2016 International Conference on

Cogeneration, Small Power Plants and District Energy

September 14-16, 2016
BITEC, Bang Na, Bangkok
THAILAND

PROGRAMS & ABSTRACTS

CONTENTS

RATIONALE OF THE CONFERENCE

The 2016 International Conference on Cogeneration, Small Power Plants and District Energy (ICUE 2016) on 14-16 September 2016 in Bangkok City, Thailand will be a venue to exchange research ideas, experiences, technical, social, financial, economic and policy issues covering advances in the Cogeneration (CHP), Small Power Plants (SPPs) and District Energy systems. Here, energy professionals, policy makers, researchers, members of the academe, engineers, members of the energy supply sector, etc., will have a platform to showcase research findings, technological innovations, transformative emerging technologies, and even to discuss burning global, regional and national issues in energy utilization for development and environment policies and programs.

The ICUE 2016 Conference will present a general outlook on the global energy sector, worldwide and accordingly, issues such as Energy and Geopolitical Balances, Energy Policies Legislations and Practices, as well as technical matters such like Energy Efficiency, Renewable Energy Technologies, Developments in the Renewable Energy Market, Conventional Energy Technologies, Operation and Maintenance of Small Power Plants (SPPs), Cogeneration, Mini-Micro Cogeneration and Tri-generation Systems, Distributed power generation and smart grid systems, Environment and Recycling Systems, New Technologies and applications, Energy Trade, Energy Soft wares, Naturel Gas and Petroleum, ASEAN Economic community (AEC) Electricity grid and market integrations, Policy Regulatory Frameworks for CHPs and SPPs: Global, Continental, Regional and ASEAN contexts, Micro CHPs and SPPs for climate change challenges, Financing of Energy Projects and Energy Law will be dealt with both in national and international scale.

ORGANIZERS

Regional Energy Resources and Information Center (RERIC)

Energy Field of Study, Asian Institute of Technology (AIT)

PARTNER

TechnoBiz Communications Co. Ltd

ORGANIZING COMMITTEE

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President
Asian Institute of Technology, Thailand

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Energy FoS, SERD, AIT

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Mr. Pornchai Chaweewat

THE ASIAN INSTITUTE OF TECHNOLOGY (AIT)

The Asian Institute of Technology promotes technological change and sustainable development in the Asia-Pacific region through higher education, research and outreach. Established in Bangkok in 1959, AIT has become a leading regional postgraduate institution and is actively working with public and private sector partners throughout the region and with some of the top universities in the world. Recognized for its multinational, multi- cultural ethos, the Institute operates as a self-contained international community at its campus located 40 km (25 miles) north of Bangkok, Thailand.

Besides the usual labs and academic buildings, the main campus includes housing, sports, and medical facilities, a conference center, and a library with over 230,000 volumes and 830 print and on-line periodicals.

Vision

AIT will strive to become a leading and a unique regional multicultural institution of higher learning, offering state of the art education, research and training in technology, management and societal development.

Mission

The mission of AIT in the context of the emerging environment is "to develop highly qualified and committed professionals who will play a leading role in the sustainable development of the region and its integration into the global economy".

Guided by the above clear, timeless vision and mission, the dedicated students, faculty and staff of AIT are set to steer the Institute along its path of becoming:

- A trailblazer in advanced education in the region, with leadership in IT and new types of multidisciplinary programs
- An exemplary institution, with an emphasis on academic quality in terms of courses and other aspects of operation
- A leader in professional development programs
- A hub for the implementation of regional and transnational research projects, and a research facility for academic professionals. A nexus for networking with other academic and research institutions in the region and the world
- A model international citizen

- A collaborator and partner of national postgraduate institutions
- A financially viable, self-sustaining institution, able to draw support from donors the private sector and individuals, with good governance and strong leadership
- A strong partner to its alumni, who are principal stakeholders through the AIT Alumni Association (AITAA)

Awards and Recognitions

- **1987 Science and Technology for Development Award** presented to AIT by the United States Agency for International Development and the National Research Council for effectively transferring industrial technology and skills to the developing world, by training scientists and engineers from Asian countries.
- **1989 Ramon Magsaysay Award for International Understanding** presented to AIT for shaping a new generation of engineers and managers committed to Asia, in an atmosphere of academic excellence.
- **1994 Development Management Award** presented to AIT by the Asian Management Awards for fostering manpower development, technological change and sustainable growth in the region, through advanced education and research.
- **1996 DAAM International Vienna Awards** presented by the Danube Adria Association and Manufacturing (DAAM) International Vienna, Austria, to express appreciation to AIT and its high-technology experts from the Industrial Systems Engineering Program of the School of Advanced Technologies for their significant contribution in the field of technical sciences and international scientific cooperation within the framework of DDAM, on the occasion of the 7 th DAAM international symposium to celebrate the 1000 th anniversary of Austria.
- **2006 Friendship Order** was awarded to AIT in the area of international relations that have contributed to human resource training for Vietnam and to the development of friendly relations between Vietnam and other countries.

Key Facts and Figures

- 1700+ Students from 60 + Countries/Territories
- 19800+ Alumni from 90 Countries/Territories
- 29000+ Short-term Trainees from 70+ Countries/Territories

- 75 Internationally recruited Faculty from 20+ Countries
- 101 Adjuct/Visiting Faculty
- 500+ Research and Support Staff from 30+ Countries
- Approximately 450 Sponsored Research Projects worth 1.6 Billion Thai Baht (THB)
- 300+ Partners
- 33 Board of Trustee members from 19 Countries
- 3 Schools
- 1000+ courses offered
- 24 Research and Outreach Centers
- Operational Turnover: 1.2 Billion Thai Baht (THB)

AIT Offers

- Masters degrees: MBA, MEng, MSc
- Executive Master Degree Programs
- Doctoral Degrees: DEng, DTechSc, PhD
- Diploma and Certificate Programs
- An intensive English language and academic Bridging Program
- Non-degree continuing education courses for practicing professionals

ABOUT RERIC

The Regional Energy Resources Information Center (RERIC) was established in 1978 as a result of recommendations made at various meetings held in Asia, and particularly those made at a meeting of experts in solar and wind energy utilization held in 1976 under the energy program of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).

RERIC collects, repackages, and disseminates information on energy and environmental issues related to energy. The Center's wide range of activities includes publishing, networking, consulting, and other information services for energy conservation and renewable energy promotion.

RERIC regularly publishes the International Energy Journal (IEJ) since 1979. It is a journal dedicated to the advancement of knowledge in energy by the vigorous examination and analysis of theories and good practices, and by encouraging innovations needed to establish a successful approach to solve identified problems. IEJ is a quarterly journal that publishes peer-reviewed papers on technical, socio-economic and environmental aspects of energy planning, energy conservation, renewable sources of energy, and electric power transmission, generation and management. The papers are reviewed by world renowned referees. IEJ also maintains an online journal system wherein not only current volumes are available but also archives containing past volumes and past special issues.

RERIC's occasional publications include conference/seminar/workshop proceedings, research reports, directories, environment systems reviewa, and do-it-yourself manuals. Annual membership fees to RERIC entitle the members to hard copies of the International Energy Journal (IEJ) as well as access to the online journal system at www.rericjournal.ait.ac.th. Members also get 20% discount on other RERIC publications and a discounted rate to trainings/workshops/conference it organizes. Annual membership fees for year 2010 are as follows: USA, Canada, European countries, Australia, New Zealand, Japan, and Middle East *(Individual: US$ 130, Institutional: US$ 275)*; Thailand *(Individual: THB 1,500, Institutional: THB 5,000)*; all other countries not mentioned above *(Individual: US$ 85, Institutional: US$ 160).*

VENUE and PARTNER EXHIBITIONS

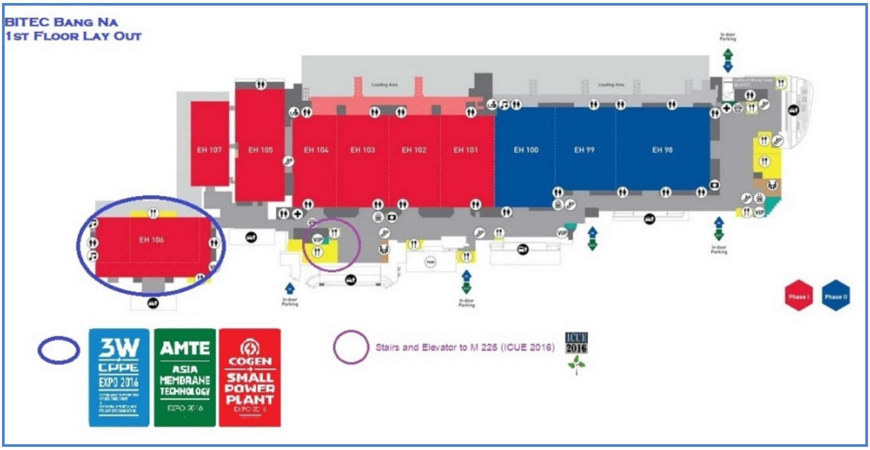
BITEC is a world-class venue for meetings, incentives, conventions and exhibitions located in the heart of Bangkok. Offering several large scale, multi-purpose event halls and comprehensive exhibition services, BITEC is the first choice for exhibition and conference organisers around the world. BITEC is conveniently connected to metropolitan Bangkok's skytrain system via Bang-Na station.

