AFORE 2018

August 21 (Tue.)

Organizing Committee & Program Committee Meeting

August 22 (Wed.)

Time/Place	Room 202 of NUM Library	Room 203 of NUM Library	Room 304 of NUM Library	Room 305 of NUM Library
08:30-	Registration			
09:20-11:00	Policy, Strategy & New Business	Photovoltaics	Energy Storage System I	Special Session I "Electric Vehicle"
11:00-12:00	Special Session II "Optimal Tax & Fare for Renewable energy"	POSTER DISCUSSION (Lobby 2F of NUM Library)		
12:00-13:20	Lunch			
13:20-14:40	Special Session III "Super Grid in Northeast Asia"	Special Session IV "Passive House"	Energy Storage System II/ Hybrid System	Small Hydro Power/ Marine Energy
14:40-15:00	Coffee Break			
15:00-15:30	Opening Ceremony (Room 303 of NUM Library)			
15:30-16:10	Opening Plenary (Room 303 of NUM Library)			
16:20-17:00	Opening Special Session (Room 303 of NUM Library)			
18:00-20:00	Banquet (Best Western Premier Tuushin Hotel 5F - Soyombo hall)			

August 23 (Thu.)

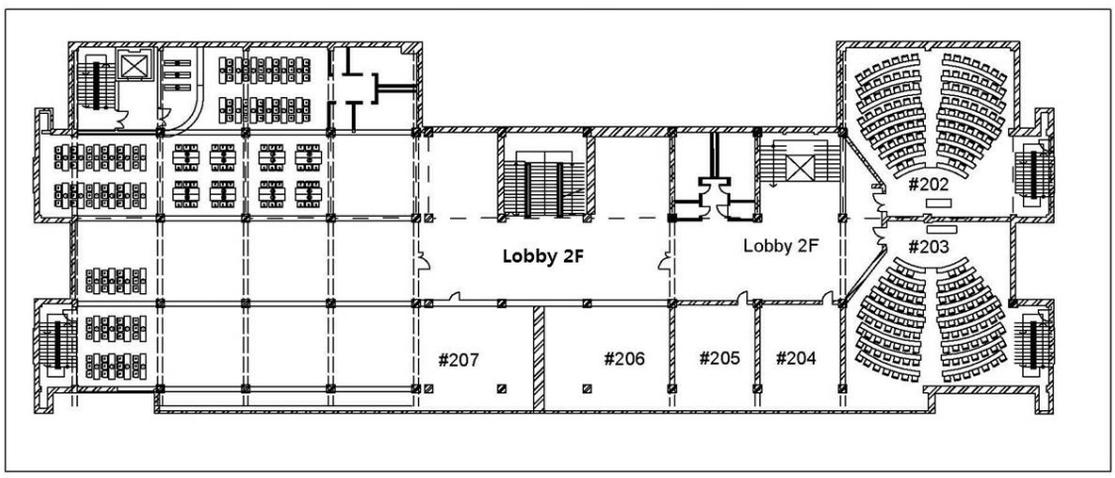
Time/Place	Room 202 of NUM Library	Room 203 of NUM Library	Room 304 of NUM Library	Room 305 of NUM Library
08:30-	Registration			
09:20-10:40	Wind Energy	Smart Grid & Micro Grid	Geothermal Energy	Wasted Energy & Utilization
10:40-12:00	Special Session V "Wind Farm Siting & Planning"	Hydrogen & Fuel Cell	Solar Thermal	Environment and Low Carbon Technology
12:00-13:00	Lunch			
13:00-15:00	Closing Ceremony (Room 202 of NUM Library) "North-East Asia Energy Collaboration"			

August 24 (Fri.)

	Technical Tour - Terelj National Park
09:00-	◆ Place : Terelj National Park & Chinggis Khaan Statue ◆ Tour 09:00 Best Western Premier Tuushin Hotel Departure 10:30 Terelj National Park arrival 10:30-12:00 Tour (Horse riding) 12:00-14:00 Lunch 14:00-16:00 Tour (Chinggis Khaan Equestrian Statue) 17:00 Best Western Premier Tuushin Hotel arrival

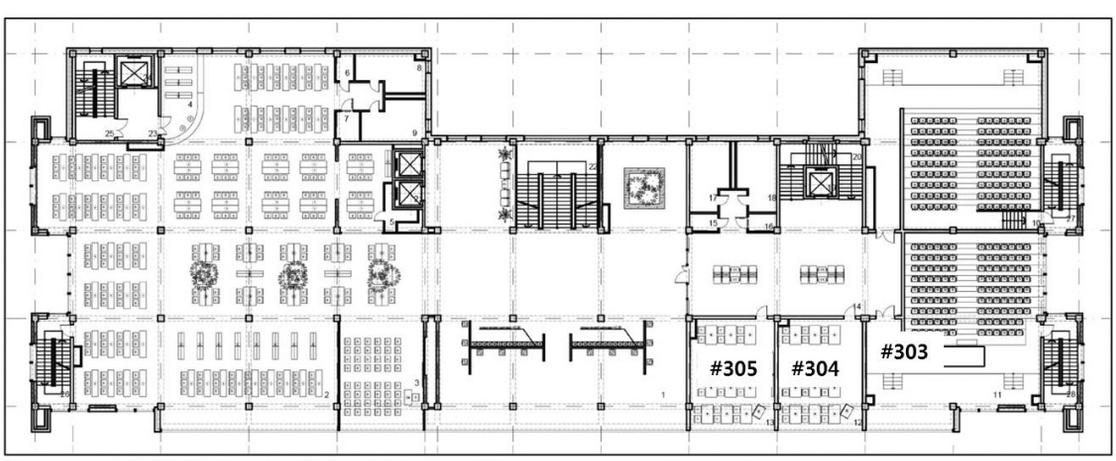
Floor Plan

2F



#202	**Oral room / Closing Ceremony**
#203	Oral room
#207	VIP room
Lobby 2F	Poster, Reservation Desk

3F



#303	Openning/ Plenary
#304	Oral room
#305	Oral room

8th Asia-Pacific Forum on Renewable Energy

AFORE 2018

August 22-24, 2018

National University of Mongolia, Ulaanbaatar, Mongolia

Co-Organized by

- Korean Society for New and Renewable Energy (KSNRE)
- Ministry of Energy, Mongolia
- Ministry of Environment and Tourism, Mongolia
- Mongolian Society of Asia Super Grid (MSASG)
- Energy Regulatory Commission of Mongolia (ERC)
- National University of Mongolia (NUM)
- Korea Institute of Energy Research (KIER)

Supported by

- Mongol Energy Club

Renewable Energy

Policy, Strategy & New Business, Photovoltaics, Solar Thermal, Wind Energy, Bioenergy, Marine Energy, Geothermal Energy, Small Hydro Power, Wasted Energy & Utilization, Hydrogen & Fuel Cell, Energy Storage System, Hybrid System, Smart Grid, Micro Grid, CCT&CCS, Low carbon Technology, Environment

한국신·재생에너지학회

The Korean Society for New and Renewable Energy

Contents

>> Welcome Message

It is my great pleasure to invite you to the 8th Asia-Pacific Forum on Renewable Energy(AFORE 2018), which is to be held from August 22 through 24, 2018 in Ulaanbaatar, Mongolia.

As you are aware of, the AFORE was created to promote renewable energy technologies and to build cooperative network with countries in Asia-Pacific region, following the first conference of its kind, the AFORE 2011 in Busan, Korea, and then has been hold every year continuously. Based on these experiences, AFORE 2018 is aimed to facilitate exchanges of information and personnel; to play the role in the advancement of renewable energy technology and expansion of its deployment, contributing to reliable energy supply, realization of low-carbon society and sustainable economic growth, and betterment of human life.

Through 3 days conference, we will have plenary session with eminent keynote speakers, technical sessions with invited papers, oral and poster presentations. There will be numerous special sessions on renewable energy cooperation including Super Grid in Northeast Asia which is to construct large scale renewable power plants and transmission network in Gobi desert for sharing generated electricity with neighboring countries.

In addition, you shouldn't miss the technical tour to visit renewable energy power plants .and historical areas with a chance to have a deeper understanding on Mongolian culture.

The exhaustion of fossil resources and the environmental disaster such as Fukushima nuclear power plant clearly send us the message for importance and necessity of the renewable energy. However, solving energy and environmental problems and creating the renewable energy market require the harmonized effort among nations toward the sustainable world. I believe that this timely event certainly should be a cornerstone for cooperation and mutual benefit each other.

Your participation will make AFORE 2018 more fruitful and special.

I sincerely look forward to welcoming you in Ulaanbaatar.

Dr. Jinsoo Song
Distinguished Professor of Silla University, Republic of Korea
Honorary Chair of the AFORE 2018

>> Welcoming Speech

Foreword from the Honorary Chairs

Ladies and Gentlemen,

I am delighted to welcome you to the Asia and Pacific Forum on Renewable Energy (AFORE-2018) to be held August 22-24, 2018, in Ulaanbaatar, Mongolia. It has been a great honor and privilege to serve as the Honor Chair of this conference. The AFORE have a rich tradition of bringing together experts, academics, students, innovators and industry leaders from around the world and highly integrative forum that is conducive to sharing information, gaining knowledge, strengthening collaborations and moving forward the science and technology of renewable energy a wide range of renewable energy research and technologies.

Since its establishment in 2015, Mongolian Society of Asian Super Grid has been promoting Asia Super Grid (ASG) initiative which aims to promote building Northeast East Asia Super Grid connecting Northeast Asia using the vast renewable energy resources in Northeast Asian countries, such as wind and solar resources in Mongolia. It is my great pleasure to announce that we are hosting the Special Session on Asia Super Grid during the AFORE-2018.

As a premier conference in the field of renewable energy, AFORE-2018 provides a highly competitive forum for reporting the latest developments in the research and application of renewable energy in Asia and Pacific region.

We want to express our gratitude to the members of the Program Committee and the International Advisory Committee, and the external reviewers for their hard work in reviewing submissions. Finally, the conference would not be possible without the excellent papers contributed by authors. We thank all the authors for their contributions and their participation in AFORE-2018! We feel honored and privileged to serve the best recent developments in the field of Renewable energy to you through this exciting program.

On behalf of the Conference Organizing Committee, I look forward to welcoming you to our AFORE-2018 being held here in Ulaanbaatar, Mongolia!

Mr. JIGJID Byamba
President, Mongolian Society of Asia Super Grid(MSASG), Mongolia
Honorary Chair of the AFORE-2018

>> Forum Committee

Organizing Committee

- **Honorary Chair :**

Mr. JIGJID Byamba *(President, Mongolian Society of Asia Super Grid(MSASG), Mongolia)*
Dr. Jinsoo SONG *(Distinguished Professor of Silla University /Former President, The Korean Society for New and Renewable Energy(KSNRE), Republic of Korea)*

- **General Chair :**

Mr. Gantulga.T *(Vice Minister, Ministry of Energy of Mongolia)*
Mr. Tsengel.Ts *(State Secretary, Ministry of Environment and Tourism of Mongolia)*
Prof. Ou-sam JIN *(Korea District Heating Corp. / President, The Korean Society for New and Renewable Energy(KSNRE), Republic of Korea)*
Prof. Young-Ho LEE *(Korea Maritime and Ocean University / Immediately-past President, The Korean Society for New and Renewable Energy(KSNRE), Republic of Korea)*
Prof. Eunnyeong HEO *(Seoul National University, Republic of Korea)*

- **Member :**

Prof. Aidarkhan Kaltayev *(Al-Farabi Kazakz National University, Republic of Kazakhstan)*
Prof. Ali Saigh *(World Renweable Energy Network, UK)*
Prof. Anthony Kucernak *(Imperial College London, UK)*
Prof. Bhola Thapa *(KathMandu University, Nepal)*
Prof. Bundit FungtamMasan *(King Mongkut's Univ. of Technology, Thailand)*
Dr. Cheng-Han Tsai *(National Taiwan Ocean University, Taiwan)*
Prof. Domenico Coiro *(Universita' degli Studi di Napoli, Italy)*
Prof. Donghwan KIM *(Korea University, Republic of Korea)*
Prof. Gento Mogi *(University of Tokyo, Japan)*
Dr. Heon JUNG *(Korea Institute of Energy Research, Republic of Korea)*
Prof. Hongda Shi *(Ocean University of China, China)*
Prof. Hongguang Jin *(Chinese Society of Engineering Thermo-physics (CSET), China)*
Prof. Hyung Kee YOON *(Korea Maritime & Ocean University / Former President, The Korean Society for New and Renewable Energy(KSNRE), Republic of Korea)*
Dr. Jin-Soo KIM *(CRISO, Australia)*
Prof. Johnny C.L. Chan *(City University of Hong Kong, Hongkong)*
Prof. Kosuke Kurokawa *(Japan Council of Renewable Energy, Japan)*
Mr. Li BaosHan *(China Renewable Energy Society, China)*
Dr. Li-Chyong Lin Chen *(National Taiwan Univ., Taiwan)*
Prof. Longlong Ma *(Guangzhou Institute of Energy Conversion (GIEC), China)*
Prof. Maziar ArzoMandi *(University of Adelaide, Australia)*
Prof. Miguel T. Escoto Jr. *(University of the Philippines, Philippines)*
Dr. Namijil Enebish *(National University of Mongolia, Mongolia)*
Director Pham Trong Thuc *(Ministry of Industry and Trade, Vietnam)*
Prof. Phouang Phouthavong *(National Univ.of Laos, Laos)*
Prof. Prasanna Gunawardane *(University of Peradeniya, Sri Lanka)*
Dr. Quing Hu *(Instituteof Hydrobiology, China)*
Prof. M. Rafiuddin Ahmed *(University of South Pacific, Fiji)*
Prof. Roshan Chhetri *(Royal Univeisity of Bhutan, Bhutan)*
Prof. Shiu-Wu Chau *(National Taiwan Science and Technology, Taiwan)*

