installed and Approved PV by the end of 2012 is **10500MW**		

- *Government Target for Solar:*

Targets for Cumulative Installation of Solar Power (GW)				
Market Sectors		2012	2015	2020
Distributed PV	Rural Electrification	0.102	3.0	10.0
	Communication and Industry	0.058	1.0	4.0
	PV Buildings	2.390	14.0	40.0
LS-PV and Others	PV products	0.058	1.0	4.0
	Large Scale PV (LS-PV)	4.392	15.0	40.0
	Solar Thermal Power (CSP)	0.000	1.0	2.0
Total		7.0	35.0	100.0
Share of Distributed PV (%)		36.4	51.4	54.0

- *Opportunity & Challenge in China*
  - Opportunity
    - Resources
    - Laboratory
    - Market
  - Challenge
    - Technology: Reliability of PV System

        - Economy: Safety, Profitability, Liquidity of PV Investment
        - Social: Mature Industry?

- *First Wave of RE Development*
    - Pushed by global fiscal subsidy and support
    - Leading role: Manufacture, especially PV Module
    - Main character and achievement
        - Large Scale
        - Lower Cost
        - Fast Speed

- *Second Wave of RE*
    - Pushed by: Grid Parity
    - Leading Role: System Solution provider, Developer
    - Five Characters
        - Innovation of Application
        - Quality & Risk Management, Evaluation System
        - Insurance: Yield Index & Revenue Insurance
        - Investment: Professional, Long-term Investor
        - Second hand market and Quit Scheme

- *Third Wave of RE*
    - Pushed by: urbanization
    - 100 Low Carbon Model Town
    - Risk of Carbon Tsunami, Global Carbon Taxation could bring the third wave of PV development
    - Risk & Casualty
    - Learn from other Industry
    - Who shall we learn from
        - Real Estate
        - Automobile
        - Clean Development Mechanism
    - What shall we learn
        - Mature Industry & Mature Market
        - Risk Management, Technology & Innovation
        - Financing, Insurance, Marketing & Service
    - Cooperation Proposal
        - Roadmap
            - Goal: sustainable development
            - Possible choices: what kind of technology, solution

- Model
  - Business & Financing Model
  - Low Carbon Model Town (LCMT)
  - Industrial Real Estate Developer
  - Price-setting Model
- Tool Kits
  - Due diligence
  - Resource evaluation
  - Design evaluation
  - Equipment manufacturing supervision
  - Construction supervision
  - Complete acceptance check
  - Operation & maintenance
  - Ex-post evaluation
  - Life cycle yield prediction
  - Financing and insurance related service
- Pilot Project: New District of Turpan
  - "Local unique clean energy and suitable ecological technology will be used in New District of Turpan, which will become a distinctive, residential, and harmonious ecological demonstration urban."

Appendix 19

Renewable System Integration Overview

Dan Ton
Program Manager, Smart grid R&D
U.S. Department of Energy

- *Background*
  - U.S. PV potential growth due to:
    - Renewable Portfolio Standards (RPS)
    - Technology improvements
    - Government programs
  - RSI Study started in 2006, completed in 2008*

- *Issues*
  - Reverse power flows
  - Power quality
  - Codes & Standards
  - System protection
  - * http://www.nrel.gov/docs/fy08osti/42292.pdf
- *Solutions*
  - Smart inverter development for PV solar system to be connected to the grid, microgrid for households
  - Grid control
  - Integrated DMS-EMS, OMS, Forecasting
  - Dynamic volt/var control
  - Modeling/simulation in GridLAB-D
  - Demonstrations: 10 demonstrations around the countries
  - Microgrid R&D

Appendix 20

Smart Grid Master Plan in Chinese Taipei

Dr. Bing Chwen Yang, Division Director
Green Energy and Environment Laboratories
Industrial Technology Research Institute, Chinese Taipei

- *Power System in Chinese Taipei*
  - Power System (2011)
  - Power Capacity 48,750 MW
  - Power Generation 252,173 GWh

- *Hydro Power System*
  - Total 15 HPPs contribute 9.52% total installed capacity and 2.74% of power generation in 2011.
  - One pump hydro contributes 36.4% of total hydro power capacity.
  - 2 conventional HPPs with capacity > 1 GW; 3 conventional HPPs with capacity between 100 ~ 200 MW, other 9 less than 100 MW.

- *Target of Renewable Energy*
  - The installed capacity of renewable energy was 3,683 MW in Dec 2012.
  - Targeted renewable power generation capacity is 12.5 GW by 2030.

- *Why Smart Grid & Energy Storage?*
  - Ensure Reliable Power Supply:
    - The SAIDI (System Average Interruption Duration Index) should be maintained on the top five of the world in 2030. (2030:15.5min./year)
    - Reducing the power transmission loss from 4.8% to 4.4% in 2030.
  - Encourage Energy Conservation and Emission Reduction:
    - Reducing 100 million ton CO2 emission per year in 2030.
  - Enhance the Use of Green Energy:
    - Improving the renewable power interconnection capability to 30% in 2030.
  - Develop Low-carbon Industry:
    - Driving smart grid industry to create NTD 700 billion value in 2030.