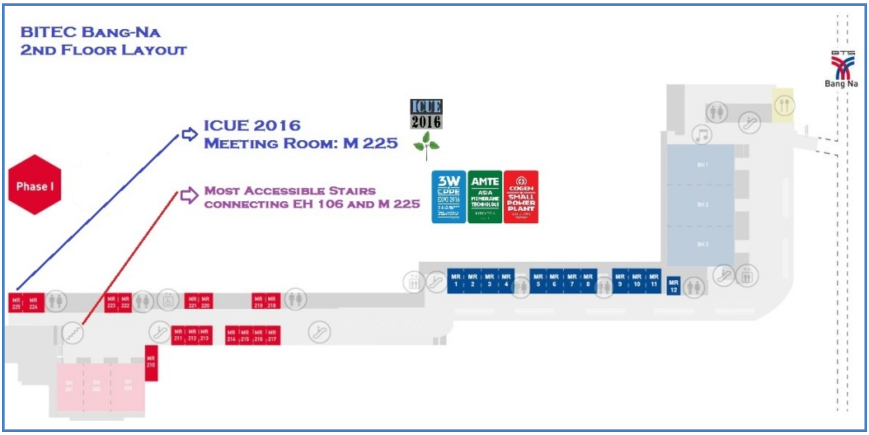
A state-of-the-art entertainment venue, meeting centre and event centre, BITEC offers a full range of services to suit any occasion, whether it's a business meeting, trade show, convention or grand party.

BITEC Phase II is currently under development. The additional facilities, which will be completed by the end of 2016, will secure BITEC's place as one of the leading venues for MICE in the region.

BITEC's team of dedicated event specialists is always on hand to ensure our corporate clients and event organisers deliver a successful event from start to finish.

The ICUE 2016 is an event co-located with the 3rd Edition of the Water, Membrane, Environment & Energy Technology Expo (WM2E) 2016. This umbrella expo covers three (3) large expos: 3W+CPPE Expo 2016; Asia Membrane Technology Expo 2016; the Cogen+Small Power Plant Expo 2016. Highlights of the WM2E 2016 include trade exhibition, conferences, educational courses, research fair, engineering job fair and networking event, all happening at the Exhibition Hall 106 of BITEC. ICUE 2016 will be conducted nearby at MR 225.


BITEC Bang Na
1st Floor Lay Out
EH 107
EH 105
EH 104
EH 103
EH 102
EH 101
EH 100
EH 99
EH 98
EH 106
Phase I
Phase II
Stairs and Elevator to M 225 (ICUE 2016)
ICUE 2016
3W CPPE EXPO 2016
AMTE ASIA MEMBRANE TECHNOLOGY EXPO 2016
COGEN SMALL POWER PLANT


BITEC Bang-Na
2nd Floor Layout
ICUE 2016
Meeting Room: M 225
ICUE 2016
Phase I
Most Accessible Stairs connecting EH 106 and M 225
3W CPPE EXPO 2016
AMTE
COGEN SMALL POWER PLANT
Bang Na

PROGRAM

	Day 1: 14 September 2016 (Wednesday)
09:00 – 10:00	**REGISTRATION for ICUE 2016 at M 225, BITEC Bang-Na; and WM2E-2016 (open to ICUE 2016 delegates) at EH 106, BITEC Bang-Na**
09:00 – 11:00	**Opening Ceremony** (Water, Membrane, Environment & Energy Technology Expo 2016)
	ICUE 2016 Opening Session, M 225 BITEC Bang Na
11:00 – 11:10	**Welcome Address:** Prof. Worsak Kanok-Nukulchai (President, Asian Institute of Technology) (10 minutes)
11:10 – 11:15	**Introduction of Keynote Speaker:** Dr. P. Abdul Salam (ICUE 2016 Conference Director, Asian Institute of Technology) (5 minutes)
11:15 – 11:50	**Keynote Address: Ir. Mohd Rozi Bin Othman** (Acting Deputy General Manager, Business Development, Gas Malaysia Berhad) ***Cogeneration: Potential, Issues and Opportunities (Experience from Malaysia and the Region)*** (35 minutes)
11:50 – 12:00	**Photo Session** (15 minutes)
12:00 – 13:00	Lunch Break – 60 minutes
13:00 – 15:00	Technical Session 1 (105 minutes: 8 papers, 12 minutes presentation + 3 minutes discussion each)

	ADVANCES IN ENERGY EFFICICENCY THROUGH COGENERATION
15:00 – 15:20	Coffee/Tea Break – 20 minutes
15:20 – 17:50	Technical Session 2 (150 minutes: 10 papers, 12 minutes presentation + 3 minutes discussion each) **BIOMASS TECHNOLOGIES AND SUSTAINABLE ENERGY**
18:00 -	*Welcome Dinner* (Farenheit Restaurant)

Day 2: 15 September 2016 (Thursday), M 225 BITEC Bang Na	
09:00 – 10:30	Technical Session 3 (90 minutes: 6 papers, 12 minutes presentation + 3 minutes discussion each) **POWER QUALITY, STABILITY AND DISTRIBUTION NETWORK PROTECTION**
10:30 – 10:50	Coffee/Tea Break – 20 minutes
10:50 – 12:05	Technical Session 4 (75 minutes: 5 papers, 12 minutes presentation + 3 minutes discussion each) **REGULATORY ASPECTS, INVESTMENT AND MARKET OPERATIONS**
12:05 – 13:05	Lunch Break – 60 minutes
13:05 – 13:15	Assembly for the field trip
13:15 – 16:00	FIELD TRIP **(Amata BGrimm Cogeneration Power Plant 4 and 5 at Amata Nakorn Industrial Estate, Chonburi Province)**
16:00 – 17:00	Arrival at the conference venue (BITEC, Bang-Na)

Day 3: 16 September 2016 (Friday) , M 225 BITEC Bang Na	
09:00 – 10:45	Technical Session 5 (105 minutes: 7 papers, 12 minutes presentation + 3 minutes discussion each)

	OPTIMAL PLANNING AND MODELING FOR WIND POWER AND MICROGRID SYSTEMS
10:45 – 11:00	Coffee/Tea Break – 15 minutes
11:00 – 12:15	Technical Session 6 (75 minutes: 5 papers, 12 minutes presentation + 3 minutes discussion each) **ELECTRIC VEHICLES INTEGRATION**
12:05 – 12:25	**Closing Session** Dr. P. Abdul Salam (ICUE 2016 Conference Director, Asian Institute of Technology) (20 minutes)
12:25 – 13:25	Lunch 60 minutes
End of Conference	

KEYNOTE SPEAKER

Cogeneration: Potential, Issues and Opportunities (Experience from Malaysia and the Region)

Ir. Mohd Rozi Bin Othman
Acting Deputy General Manager
Gas Malaysia Berhad

Mohd RoziBin Othman joined Gas Malaysia in 1992 as Superintendent in Technical Support, Marketing section. He was subsequently promoted to Senior Executive, Industrial Sales of Marketing in 1997. Later in 2002, he was assigned to a new responsibility as Manager, Combined Heat and Power (CHP) to manage the new natural gas market in providing energy solutions to customers for the growth of natural gas business.

In 2014, he was promoted as Senior Manager, Business Development where he was responsible for the overall function in managingthe activities for new business in accordance to the company's overall strategy in order to meet the revenue and business objectives and to create and develop opportunities for the growth of business of Gas Malaysia Berhad. As to date, three (3) Joint-Venture companies; Gas Malaysia Energy Advance SdnBhd for the Combined Heat and Power (CHP) business, Gas Malaysia IEV SdnBhd for the Virtual Pipeline distribution business and Sime Darby Gas Malaysia BioCNGSdnBhd for the Bio Compressed Natural Gas (BioCNG) distribution have been incorporated. In 2016, he was promoted as Acting Deputy General Manager to Head the Business Development Department.

He began his working life in 1988 when he joined Public Work Department. Mohd Rozi graduated with Mechanical Engineering from the University of Technology Malaysia.

PRESENTATION SCHEDULES

Day 1: 14 September 2016 (Wednesday)

S 01: Advances in Energy Efficiency through Cogeneration
Time: 13:00 – 15:00
MR 225, BITEC Bang Na

Ref. No.	Title, Authors, Affiliation	Country of Origin
S 01.1	**Organic Rankine Cycle Power Generation from Industrial Waste Heat Recovery Integrated with Solar Water Heating System by using Vapor Compression Heat Pump as Heating Booster in Thailand** *Sorawit Sonsaree[1], Tatsunori Asaoka[2], Hernan Aguirre[2], Somchai Jiajitsawat[3] and Kiyoshi Tanaka[2]* [1]Interdisciplinary Graduate School of Science and Technology, Shinshu University, Japan [2]Academic Assembly (Institute of Engineering), Shinshu University, Japan [3]Energy Research and Promotion Center, Faculty of Science, Naresuan University, Thailand	Japan
S 01.2	**Hybrid Stand-Alone Power Supply System in Conditions of Extreme Continental Climate in Central Asia** *Saule Kumyzbayeva[1], Madina Ibragimova[1], Vyacheslav Stoyak[1], and Alimzhan Apsemetov[2]* [1]Almaty University of Power Engineering and Telecommunications, Almaty, The Republic of Kazakhstan [2]Department of Energy Audit, The Republic of Kazakhstan	Kazakhstan
S 01.3	**High-Efficiency PWM DC-AC Inverter for Small PV Power Generation System** *Damrong Amorndechaphon* Automotive and Transportation Technology Development Center, University of Phayao, Thailand	Thailand
S 01.4	**Optimal Sizing and Operational Strategies for Diesel Engine Driven CCHP System**	Thailand