Prof. Shuichi Nagata *(Saga University, Japan)*
Prof. Song K. Choi *(University of Hawaii, USA)*
Prof. Soogab LEE *(Seoul National University, Republic of Korea)*
Prof. Soteris Kalogirou *(Cyprus University of Technology, Cyprus)*
Mr. Stefan Gsanger *(World Wind Energy Association)*
Prof. Yoon Young LEE *(Auburn University, USA)*
Prof. Wei Shi *(Dalian University of Technology, China)*

Program Committee

- **Chair :**

Prof. Seung-Ho SONG *(Kwangwoon University, Republic of Korea)*
Prof. Bayasgalan Dugarjav *(National University of Mongolia, Mongolia)*

- **Member :**

(Photovoltaic)
Prof. ENEBISH Namjil *(National University of Mongolia, Mongolia)*
Dr. Erdenebaatar Dashdondog *(National University of Mongolia, Mongolia)*
Dr. Jae Ho YUN *(Korea Institute of Energy Research, Republic of Korea)*

(Solar Heat)
Dr. Jong Kyu KIM *(Korea Institute of Energy Research, Republic of Korea)*

(Wind)
Dr. Bavuudorj Ovgor *(Renewable energy division, Ministry of Energy, Mongolia)*
Prof. Jang-Ho LEE *(Kunsan National University, Republic of Korea)*
Mr. Sukhbaatar Tsegmid *(Clean Energy LLC, Mongolia)*
Prof. Ulam-Orgil Choijiljav *(Mongolian University of Science and Technology, Mongolia)*

(Hydro Power)
Mr. Boldbaatar Burentsagaan *(Ministry of Energy, Mongolia)*
Prof. Youngdo CHOI *(Mokpo National University, Republic of Korea)*

(Waste Energy)
Dr. Sang-Kyu CHOI *(Korea Institute of Machinery& Materials, Republic of Korea)*
Prof. Jeongsoo YU *(Tohoku University, Japan)*

(Geothermal)
Prof. Jong Min CHOI *(Hanbat National University, Republic of Korea)*
Mr. Purevsuren Dorj. *(National Renewable Energy Center, Mongolia)*

(Fuel cell)
Dr. Seok-Hee PARK *(Korea Institute of Energy Research, Republic of Korea)*
Mr. Zayabaatar Baljinnyam *(Green Energy International LLC, Mongolia)*

(CCS)

Dr. Chang Keun YI *(Korea Institute of Energy Research, Republic of Korea)*

(Policy)

Mr. Byambasaikhan Bayanjargal *(Nova Terra LLC, Mongolia)*
Dr. Sang Hoon LEE *(Green Energy Strategy Institute, Republic of Korea)*
Mr. Tovuudorj Purevjav *(World Energy Council Member Committee, Mongolia)*
Mr. Yeren-Ulzii Batmunkh *(Ministry of Energy, Mongolia)*

(General)

Mr. Chul Hyu LEE *(Korea Electric Power Corporation, Republic of Korea)*

Local Committee

- **Chair :**

Mr. Tleikhan . A *(Chairman and Chief Commissioner, Energy Regulatory Commission of Mongolia, Mongolia)*

- **Member :**

Mr. Byambasaikhan.B *(Nova Terra LLC, Mongolia)*
Prof. Cheol OH *(Korea Maritime and Ocean University, Republic of Korea)*
Prof. Chul Hee JO *(Inha University, Republic of Korea)*
Mr. Ganbold.Ts *(Erchim Suljee LLC, Mongolia)*
Mr. Gankhuyag.D *(Infra structure and Energy sector of Newcome Group, Mongolia)*
Dr. Gi-Sung PANG *(Korea institute of Energy Technology Evaluation and Planning, Republic of Korea)*
Dr. Hyungjin KIM *(Green Energy Institute, Republic of Korea)*
Mr. Jigjid.R *(Everyday Farm LLC, Mongolia)*
Dr. Jin-Suk LEE *(Korea Institute of Energy Research, Republic of Korea)*
Dr. Jintaek WHANG *(Korea University, Vice President of KREA, Former President of KETEP, Republic of Korea)*
Dr. Ji-yune RYU *(Unison Corporation Ltd., Republic of Korea)*
Dr. Kwon Pyo HONG *(Korea New & Renewable Energy Association, Republic of Korea)*
Prof. Junsin YI *(Sungkyunkwan University, Republic of Korea)*
Prof. Joo-Heon PARK *(Dongduk Women's University, Former President of KREA, Former President of KEEI, Republic of Korea)*
Mr. Mandalbayar *(Power International LLC, Mongolia)*
Mr. Osgonbaatar.J *(Mongolian Renewable Energy Industry Association, Mongolia)*
Prof. Seung-Jin KANG *(Korea Polytechnic University, Former President of KREA, Republic of Korea)*
Dr. Si-Doek OH *(Blue Economy Strategy Institute Co., Ltd., Republic of Korea)*
Mr. Sukhbaatar.Ts *(Clear Energy LLC, Mongolia)*
Dr. Tumurbaatar.Ya *(National University of Mongolia, Mongolia)*
Prof. Yang-Hoon SONN *(Incheon National University, Former President of KREA, Former President of KEEI, Republic of Korea)*
Dr. Yeon seok CHOI *(Korea Institute of Machinery and Materials, Republic of Korea)*
Dr. Young-Doo KIM *(Korea Gas Corp., Republic of Korea)*
Prof. Youngsoon BAEK *(The University of Suwon, Republic of Korea)*

>> Forum Schedule

August 22 (Wed.)				
Time/Place	Room 202 of NUM Library	Room 203 of NUM Library	Room 304 of NUM Library	Room 305 of NUM Library
08:30-	Registration			
09:20-11:00	Policy, Strategy & New Business (Mr. Jambaa Lkhagvaa)	Photovoltaics (Prof. Junsin YI)	Energy Storage System I (Dr. Batsaikhan Nyamdash)	Special Session I "Electric Vehicle" (Prof. Ock Taeck LIM)
11:00-12:00	Special Session II "Optimal Tax & Fare for Renewable energy" (Dr. Jintaek WHANG)	POSTER DISCUSSION (Lobby 2F of NUM Library) (Prof. Ulamorgil, Prof. Juhoon BACK)		
12:00-13:20	Lunch			
13:20-14:40	Special Session III "Super Grid in Northeast Asia" (Dr. Jinsoo SONG)	Special Session IV "Passive House" (Prof. Amarbayar Adiyabat)	Energy Storage System II/ Hybrid System (Prof. Eun-Chel CHO)	Small Hydro Power/ Marine Energy (Prof. Young-Do CHOI)
14:40-15:00	Coffee Break			
15:00-15:30	Opening Ceremony (Room 303 of NUM Library)			
15:30-16:10	Opening Plenary (Room 303 of NUM Library) (Prof. Eunnyeong HEO)			
16:20-17:00	Opening Special Session (Room 303 of NUM Library) (Mr. Tovuudorj Purevjav)			
18:00-20:00	Banquet (Best Western Premier Tuushin Hotel 5F - Soyombo hall)			

August 23 (Thu.)				
Time/Place	Room 202 of NUM Library	Room 203 of NUM Library	Room 304 of NUM Library	Room 305 of NUM Library
08:30-	Registration			
09:20-10:40	Wind Energy (Prof. Kyung Nam KOH)	Smart Grid & Micro Grid (Dr. Erdenebaatar Dashdondog)	Geothermal Energy (Mr. Purevsuren Dorj)	Wasted Energy & Utilization (Dr. Hyung-Don LEE)
10:40-12:00	Special Session V "Wind Farm Siting & Planning" (Dr. Seokwoo KIM)	Hydrogen & Fuel Cell (Dr. Won Yong LEE)	Solar Thermal (Prof. Enebish Namjil)	Environment and Low Carbon Technology (Mr. Hee Dong KWON)
12:00-13:00	Lunch			
13:00-15:00	Closing Ceremony (Room 202 of NUM Library) "North-East Asia Energy Collaboration"			

>> General Information

▸ 8th Asia-Pacific Forum on Renewable Energy(AFORE2018)

"Super Grid and Renewable Energy Cooperation in Northeast Asia"

Date : August 22(Wed.)-24(Fri.), 2018

Place : Library of National University of Mongolia, Ulaanbaatar, Mongolia

▸ Registration Desk

▪ Location : Lobby(2F) of NUM Library

▪ Registration Hours

August 22(Wed.) 08:30-15:00

August 23(Thu.) 08:30-13:00

▪ Registration Fee

	Early-bird Registration	On-site Registration
Regular participant	US$ 360 (KRW 360,000)	US$ 400 (KRW 400,000)
Student	US$ 180 (KRW 180,000)	US$ 200 (KRW 200,000)

▸ Official Program

▪ Opening Ceremony

Date : August 22(Wed.)

Time : 15:00-15:30

Place : Room 303 of NUM Library

▪ Opening Plenary

Date : August 22(Wed.)

Time : 15:30-16:10

Place : Room 303 of NUM Library

▪ Opening Special Session

Date : August 22(Wed.)

Time : 16:20-17:00

Place : Room 303 of NUM Library

▪ Closing Ceremony

Date : August 23(Thu.)

Time : 13:00-15:00

Place : Room 202 of NUM Library

▸ Social Program

- Forum Banquet

  Date : August 22(Wed.)

  Time : 18:00-20:00

  Place : Soyombo hall(5F) of Best Western Premier Tuushin Hotel

▸ Side Events - Technical Tour

Date : August 24(Fri.)

Place : Terelj National Park & Chinggis Khaan Statue

Tour :	09:00	Best Western Premier Tuushin Hotel Departure
	10:30	Terelj National Park arrival
	10:30-12:00	Tour(Horse riding)
	12:00-14:00	Lunch
	14:00-16:00	Tour(Chinggis Khaan Equestrian Statue)
	17:00	Best Western Premier Tuushin Hotel arrival

▸ Official Language

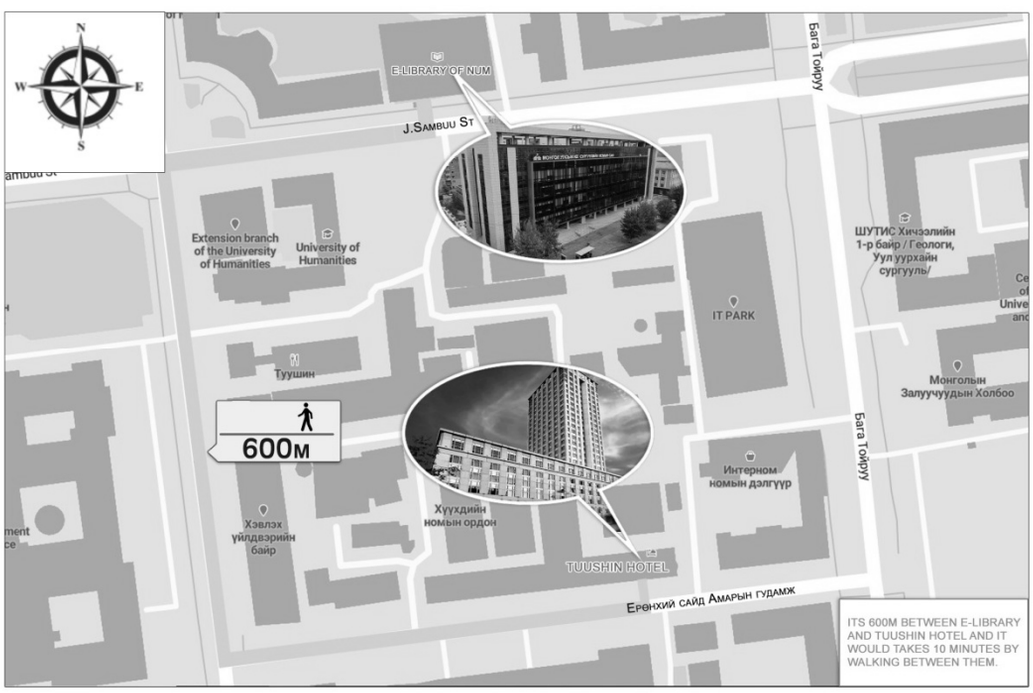
English is the official language of the forum.