- *Summary*
  - The expectations of Smart Grid Master Plan are not only to upgrade existing power grids, but also to enhance the supplementary schemes including regulations and policies.

- ◦ Following work:
  - A supra-ministerial mechanism is required to coordinate the resources and manage the progress of different departments.
  - Establish a rolling review mechanism to adjust objectives of each phase.

Appendix 21

Technical visit

In the afternoon of 5 April 2013, a technical visit was organized to a small hydropower plant namely Nui Coc hydropower plant owned by Nui Coc hydropower Joint Stock Company. About 20 participants participated in this visit.

The Nui Coc hydropower plant is located near Nui Coc lake in Thai Nguyen province. The site of power plant is 100km from Hanoi, in the north of Vietnam. This hydropower plant has 3 Francis turbines with total capacity of 3x 650kW = ~ 2MW. The main equipments of the power plant (turbines, generators, transformers, etc.) are imported from China.

The power plant started construction in 2007 and was commissioned in 2009. From then, it has been being operated well. Nui Coc lake is a irrigation reservoir whose water is used for irrigation of land fields in Thai Nguyen province. Water, after flowing through turbines, is used for irrigation. Load of the power plant is depending on required water flow for irrigation. Therefore, some times plant operates only one or two units.

Its all generated electricity is supplied to the national power grid. The electricity generated at peak hours has higher tariff. This is very good model for combination between irrigation and electricity generation. In construction of this hydropower plant, the investment cost does not cover reservoir and dam because they are existing ones. According to Mr. Phi Ngoc Lam, the president of Nui Coc hydropower Joint Stock Company, investment cost is about 2 million USD. The stakeholders contributed 40% and remained 60% is loan from the bank.

This is impressive and interesting visit.

Appendix 22

List of speakers and participants
APEC Workshop on Small Scale Hydro and Renewable Grid Integration
Ha Noi, Viet Nam_3-5 April 2013

No.	Full Name	Organization
1	Dr. Tom Lee	APEC EGNRET Chairman, Director of New Energy Technology Division, Green Energy & Environment Research Labs. Industrial Technology Research Institute, Chinese Taipei
2	Mr. Cary Bloyd	Senior Staff Scientist, Electricity Infrastructure & Buildings Division. US Pacific Northwest National Laboratory
3	Mr. Dan Ton	Program Manager, Smart Grid Research & Development. US Department of Energy, Office of Electricity Delivery and Energy Reliability
4	Dr. Tran Thanh Lien	Team Leader. APERC , Japan
5	Mr. Jeff Skeer	Senior Program Manager. International Renewable Energy Agency. Abu Dhabi, United Arab Emirates
6	Mr. Rida Mulyana	Director General of New Renewable Energy and Energy Conservation. Ministry of Energy and Mineral Resources of Indonesia
7	Ms. Nurhafiza	Licensing Unit, Energy Commission of Malaysia
8	Ms. Krittiya Petsee	Plan and Policy Analyst, Work Plan Devision Department of Alternative Energy Development and Efficiency (DEDE), Thailand
9	Mr. Duong Manh Cuong	General Directorate of Energy. Ministry of Industry and Trade of Viet Nam
10	Mr. Wan Lin	Director. Beijing Energy Innovation Ltd, China
11	Mr. Suroso Isnandar	Division of System Planning, PT PLN (Persero), Indonesia. System Planning Engineer
12	Mr. HO Wai-yip	Electrical and Mechanical Services Department, Hong Kong, China. E&M Engineer
13	Mr. Lee Tai-on	Electrical and Mechanical Services Department, Hong Kong, China. Senior Electrical Engineer
14	Mr. LO Wing-keung Derek	Electrical and Mechanical Services Department, Hong Kong, China. Mechanical Engineer
15	Mr. T. Khoi Do	Underwriters Laboratories Inc. USA. Senior Global Government Affairs Specialist – Product Safety
16	Mr Saharuddin Sulaiman	Malaysia
17	Mr. Erick Elsafan	Directorate General of Electricity. Ministry of Energy and Mineral Resources, Republic of Indonesia
18	Mr. Setiadi Indra D Notohamijoyo	Coordinating Ministry of Economic Affairs
19	Mr. Eko Wahyu Purnomo	Coordinating Ministry of Economic Affairs
20	Ms. Azah Ahmad	SEDA Malaysia
21	Ms. Agnes Koh	Energy Market Authority. Singapore
22	Dr. Chung-Hsien Chen	Bureu of Energy, Ministry of Economic Affairs. Chinese Taipei

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