	Sachin Muralee Krishna, P. Abdul Salam, Nimal Madhu Energy Field of Study, School of Environment Resources and Development Asian Institute of Technology, Thailand	
S 01.5	**Study of Optimal Generator Temperature of Single Effect NH_3-H_2O Absorption Refrigeration Machine for Ice-Making** *Nghia-Hieu Nguyen[1], Hiep-Chi Le[1], and Quoc-An Hoang[2]* [1]Department of Heat and Refrigeration, Ho Chi Minh City University of Technology, Ho Chi Minh, Vietnam [2]Research and International Relations Office, Ho Chi Minh City University of Technology and Education, Ho Chi Minh, Vietnam	Vietnam
S 01.6	**Modeling of Power Distribution Feeder and Analysis of Small PV Plant Penetration In Kerala Low Voltage Distribution System** *Jayakumar P. and Reji P.* Department of Electrical Engineering Government Engineering College, Thrissur, India	India
S 01.7	**Real Time Simulation of a Microgrid with Multiple Distributed Energy Resources** *Onyinyechi Nzimako[1] and Athula Rajapakse[2]* [1]RTDS Technologies, Winnipeg, Canada [2]University of Manitoba, Canada	Canada
S 01.8	**Model Predictive Control of Five Level Cascaded H Bridge Multilevel Inverter for Photovoltaic System** *Deepa Sankar and C.A. Babu* Department of Electrical Engineering, Cochin University of Science and Technology, Ernakulam, Kerala	India

S 02: Biomass Technologies and Sustainable Energy
Time: 15:20 – 17:50
MR 225, BITEC Bang Na

Ref. No.	Title, Authors, Affiliation	Country of Origin
S 02.1	**Community Scale, Decentralised Anaerobic Digestion for Energy and Resource Recovery** *Tanja Radu[*], Richard Blanchard[#], Andrew Wheatley[*], P. Abdul Salam[^], and Chettiyappan Visvanathan[^], Vincent Smedley[*]* [*]School of Civil and Building Engineering, Loughborough University, United Kingdom [#]School of Mechanical, Electrical and Manufacturing Engineering, Loughborough University, United Kingdom [^]Asian Institute of Technology, Thailand	United Kingdom
S 02.2	**Analysis of Biogas During Oxy-fuel Gas Cutting of 1045 Carbon Steel** *Chairat Hongthong, Somchai Jaiajitsawat, Somchai Kritpolwiwattana, and Nuchjira Dejang* Faculty of Science, Naresuan University	Thailand
S 02.3	**Small-Scale Shaking Single-Stage Downdraft Biomass Gasifier** *Mary Grace A. Rubio and Kitipong Jaojaruek* Mechanical Engineering Department, Faculty of Engineering Kasetsart University Kamphaeng Saen Campus, Thailand	Thailand
S 02.4	**Sustainable and Secure Energy Future for Oil-Rich Economies: a Case Atudy from Brunei Darussalam** *Dayana K.B., Mathew S., Petra I., and Lim C.M.* Universiti Brunei Darussalam, Brunei Darussalam	Brunei
S 02.5	**Scaling up the Indonesia's Small-scale Renewable Energy Investment under Feed-in Tariff Policy: a Preliminary Assessment** *Naufal Rospriandana[*] and Novelita Wahyu Mondamina[#]* [*]Graduate School of Environmental Science Hokkaido University, Japan [#]Faculty of Engineering and Environment	United Kingdom

	University of Southampton, United Kingdom	
S 02.6	**Modeling and Performance Assessment of the Thai National Power Grid Considering Wind Farms Integration** *Watcharakorn Pinthurat, Jai Govind Singh and Tristan G. Magallones Jr.* Asian Institute of Technology, Thailand	Thailand
S 02.7	**Small Signal Stability and Transient Stability Analysis on the Philippine-Sabah Power Interconnection** *Tristan G. Magallones Jr., Jai Govind Singh, and Watcharakorn Pinthurat* Asian Institute of Technology, Pathumthani, Thailand	Thailand
S 02.8	**Rotary Dryer and Roaster for Fresh Chili by using Heat Energy from LPG** *Kolayuth Tagong[1], Sirinuch Jindarak[1], Chantana Phanlek[1] and Pipatana Ammatachaya[2]* [1]Faculty of Science Naresuan University, Thailand [2]Faculty of Engineering and Architecture Rajamangala University Isan, Thailand	Thailand
S 02.9	**Baseline Study of the Techno-Economical Feasibility for Anaerobic Lagoon Closed on the Palm Oil Mill Effluent Management** *E. Mahajoeno, J. Sutrisno, Siswanto, and M. Kismurtono* P.S. Biological Science FMIPA University of Sebelas Maret, Surakarta	Indonesia
S 02.10	**Development of Enhanced Biogas Production from Palm Oil Mill Effluent (POME)** *Muhammad Kismurtono[1], H. Julendra[1], E. Mahajoeno[2] and M. Korniawan[3]* [1]Technical Implementation Unit for Engineering Processes Development of Chemical, LIPI Gunungkidul, Indonesia. [2]University of Sebelas Maret, Surakarta, Indonesia. [3]PT Swastisiddhi Amarga Bioenergi, Pekanbaru, Riau, Indonesia.	Indonesia

Day 2: 15 September 2016 (Thursday)

S 03: Power Quality, Stability and Distribution Network Protection
Time: 09:00 – 10:30
MR 225, BITEC Bang Na

Ref. No.	Title, Authors, Affiliation	Country of Origin
S 03.1	**Recognition of Power Quality Disturbances Using S-Transform and Fuzzy C-Means Clustering** *Om Prakash Mahela and Abdul Gafoor Shaik* Department of Electrical Engineering, Indian Institute of Technology Jodhpur, India	India
S 03.2	**Determination of TTC and Application of SVM for Demarcation of Stability limits** *Akhil Prasad[1], Aman Kumar[1], Atul Manmohan[1], and S. Prabhakar Karthikeyan[2], Chirag Vibhakar[1]* [1]School of Electrical Engineering, VIT University, Tamil Nadu, India [2]Central Power Research Institute, Bengaluru, Karnataka,India	India
S 03.3	**Research on DG Distribution Network Protection Based on Topological Analysis and Power Automatic Recovery Scheme** *Xia Lin, Qun Wang, and Yao Li* Shandong Zaozhuang Power Supply Company, Zaozhuang, China	China
S 03.4	**Peak-Shaving and Valley-Filling Strategies with UHV Introduction Based on an Improved Peaking Model** *Yangguang Wang[*], Binqi Hu*, Tao Cheng[*], Xianzhuang Liu[#], and Wei Hu[#]* *Hunan Electric Power Co. Ltd, Changsha, China [#]State Key Lab of Power Systems Department of Electrical Engineering, Tsinghua University	China
S 03.5	**Observation of Applying POD Function to Renewable Energy Sources** *Nichaphat Jaengarun and Thamvarit Singhavilai* Department of Electrical Engineering, Mahidol	Thailand

	University, Nakhon Pathom, 73170 Thailand	
S 03.6	**Static ZIP Load Modelling of Microwave Ovens and its Impact on Distribution System** *Nikhil Sasidharan and Jai Govind Singh* Energy Field of Study School of Environment Resources and Development Asian Institute of Technology, Thailand	Thailand

S 04: Regulatory Aspects, Investment and Market Operations
Time: 10:50 – 12:05
MR 225, BITEC Bang Na

Ref. No.	Title, Authors, Affiliation	Country of Origin
S 04.1	**Impact of Distributed Generation on Electricity Prices at Buses in Distribution Networks** *Trinh Trong Chuong and Binh Van Doan* Hanoi University of Industry Institute of Energy Science, Vietnam Institute of Energy Science	Vietnam
S 04.2	**Small Power Plants and Renewable Energy Policy under Fluctuation of Energy Price and Economic Growth in Thailand** *Ronayut Teetong* Office of Regulatory Energy Commission, Thailand	Thailand
S 04.3	**Design and Analysis of Profit Ceiling Model for Regulating Electricity Market in Developing Countries** *Indhu Nair and Anasraj Robert* Department of Electrical Engineering, Government Engineering College Thrissur Thrissur, India	India
S 04.4	**Financial Incentive Mechanisms for Residential PV Systems: An Analysis Based on the Real Performance Data** *H. Najmu, V.Femin, K.B. Dayana, S. Mathew and I. Petra* Universiti Brunei Darussalam, Brunei Darussalam	Brunei
S 04.5	**Outage Cost Assessment for Investment-**	Thailand

	Benefit Model of Smart Grid in Thailand *Narongkorn Uthathip, Pornrapeepat Bhasaputra and Woraratana Pattaraprakorn* Electrical and Computer Engineering, Faculty of Engineering, Thammasat University Pathumthani, Thailand	

Day 3: 16 September 2016 (Friday)

S 05: Optimal Planning and Modeling for Wind Power and Microgrid Systems
Time: 09:00 – 10:45
MR 225, BITEC Bang Na

Ref. No.	Title, Authors, Affiliation	Country of Origin
S 05.1	**Intelligent Models for the Power Curves of Small Wind Turbines** *R. Veena[1], V. Femin[1], S. Mathew[1], I. Petra[1] and J. Hazra[2]* [1]Universiti Brunei Darussalam, Brunei Darussalam [2]UBD | IBM Centre, IBM Research Bangalore, KA, India	Brunei
S 05.2	**Optimal Planning Approach for a Cost-effective and Reliable Microgrid** *Adil Nasser and P. Reji* Department of Electrical and Electronics Engineering Government Engineering College Thrissur, Kerala	India
S 05.3	**Modelling the Ramping Behaviour of Wind Turbines** *V. Femin[1], R. Veena[1], I. Petra[1], S. Mathew[1] and J. Hazra[2]* [1]Universiti Brunei Darussalam, Brunei Darussalam [2]UBD | IBM Centre, IBM Research Bangalore, KA, India	Brunei
S 05.4	**Optimal Power Dispatch Considering Wind and Battery Energy Storage Cost Functions Using Stochastic Weight Trade-Off PSO**	Thailand