▸ Transportation to Ulaanbaatar

- Way from the Chinggis Khaan International airport to the Library of National University of Mongolia (building no.2)

- Taxi (Most easy and convenient way to Ulaanbaatar)
- When you get out the gate, there are some drivers of 1991(name of the official airport taxi company) that ask you buy taxi. It costs 20500-25000 tugrig (8.2-10.2) to downtown.
- Base rate (airport->downtown) =20500 tugrig
- Approximately to the Tuushin hotel= 25000 tugrig

▪ Way to the library of National University of Mongolia (building no.2)-> Best Western Premier Tuushin hotel (Banquet place)



>> Forum Program

Opening Ceremony

August 22 [Wed.] 15:00-15:30 [Room 303 of NUM Library]

Opening Plenary

August 22 [Wed.] 15:30-16:10 [Room 303 of NUM Library]

Chair : Prof. Eunnyeong HEO (Seoul National University, Republic of Korea)

Plenary Session I
15:30-15:50

THE CURRENT STATUS OF RENEWABLE ENERGY IN MONGOLIA

Bavuudorj OVGOR*
Renewable energy division, Ministry of Energy, Ulaanbaatar, Mongolia
**corresponding author (bavuudorj@energy.gov.mn)*

Plenary Session II
15:50-16:10

RENEWABLE ENERGY COOPERATION IN NORTHEAST ASIA

Jinsoo Song*
Distinguished Professor of Silla University, Republic of Korea
**corresponding author (jsong8817@gmail.com)*

Opening Special Session

August 22 [Wed.] 16:20-17:00 [Room 303 of NUM Library]

Chair : Mr. Tovuudorj Purevjav (Chairman of Mongolian member committee, World Energy Council, Mongolia)

O-OSS-001
16:20-16:40

NORTHEAST ASIA POWER SYSTEM INTERCONNECTION (NAPSI)

Byambasaikhan BAYANJARGAL*
Country coordinator, NAPSI project, Mongolia
**corresponding author (byambasaikhan@novaterra.mn)*

O-OSS-002
16:40-17:00

GEOPOLITICS OF NORTHEAST ASIA SUPERGRID : KEY QUESTIONS FOR GREEN RAPPROACHEMENT

Sang-Hyup Kim*
Korea Advanced Institute of Science and Technology(KAIST), Republic of Korea
**corresponding author (conanstory@gmail.com)*

Special Session I

▌Electric Vehicle (This Session is co-organized with Mongolia Electric Vehicle Association (MEVA))

August 22 [Wed.], 09:20-11:00 [Room 305 NUM Library]

Chair : Prof. Ock Taeck LIM (University of Ulsan, Republic of Korea)

O-SSI-001
09:20-09:40

THE STATE OF ART ON HYBRID & ELECTRIC VEHICLES

Ock-Taeck Lim*
University of Ulsan, Republic of Korea
**corresponding author (otlim@ulsan.ac.kr)*

O-SSI-002
09:40-10:00

KOREAN AUTOMOTIVE INDUSTRY AND LESSONS LEARNED

Chun-Beom Lee*
Executive Advisor of KATECH, South Korea
**corresponding author (cblee@katech.re.kr)*

O-SSI-003
10:00-10:20

CURRENT STATE OF MONGOLIAN ELECTRIC VEHICLE INDUSTRY

Dorjdagva. D[1], Bayasgalan. D[2]*, and Batsaikhan. D[3]
[1]*Ecologbus LLC, Mongolia*
[2]*School of Engineering and Applied Sciences, National University of Mongolia, Mongolia*
[3]*Electro Engineering LLC, Mongolia*
**corresponding author (bayasgalan@seas.num.edu.mn)*

O-SSI-004
10:20-10:40

IMPACTS ON ELECTRICITY CONSUMPTION AND REDUCTION OF CO_2 EMISSION ACCORDING TO ELECTRIC VEHICLE PENETRATION IN JEJU ISLAND

Ankhzaya Baatarbileg*, and Gae Myoung LEE
Department of Electrical Engineering, Jeju National University, Jeju, Republic of Korea
**corresponding author (ankhzaya.jeju@gmail.com)*

Special Session II

▌Optimal Tax & Fare for Renewable energy (This Session is co-organized with Korea Resource Economics Assocation (KREA))

August 22 [Wed.] 11:00-12:00 [Room 202 of NUM Library]

Chair : Dr. Jintaek WHANG (Korea Resource Economic Association, Republic of Korea)

O-SSII-001
11:00-11:15

INDUCED PRODUCTION EFFECT OF PHOTOVOLTAIC POWER AND NATURAL GAS POWER PLANT

Yoon Kyung Kim* (Chief Editor of Enviromental Resource Economics Review)
Department of Economics, Ewha Womans University, Seoul, Republic of Korea
**correspondingauthor (yoonkkim@ewha.ac.kr)*

O-SSII-002
11:15-11:30

OPTIMAL FUEL TAX POLICY WITH DRIVING, GASOLINE USE, AND VEHICLE FUEL EFFICIENCY

Bong-seok Choi*
Department of International Trade, Daegu University, Gyeongbuk, Republic of Korea
**corresponding author (bchoi4@daegu.ac.kr)*

Panel Discussion
11:30-12:00

PANEL DISCUSSION

Seung-Jin Kang (Korea Polytechnic University, Former President of KREA)
Joo-Heon Park (Dongduk Women's University, Former President of KREA, Former President of KEEI)
Yang-Hoon Sonn (Incheon National University, Former President of KREA, Former President of KEEI)
Eunnyeong Heo (Seoul National University, Senior Vice President of KREA)

Special Session III

▌Super Grid in Northeast Asia

August 22 [Wed.] 13:20-14:40 [Room 202 of NUM Library]

Chair : Dr. Jinsoo SONG (Distinguished Professor of Silla University, Republic of Korea)

O-SSIII-001
13:20-13:35

OPTIONS FOR MONGOLIA IN ENERGY TRANSITION TO 100% RENEWABLES

Namjil Enebish[1]*, Christian Breyer[2], and Dimitrii Bogdanov[2]
[1]*School of Engineering and Applied Sciences, National University of Mongolia*
[2]*Lappeenranta University of Technology, Skinnarilankatu 34, 53850 Lappeenranta, Finland*
**corresponding author (enebish@seas.num.edu.mn)*

O-SSIII-002
13:35-13:50

CURRENT STATUS & FUTURE OF NORTHEAST ASIA SUPERGRID

YoungSoo Han*
Power System Planning Department, KEPCO (Korea Electric Power Corporation), Republic of Korea
**corresponding author (hanys9986@kepco.co.kr)*

O-SSII-003
13:50-14:05

LONG-TERM ELECTRICITY POLICY DIRECTION AND PLANS FOR NEA ELECTRICITY COOPERATION OF MONGOLIA

Saruultur Bayarsaikhan*
Energy Economic Institute, Mongolia
**corresponding author (saka_saruultor@yahoo.com)*

O-SSII-004
14:05-14:20

COMPARATIVE ANALYSIS OF THD TRANSIENT MODEL OF HYBRID HVDC AND FACTS PERFORMANCE FOR AVOIDING COMMUTATION FAILURE

Zicong ZHANG, Kisuk KIM, Sungchul Hwang, and Gilsoo JANG*
Department of Electrical Engineering, Korea University, Seoul, Republic of Korea
**corresponding author (zicongyouyou@korea.ac.kr)*

O-SSII-005
14:20-14:40

AN ADVANCED TECHNOLOGIES OF GRID AND INTERCONNECTION SOLUTIONS OF RENEWABLE ENERGY

Batsuren BATLKHAGVA*
Director of Energy and Infrastructure, Monhorus International LLC, Mongolia
**corresponding author (batlkhagva@monhorus.mn)*

Special Session IV

▮ Passive House

August 22 [Wed.] 13:20-14:40 [Room 203 of NUM Library]

Chair : Prof. Amarbayar Adiyabat (National University of Mongolia, Mongolia)

O-SSIV-001
13:20-13:40

ENERGY INDEPENDENT PASSIVHAUS IN KOREA AND IT'S POTENTIAL APPLICATION TO THE MONGOLIAN ARID AND SEMI-ARID REGION

Pil Ryul LEE*
Department of Liberal Arts and Culture, Korea National Open University, Seoul, Republic of Korea
**corresponding author (lprlso@gmail.com)*

O-SSIV-002
13:40-14:00

ENERGY USE REDUCTION IN LOWRISE HOUSING ZONES BY DESIGNING TECHNIQUES

PUREV-ERDENE Ershuu*
Architecture department, School of Civil Engineering and Architecture, Mongolian University of Science and Technology, Mongolia
**corresponding author*

O-SSIV-003
14:00-14:20

SUSTAINABLE HOUSING IN MONGOLIA

GANBAA Nyamaa*
Sakura Property LLC, Founder, Mongolia
**corresponding author (nganbaa@gmail.com)*

O-SSIV-004
14:20-14:40

EXPERIMENTAL EVALUATION OF WAYS TO REDUCE AIR POLLUTION THROUGH EFFICIENT ENERGY USAGE IN GER DISTRICT IN MONGOLIA

Thomas Müller[1], Amarbayar Adiyabat[1]*, Bat-Erdene Bayandelger[2], and Yuzuru Ueda[2]
[1]School of Engineering and Applied Science, National University of Mongolia, Ulaanbaatar, Mongolia
[2]Department of Electrical Engineering, Tokyo University of Science, Tokyo, Japan
**corresponding author (amarbayar@seas.num.edu.mn)*

Special Session V

▮ Wind Farm Siting & Planning

August 23 [Thu.] 10:40-12:00 [Room 202 of NUM Library]

Chair : Dr. Seokwoo KIM (Korea Institute of Energy Research, Republic of Korea)

O-SSV-001
10:40-11:00

THE WIND FARM OPERATIONAL ISSUES IN HARSH CLIMATE CONDITION

Sukhbaatar Ts.*
Executive director of Clean Energy LLC, Mongolia
**corresponding author (sukhbaatar@newcom.mn)*

O-SSV-002
11:00-11:20

ZONE PLANNING FOR WIND ENERGY DISSEMINATION

Seokwoo KIM*
Wind Energy Laboratory, Korea Institute of Energy Research, Jeju, Republic of Korea
**corresponding author (wemins@kier.re.kr)*

O-SSV-003
11:20-11:40

INVESTIGATION ON WAKE EFFECT ON ONSHORE WIND FARM SITUATED IN COMPLEX TERRAIN

Undarmaa TUMENBAYAR, and Kyung Nam KO*
Faculty of Wind Energy Engineering, Graduate School, Jeju National University, Jeju, Republic of Korea
**corresponding author (gnkor2@jejunu.ac.kr)*

O-SSV-004
11:40-12:00

A STUDY ON WIND SPEED VARIABILITY FOR ONSHORE AND OFFSHORE SITES ON JEJU ISLAND, SOUTH KOREA

Dongbum Kang[1], Jongchul Huh[2], and Kyungnam Ko[3]*
[1]*Multidisciplinary Graduate School Program for Wind Energy, Graduate School, Jeju National University, Jeju, Republic of Korea*
[2]*Faculty of Mechanical Engineering, College of Engineering, Jeju National University, Jeju, Republic of Korea*
[3]*Faculty of Wind Energy Engineering, Graduate School, Jeju National University, Jeju, Republic of Korea*
**corresponding author (gnkor2@jejunu.ac.kr)*

Oral Sessions
PS&B : Policy, Strategy & New Business

▌O-PS&B

August 22 [Wed.] 09:20-11:00 [Room 202 of NUM Library]

Chair : Mr. Jambaa Lkhagvaa (Energy Regulatory Commission, Mongolia)

O-PS&B-001
09:20-09:40

RENEWABLE ENERGY REGULARTORY ISSUES IN ENERGY SYSTEM OF MONGOLIA

JAMBAA Lkhagva*
Energy Regulatory Commission, Mongolia
**corresponding author (jambaa@erc.mn)*

O-PS&B-002
09:40-10:00

ISSUES ON RENEWABLE ENERGY TARIFFS IN MONGOLIA

ERDENEBULGAN Bazarvaani*
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**corresponding author (erdenebulgan@erc.mn)*

O-PS&B-003
10:00-10:20

A STUDY FOR THE ECONOMIC, ENVIRONMENTAL, AND SOCIAL EFFECTS OF GREEN PUBLIC PROCUREMENT POLICY IN KOREA

Jaejoon KIM*
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O-PS&B-004
10:20-10:40

ENERGY CONSERVATION AND EFFICIENCY POLICY IN MONGOLIA

Atarjargal Tserendoo*, and Enkhjargal Bazarragchaa*
Department of Energy Conservation, Energy Regulatory Commission of Mongolia
**corresponding author (atarjargal@erc.mn, enkhjargal@erc.mn)*

O-PS&B-005
10:40-11:00

AN ANALYSIS ON LEVELIZED COST OF ELECTRICITY FOR INDEPENDENT POWER SYSTEMS: THE CASE OF MALAHINI KUDA BANDOS RESORT IN MALDIVES

Tae Yong Jung[1]*, Donghun Kim[1], SeoKyung Lim[1], and Jongwoo Moon[2]
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PV : Photovoltaics

▮ O-PV

August 22 [Wed.] 09:20-10:50 [Room 203 of NUM Library]

Chair : Prof. Junsin YI (Sungkyunkwan University, Republic of Korea)

O-PV-001
09:20-09:35

ESTIMATION OF SOLAR ENERGY POTENTIAL OVER MONGOLIA BASED ON SATELLITE DATA

Onon Bayasgalan[1,2,3]*, Jun Hashimoto[2], Kenji Otani[2], Taha Selim Ustun[2], Saji N Hameed[1], and Amarbayar Adiyabat[3]

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O-PV-002
09:35-09:50

PERFORMANCE EVALUATION OF THE 10MW PHOTOVOLTAIC POWER PLANT IN COLD CLIMATIC CONDITIONS OF MONGOLIA

Enebish Namjil[1]*, Bat-Erdene Bayandelger[1], and Baldan Mandalbayar[2]

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[2]*Solar Power International LLC, Mongolia*

**corresponding author (enebish@seas.num.edu.mn)*

O-PV-003
09:50-10:05

ROLE OF ULTRATHIN ALUMINUM OXIDE AS A PASSIVATING TUNNEL OXIDE LAYER

Subhajit DUTTA[1], Kumar MALLEM[1], Somenath CHATTERJEE[2], Minkyu JU[1], Eun-Chel CHO[1], Young Hyun CHO[1], and Junsin YI[1]*

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O-PV-004
10:05-10:20

REPLACEMENT OF P-EMITTER LAYER WITH TRANSITION METAL OXIDE AS HOLE SELECTIVE CONTACT LAYER APPROACH ON HETEROJUNCTION CRYSTALLINE SILICON SOLAR CELL

Kumar Mallem, Yong Jun Kim, Shahzada Qamar Hussain, Subhajit Dutta, Minkyu Ju, Youngkuk Kim, Young-Hyun Cho, Eun-chel Cho*, and Junsin Yi*

College of Information and Communication Engineering, Sungkyunkwan University, Republic of Korea.