	Wannakorn Supingklad, Amrit Paudel and Weerakorn Ongsakul Energy Field of Study School of Environment, Resources and Development Asian Institute of Technology	
S 05.5	**Data Driven Models for Understanding the Wind Farm Wake Propagation Pattern** *R. Veena[1], S. Fauziah[1], S. Mathew[1], M.I. Petra[1] and J. Hazra[2]* [1]Universiti Brunei Darussalam, Brunei Darussalam [2]UBD | IBM Centre, IBM Research Bangalore, KA, India	Brunei
S 05.6	**Research on Thermal-Hydro-Wind Joint Scheduling Considering N-1 Security Constraints** *Biqin Hu[1], Tao Cheng[1], Yilin Tian[2], Wei Hu[3], and Yifan Zhou[3]* [1]Hunan Electric Power Co. Ltd, Changsha, China [2]Advanced Training Center of State Grid Corporation of China, Beijing, China [3]Department of Electrical Engineering, Tsinghua University, Beijing, China	China
S 05.7	**Economic Dispatch and Network Reconfiguration of Microgrid using Artificial Bee Colony Algorithm: a Case Study of Mae Sariang, Thailand** *Pornchai Chaweewat[1,#], Jao Govind Singh[1], Weerakorn Ongsakul[1], and A.K. Srivastava[2]* [1]Energy Field of Study, School of Environment Resources and Development, Asian Institute of Technology, Pathumthani, Thailand. [2]School of Electrical and Computer Science, Washington State University, Pullman, Washington, USA. [#]Provincial Electricity Authority of Thailand (PEA)	Thailand

S 06: Electric Vehicles Integration
Time: 11:00 – 12:15
MR 225, BITEC Bang Na

Ref. No.	Title, Authors, Affiliation	Country of Origin
S 06.1	**The ANFIS Model of Electric Vehicle Energy Consumption for Thailand Power Development Plan** *Vivat Chutiprapat, Woraratana Pattaraprakorn, and Pornrapeepat Bhasaputra* Department of Electrical and Computer Engineering Thammasat University, Thailand	Thailand
S 06.2	**Simulation and Analysis of Renewable Energy Resource Integration for Electric Vehicle Charging Stations in Thailand** *Tongpong Sriboon[1], Supakorn Sangsritorn[1], Paul Gerard Tuohy[2], Mahesh Kumar Sharma[3] and Nopbhorn Leeprechanon[3],* [1]Alternative Energy Division, Provincial Electrical Authority (PEA), Bangkok, Thailand [2]Department of Mechanical and Aerospace Engineering, University of Strathclyde, Glasgow, Scotland, Uited Kingdom [3]Department of Electrical and Computer Engineering, Thammasat University, Pathum Thani 12120, Bangkok, Thailand	Thailand
S 06.3	**Optimal Reconfiguration of Distribution Network with Electric Vehicles using Particle Swarm Optimization** *Amrit Paudel, Wannakorn Supingklad and Weerakorn Ongsakul* Energy Field of Study School of Environment, Resources and Development Asian Institute of Technology	Thailand
S 06.4	**Distribution Network Reconfiguration to Support Electric Vehicles Integration** *Amrit Paudel, Wannakorn Supingklad and Weerakorn Ongsakul* Energy Field of Study School of Environment, Resources and	Thailand

	Development Asian Institute of Technology	
S 06.5	**Heuristic Approach on Economic Load Dispatch Problem using Willingness to Pay along with Incentive based Load Curtailment Schemes** *Baishali Mullick*[*], *Debraj Das*[*] *and S. Prabhakar Karthikeyan*[#] [*]School of Electrical Engineering, VIT University Vellore, Tamil Nadu, India. [#]Central Power Research Institute Bengaluru, Karnataka, India	India

DETAILED ABSTRACTS

S 01: Advances in Energy Efficiency through Cogeneration
Time: 13:00 – 15:00
MR 225, BITEC Bang Na

S 01.1 Organic Rankine Cycle Power Generation from Industrial Waste Heat Recovery Integrated with Solar Water Heating System by using Vapor Compression Heat Pump as Heating Booster in Thailand

Sorawit Sonsaree[1],Tatsunori Asaoka[2], Hernan Aguirre[2], Somchai Jiajitsawat[3] and Kiyoshi Tanaka[2]

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In this study, a novel concept of Organic Rankine Cycle (ORC) power generation from industrial waste heat recovery (IWHR) combined with solar hot water system (SHWS) by using vapor compression heat pump (VCHP) as heating booster was proposed. The system is mathematically modeled and simulated to evaluate the economics and the environmental impact of the system. The weather condition of Phitsanulok, Thailand was taken as the input data of the simulations. The results of the evaluation showed that the more number of solar collectors is, the more electricity the system can generate. For instant, when the number of the solar collectors is 700 units, the system can produce 50.0 MWh/Year of electricitywith the Levelized Electricity Cost (LEC) and payback period of 0.098 USD/kWh, and 20.2 Year, respectively. In term of the environmental impact analysis, the system can reduce the CO_2 emission by approximately 25.8 Ton CO_2 eq./Year.

S 01.2 Hybrid Stand-Alone Power Supply System in Conditions of Extreme Continental Climate in Central Asia

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In recent years, Kazakhstan has growing interest in sustainable and energy effective combined supplying for decentralized energy consumers. This is due to the development of the regions and the desire of consumers to obtain modern energy services. This paper presents a comparative analysis of the energy efficiency of a combined energy autonomous systems constructed on the basis of cogeneration (CHP) and trigeneration (TG) (involving low-potential heat of the earth (LPH)) low and domestic size power plants. Method of research is mathematical modeling and simulation of combined heating, cooling and power supplying in the system that combines thermodynamic cycle internal combustion engine (ICE) and geothermal heat pump. Parametric adjustment and calibration of mathematical models implemented on the basis of experimental research prototype trigeneration plant. Established, that the application of cogeneration plants for autonomous objects in extreme continental climate in Kazakhstan with a large seasonal variation in outdoor temperatures significantly inferior to the energyefficiency of trigeneration plants. So, if the average annual energy efficiency of cogeneration systems based on internal combustion engine does not exceed 50-60%, and usage the TGP allows 3-4 times to reduce the consumption of fossil fuel by involving all-season source of renewable energy lowpotential heat of the earth.

S 01.3 High-Efficiency PWM DC-AC Inverter for Small PV Power Generation System

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This paper proposed an improved topology for a high efficiency PWM DC-AC grid-connected PV inverter that utilizes a zero-voltage-transition (ZVT) auxiliary network to provide soft-switching condition. In this paper, a soft-switching method using ZVT technique is presented to increase the efficiency of the single-phase grid-connected photovoltaic (PV) power generation system. ZVT technique employs a resonant auxiliary circuit that is connected in parallel with the main power path to achieve the soft-switching conditions for the active and passive switches in PV inverter, without increasing their voltage and current stresses. The auxiliary circuit will be activated just before the main switch is turned on and ceases after the soft-switching condition has been achieved. The operation principle, soft-switching conditions and parameter design consideration of the ZVT network for DC-AC Inverter are analyzed in detail. Mathematical modeling and simulated validation of the proposed PV system is thoroughly presented based on 500 W prototype. The proposed method contributed to switching loss reduction as well as to minimization of the stress on power semiconductor switches. These results demonstrate that the proposed dc-ac inverter with ZVT technique can achieve high efficiency while maintaining stable current injection to the grid with unity power factor. The efficiency of the proposed inverter is improved by about 4% at full load condition. It is confirmed that the ZVT technique is effective in improving circuit performance in term of efficiency.

S 01.4 Optimal Sizing and Operational Strategies for Diesel Engine Driven CCHP System

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This study investigates the use of a diesel engine generator (DG) driven trigeneration system fueled by diesel-bio-diesel-ethanol (DBE) blend to meet the energy demand of buildings in Bangkok, Thailand. The hourly electric, cooling and heat-ing demands, for the building, are estimated using the software EnergyPlus. An algorithm is developed for optimal sizing of power generation unit (PGU) and absorption chiller that gives minimum annual total cost (ATC) for the system. Moreover, op-erational optimization schemes which minimize the annual en-ergy charge (AEC) are also established to determine the optimal capacity of the considered trigeneration system. Different PGU sizes and absorption chiller capacities are used to demonstrate the performance of operationally optimized combined cooling heat-ing and power (CCHP) system in this study. It is found that sys-tem fueled with DBE blends could reduce the total system cost by 17% compared to the systems using base diesel. Also, the best configuration and the operational strategy for the considered CCHP system is found at each specific condition and the results are discussed.

S 01.5 Study of Optimal Generator Temperature of Single Effect NH_3-H_2O Absorption Refrigeration Machine for Ice-Making

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This paper present the coefficient of performance analysis of a continued NH_3-H_2O absorption refrigeration machine with the heat supply 3.7kW, coolingthe 23% NaCl solution from the ambient temperature 30°C to -18°C. The working unit is controlled according to the different flow rates of the weak solution supplying the absorber. This study reveal the efficency of the unit decreases strongly according to the evaporating temperature while theNaCl solutiontemperaturereachs -15°C to lower at suitable ice-making mode. The fluctuation of the cooling capacity according to the NH_3 refrigerant throttling to the evaporator which is observed. The absorption refrigeration machine simulation program is established for testing and evaluating the experiment data again to ensure the absorption refrigeration machine working correctly to the initial design. The weak NH_3-H_2O solution supply the absorber is analysed by this simulation program to determine the optimal COP while the unit work continuely.

S 01.6 Modeling of Power Distribution Feeder and Analysis of Small PV Plant Penetration In Kerala Low Voltage Distribution System

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Photovoltaic plant interconnection to grid is increasing day by day. Major share of them are single phase small plants connected at distribution level by domestic consumers. Distribution system is inherently in phase unbalance due to single phase loads. Domestic load during daytime is low. Higher penetration of single phase PV plants in low voltage feeder needs proper analysis.
The modeling of exact state of distribution feeder is not easy. A more realistic model is attempted by parameter approximation. Effects of improper joints, section fuses, etc are accounted using voltage regulation data. A real feeder of Kerala State Electricity Board is considered. OpenDSS software tool is used for the analysis. The voltage profile, phase unbalance, line loss and voltage spread along the feeder are presented. This will help the planning and management of power distribution system.

S 01.7 Real Time Simulation of a Microgrid with Multiple Distributed Energy Resources

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In this research, a real-time simulation model of a medium voltage (MV) microgrid with distributed energy resources (DERs) was developed using the RTDS™ real-time digital simulator. The DERs in this microgrid include a diesel generator, a photovoltaic (PV) system, and a doubly-fed induction generator (DFIG) wind turbine system. The average-value models for the PV and DFIG power electronic interfaces were developed to reduce the hardware requirements on the RTDS. The steady state and transient response of the microgrid when in the grid-connected and islanded modes of operation was shown to give satisfactory performance. The microgrid was interfaced to a protection relay to demonstrate hardware in the loop simulations. This simulation model will be used in future research on developing microgrid protection solutions.

S 01.8 Model Predictive Control of Five Level Cascaded H Bridge Multilevel Inverter for Photovoltaic System

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In this paper, a model predictive control strategy for a five level cascaded H bridge multilevel inverter used in a grid connected photovoltaic system is presented. Finite Control Set Model Predictive Control (FCS-MPC) is used here due to its simple and flexible nature to adapt with the discrete nature of power electronic circuits. Its digital implementation is also made easier with the advancement of microprocessor technology. The control objectives of Multilevel Inverters (MLI's)are represented by a cost function in the MPC algorithm. The cost functions are evaluated for each of the switching states based on predictive variables defined by the discrete model of the system. Cost function is then optimized to meet the control

objectives of the system. But the large number of switching states in an MLI will result in more complex calculations. By means of MPC, the number of states to be evaluated can be reduced, but the dynamic response of the system will get affected. To overcome that, nearest switching vectors of the selected states can be utilized to improve the dynamic response of the system.The effectiveness of the proposed system is implemented using Matlab/Simulink.

S 02: Biomass Technologies and Sustainable Energy
Time: 15:20 – 17:50
MR 225, BITEC Bang Na

S 02.1 Community Scale, Decentralised Anaerobic Digestion for Energy and Resource Recovery

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The paper describes “Community scale, decentralized anaerobic digestion for energy and resource technology” which is a joint UK-Thailand project much in line with the current aims of the Thai Government for decentralized energy generation. The use of food waste for biogas generation by the process of anaerobic digestion provides multiple benefits: decreased energy dependency, nutrient preservation and recycling, and reduced greenhouse gas emissions. It is also promoted in the remoter Scotland and Wales of the UK.
The aim of the project is the design and deployment of small scale digesters and their networking into remotely monitored units. Here, we are describing initial design of the reactors and some issues associated with using food waste as substrate. Based on the literature, we have also

estimated the reactors performance to be 0.40-0.50 m^3/kg of feedstock for biogas production.

S 02.2 Analysis of Biogas During Oxy-fuel Gas Cutting of 1045 Carbon Steel

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The objectives of this research were to study using of pig–dung biogas as fuel for a metal cutting process, to study the surface roughness of the cut metal, and to analyze metal composites influenced by heat. The specimens were AISI 1045 with the size of 50 mm x 50 mm x 6 mm. They were cut by a cutter KT 5NX and then the surface roughness was measured by Mitutoyo SURFTEST SJ-301. The result showed that the average surface roughness was 3.79 µm. The metal composites were analyzed by Scanning electron microscope (SEM) JSM. 5410 LV and the result showed that the specimens, cut by oxygen and biogas as fuel and affected by heat, could divided into 4 part. The essential composites of the metal were Carbon, Ferrous, and Manganese. After cutting process, the average Carbon average 0.71%, average Ferrous 82.50%, and average Manganese 0.52%.

S 02.3 Small-Scale Shaking Single-Stage Downdraft Biomass Gasifier

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Gasification technology is a well-known biomass conversion usually associated with high amount of tar in the producer gas. Various studies have been conducted in eliminating or reducing tar content. This study focuses on the development of a single-stage downdraft gasifier with an automatic shaking grate mechanism in improving the quality of the producer gas. If concentration of tar is further reduced, the cleaning

process of producer gas can be eliminated, thereby reducing cost. The experiment used wood chips on a single-stage gasification process on a 10-15 kW reactor with air as the gasifying agent. A temperature of approximately 900°C favorable for tar cracking was achieved. The automatic shaking mechanism of the gasifier was found to be effective in reducing the tar content up to 0.17-0.25 g/m^3 compared to the conventional single-stage without shaking.

S 02.4 **Sustainable and Secure Energy Future for Oil-Rich Economies: a Case Study from Brunei Darussalam**

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Brunei Darussalam, located at the north coast of the island of Borneo in Southeast Asia, has an ambitious program on managing its available energy resources. The country has a commitment to reduce the energy intensity by 63 per cent by 2035 and meeting 10 per cent the energy demand by renewable sources by this period. In this paper, we model this long term National energy scenario using the LEAP System. The population of the country would increase at the rate of 2.7% per annum to reach 0.7 million by 2035 and the GDP would reach US$ 73.8 billion around this time period. With these basic information and various inputs on energy use pattern, the long term energy scenario was modelled. The contributions to the targeted reduction in the energy intensity from different sectors like domestic, government, industrial and commercial, have been identified and presented in the paper.

S 02.5 Scaling up the Indonesia's Small-scale Renewable Energy Investment under Feed-in Tariff Policy: a Preliminary Assessment

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This study intends to provide a preliminary economic assessment of three small-scale RE investments in Indonesia i.e. small hydropower (SHP), biomass power plant, and solar PV at 5 MW installed capacity by calculating the Levelized Cost of Electricity (LCOE) and constructing the Cost-Benefit Analysis under the latest feed-in tariff (FIT) policy implemented in Indonesia. Four main financial parameters were assessed i.e. Net-Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost-Ratio (B/C), and Discounted Payback Period (DPP). Results showed that all RE systems are feasible at baseline scenario with positive NPV, IRR 15.4-16.6%, B/C value 1.11-1.12, and DPP 8-9 years. However, apart from its promising investment feasibility, the lack of institutional capacity building, research and development (R&D), and financial support remains challenging the RE development in Indonesia, thus, a comprehensive policy measures beyond solely the economic consideration aspect is an inevitable.

S 02.6 Modeling and Performance Assessment of the Thai National Power Grid Considering Wind Farms Integration

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This paper covers the integration of wind power plants with National Thailand Power Grid which includes the impact the power systems.The

modeled Thai Power System in PSAT consists of 118 buses, 32 power plants (thermal, hydro, and combined cycle power plant), 139 lines, and 88 loads. The 230 kV and 500 kV of voltage levels have been considered in the model with 100 MVA as based for power flow analysis. This paper also develops and study whole power system of Thailand and interconnection with other neighboring countries e.g., Laos PDR, which seems to be not available in any paper so far. According to Power Development Plan (PDP) and Alternative Energy Development Plan (AEDP) of Thailand which aim to increase renewable energy production, especially wind and solar energy in the future, an existing wind power plant for 6.9 MW and for probably power capacity of 150 MW have been analyzed. The impact to national grid and compatibility with standards of fault ride through capability has been checked by using different type of wind turbines. This praxis has been also repeated for the existing full scaled frequency inverted doubly fed induction generators (DFIGs) and fixed speed wind turbines.

S 02.7 Small Signal Stability and Transient Stability Analysis on the Philippine-Sabah Power Interconnection

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In the advent of multinational cooperation within the Southeast Asian region, massive connectivity for both goods and services has been envisioned. Energy systems are ought to be collaborated to jointly develop a borderless electricity industry and one of which is the Philippines-Sabah interconnection to be inaugurated in 2020. This paper presents an analysis on the small signal stability and transient stability analysis of the interconnected Philippine-Sabah Power Grid. To achieve these objectives, eigenvalue analysis and time domain simulations were employed to probe the ability of the power grids to withstand large and small disturbances and maintain stable when connected. The free software, Power Systems Analysis Toolbox (PSAT), is used to develop the model using MATLAB ® in Simulink ® environment. There have been no publicly available studies regarding the new link. This paper ends with the validation of the dynamic

stability of the new interconnection under various disturbances.

S 02.8 Rotary Dryer and Roaster for Fresh Chili by using Heat Energy from LPG

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The rotary dryer and roaster for fresh chili by using heat energy from LPG was designed and fabricated as 60 cm x 120 cm of cylindrical drum. It was tested with 3, 5, and 7 rpm of different speeds at a constant temperature of 105°C. A Chilli sample of 13 kg was dried from an initial moisture content of 77.63% wb to 13% wb. The test showed that at a speed of 5 rpm, the quality of dried chilli was the best in terms of colour, breakage due to centrifugal force and overlieing. The temperature effect test between 60°C - 110°C showed that the best quality of dried chilli can be achieved at 80°C at a colour that meets market needs. Energy consumption was 261,144.00 kJ and efficiency of the machine was 8.48%. According to a financial analysis using LPG as fuel, the operating cost was 116112.66 baht/year for 112.73 baht/kg of dried chilli with a life cycle of 10 years.