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O-PV-005

10:20-10:35

ANALYSIS OF DONOR AND ACCEPTOR CONSENTRATION EFFECT IN SEMICONDUCTOR MATERIALS

Ulziibat Lkhagvabat, Altantsooj Batsukhyn, and Bolormaa Dalanbayar*

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O-PV-006

10:35-10:50

PREDICTION MODEL OF PHOTOVOLTAIC POWER GENERATION FROM WEATHER DATA USING MACHINE LEARNING

Tsolmon Zundui[1]*, and Bayasgalan Dugarjav[2]

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ESSI : Energy Storage System I

▌O-ESSI

August 22 [Wed.] 09:20-11:00 [Room 304 of NUM Library]

Chair : Dr. Batsaikhan Nyamdash (Monhorus LLC, Mongolia)

O-ESSI-001
09:20-09:40

THE MULTIPLE APPLICATION OF ENERGY STORAGE SYSTEM IN MONGOLIAN ENERGY SYSTEM

Tovuudorj Purevjav*
Mongolian Member Committee, World Energy Council
**corresponding author (tovuu@yahoo.com)*

O-ESSI-002
09:40-10:00

GRAVITY STORAGE A NEW CLASS OF PUMPED HYDRO STORAGE

Eduard R. Heindl[1]*, and Enebish Namjil[2]
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[2]*School of Engineering and Applied Sciences, National University of Mongolia*
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O-ESSI-003
10:00-10:20

ENERGY MANAGEMENT ON GER WITH AREAL PV AND ELECTRIC THERMAL STORAGE IN THE ULAANBAATAR, MONGOLIA

Bat-Erdene BAYANDELGER[1,2]*, Yuzuru UEDA[1], Thomas MUELLER[2], Zandargiraa ERDENESUREN[2], Battulga BATBAYAR[2], Amarbayar ADIYABAT[2], and Namjil ENEBISH[2]
[1]*Department of Electrical Engineering, Tokyo University of Science, Tokyo, Japan*
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O-ESSI-004
10:20-10:40

FACTORS AFFECTING STABILITY OF GRID FREQUENCY BY SIMULATION OF GENERATOR DROPOUT IN IEEE 14 BUS MODEL

Oh-Ryun Kwon[1], Soo-Bin Kim[1], Hyun-Dong Jin[1], Seung-Ho Song[1]*, and Yong-Cheol Kang[2]
[1]*Department of Electrical Engineering, Kwangwoon University, Seoul, Republic of Korea*
[2]*Department of Energy IT, Gachon University, Gyeonggi-do, Republic of Korea*
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O-ESSI-005
10:40-11:00

HVDC GRID SUPPORT CAPABILITY IN JEJU GRID

Jung Hun LEE, So Seul Jung, and Gilsoo Jang*
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ESSII&HS : Energy Storage System II/Hybrid System

▌O-ESSII&HS

August 22 [Wed.] 13:20-14:40 [Room 304 of NUM Library]

Chair : Prof. Eun-Chel CHO (Sungkyunkwan University, Republic of Korea)

O-ESSII&HS-001
13:20-13:40

STUDY ON BATTERY CELL BALANCER

Turmandakh BAT-ORGIL[1,2], Bayasgalan DUGARJAV[2], and Toshihisa SHIMIZU[1]*
[1]*Department of Electrical Engineering and Computer Science, Tokyo Metropolitan University, Tokyo, Japan*
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**corresponding author (shimizut@tmu.ac.jp)*

O-ESSII&HS-002
13:40-14:00

SCREENING PROCESS OF MAZAALAI SATELLITE's NiMH BATTERY

Erdenebaatar DASHDONDOG[1]*, Amartuvshin DAGVASUMBEREL[2], Amartuvshin DAGVASUMBEREL[2], Turtogtokh TUMENJARGAL[2], Begzsuren TUMENDEMBEREL[3], and Bat-Otgon BAT-OCHIR[4]
[1]*Department of Physics, National University of Mongolia, Mongolia*
[2]*Department of Integrated Systems Engineering, Kyushu Institute of Technology, Japan*
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**corresponding author (erdenebaatar.d@num.edu.mn)*

O-ESSII&HS-003
14:00-14:20

SELF-POWERED HYBRID NANOGENERATOR FOR SIMULTANEOUSLY HARVESTING MECHANICAL AND SOLAR ENERGY

Hyunjun Kim, Moon-Hyun Chung, Seunghwan Yoo, and Hakgeun Jeong*
Energy ICT·ESS Lab., Korea Institute of Energy Research, Daejeon, Republic of Korea
**corresponding author (hgjeong@kier.re.kr)*

O-ESSII&HS-004
14:20-14:40

A SIMPLE FABRICATION OF PIEZOELECTRIC ENERGY HARVESTER WITH ELECTRICALLY CONDUCTIVE METAL TAPE

Moon Hyun Chung[1,2], Hyun-Jun Kim[1], Seunghwan Yoo[1,2], and Hakgeun Jeong[1]*
[1]*Energy ICT·ESS Laboratory, Korea Institute of Energy Research, Daejeon, Republic of Korea.*
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SHP&ME : Small Hydro Power/Marine Energy

▌O-SHP&ME

August 22 [Wed.] 13:20-14:40 [Room 305 of NUM Library]

Chair : Prof. Young-Do CHOI (Mokpo National University, Republic of Korea)

O-SHP&ME-001
13:20-13:40

HYDRAULIC DESIGN FOR PERFORMANCE IMPROVEMENT BY LOSS ANALYSIS IN HYDRO TURBINE AND MULTI-STAGE CENTRIFUGAL PUMP

Young-Do Choi[1]*, Ming Guo[2], and Zhenmu Chen[2]
[1]*Department of Mechanical Engineering, Institute of New and Renewable Energy Technology Research, Mokpo National University, Muan, Republic of Korea*
[2]*Graduate School, Department of Mechanical Engineering, Mokpo National University, Muan, Republic of Korea*
**corresponding author (ydchoi@mokpo.ac.kr)*

O-SHP&ME-002
13:40-14:00

NUMERICAL AND EXPERIMENTAL ANALYSIS OF MICRO-CLASS HYDRO FRANCIS TURBINE

Enkhtaivan Batmunkh, and Young Ho LEE*
Department of Mechanical Engineering, Graduate School, Korea Maritime and Ocean University, 727- Taejong-ro, Yeongdo-Gu, Busan 49112, Republic of Korea
**corresponding author (lyh@kmou.ac.kr)*

O-SHP&ME-003
14:00-14:20

MONGOLIA`S HYDRO POWER URGE AND DEVELOPMENT

Angarag Myagmar[1]*, and Boldbaatar Burentsagaan[2]*
[1]*Erdeneburen HPP project, Ministry of Energy, Ulaanbaatar,Mongolia*
[2]*Eg HPP project company, State property agency, Ministry of Energy, Mongolia*
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O-SHP&ME-004
14:20-14:40

OPTIMUM MOORING SYSTEM DESIGN FOR UNDERWATER FLOATING TIDAL CURRENT POWER DEVICE

Chul Hee JO, Su Jin HWANG, and Hong Jae PARK*
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WE : Wind Energy

▌O-WE

August 23 [Thu.] 09:20-10:20 [Room 202 of NUM Library]

Chair : Prof. Kyung Nam KOH (Jeju National University, Republic of Korea)

O-WE-001
09:20-09:40

LAB-SCALE EXPERIMENT OF HAWT BLADE PERFORMANCE TEST USING DIGITAL WIND TUNNEL

Jae Sang MOON, Sang-Kyun KANG, Sung Ho Yu, Sung Soo Park, and Jang-Ho LEE*
Department of Mechanical Engineering, Kunsan National University, Gunsan, Republic of Korea
**corresponding author (jangho@kunsan.ac.kr)*

O-WE-002
09:40-10:00

A STUDY ON BEARING LIFE PREDICTION FOR WIND TURBINE GENERATOR

Jin Hyuk SON[1], and Kyung Nam KOH[2]*
[1]*Multidisciplinary Graduate School Program for Wind Energy,Graduate School Program for Wind Energy, Jeju University, Jeju, Republic of Korea*
[2]*Faculty of Wind Energy Engineering, Graduate School, Jeju University, Jeju, Republic of Korea*
**corresponding author (gnkor2@jejunu.ac.kr)*

O-WE-003
10:00-10:20

DESIGN AND ANALYSIS OF A SMALL WIND TURBINE WITH A WIND SPEED AUGMENT DEVICE

P. Chanaka Hasitha Weerasena[1], Ali A. Mohammed[1], Ho Seong Yang[1], Hyeon Soo Park[1], and Young Ho Lee[2]*
[1]*Department of Mechanical Engineering, Graduate School, Korea Maritime and Ocean University, Busan, Republic of Korea*
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O-SGMG

August 23 [Thu.] 09:20-10:20 [Room 203 of NUM Library]

Chair : Dr. Erdenebaatar Dashdondog (National University of Mongolia, Mongolia)

O-SGMG-001
09:20-09:40

CURRENT CONTROL OF POWER CONVERTER USING CURRENT SENSORS INSIDE POWER MODULE FOR SMART GRID APPLICATION

Kensuke Suzuki, and Keiji Wada*
Department of Electric and Electrical Engineering, Tokyo Metropolitan University, Japan
**corresponding author (kj-wada@tmu.ac.jp)*

O-SGMG-002
09:40-10:00

SECURITY CONSTRAINED OPTIMAL POWER FLOW BASED ON DC POWER FLOW MODEL CONSIDERING VARIATION IN RENEWABLE ENERGY PENETRATION

BenJeMar-Hope Flores*, and Hwachang Song
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O-SGMG-003
10:00-10:20

RELIABILITY AND ECONOMIC STUDY ON PV-WIND HYBRID SYSTEM IN ISOLATED LOCALITY

OYUNDARI Davaanyam, and BAYASGALAN Dugarjav*
Department of Electronic and Communication Engineering, National University of Mongolia, Ulaanbaatar, Mongolia
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GE : Geothermal Energy

▌O-GE

August 23 [Thu.] 09:20-10:00 [Room 304 of NUM Library]

Chair : Mr. Purevsuren Dorj (National Renewable Energy Center, Mongolia)

O-GE-001
09:20-09:40

STATUS OF GEOTHERMAL ENERGY STUDY IN MONGOLIA

Dorj PUREVSUREN[1], and Tsend-Ayush NYAMBAYAR[2]*
[1]*General Engineer, National Renewable Energy Center, Ulaanbaatar, Mongolia*
[2]*Engineer, Institute of Geophysics and Astronomy, Academy of Sciences, Ulaanbaatar, Mongolia*
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O-GE-002
09:40-10:00

GEOMECHANICAL REVIEW ON INDUCED SEISMICITY OF HYDRAULIC STIMULATION IN ENHANCED GEOTHERMAL SYSTEM: ROLE OF DIFFERENTIAL STRESS

Linmao XIE, and Ki-Bok MIN*
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WEU : Waste Energy&Utilization

▮ O-WEU

August 23 [Thu.] 09:20-10:20 [Room 305 of NUM Library]

Chair : Dr. Hyung-Don LEE (Korea Testing Laboratory, Republic of Korea)