S 02.9 Baseline Study of the Techno-Economical Feasibility for Anaerobic Lagoon Closed on the Palm Oil Mill Effluent Management

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Palm Oil Mill Effluent (POME) has a very high organic matter therefore needs for the management more profitable and environmental friendly. The application of biogas technology in the crude palm oil industry will be able to improve the clean production process and renewable energy and electricity generated. As the main commodity, the Indonesian palm oil industry entitled to notice more serious consideration in the provision of facilities for the management increasing of bioenergy from waste. The aims of this study were 1) to analyze the feasibility of biogas technology through the closure of anaerobic lagoon (bioreactor) for the management of POME, 2) assess the economics of anaerobic bioreactor production of renewable energy and electricity needs of industrial. The research method was a descriptive invention of engineering equipment and construction materials (anaerobic bioreactor) for the closure of an anaerobic lagoon, calculating optimum biogas production, power plants (generators / CHP), land requirements, grid infrastructure, and human resources; the total electricity needs of the production process, and additional grid outside the plant. The results showed that the biogas technology duly constructed and utilized renewable energy obtained to support the independence of the electrical energy industry and additional grid to the surrounding community. Production of biogas up to 13,300 m3 / day in the bioreactor capacity of 4500 m3, investment costs 400 million, with a payback period of 18 days, and assuming the service life of 1 year, bank interest of 20% / year. NPV 4.199.318.300, 00 (IRD), IRR> 35% and Net B/C 173.48. In conclusion, the technology of covered anaerobic lagoon were efficient, effective and useful for the management of POME, so it is feasible to POME management, as well as very important to be implemented.

S 02.10 Development of Enhanced Biogas Production from Palm Oil Mill Effluent (POME)

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This study aims to characterize palm oil mill effluent (POME) as a source of biogas production and to examine the biotic and abiotic factors for enhancing the POME biogas production. The results show that the POME sludge (LCPMKS) generated from PT Swastisiddhi Amarga Bioenergi mill

is viscous, brown or greyish in color with total solid (TS) content of 38.5-57.4, chemical oxygen demand (COD) of 56.5-75.6, biological oxygen demand (BOD) of 35.5-40.7 and suspended solid (SS) of 28.1-46.9 in g/L. These values are above the standard threshold limits, thus POME is a potential source of environmental contamination if released untreated. Abiotic factors such as addition of Ca(OH)2 to neutralize the pH, provision of agitation system and increase in temperature enhanced the biogas production up to 50.5 L, 50.5 L and 98.5 L respectively. While, among the biotic factors, the condition which produced the highest biogas (250 L) contains the substrate volume of 50 L with 25% inoculum of type mud LCPMKS pool II using a laboratory scale anaerobic digester.

S 03: Power Quality, Stability and Distribution Network Protection

Time: 09:00 – 10:30
MR 225, BITEC Bang Na

S 03.1 Recognition of Power Quality Disturbances Using S-Transform and Fuzzy C-Means Clustering

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This paper presents a method for detection and classification of power quality (PQ) disturbances using Stockwell's transform. PQ disturbances are generated using MATLAB as per IEEE-1159 standard. Various features of signals are extracted from the multi-resolution analysis based on Stockwell's transform. These features are used to classify PQ disturbances using the decision tree initialized Fuzzy C-means clustering. It is observed that the Fuzzy C-means clustering based classification yields satisfactory accuracy even under noisy conditions. The investigated PQ disturbances include voltage sag, swell, interruption, harmonics, notch, flicker, oscillatory transient, impulsive transient and spike. Effectiveness of proposed algorithm has been established by satisfactory results of various case studies.

S 03.2 Determination of TTC and Application of SVM for Demarcation of Stability limits

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The increasing demand for electrical power necessitates the expansion of power system, which is constrained by land availability and other resources. This results in the utilization of power system up to its stability limits. The ATC for an instance gives us the load that can be further supplied by the system before it loses stability. This paper aims at computing the stability limits of the power system network employed for the computation of Total Transfer Capability (TTC) using Support Vector Machine (SVM). Computation of voltage stability (using voltage stability index method and P-Q plane method) and small signal stability limit (Eigen value approach) has been considered on an IEEE 30 bus system. All simulations are carried out in MATLAB 8.0-R 2012 b environment.

S 03.3 Research on DG Distribution Network Protection Based on Topological Analysis and Power Automatic Recovery Scheme

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It is needed to take islanding or micro grid as the power supply which can provide fault current when it concerns the fault diagnosis, on this premise, can the protection still maintain their its selectivity, because the micro grid or the intentional island will also serve as a power point to provide fault current for the fault point. How to select a set of protection algorithm, fully take the impact of the micro grid and the intentional island on the

protection into account, and use the characteristics of the network internal power supply and load power balance so as to create useful conditions for fault diagnosis and removal? Based on the analysis of the network topology, the study takes the fault current at fault time (or the directional protection criterion in distribution network automation) as a search driver so as to lock the fault area and isolate the fault; then the power load capacity is taken as the drive, by means of recursion layer by layer, namely, through the method of reverse search from root to leaf, the load is gradually loaded and polymerized, finally, the optimal power flow balance is found out so as to realize the best island division. This method is carried on by adopting different searches: at the fault time, each power supply is taken as the starting point, at the island division, the switching off of the power supply is taken as the starting point; with different search drives, at the fault time, it is driven by the fault current or the directional protection criterion, at the island division, it is driven by the power overload capacity; with different search directions, at the fault time, when the power supply directs to the power supply or load, it is positive, at the island division, when the switch directs to the power search, it is positive. In this way, it completes the protection control strategy which integrates the fault isolation with island division. Finally, the program simulation verifies the effectiveness of the algorithm.

S 03.4 Peak-Shaving and Valley-Filling Strategies with UHV Introduction Based on an Improved Peaking Model

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Peak-shaving and valley-filling are important respects while making a scheduling plan, especially faced with the situation when Ultra-High Voltage (UHV) is introduced into the grid. With the target for calculating the cost and effectiveness of different peaking strategies continuously rather than only at the optimal point, this paper proposes an improved peaking model. The values of the objectives reflect the effectiveness of the strategies, and with the controllable variables of the model we can define different peaking costs. Based on the model, we develop several peaking strategies, including optimized hydropower scheduling, water abandoning, regulation of UHV power and load increasing. Using the realistic data, we analyze the effectiveness of the strategies and showed the practicality of the proposed model.

S 03.5 Observation of Applying POD Function to Renewable Energy Sources

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This paper presents a comparison of the responses from a power system, including a renewable energy source, with Power Oscillation Damping (POD) function and the responses from the system with Power System Stabilizer (PSS). The well-known 3 machine 9 bus system, including a Western Electricity Coordinating Council (WECC) generator/ converter simplified model was used in the study. A three phase fault was conducted in the simulation and the response damping of the system were observed in both POD and PSS cases. The result shows that POD function on renewable energy sources can provide the satisfactory response as well as PSS for power system stability.

S 03.6 Static ZIP Load Modelling of Microwave Ovens and its Impact on Distribution System

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Load model is key components in any power system studies. Modern household loads have different characteristics compared to loads available in earlier time. To make human life more comfortable and time efficient, a lot of technological innovations are found in home appliances.

For an example, a lot of conventional fossil fuel based cooking equipment are replaced with electrical appliances like microwave oven, induction cook top, electric heater, bread toasters etc. The use of microwave oven are very significant due to fast urban life and need for the nutritious cooking and numbers of home which owning a microwave oven is increased around 20% in the use of microwave oven from 2002 till 2010. Load modelling is a significant component in power system studies in order to ensure the reliable and economic operation. Even though real time exact load model especially for modern residential feeder is very difficult to obtain which consists of nonlinear home appliances, it is still possible to make an appropriate individual appliances load model that can improve the accuracy of simulation studies. Past two decades there is a tremendous increment in use of microwave oven in residences and added a lot of non-linearity in the residential feeder. In this paper, load characteristics of Microwave Oven are represented by a static ZIP coefficient model which will be beneficial for determining the load model for more accurate analysis of the system operations as well as sizing of the components. Further, the simulated results from MATLAB/Simulink are validated with experimental data. The behaviour of this load model in power flow and stability simulation studies are illustrated using Power System Analysis Toolbox (PSAT). All results ensures the impact of this load model in power system simulation studies.

S 04: Regulatory Aspects, Investment and Market Operations
Time: 10:50 – 12:05
MR 225, BITEC Bang Na

S 04.1 Impact of Distributed Generation on Electricity Prices at Buses in Distribution Networks

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The article represents the research result on simulating mathathematic calculation of electricity price at buses without distributed generation (DG) and with DG. The article aims at comparing the impact of DG on the electricity price at buses. The simulation results showed that when DG is integrated into the distribution network, the price signals are more efficient and the power losses reduce in the network. Electricity price in a competitive electricity market depends not only on locals but also time; and it can regulate the load and adjust the behavior of the market participants in order to ensure system security. The simulation results help the owner of DG sources have further information to successfully give out market bidding strategy.

S 04.2 **Small Power Plants and Renewable Energy Policy under Fluctuation of Energy Price and Economic Growth in Thailand**

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Thailand Power Development Plan (PDP: 2015-2030) has targeted on using Small Power Plants(SPP) year 2010-1020 at 16.41% (3,539 MW) of total electricity generation by 2020 and year 2011-2030 3,800 MW at 11.71% (3,800 MW) of total electricity generation by 2030. Thailand has mechanism for passing through partial price that exceeds the average electricity wholesale price by Fuel adjustment charge (Ft). Each unit has been subsided to all end user by Ft. Moreover Ft has useful for policy making to illustrate, public is becoming more concerned about that electricity price will be higher than it should be due to increasing share of renewable electricity and SPP.