O-WEU-001
09:20-09:40

A STUDY ON LANDFILL ACCEPTANCE CRITERIA TO ENHANCE ENERGY RECOVERY AND RECYCLING OF WASTE IN KOREA

Kyuyeon KIM*, Suyoung LEE, Heesung MOON, Shinyoung CHO, and Taewan JEON
Environment Resources Research Department, NIER, Incheon, Republic of Korea
**corresponding author (qykim@korea.com)*

O-WEU-002
09:40-10:00

PRELIMINARY STUDY FOR CONSTRUCTION OF POWER PLANT USING LANDFILL GAS AT NARANGIIN ENGER DISPOSAL SITE, IN ULAANBAATAR, MONGOLIA

Hee-Dong Kwon[1,3], Hyung-Don Lee[2], and Seung-Kyu Chun[3]*
[1]*Climate Change Business Division, SUDOKWON Landfill Site Management Corporation, Incheon, Republic of Korea*
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[3]*Graduate School of Energy & Environment, Seoul National University of Science & Technology, Seoul, Republic of Korea*
**corresponding author (skchun@seoultech.ac.kr)*

O-WEU-003
10:00-10:20

DEVELOPMENT OF MILK COOLING PROTOCOLS TO INTEGRATE RENEWABLE ENERGY FOR MILK PRESERVATION

S.D.G.S.P.GUNAWARDANE[1]*, Rusiru RAJAKARUNA[1], L. RAJAPAKSE[1], Byoung Ha KIM[2], and Young HO LEE[2]
[1]*Department of Mechanical Engineering, University of Peradeniya Peradeniya, Sri Lanka*
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H&FC : Hydrogen&Fuel Cell

▮ O-H&FC

August 23 [Thu.] 10:40-12:00 [Room 203 of NUM Library]

Chair : Dr. Won Yong LEE (Korea Institute of Energy Research, Republic of Korea)

O-H&FC-001
10:40-11:00

SUBSYSTEM LEVEL FAULT DETECTION AND DIAGNOSIS OF A POLYMER ELECTROLYTE FUEL CELL SYSTEM

Won-Yong LEE[1]*, Min-Jin KIM[1,2], Hwan -Young OH[1], Seung-Gon Kim[1], and Young-Jun Sohn[1,2]

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O-H&FC-002
11:00-11:20

THERMOMECHANICAL STABLE FLEXIBLE SOLID OXIDE FUEL CELLS

Ok Sung Jeon[1], Jin Goo Lee[2], Ho Jung Hwang[3], Chanmin Lee[1], Oh Chan Kwon[1], Jeong Pil Kim[1], and Yong Gun Shul[1,3]*

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[2]School of chemistry, University of St Andrews, St Andrews, UK

[3]Graduate Program in New Energy and Battery Engineering, Yonsei University, Seoul, Republic of Korea

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O-H&FC-003
11:20-11:40

FAULT DIAGNOSIS OF FUEL CELL AIR SUPPLY SYSTEM

Hwan Yeong OH, Min Jin KIM, Young Jun SOHN, Seung Gon KIM, and Won Yong LEE*

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O-H&FC-004
11:40-12:00

POLYMER ELECTROYTE FUEL CELL OPERATION OF HIGH FUEL UTILIZATION BY ANODE RECYCLE OF EJECTOR

Jung Wook Yang[1], Beom Jun KIM[2]*, Nam Jin Lee[2], Min Ho Seo[2], and Chi Young Jung[2]

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ST : Solar Thermal

▌O-ST

August 23 [Thu.] 10:40-11:40 [Room 304 of NUM Library]

Chair : Prof. Enebish Namjil (National University of Mongolia, Mongolia)

O-ST-001
10:40-11:00

RESEARCH AND DEVELOPMENT ON THE SOLAR AIR HEATER

E.Zandargiraa, and A.Amarbayar*
Renewable Energy laboratory, School of Applied Science and Technology, National University of Mongolia, Ulaanbaatar, Mongolia
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O-ST-002
11:00-11:20

ANALYTICAL STUDY OF CSP INSTALLATION SCENARIO IN MONGOLIA USING AN ENERGY PERFORMANCE MODEL

Baldorj CHIMEDDORJ, Li-Hua Xu, and Hyung-Taek KIM*
Department of Energy System Research, Ajou University, Suwon, Republic of Korea
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O-ST-003
11:20-11:40

EVALUATION OF DUST DEPOSITION ON EVACUATED SOLAR THERMAL COLLECTORS IN MONGOLIA

Amarbayar Adiyabat[1]*, Purevdalai Erdenedavaa[2], and Atsushi Akisawa[2]
[1]School of Engineering and Applied Science, National University of Mongolia, Mongolia
[2]Graduate School of Bio-Applications and Systems Engineering, Tokyo University of Agriculture and Technology, Japan
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E&LCT : Environment and Low Carbon Technology

▌O-E&LCT

August 23 [Thu.] 10:40-11:40 [Room 305 of NUM Library]

Chair : Mr. Hee Dong KWON (Sudokwon Landfill Site Management Corp., Republic of Korea)

O-E&LCT-001
10:40-11:00

THE CLIMATE AND RENEWABLE ENERGY RESOURCES IN MONGOLIA

Batjargal Zamba*
Special Envoy of Mongolia for Climate Change, Government of Mongolia, Mongolia
**corresponding author (z_batjargal@yahoo.com, zbatjargal@mne.gov.mn)*

O-E&LCT-002
11:00-11:20

A POTENTIAL OF END-OF LIFE BATTERIES FOR HYBRID VEHICLES: FOCUS ON THE SECONDHAND VEHICLES FROM JAPAN

YU. Jeongsoo[1]*, and BAYASGALAN Dugarjav[2]
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O-E&LCT-003
11:20-11:40

LOW CARBON GREEN DEVELOPMENT OF MONGOLIA

BULGAN Tumendemberel*
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**corresponding author (bulgantumen@mne.gov.mn)*

Poster Discussion

Chair : Prof. Ulamorgil (Mongolian University of Science and Technology, Mongolia)
Prof. Juhoon BACK (Kwangwoon University, Republic of Korea)

PS&B : Policy, Strategy&New Business

▌P-PS&B

August 22 [Wed.], 11:00-12:00 [Lobby 2F of NUM Library]

P-PS&B-001

ASSESSMENT OF HIGH EFFECTIVE SEPARATION SYSTEM TO PROMOTE URBAN MINING

Daehyun WEE, Sangmi YOON, Jiwon KIM, and Jung Hyun CHOI*

Department of Environment Science and Engineering, Ewha Womans University, Seoul, Republic of Korea

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P-PS&B-002

INDONESIA'S NEW & RENEWABLE ENERGY POLICY NETWORK ANALYSIS

Inkyung CHO*

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P-PS&B-003

AN ECONOMIC ANALYSIS OF SOLAR PV SYSTEMS UNDER THE HOUSEHOLD SUPPORTING PROGRAMS IN KOREA

Gobong CHOI*

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P-PS&B-004

THE IMPACTS OF ELECTRIC VEHICLE IN KOREA

Surim Oh*

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P-PS&B-005

CHOICE BETWEEN NUCLEAR AND RENEWABLES IN DEVELOPING COUNTRIES

Soohyeon KIM*, Inkyung Cho, Soorim Oh, and Youngjib Choi

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P-PS&B-006

HYDROELECTRIC POWER AND NATURAL GAS ELECTRIC POWER USE - ECONOMIC GROWTH NEXUS: THE CASE OF MYANMAR

Kyaw Zin Hpyo[1], and Eunnyeong Heo[2]*

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P-PS&B-007

RESEARCH AND DEVELOPMENT ON PARTIAL HEATING DEVICE FOR MONGOLIAN GER.

Tsend-Ayush Oldokh, Batsugir Bat-Orshikh, Munkh-Erdene Tseveen, and Bayasgalan Dugarjav*

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P-PS&B-008

OPERATION CHARACTERISTICS USING AN ESS-EHP PACKAGE FOR A PEAK-OFF MANAGEMENT PROGRAM IN KOREA

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P-PS&B-009

FACTORS FOR RENEWABLE ENERGY TECHNOLOGY ASSESSMENT: ON THE CASE OF MONGOLIA

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P-PS&B-010

AN ECONOMIC ANALYSIS OF NEW AND RENEWABLE ENERGY BUILDING SUBSIDY IN KOREA

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P-PS&B-011

SURVEY ON CONSTRAINTS ON NUCLEAR POWER IN EVELOPING COUNTRIES - FOCUSED ON MYANMAR AND CAMBODIA

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P-PS&B-012

BEHAVIOR OF SPECULATORS ON ALUMINUM STOCKS

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P-PS&B-013

RESOLVING ENERGY EXPANSION CONSTRAINTS IN ASEAN COUNTRIES

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PV : Photovoltaics

▌P-PV

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-PV-001

LOW-COST PRODUCTION PROCESS FOR CU(IN,GA)SE_2 THIN FILM SOLAR CELL

Na Kyoung Youn[1,2], SeJin Ahn[1], Ara Cho[1], Jihye Gwak[1], Seung Kyu Ahn[1], Jun Sik Cho[1], Joo Hyung Park[1], Jin Soo Yoo[1], Kihwan Kim[1], Donghyeop Shin[1], In-Young Jeong[1], Jae Ho Yun[1], Young-Joo Eo[1]*, and Dong-Hwan Kim[2]*

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P-PV-002

ESTABLISHMENT OF BIFACIAL SOLAR CELL MEASUREMENT TECHNIQUE AT THE KOREA INSTITUTE OF ENERGY RESEARCH (KIER)

Seung Kyu Ahn*, Kihwan Kim, Jae Ho Yun, Ara Cho, Young Ju Eo, Jun-Sik Cho, SeJin Ahn, Joo Hyung Park, Jin Su Yoo, Donghyup Shin, Inyoung Jung, and Jihye Gwak

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P-PV-003

ELECTROCHROMIC PROPERTIES OF SOL-GEL DERIVED TITANIUM DOPED WO3 FILM

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P-PV-004

ENHANCED ELECTROCHROMIC PROPERTIES OF TITANIUM OXIDE NANOCRYSTAL EMBEDDED AMORPHOUS TUNSTEN OXIDE FILMS

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P-PV-005

PLANAR HOLE-CONDUCTOR FREE PEROVSKITE SOLAR CELLS WITH CARBON ELECTRODE

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P-PV-006

IMPROVING WATER RESISTANCE OF PEROVSKIOTE SOLAR CELLS WITH AN ENCAPSULATION OF POLYDIMETHYLSILOXANE

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P-PV-007

USING RENEWABLE ENERGY AS A HOUSEHOLD HEATING: CASE STUDY IN MONGOLIA

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P-PV-008

CHARACTERIZATION ANALYSIS OF OPTIMIZED SIO_2 / SIONX STACK PASSIVATION LAYER AND STUDY ON APPLICATION OF HIGH EFFICIENCY N-TYPE C-SI SOLAR CELL

Se Hyeon KIM[1], Geon Ju YOON[1], Seong Ho JEON[1], Donggi SHIN[1], JungSoo KIM[1], Taeyong KIM[1], Young Kuk KIM[1], Sang Ho KIM[2], and Jun Sin YI[1]*
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ESS : Energy Storage System

▌P-ESS

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-ESS-001

FABRICATION OF COPPER/NICKEL OXIDE NANOPARTICLES ON ACTIVATED CARBON VIA A LIQUID PHASE PLASMA METHOD AND ITS APPLICATION AS SUPERCAPACITOR

Won-June LEE, Heon LEE, and Sang-Chul JUNG*
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P-ESS-002

SOC BALANCE STRATEGY OF LI-ION BATTERY SYSTEM BY USING FUZZY LOGIC CONTROL SYSTEM

Prakash Thapa[1], Hui Il Chang[2], Kil Ju Na[3], Sung Gi Kwon[1], Jin Lee[1], and Gye Choon Park[1]*
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HS : Hybrid System

▮ P-HS

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-HS-001

STUDY ON POSSIBILITY OF PROVIDING HEATING AND ELECTRICITY DEMAND OF A HOUSEHOLD USING GRID CONNECTED PV SYSTEM WITH ENERGY STORAGE

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SH : Small Hydro Power

▌P-SH

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-SH-001

A STUDY ON THE CONSTRUCTION OF HORIZONTAL AND VERTICAL AXIAL MODEL TURBINE TEST FACILITIES

Jung Jae HYUN, Yun Ryeong OH, Hyun Sik JO, Sung Taek HONG, Ho Hyun LEE, and Jong Woong CHOI*

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▮ P-ME

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-ME-001

OPTIMIZE THE DIFFUSER OF A TIDAL CURRENT TURBINE USING RESPONSE SURFACE METHOD

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GE : Geothermal Energy

P-GE

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-GE-001

GEOTHERMAL HEAT PUMP RESULTS IN ULAANBAATAR

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WE : Wind Energy

▮ P-WE

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-WE-001

DESIGN AND SIMULATION OF TWO SMALL HORIZONTAL AXIS WIND TURBINE

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P-WE-002

STUDY ON OPTIMAL LAYOUT METAMODEL FOR SMALL OFFSHORE WIND FARM

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P-WE-003

SCOUR RISK ASSESSMENT FOR OFFSHORE WIND TURBINE SUPPORT STRUCTURES

Dong Hyawn KIM[1]*, Young Jin KIM[2], Gee Nam LEE[2], NGO DUC VU[2], and Soo Young LIM[1]

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P-WE-004

PHYSICAL PROPERTIES WITH POLYMERIZATION CONDITIONS OF T-RTM PROCESS FOR CFPA6 COMPOSITES BY RESPONSE SURFACE METHOD

Ki Weon KANG[1]*, Chan Woong CHOI[1], Jang Ho LEE[1], Young Chul KIM, and Byung Young Moon[2]

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P-WE-005

VIBRATION SUPPRESSION CONTROL FOR TWO-INERTIA SYSTEM

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P-WE-006

ACCURATE ESTIMATION OF GENERATOR SPEED IN VARIABLE SPEED WIND TURBINE

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P-WE-007

CALCULATION OF POWER LOSSES OF TRASNMISSION LINE OF INTERNAL GRID IN A WIND POWER PLANT

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P-WE-008

A STUDY ON THE EFFECT OF VIBRATION REDUCTION BY COMPENSATING YAW MISALIGNMENTS OF WIND TURBINE USING NACELLE LIDAR

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WEU : Wasted Energy & Utilization

▮ P-WEU

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-WEU-001

FLUID FLOW ANALYSIS OF AN EJECT CIRCULATOR

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LCT : Low Carbon Technology

▌P-LCT

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-LCT-001

A NUMERICAL STUDY ON THE EFFECTIVE VARIABLE SPEED VENTILATION FLOWS FOR CONTAMINANTS AND TEMPERATURE CONDITIONS IN THE INDUSTRIAL FACILITY

Sungjin YANG*, Myungsung LEE, and Joo Han KIM
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P-LCT-002

A NUMERICAL STUDY ON A 330W WALL AXIAL FAN USING COMMERCIAL CFD CODE AND OPEN SOURCE CFD CODE

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P-LCT-003

DEVELOPMENT OF SYNCHRONOUS RELUCTANCE MOTORS WITH SUPER-PREMIUM EFFICIENCY CLASS (IE4)

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H&FC : Hydrogen&Fuel Cell

▌P-H&FC

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-H&FC-001

EXPERIMENTAL STUDY ON ALKALINE ELECTROLYSIS OF CNF AQUEOUS SOLUTION

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P-H&FC-002

TEMPERATURE MEASUREMENT INSIDE PEMFC CHANNEL USING INFRARED THERMOGRAPHY

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P-H&FC-003

ELECTROSPUN TIO_2/ZRO_2 NANOFIBER REINFORCED MEMBRANES FOR HIGH TEMPERATURE PEMFC APPLICATION

Oh Chan Kwon[1], Ho Jung Hwang[2], Yunseong Ji[1], Oksung Jeon[1], Jeong Pil Kim[1], Chan Min Lee[1]*, and Yong-Gun Shul[1,2]*
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P-H&FC-004

THERMALLY TREATED GRAPHITIC CARBON NANOFIBER FOR HIGHLY EFFECTIVE AND DURABLE PEMFC ELECTROCATALYSTS

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P-H&FC-005

HIGHLY STABLE AND PERFORMANCE-IMPROVED PT/TIO_2 NANOFIBER CATALYSTS

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P-H&FC-006

STUDY ON HEATING SYSTEM BASED ON LENR AND PLASMA ELECTROLYSIS

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P-H&FC-007

A NANOFIBROUS OXIDE-CARBON COMPOSITE SUPPORT FOR A HIGHLY ACTIVE AND STABLE PEMFC CATHODE CATALYST

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▮ P-CCT&CCS

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-CCT&CCS-001

SO_2 SORPTION PROPERTY OF POTASSIUM-BASED DRY SORBENTS AT A LOW TEMPERATURE RANGE BELOW 70 °C

Ho Jin Chae[1], Soo Jae Lee[2], Min Sun Cho[1], Yong Mok Kwon[1], Byung Wook Hwang[1], Soo Chool Lee[3]*, and Jae Chang Kim[1]*

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SG : Smart Grid

▌P-SG

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-SG-001

A STUDY ON PHASE ANGLE DETECTING ALGORITHM FOR GRID TIED INVERTER

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▮ P-BE

August 22 [Wed.], 11:00-12:00 [Lobby 2F]

P-BE-001

OPTIMIZATION OF BIOGAS PRODUCTION FROM KITCHEN WASTE INSTALLED AT COLLEGE OF SCIENCE AND TECHNOLOGY, BHUTAN

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Opening Session

THE CURRENT STATUS OF RENEWABLE ENERGY IN MONGOLIA

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Due to abundance of renewable energy resources especially wind energy resource the government of Mongolia is set target to increase renewable energy share in total energy. The state energy policy paper adopted by Parliament of Mongolia set target to reach 30 percent share of renewable energy in total energy of Mongolia. The wind and solar energy has potential to make major contribution in such increased application of renewable energy. The recent years' experience of application of the first wind and solar farms in Mongolia clearly showed need of careful planning, technical design and forecasting possible impact on the national grid network in order to successfully utilize wind energy in the future.

RENEWABLE ENERGY COOPERATION IN NORTHEAST ASIA

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Objectives of Super Grid as a dream project is to construct large scale renewable power plants and transmission network in Gobi desert for sharing generated electricity with neighboring countries in North-East Asia. In addition, the driving force for Korea is the need for energy independence, moving away from the dependence on fossil fuel import and nuclear power plant. Renewable Energy, as a core technology of Super Grid, is becoming more important in Korea with rapidly changing domestic business environment due to the frequent fluctuation of international petroleum price and UN framework convention on climate change.

For the promotion of Super Grid, the core technologies are large scale RE power generation in the Gobi Desert, IT, WAMS, ESS, and HVDC. Expected effects are technical benefits, economic benefits, social benefits, and environmental benefits. And key challenges could be the consensus among participating countries and stakeholders, developing implementation road map with action plan, and developing managing rules and establishing organizations needed.

In this paper, results of the feasibility study from 2015~2016 are reviewed and status of Super Grid in Northeast Asia is also introduced for discussion.

At present, a practical project for demonstration site in the next stage has been proposed to raise funds which will carry out site selection, analysis of weather and electrical condition, and actual design for demonstration site.

NORTHEAST ASIA POWER SYSTEM INTERCONNECTION (NAPSI)

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As part of the Asian Development Bank (ADB) country operations business plan for 2015, the Government of Mongolia sought ADB technical assistance (TA) to prepare a strategy for Northeast Asia power system interconnection (NAPSI) using Mongolia's abundant renewable energy. To reduce the carbon footprint, a low carbon transformation is needed as the power sector is the single largest source of greenhouse gas emissions in the region. Although the region has sufficient renewable sources to meet demand, limited connectivity, unique power utility ownership, tariff policies, market design and regulations and other institutional frameworks that are not well coordinated pose challenges to prevent against energy shortage and high energy cost.

NAPSI work has begun starting from May 2017 and it is being led by Électricité de France (EDF), leading European electricity company, supported by NovaTerra as the local consultant. With the progression of this TA, six workshops will be held in various countries, engaging the relevant stakeholders from Mongolia, China, Russia, Japan and South Korea.

The impacts of the TA will be reduction of carbon footprints of the power system in Northeast Asia, optimization of the power system and consensus among the stakeholders. The outcome of the TA will be a strategy detailing an action plan and road map utilizing Mongolia's vast energy resources.

Special Session

CURRENT STATE OF MONGOLIAN ELECTRIC VEHICLE INDUSTRY

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In this article presents Mongolian electric vehicle development, manufacturing industries, and near goals. First, in 1987, remedial depot of 150 trolleys, 13 secondary station of electric provision. We built complement trolleys with 250 km contacts and electric network. Until now, during the 31 years, we serviced public transportation in Ulaanbaatar. In 2006, we manufactured first trolley also this year finish this trolley's usage time successfully. We manufactured totally 87 trolleys, 5 kinds of 50 electric vehicles successfully. That means this subsidiary base of development also standardize and confirmed evaluation of adjustment practice. We can see our future significant, further using electric bus in public transportation, electric taxi, using private usage electric vehicle. That will influence bondage of import gas, decreasing air pollution, frugality, smart consumption. Based on the experiment of trolleybus industry, Ecologbus LLC is developing the EV's in Mongolia and plays main role in Mongolian market. The Ecologbus company is manufacturing several kind of vehicles, for example duobus-battery and genset supplied bus, battery electric vehicle with small medium and grand size buses.

Keywords: trolley, duobus, electic vehicle, battery electric vehicle,

O-SSI-004

IMPACTS ON ELECTRICITY CONSUMPTION AND REDUCTION OF CO_2 EMISSION ACCORDING TO ELECTRIC VEHICLE PENETRATION IN JEJU ISLAND

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The provincial government of Jeju Island declared "Carbon-Free Island, Jeju by 2030" plan in 2012. To reach the goals, the penetration of electric vehicles must increase year by year in Jeju Island. And the increase of electric vehicles increases the electricity consumption and decreases CO_2 emissions. To preventing electric power of electric grid from increasing during electric power peak time according to increase of electric vehicles, the time of use electricity pricing system for charging electric vehicles is implemented in Korea. The objective of this study estimates the resulting impact on electricity consumption and the reduction of CO_2 emissions up to 2030. The results show that demand of electric energy will increase 54% according to 100% penetrated electric vehicles by 2030. And the reduction of CO_2 emissions will reach to 2.78×10^6kg and 4.90×10^6kg by 2030 according to 100% penetrated electric vehicles and 100% renewable energy, respectively.

ACKNOWLEDGMENT

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INDUCED PRODUCTION EFFECT OF PHOTOVOLTAIC POWER AND NATURAL GAS POWER PLANT

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The Korean government push ahead various policies to disseminate photovoltaic (PV), wind power, small hydro, bio-fuel, etc. The R&D budgetary supports for Renewable Energy System increased in the past decades. It is necessary to confirm RES budget expenditure that renewable energy promotion policy makes good performance evaluated in quantity level. In addition the 8th electricity supply basic plan adds significances on environmental protection and public safety to the 7th planning, which aimed to achieve reliability and efficiency in generation mix. According to the new plan, nuclear and coal-fired power plants are planned to be phased out steadily, while renewable energy and LNG power plants are to enter to the system. This paper made Input-Output Table 2010 contains both photovoltaic power generation equipment industry and LNG power plant construction industry as dependent sectors and analyzed induced production effect by demand of photovoltaic power generation equipment industry and LNG power plant construction industry. Photovoltaic power generation equipment is estimated to give the production induced coefficient of 1.932 and employment induced coefficient of 2.9 people/bil. Won. LNG Power Plant Construction is estimated to give the production induced coefficient of 2.258 and employment induced coefficient of 6.2 people/ bil. Won. LNG Power Plant operation is estimated to result in the production induction coefficient of 1.176 and employment induced coefficient of 1.1 people/bil. Won. Induced impacts of both production and employment by increasing LNG power generations are estimated to be equal or greater those induced by Photovoltaic power generation equipment.

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OPTIMAL FUEL TAX POLICY WITH DRIVING, GASOLINE USE, AND VEHICLE FUEL EFFICIENCY

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The paper derives the optimal tax policy for gasoline by solving a Ramsey planner problem. Frist, we construct a dynamic general equilibrium model to study the endogenous determination of gasoline use, driving and vehicle fuel efficiency. Before vehicles are produced, their fuel efficiency can be chosen optimally. Once produced, their fuel efficiency cannot be changed. Second, we find dynamic paths of gasoline use, driving and vehicle fuel efficiency to maximize the Ramsey planner's utility. The simulation results for the competitive equilibrium and the Ramsey solution show that in the long run, they are different in terms of the transmission mechanism, magnitudes of responses and dynamic paths of key endogenous variables. In response to an 1% increase in fuel cost, the optimal tax rate for the Ramsey planner decreases temporarily to relieve cost burden of vehicle owners and smooth their welfare.