The institutions tasked with developing support schemes are concerned about many issues, from the cost of state support to ensuring the safe operation of the national electricity grid. At the same time, the government is worried about the sharp electricity price increases for end-users and has recently introduced price control measures. In view of this trend which is perceived to be more expensive than producing electricity from IPP, would lead to higher electricity prices. Such concerns among Thailand policymakers are understandable, particularly at a time when many other countries have reduced their support for renewables in the context of the economic slowdown and the resulting budget constraints. However, the use of renewables in Thailand tries to clear environmental, economic and

energy security benefits. Any further delays in adopting the support measures announced will ultimately raise the costs of meeting the renewable energy target. There will also be indirect costs resulting from the "missed opportunities" to reap the benefits of renewables based generation.
This paper provides an overview of cost of pricing, legal and regulatory, market performance, public investment and market facilitation activities, emission reduction policies, power sector restructuring policy, distributed generation policies and rural electrification Policies. Then the previous and existing policies have been analyzed. Policy analysis bases on rational expectations equilibrium model describing the application of vector auto regression (VAR) model to economics. The study examines real gross domestic product, wholesale price of electricity from SPP, wholesale price of electricity from IPP, wholesale price from VSPP, weight of Renew electricity share and weight of SPP electricity share with the structural vector autoregressive model. The result of the analysis has shown that the increasing share of SPP electricity and Renewable energy affected the economics growth negatively. The policy implication is that energy conservative policies on electricity might have an economic cost in Thailand. The conclusion is that complimentary policies such as conservation tools that achieve environmental goal at the least cost should be implementing.

S 04.3 Design and Analysis of Profit Ceiling Model for Regulating Electricity Market in Developing Countries

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This exploration is to design an electricity market regulation model which is applicable to a developing country, specifically to Indian Electricity Market. The proposed Profit Ceiling Model (PCM) emphasizes on the quantitative relation between price level and uplift. The regulatory authority should forecast and promulgate the uplift for the next year to implement the proposed PCM model effectively. The uplift forecast can be treated as an optimization problem where the objective function is to

maximize the allowed uplift for next year. In this paper, a new approach termed as Hybrid Genetic Particle Swarm Optimization (GPSO) is used to solve the optimization problem. The proposed GPSO approach is found to be very effective in terms of computational complexity and optimization. The PCM model incorporates the incentive mechanisms for new and aged power plants. The major characteristics of designed PCM model are the regulatory control on price level, profit regulation, uplift evaluation and incentives for investors.

S 04.4 Financial Incentive Mechanisms for Residential PV Systems: An Analysis Based on the Real Performance Data

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One of the major hurdles in popularizing the residential solar projects is its high cost, which has to be borne by individual house owners. Several policy frameworks and incentive mechanisms like Feed in Tariff (FiT) and Net Metering (NM) are being implemented globally to make these projects attractive to the consumers. In this study, we identify the viable FiT and NM for making residential solar PV projects economically attractive in Brunei Darussalam. The analysis is based on the actual performance data collected from a 6kWp Multi-crystalline residential solar PV system. By considering the break-even point of Net Present Value (NPV) of the project, the minimum FiT for the residential PV projects is estimated as $ 0.22 /kWh. Due to the very low electricity tariff in Brunei, the NM rate is highly sensitive to the installed PV size and electricity consumption pattern. Under this condition, the viable NM rate is identified as $ 0.74/kWh. Sensitivities of Fit and NM rates on other economic metrics are also presented in the paper.

S 04.5 Outage Cost Assessment for Investment-Benefit Model of Smart Grid in Thailand

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The goal of electric distribution design and planning is to meet the customer reliability requirement at the lowest investment cost. Smart grid (SG) investment has a potential to meeting these goals. However, the risk of investment of smart grid needs to be considered such as the decision of the investment area, suitability of automatic devices for the power interruption cause and installation position of devices etc. Hence, in this paper presents the investment and benefit model of smart grid in Thailand by considering the customer outage cost (COC). First, the survey information of interruption cost for interesting area is summarized and used to assess customer loss in term of the customer outage cost. Second, outage cost models are developed by adaptive neuro-fuzzy inference system (ANFIS) algorithm. The outputs of outage cost models are unplanned outage and planned outage in term of the sector customer damage function (SCDF). After that, automatic devices are reviewed and considered by the characteristic of power interruption. Finally, the benefits is evaluated by maximum outage cost reduction for each automatic device. The result in this study shows that the smart grid investment can effect to the outage cost in distribution system. It can reduce the time frequency and outage duration. The outage cost reduction is depends on power interruption area and appropriate devices for cause of power interruption. Moreover, automatic device installation is recommended first for high outage cost area. Because, this area is high potential of benefits and high payback period ratio. Therefore, the investment and benefit model for smart grid design and planning in Thailand from the perspective of the outage cost reduction is needed.

S 05: Optimal Planning and Modeling for Wind Power and Microgrid Systems

Time: 09:00 – 10:45
MR 225, BITEC Bang Na

S 05.1 Intelligent Models for the Power Curves of Small Wind Turbines

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Along with the rapid expansion of the MW sized big wind turbine sector, the small wind turbine industry is also growing. Understanding the power response of these systems to the variations in wind velocity is essential for the optimal selection and efficient management of these turbines. This is defined by the power curves of wind turbines. In this paper, we propose nonparametric models for the power curves of two small wind turbines of 50 kW and 2.5 kW rated capacities, based on the manufacturer power curve. Four different machine learning methods viz. Artificial Neural Network (ANN), Support Vector Machines (SVM), k-Nearest Neighbors (KNN) and Gradient Boosting Machines (GBM) were used for the modeling. The accuracies of these models are validated by estimating the error between the model output and the field observations from these turbines. With the lowest NRMSE values of 0.16 and 0.12, ANN-based models are found to be more reliable in defining the velocity-power performances of the turbines.

S 05.2 Optimal Planning Approach for a Cost-effective and Reliable Microgrid

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As the new world order is running towards microgrid and renewable generation, effective planning of the same is the need of the hour. The major challenge in planning the integration of renewable generation is its derating nature. This paper proposes an optimal design approach for cost effective and reliable microgrid. The optimum combination of generation capacities of multiple energy carriers in a microgrid are determined by analyzing the cost and reliability. The optimization method makes use of a hybrid Genetic Particle Swarm Optimization (GPSO) which outperforms Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) in terms of initial population and time for convergence respectively. The generation adequacy study is done on hourly basis and is evaluated using Expected Energy Not Served (EENS) index. The simulation results demonstrate the easiness in planning hybrid energy systems like photovoltaic (PV) system and wind turbine along with conventional systems like diesel generator and storage batteries.

S 05.3 Modelling the Ramping Behaviour of Wind Turbines

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Being stochastic phenomena, magnitude and direction of wind spectra, available at a site, may vary with time which results in frequent changes in the output from the wind turbines. This frequent fluctuation in the output from the turbines makes the grid integration of wind energy systems rather challenging. Understanding the ramping behaviour of wind turbines under fluctuating wind conditions is essential for the efficient management of the power grids integrated with different generating options. In this paper, a mathematical model is presented to estimate the ramping behaviour of wind turbines by considering the Weibull probability distribution of wind velocity and the power curve analytics of the wind turbine. The developed model was tested with the real performance data from a wind turbine of 2MW rated capacity. By analyzing the Normalized Root Mean Squared Error between the estimated and observed performances, it was found that the model could predict the ramp events with an accuracy of around 85 per cent.

S 05.4 Optimal Power Dispatch Considering Wind and Battery Energy Storage Cost Functions Using Stochastic Weight Trade-Off PSO

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This paper proposes optimal power dispatch considering wind and battery energy storage cost functions using Stochastic Weight Trade-off Particle Swarm Optimization (SWT-PSO). The objective is to minimize the total combined weighted operating cost of thermal, wind, battery and emission cost subject to power balance, thermal operating limits, ramp rate limits, prohibited operating zones, wind operating limit and BES operating & state-of-charge limits over a 24-hour time horizon. The cost of wind power consists of direct, overestimation and underestimation cost function. The Weibull probability density function model is used to determine the overestimation and underestimation costs. The BES is also used to compensate the overestimation and underestimation cost of wind generation. If charging cost of BES is lower than overestimation cost of wind generation, the excess power from wind turbines will be stored in the BES. On the other hand, if discharging cost of BES is lower than underestimation cost of wind generation, the shortage of wind power is compensated by BES. The different operating cost of having battery and without battery in system will be compared. Test results indicate that the proposed method gives lower cost than Basic Particle Swarm Optimization (BPSO), Particle Swarm Optimization with Time-Varying Acceleration Coefficients (PSO-TVAC) and Adaptive Particle Swarm Optimization (APSO).

S 05.5 Data Driven Models for Understanding the Wind Farm Wake Propagation Pattern

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In a wind farm, where several wind turbines are arranged in rows and columns, the wind speed available for the downstream turbines are significantly reduced by the wake effect. The wake losses can reduce the total productivity of a wind farm up to 20 per cent. Understanding the wake pattern in an existing wind farm is essential for the short-term wind power forecast. In this paper, we propose the use of artificial intelligence to understand the wind flow pattern and thereby the wake induced power losses within an existing wind farm. The farm considered for this study has 64 wind turbines of 2 MW rated capacity. Three learning methods based on artificial intelligence are used for the study. These are (i) Artificial Neural Network (ANN), (ii) Support Vector Machines (SVM), and (iii) K-Nearest Neighbors (KNN). The accuracies of these models, based on the error between the estimated and observed power produced by the turbines, are also presented.