OPTIONS FOR MONGOLIA IN ENERGY TRANSITION TO 100% RENEWABLES

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Energy transition towards higher shares of renewable energy (RE) is a priority reflected in the National Renewable Energy development program of Mongolia (2006-2020). Mongolia has a great potential to achieve their RE development targets and build a 100% RE-based system: excellent solar and wind conditions, complemented by hydro and geothermal power potential in some parts of the country. This paper describes the methodology and results of a study on the different possible options of energy transition scenarios for 100% RE supply for Mongolia using an hourly resolved linear optimization model for energy systems, which allows to define: an optimal set of technologies which are best adapted to the available resources in the country, optimal values of installed capacities for every technology and optimal operational modes of the system elements to reach least cost energy supply with respect to given constrains. The input data for the analysis of 100% RE supply options for Mongolian energy system includes the solar and wind conditions, hydro and geothermal power sources: PV system (on-grid residential, commercial and industrial self-supply), ground-mounted PV (large scale plants, fixed tilted and single-axis tracking), onshore wind turbines and concentrating solar thermal electricity generation (CSP). As a fossil fuel source we utilize coal, natural gas and as for the energy storage technologies: batteries, pumped storage hydro, gas storage and thermal energy storage. The simulation was carried out using long-term database of solar, wind, hydro and geothermal resources of Mongolia at full hourly resolution for an entire year. In this analysis the total electricity demand was assumed to increase from approximately 6TWh in 2018 to around 17TWh in the year 2050. Results of the simulation show that for the energy transition to 100% renewables the solar PV increasingly drives most of the system, while wind energy complements and hydro, geothermal and storage provides flexibility to the power system. The solar PV power share increases from more than 32% in 2030 to about 74% in 2050 becoming the least cost energy source and batteries are the most important to provide flexibility to the energy system of Mongolia. The simulations are made for the years 2020, 2030, 2040 and 2050 considering various technical options and operational modes with certain financial and technical assumptions and results shows that a 100% RE-based power system is more efficient and cost competitive than a fossil-based option for Mongolia by 2050. The simulations are made for the years 2020, 2030, 2040 and 2050 considering various technical options and operational modes with certain financial and technical assumptions. As results, a 100% RE-based system by 2050 will be lower in cost than the existing coal-fired fossil fuel-based system and the average levelised cost of electricity (LCOE) will decline to around 53.6€/MWh for 100% Renewables in 2050 (including curtailment, storage and some grid costs) compared to the total LCOE of 78.1€/MWh in 2018. The simulation results also indicates that the GHG emissions can be reduced from about 5 $MtCO_{2eq}$ in 2018 to zero by 2050 as fossil coal-fired power plants are eliminated from the system, while the total LCOE of the energy system declines

COMPARATIVE ANALYSIS OF THD TRANSIENT MODEL OF HYBRID HVDC AND FACTS PERFORMANCE FOR AVOIDING COMMUTATION FAILURE

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This article will discuss a new hybrid transmission method for the microgrid, which is different from traditional high-voltage direct current (HVDC) transmission. The new way will used Hybrid bipolar HVDC to compare with the flexible AC transmission systems (FACTS) which modeling based on Real Time Digital simulator (RTDS). An interconnected power system includes synchronous generators, hybrid bipolar HVDC, FACTS and variable loads. Experiments are needed to compare the commutation failure immunity index (CFII), TOV of the system under different conditions and to make a delicate analysis about the state of commutation failure and the changes of the extinction angle when faults occur. Single phase inductive ground fault will be used respectively on the rectifier side and the inverter side. Then the experiment results will compare again by changing the SCR of AC system which connected with HVDC system. Also, the third experiment will change the gain of the outer loop controller and observe the results at the time of the faults. At the same time, its comparative analysis of the transient states and fault recovery time of each line for faults. Further analysis of the hybrid bipolar HVDC and LCC-FACTS for evaluating the performance of the HVDC system.

O-SSIII-005

AN ADVANCED TECHNOLOGIES OF GRID AND INTERCONNECTION SOLUTIONS OF RENEWABLE ENERGY

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Advanced technologies of grid and interconnection solutions of renewable energy and specially focusing on the high tech HVDC, FACTS (Energy storage etc.) and renewable technologies will be discussed in this paper. In an attempt to develop Asian super grid, this paper evaluated the solutions and technologies applied for Asian Super Grid regulations when it is connected to Mongolia power grid, further examined the opportunities to improve the project economic benefits and system stability and reliabilities. It brings further advantages such as grid resilience, trade of electricity to reach healthy price levels, avoids excessive construction and enables renewable power plants to be constructed at sites with the best conditions for solar and wind.

Currently, number of HVDC technologies are commercially available and we studied these options with latest control and protection systems and in an attempt to identify the optimal technology that can deliver greater efficiency and reliability of the Asian Super Grid while bringing substantial benefits, facilitating more interconnections, greater integration of renewables and lowering environmental impact. Even energy storage is considered to be the good solution to integrate renewable generation into the grid and it significantly increases the electricity cost, it should be the attractive application with optimal capacity.

O-SSIV-001

ENERGY INDEPENDENT PASSIVHAUS IN KOREA AND IT'S POTENTIAL APPLICATION TO THE MONGOLIAN ARID AND SEMI-ARID REGION

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Most land of Mongolia is located in the cold or cold temperate climate zone. In winter the temperature often falls below -30 Centigrades. To keep the indoor climate warm and to achieve relative comfortable indoor space, much of heating energy is required. Especially for the traditional housing ger, it should be heated vigorously to get minimum indoor space comfort. The ger is mostly heated by hard coal, and because it is burned in the indoor space, the hazardous gases generated during burning affect the health of the inhabitants and the air quality of the big city like Ulanbator. The highly energy efficient Passivhaus could contribute for solving or mitigating this situation. In Korea I realized energy independent Passivhauses in 2013 and 2014 with relative low buget. During last five or four years these houses could produce most of energy they needed from their off-grid solar power plant and verified the idea of energy independence. This concept of energy independence achieved with Passivhaus building technology and solar facility could be well applied to the Mogolian housing and contribute to solve the air pollution problems.

O-SSIV-002

ENERGY USE REDUCTION IN LOWRISE HOUSING ZONES BY DESIGNING TECHNIQUES

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Problematic issues of urbanization are becoming major challenges in UB urban area, as other cities of the South. Rapid population growth of capital city caused by immigration from rural, extends monofunctional land use of low rise residential zones and it makes the urban sprawl in fringe areas. Widespread usage of exhaustible and non-renewable resource in this type of settlement produces multi type pollutions and it degrades inhabitant's health crucially. Major percent (56.7% households, by 2016) of population of this part live energy inefficient self-built houses and Gers (traditional home), which heats by mostly raw coal. Previous some studies gave tremendous heat loss results of those sorts of accommodations. Average acceptable heat consumption rate allowed to be 200kW.hr/sq.m.year in Mongolia, but the current statistics is saying that, it takes from 150 to 600, not comparable with European standard, comparable 40-70 kW.hr/sq.m.year. According to sustainable future urban development concept, such unplanned urban parts should be densely planned (under the Population density, FAR, BCR norms and standards) and homes constructed to follow energy efficient building requirements. Such as PHPP (Passive House Planning Package) software's calculations are useful to predict annual an energy balance of heating. Selection of building materials and architectural designing techniques are giving appropriate results in model-based energy consuming simulations.

O-SSIV-003

SUSTAINABLE HOUSING IN MONGOLIA

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Although Mongolia has known for its' arid, cold, harsh winters, there are plenty of sunny days. In order to capture the solar energy for high annual heating demand, there are several proven technology available today such as PV, Solar thermal system or Passive House concept. We have combined these technology on a model housing project in Dundgobi province, to prove that a sustainable housing with minimal demand of energy is achievable in Mongolian harsh climate. Passive House standard is implemented into the Model house, as well as on-site renewable technologies such as black water recycling system, earth heat exchanger, seasonal thermal storage system that stores summer excess solar thermal energy for winter heating demand, PV electric heating system for domestic hot water, solar thermal stratified vertical tank for various temperature of heat demand. We have chosen locally available materials such as cellulose insulation and foam concrete for the foundation in order to fulfill both the cost demand of local housing market and Passive house standard.

O-SSIV-004

EXPERIMENTAL EVALUATION OF WAYS TO REDUCE AIR POLLUTION THROUGH EFFICIENT ENERGY USAGE IN GER DISTRICT IN MONGOLIA

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With Ulaanbaatar being among the most polluted capitals in the world and 60% of households living in ger districts, it is of utmost importance to reduce the amount of coal burnt in ger districts. There are several ways to improve gers. We installed a thermal storage electric heater, improved insulation of all areas and added a foundation to a ger and compared it to a regular ger in order to get a reference.

Results have been very promising with an improvement of 41% less energy used in the experimental ger. Heat lost into the ground has been reduced by a factor of 7.5. Heat losses over areas have been listed and suggestions to further improve insulation have been made. The effects of the thermal storage electric heater have been compared to that of a normal stove and several advantages including the fact that electricity is free during night speak for the usage of said heater.

O-SSV-001

THE WIND FARM OPERATIONAL ISSUES IN HARSH CLIMATE CONDITION

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Mongolia has enormous wind and solar resources and low population density makes such areas attractive for wind and solar energy generation, but weather conditions hinder the exploitation of these resources. The purpose of this report is to introduce the operation of the wind and solar power plant of Mongolia in severe cold climate. It means icing conditions and low temperatures outside the normal operational limits of the wind turbines and solar panels. Salkhit wind farm is connected to the central regional power system of Mongolia, the turbines need to have time to adapt to the climate and weather. Many technical as well as health and safety issues need to be addressed before wind and solar energy project investments whether can be economically feasible in cold climates. Icing of wind turbines reduces energy yield, reduces the mechanical life time of turbines, and poses safety risks in the form of ice throw, among other challenges. Snow cleaning by solar plants is a problem for large scale solar plants. Progress to solve these challenges has been made in recent years, for example, anti- and de-icing systems have been developed, but still more is to be done to reduce further the cost of wind energy in cold climates.

O-SSV-002

ZONE PLANNING FOR WIND ENERGY DISSEMINATION

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In Korea, the government has announced an ambitious plan named Renewables 3020 to produce 20% of total domestic energy production by renewables mainly PV and wind energy in 2030. The current related legislations and legal processes are, however, not favorable to achieve the plan successfully. Wind farm development in every country is not easy project mainly due to public acceptance, environment impact, and permissions and licensing, etc. Public acceptance is issued by local resident around planned wind farm site and environment impact is involved with local resident, government authorities, and non-governmental organizations. In processes of permissions and licensing, local and central governments are main agents. Renewable 3020 requires deployment of about 17MW wind capacity in 2030 and that makes us reorganize legislations and legal processes in more efficient and fare enough to stakeholder. In this regard, the author has reviewed existing laws and licensing processes with precedent wind farm development projects faced with public acceptance and environmental issues. As a results, the author suggests zone planning for wind energy and public acceptance improvement plans.

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O-SSV-003

INVESTIGATION ON WAKE EFFECT ON ONSHORE WIND FARM SITUATED IN COMPLEX TERRAIN

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In order to clarify the wake effect behind wind turbines of a wind farm located on complex terrain, Computational Fluid Dynamics (CFD) simulations was performed by WindModeller software, which is the module for wind farm simulation developed by ANSYS. The wake is modelled by actuator disc model approach which is defined based on wind turbine thrust coefficient and wind speed. WindModeller simulation was carried out for a DBK wind farm located on Jeju Island, Korea. The nacelle wind speed data from 15 Hanjin 2MW turbines were collected through the Supervisory Control And Data Acquisition (SCADA) system. The wind condition was measured from a 80m-tall met mast near the wind farm, which was used as a reference wind data. The site is located on a complex terrain with landfill and quarries close to the turbines and 2 hills are 2km away from the site. WindModeller simulated the wind speed and turbulence intensity for the wind farm with 9.4 m/s of wind speed, 66 degrees of wind direction and 9.1 m/s of wind speed, 288 degrees of wind direction, respectively. The wakes from the single and the multiple turbines were predicted by WindModeller, which were compared with the actual wind data from SCADA system. Then, the wake effect was analyzed with the distance between wind turbines. As a result, it is confirmed that some of the turbines were affected by the wake from the hills.

O-SSV-004

A STUDY ON WIND SPEED VARIABILITY FOR ONSHORE AND OFFSHORE SITES ON JEJU ISLAND, SOUTH KOREA

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One of main uncertainty factors for the estimated electricity production for future wind power projects is the long-term wind variability at given sites. Thus, wind farm developers should analyze the long-term wind variability to reduce their business risks. In order to estimate wind speed variability an investigation on variations of onshore and offshore wind speeds was conducted on Jeju Island, South Korea. The selected sites were various onshore and offshore sites and the long-term wind speed data were collected from the sites. Onshore sites with various topographical conditions were chosen to evaluate the effect of topographical conditions on wind speed variability. In addition, the onshore long-term wind condition were measured by wind sensors on automatic weather system(AWS) while the offshore wind condition was gained from the reanalysis data which are produced based on the numerical weather prediction(NWP) models. For wind variability in different time scales, diurnal, monthly and yearly variations of wind speed and wind power density were analyzed and then compared each other. As a result, the outcome of statistically analyzed variability for different onshore and offshore sites on Jeju Island was presented in this study.

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RENEWABLE ENERGY REGULARTORY ISSUES IN ENERGY SYSTEM OF MONGOLIA

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Today, when renewable energy defines future energy trends, technology costs of solar panels and wind turbine is decreasing in the international market from year to year and it is becoming cheaper than the technology cost of power plants based on conventional energy resources such as coal and natural gas. Currently, two wind farms and two solar power plants built with private investment are operating in Mongolia while many other solar and wind power plants are planned to be built. There are some issues that need to be solved as new technology is being localized. In technical terms, when connecting the Renewable power plant to the integrated system, there is a situation where the production of renewable energy generators need to be curtailed sometimes, depending on the nature of Mongolia's electricity consumption, whereas tariff for electricity from sun and wind power plants is higher than unit-cost of electricity from traditional sources. Therefore, it is necessary to address some regulatory issues of how and from where to compensate the loss from price difference, whether or not to provide compensation to electricity that is curtailed to technical requirements and the legal and regulatory aspects of renewable energy licenses and tariff approval.