S 05.6 Research on Thermal-Hydro-Wind Joint Scheduling Considering N-1 Security Constraints

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Day-ahead optimal scheduling is a crucial problem for power system operation. With the fast development of modern power system, power diversification and increasingly high demand of security are calling for new considerations in the research of this area. It is necessary to schedule

multi power supplies jointly and optimally under possible contingencies, thus to ensure the safety and economic operation of power grid. This paper specifically aims at the problem of day-ahead generation scheduling considering multi-type power generation and power system security requirement. An optimal scheduling model is proposed for thermal-hydro-wind joint operation considering system security constraints. In this model, refined characteristics of different generations and system operation constraints are well modeled. Specifically, in thermal power modeling, the nonlinearity of operation cost start-up/shut-down cost function is considered. In hydro power modeling, hydro power stations of different water-holding capacity and adjustment ability are formulated separately. In system-level, a novel formulation for available reserve capacity and N-1 security criteria is proposed, to obtain a more practical and security scheduling plan. The integrated model is established as a mixed-integer linear programming optimization problem, so that it can be easily solved by multiple mature and effective algorithms.

S 05.7 Economic Dispatch and Network Reconfiguration of Microgrid using Artificial Bee Colony Algorithm: a Case Study of Mae Sariang, Thailand

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This study investigates economic dispatch (ED) problem and network reconfiguration of microgrid (MG) which is integrated with distribution generator (DG) and battery energy storage (BES). ED problem considers the objective problem of DGs' generation cost and distribution losses minimizing. The network configuration solves the problem of unbalance power generation and load demand under emergency situations and considers the objective problem of minimizing outage cost and customer's interruption. The test existing MG is located on Mae Sariang district, Thailand, which is included renewable and fossil fuel DGs, and BES.

Artificial bee colony (ABC) algorithm is applied with BES co-ordinating to solve the problems of ED and network reconfiguration of MG. ABC algorithm searches for real and binary numbers of generation power and switch's status, respectively. The final outcomes of ABC algorithm are generation scheduling and MG's topology which provides high income for utility and low generation and outage cost. Finally, the result of the study can be implemented to operation and planning of MG which is consisted of renewable generators and energy storage systems.

S 06: Electric Vehicles Integration
Time: 11:00 – 12:15
MR 225, BITEC Bang Na

S 06.1 **The ANFIS Model of Electric Vehicle Energy Consumption for Thailand Power Development Plan**

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The energy security and global warming are considerable issues in Thailand that have been increasing continuously imported fuel which uses over 50 percent of transportation sector .Although, Thailand has already promoted conservation energy under the EEDP which is promoted the electric vehicle .The switching energy fuel to electric will affect to the PDP 2015. This paper presents the ANFIS model of electric vehicle energy consumption for PDP which are considerate fuel and electric vehicles such as passenger car, taxi, motorcycle and bus .The technical factors are analyzing efficiency of both vehicles which are classified information by ANOVA process and simulated model under the ANFIS method to forecast the number of electric vehicle .The simulation of three feasible scenarios will be presented to guide the appropriate number of electric vehicle which compare with PDP .Finally, the worst scenario of energy consumption will be information to discuss and review the PDP.

S 06.2 Simulation and Analysis of Renewable Energy Resource Integration for Electric Vehicle Charging Stations in Thailand

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This paper presents simulation results and analysis of renewable energy system integration to supplying EV charging stations using Provincial Electricity Authority (PEA) head office located in Bangkok, the capital territory of Thailand. This study has incorporated three types of renewable energy resources, i.e. solar, wind and energy storage. The MERIT™ program is being used in this study to simulate the system performance. However, relevant system data and other parameters, i.e. energy matching (%) between power demand and power supplied from renewable energy resources, capital cost (£) incurred in building renewable energy system, the amount of surplus and deficit (kWh), are also brought into consideration. This work also targeted to devise the annual proportion of three size cases of EVs available in market today−small, medium and large, respectively. On comparing the simulation results with real electricity generating situations, it is envisaged that the obtained solutions being employed to improve performance of a completely installed renewable energy system integrated into EV charging stations, located at PEA head office, are expected to alleviate the electricity use of the grid and meet the charging demand of EV's in the long term.

S 06.3 Optimal Reconfiguration of Distribution Network with Electric Vehicles using Particle Swarm Optimization

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The presence/integration of Electric Vehicles (EV) in electric distribution system creates both opportunities and challenges to distribution utilities. In fact EVs are movable load to distribution system but it can be used as movable source of power with the help of V2G technology that can benefit both electric vehicles owner and distribution utilities. However, increased and uncontrolled use of electric vehicles results into various problems such as greater power loss, feeder congestion, poor voltage profile etc. in the distribution network. This paper aims to find the optimal network topology for minimum operational cost to distribution utilities with the minimum effect of EVs integration on network performance using distribution network reconfiguration strategy. The coordinated charging of electric vehicles along with V2G technology is considered using price based signal and benefit to the EV owners due to coordinated charging with V2G technology is calculated. Distribution network reconfiguration is performed from operational cost point of view using binary particle swarm optimization with varying inertia weight and acceleration constants. Simulation results for typical IEEE 69 bus distribution network verify the efficacy of proposed strategy.

S 06.4 Distribution Network Reconfiguration to Support Electric Vehicles Integration

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This paper presents the efficacy of network reconfiguration strategy along

with coordinated charging of electric vehicles to support its integration on smart distribution network. The potential impacts of electric vehicles integration with different charging schemes namely: uncoordinated charging and coordinated charging with vehicle-to-grid capability are assessed. In order to mitigate the adverse effects of electric vehicles integration to distribution system, network reconfiguration problem is formulated and applied to find the on/off status of sectionalizing and tie switches in each hour of particular day. The optimization problem is solved using binary particle swarm optimization with varying inertia weight and acceleration constants. Various constraints associated with distribution network and electric vehicles loads are considered during optimization. Simulation results for typical IEEE 69 bus distribution network are provided as evidence of effectiveness of proposed strategies. Simulation results indicate that if coordinated charging with vehicle-to-grid capability is implemented using price based signal imposes less burden to the distribution network than uncoordinated charging and distribution network reconfiguration can contribute further to reduce power loss and improve voltage profile significantly.

S 06.5 Heuristic Approach on Economic Load Dispatch Problem Using Willingness to Pay along with Incentive Based Load Curtailment Schemes

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In the current electricity market, the demand for power increases exponentially day by day. The ISO can boost the power sales by using "willingness to pay" approach on the consumers. This paper proposes a novel approach of scheduling power by incorporating willingness to pay of consumers into the load dispatch problem. The consumers with higher willingness to pay usually use appropriate capacity transmission lines to receive power owing to their evident power needs. The appropriate

capacity of the transmission lines allows congestion free power distribution and thus enabling a holistic improvement of the transmission system. The paper also includes the emission constraints to reduce the emissions from the generating plants and an incentive based curtailment scheme to support the willingness to pay based load dispatch. The proposed optimized model uses bees foraging algorithm (BFA) to perform economic load dispatch problem. A three generator model is used to illustrate the proposed approach.

FIELD VISIT SITES

Amata B.Grimm Power 3 Limited
Amata Nakorn Industrial Estate, Chonburi Province, Thailand

B.Grimm Power is a Thailand-based energy company that focuses on the development, financing, construction and operation of green-field power plants. It started its business in 1993 when B.Grimm pioneered into Thailand's emerging private power generation industry with B.Grimm Power as its investment arm and in the following set up Amata B.Grimm Power.

B.Grimm Power strives to be a world class energy company aiming to fulfill the needs of its associates, business partners and society at large by doing business with compassion in harmony with its neighbors. Together with their partners, B.Grimm Power have successfully developed gas-fired electricity and steam generating power plants, purchased additional projects and more in the pipeline. The company delivers through its own distribution networks to over 500 industrial users with the service continuity and efficiency of the highest international standards.

While B.Grimm is active in Thailand and Vietnam, they are also seeking investments in Myanmar, Malaysia and Indonesia. Its existing plants of 1,626.2 MW produce at full capacity and by 2019 plan to have over 2,100 MW in operation as the second largest Small Power Producer in Thailand and a total of 5,000 MW in obtained licenses across the region. B.Grimm Power has gas-fired plants, heavy oil diesel plants, solar farms, and are open to other fuels. The company has already obtained licenses for wind farms and is pursuing hydro opportunities.

B.Grimm Power currently operates thirteen power plants and fifteen solar farms with a combined power generating capacity of 1,626.2 MW. 960 MW of electricity is dispatched to the Electricity Generating Authority of

Thailand (EGAT) under the Small Power Producer (SPP) Program as well as to the Electricity of Vietnam (EVN). The remaining power is supplied to over 500 industrial users across six industrial estates.

ICUE 2016 delegates will visit Amata B.Grimm Power 4 Ltd. and Amata B.Grimm Power 5 Ltd, two of its installations in Amata Nakorn Industrial Estate, Chonburi Province. These plants are combined cycle cogeneration type capable of producing 131 MW and 132 MW of electricity, respectively.

NOTES

The 2016 International Conference on Cogeneration, Small Power Plants and District Energy (ICUE 2016) on 14-16 September 2016 in Bangkok City, Thailand will be a venue to exchange research ideas, experiences, technical, social, financial, economic and policy issues covering advances in the Cogeneration (CHP), Small Power Plants (SPPs) and District Energy systems. Here, energy professionals, policy makers, researchers, members of the academe, engineers, members of the energy supply sector, etc., will have a platform to showcase research findings, technological innovations, transformative emerging technologies, and even to discuss burning global, regional and national issues in energy utilization for development and environment policies and programs.

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