As a result of many countries have been introduced a competitive bidding mechanism rather than legalize fixed price for electricity purchased from Renewable energy power plants, price per kWh is rapidly decreasing. The introduction of competitive bidding mechanism gives opportunities for purchaser to determine their own electricity demand based on their own financial capabilities and purchase cheapest price for renewable energy through competitive bidding mechanism.

Key words: Wind farm, solar power plant, renewable energy tariff, Auction

ISSUES ON RENEWABLE ENERGY TARIFFS IN MONGOLIA

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Since the Law of Mongolia on Renewable Energy was adopted in 11st January, 2007 four wind and solar PV power plants are operating.

Feed-in-tariffs for the electricity generated and supplied by solar, wind, hydropower are clearly outlined in the law on renewable energy, which did not changed for 11 years since 2007. The amendment of the law was adopted in 2015, it provides the "supportive tariff" for renewable energy, which is set to be calculated by absorbing levy in selling prices and therefore the levy to be renewed annually. Today, when investment cost of RE is decreasing due to the fact that feed-in-tariffs set by the law have not changed for many years, requests for establishing and operating RE generators increased and a large number of licenses are provided, therefore the renewable energy levy in consumer tariffs is increasing from year to year.

Today, competitive market principle has not been implemented in energy system of Mongolia yet, electricity tariffs are fully regulated by the state, also there is, to some degree, political influence in government regulation and consumers have negative attitude towards tariff changes. In that case raising levy every year will further increase the social protest.

Accordingly, this report highlights the impact of high feed-in-tariffs specified by the Renewable Energy Law on the energy sector of the economy, the growth trend of the percentage of levy in consumer tariffs, also its negative consequences, the challenges it faces and we hope to share some ideas on solutions of this problem.

O-PS&B-003

A STUDY FOR THE ECONOMIC, ENVIRONMENTAL, AND SOCIAL EFFECTS OF GREEN PUBLIC PROCUREMENT POLICY IN KOREA

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It passed over almost 10 years of introducing GPP (Green Public Procurement) policy against GHG (Green House Gas) emission reduction and green industry promotion simultaneously in Korea. However, there is almost nothing to evaluate of GPP policy such as what's the economic, environmental, and social performance of the policy.

This paper develops a methodology of analyzing economic, environmental, and social effect of GPP policy in the long run. In spite of data restriction, it has generated new types of GPP statistics in collaborate with KIETI (Korea Environmental Industry & Technology Institute) to construct GPP sector independently in the model. The study newly developed standard CGE model including GPP sector, called 'GPP CGE model'. The study considers new and renewable energy goals 3020 based on GHG mitigation target in Korea. We may estimate or expect that GPP policy can contribute economic performance mitigating environmental degradation including GHG and promoting green technology.

Paper proposes quantitative analysis methodology based on GPP CGE model and calculate the economic and environmental effects of GPP policy in national level. Finally, it will be completed with few policy recommendations such as the importance of green technology and the GPP policy promotion.

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ENERGY CONSERVATION AND EFFICIENCY POLICY IN MONGOLIA

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The law and legalizing environment have been introduced first time in Mongolia to regulate relations of energy conservation and usage efficiency with rationale of improving economic capabilities by encouraging sustainable development, introducing environmentally friendly technology and equipment, as well as creating awareness among consumers and aiming to improve living conditions for general public.

With increasing demand of energy usage, there is a greater need to generate energy supply through sustainable resources, and it is agreed internationally that the most beneficial method is calculating service organizations' electricity consumption per capita and encouraging industries use energy efficiently and accordingly within calculation in order to implement policies for energy conservation effectively. Therefore, following presentation focuses on the energy conservation, the energy efficiency concept, the implementation of the Energy Conservation Law, encouraging best practices and mentioning further issues to consider.

AN ANALYSIS ON LEVELIZED COST OF ELECTRICITY FOR INDEPENDENT POWER SYSTEMS: THE CASE OF MALAHINI KUDA BANDOS RESORT IN MALDIVES

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The concept of grid parity has become more significant as the cost of renewable technologies dropped drastically in recent years. Achieving grid parity is especially important to Small Island Developing States (SIDS) that are keen to adopt renewable energy systems fully to reduce their heavy reliance on imported oil and fossil fuels for power generation. With declining costs and increasing performance of solar photovoltaic (PV) as well as declining costs and technological improvements in electricity storage and control systems, adopting optimum combination of renewable energy systems could allow SIDS to diversify the source of energy supply. In this respect, this paper explores the three cases that could allow one of the SIDS, Maldives, to achieve PV grid parity: Diesel only, PV-Diesel, or PV-Energy Storage System (ESS)-Diesel. Based on the load pattern data from Malahini Kuda Bandos resort in Maldives, technical criteria will be examined using HOMER to suggest which combination of renewable energy systems could achieve grid parity within the shortest period of time. Moreover, such environmental criteria as CO2 emission level and renewable shares will be reviewed to suggest that adopting PV-ESS-Diesel combination of renewable energy systems could contribute to GHG mitigation and climate adaptation efforts the most.

ESTIMATION OF SOLAR ENERGY POTENTIAL OVER MONGOLIA BASED ON SATELLITE DATA

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We propose to map solar irradiance of Mongolia using fine resolution satellite data and limited ground measurements. We have implemented a semi-physical model to retrieve solar irradiance from brightness data provided by Japanese geostationary meteorological satellite Himawari 8/9 which are successors of the previous MTSAT series. Solar irradiance at the top of the atmosphere has almost constant value of 1370 W/m2 throughout the year. However, it is attenuated and absorbed by atmospheric gases and clouds while travelling through the atmosphere. When it reaches the surface of earth, some part is reflected back into atmosphere by the ground albedo (reflectance). Planetary albedo (average reflectance of earth) is observed by satellite and constitutes of ground, atmospheric and cloud albedo. Thus, ground albedo is the minimum value of planetary albedo because reflectance of surface is usually lower than that of cloud. Thus, solar irradiance received by horizontal surface on earth can be estimated by means of ground albedo. We evaluated the model with ground measurement located in Choibalsan City (48.065° N, 114.515° E, 742 m) and it is found with mean bias error (MBE) and root mean square error (RMSE) of 109 W/m2 and 230 W/m2, respectively, and a correlation coefficient of 0.87.

PERFORMANCE EVALUATION OF THE 10MW PHOTOVOLTAIC POWER PLANT IN COLD CLIMATIC CONDITIONS OF MONGOLIA

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Grid connected Photovoltaic (PV) power plants have become the best alternatives to utilize the untapped potential of renewable resources at large scale. The main objective of the paper is to evaluate the performance of the 10MWp solar power plant, which is a 1st pioneer large scale PV plant in Mongolia. The performance of PV plant depends on many design parameters and environmental conditions. The efficient design must optimize each parameters in order to achieve maximum possible amount of production of the PV plant and can boost the system performance and increase reliability of the operation of PV plant. To obtain best performance from any PV power system the system design must address all pertinent factors. This paper presents performance evaluation of the 10MW grid connected PV power plant, operating near to the Darkhan city, north part of Mongolia. The plant has been in operation in harsh and cold climatic conditions of Mongolia since January 2017. Operation of the PV power plant is continuously monitored during 2017-2018 and the performance ratio and the various power losses (temperature, soiling, internal, network, power electronics, grid availability and interconnection) are calculated and energy yield of the PV plant has been estimated. This study also present a few cleaning method to prevent from snow and dust accumulation on the surface of PV arrays. Operation of the PV power plant was continuously monitored during 2017-2018 and the performance ratio and the various power losses (temperature, soiling, internal, network, power electronics, grid availability and interconnection) are calculated and energy yield of the PV plant has been estimated. This study also present a few cleaning method to prevent from snow and dust accumulation on the surface of PV arrays.

O-PV-003

ROLE OF ULTRATHIN ALUMINUM OXIDE AS A PASSIVATING TUNNEL OXIDE LAYER

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Development of ultrathin tunnel oxide has been one of the key factors for the high efficiency tunnel oxide passivated contact (TOPCon) solar cells. The challenging task is the passivation of the Silicon surface by this ultrathin oxide layer without hampering the carrier tunnelling effect. In that context, we report a study on the performance of atomic layer deposited (ALD) and oxygen (O_2) annealed aluminium oxide (Al_2O_3) as passivating tunnel oxide. The thickness of the Al_2O_3 was maintained about 1 nm by controlling the purging cycle of the ADL. The scanning electron microscopy (SEM) images confirmed the formation of the O_2 rich Al_2O_3 (AlO_x) tunnelling layer of thickness ~1.5 nm. Passivation performance of the AlO_x was observed to enhance with the increase in oxygen annealing. The effective carrier lifetime was observed to increase beyond 1 ms with an enhanced implied V_{oc} of 650 mV on optimized oxygen annealing. The stoichiometric study of the AlO_x layer was confirmed by the XPS study. The electrical study of the tunnel layer showed lowering of the interfacial defect levels with oxygen annealing that improved the quality of the film.

O-PV-004

REPLACEMENT OF P-EMITTER LAYER WITH TRANSITION METAL OXIDE AS HOLE SELECTIVE CONTACT LAYER APPROACH ON HETEROJUNCTION CRYSTALLINE SILICON SOLAR CELL

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The low band gap and low optical properties (low transmittance and high absorption) of a-Si:H which is used as an emitter layer in HIT (Heterojunction with Intrinsic Thin layer) solar cell caused a large part of parasitic absorption on the front side which significantly harms the cell's blue response. To improve this matter, we applied the so-called Carrier Selective Contacts to reduce the recombination of carriers and make the efficient carrier transportation for reaching the theoretical efficiency of silicon solar cells.

Molybdenum oxide (MoO_x) is applied as a hole transport layer with high work function and wide bandgap material placed over the intrinsic layer which makes a hole extraction easy by reducing the barrier height. The optical properties of molybdenum oxide thin films exhibit high transmittance and low absorption coefficient in comparison with materials generally used as p-emitter (a-Si:H and μc-SiO_x:H). The analysis of oxygen deficiency through showed that the open circuit voltage and fill factor decreased as the oxygen defect intensity increased. The TMO/HIT structure shows V_{oc} of 695 mV, J_{sc} of 38.88 mA/cm^2, F.F of 74.0 % and efficiency of 20.0 %.

ANALYSIS OF DONOR AND ACCEPTOR CONSENTRATION EFFECT IN SEMICONDUCTOR MATERIALS

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Heterojunction type solar cells are used in commercial solar energy harvesting technology. To maximize energy harvest, in other words, efficiency, designing solar cell is crucial. Therefore, studying photovoltaic(PV) effect is fundamental research in renewable energy. In some study, three-terminal heterojunction bipolar transistor solar cell is proposed for high-efficiency photovoltaic(PV) conversion [1]. To do so, we have to study the nature of semiconductor and its characteristics. Because device simulation optimization helps to maximize solar cell performance. In this paper semiconductor materials specially transistors are studied with different donor and acceptor concentration. Continuation of this study can be engaged with further investigation of designing new PV based devices, its effect, maximization in energy harvest performance.

PREDICTION MODEL OF PHOTOVOLTAIC POWER GENERATION FROM WEATHER DATA USING MACHINE LEARNING

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Renewable energy includes solar and wind energy are depend on weather conditions and site-specific conditions. In this research work, we develop site-specific model for predicting energy productions from a photovoltaic (PV) system using machine learning based on weather data. The weather and the production data used in this work corresponds to a day averaged weather and power measurements collected from 2014. We compare two regression techniques, including Ridge and Random Forest. We evaluate the accuracy of each models using test dataset. Our results show that Random Forest regression-based model accuracy is highest with 0.99 and less features used.

Keywords: ridge regression; random forest regression; photovoltaic (PV) forecasting

THE MULTIPLE APPLICATION OF ENERGY STORAGE SYSTEM IN MONGOLIAN ENERGY SYSTEM

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This paper to demonstrate the viability of deploying energy storage system in simultaneously providing multiple applications, i.e., peak shaving, arbitrage, renewable energy and backup power in Mongolian energy sector. Mongolian Energy System have several problems that (1) peak and night load difference is high that at least 200-300MW, (2) long distance transmission line that transmission loss is high and power quality is poor, (3) several solar and wind power plant connected to the grid that need grid stabilization and curtailment for renewable energy sources. Energy storage system can provide multiple benefits to the Central Grid including power quality improvement, frequency regulation and load shifting. Energy storage system has been considered as the key source of flexibility to support the integration of renewable energy and energy security in Mongolian Energy system. The simulation results show that ESS can successfully provide load shifting, frequency regulation and power quality improvement to the transmission system. One of the challenges faced by energy storage system developers is quantifying their value, especially considering benefits that may not be fully captured within Mongolian energy markets. Tariff for energy are known to a storage operator in advance and then optimize the charge and discharge of a storage device to maximize its net revenue. Fact that the tariff do not attractive investor that invest Energy storage project in Mongolian energy system for commercial business case. If Mongolian energy system want to solve mentioned problems, Energy system adhered the potential revenue different type of storage system when providing ancillary services that frequency regulation, backup power and power quality improvement.

O-ESSI-001

GRAVITY STORAGE A NEW CLASS OF PUMPED HYDRO STORAGE

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To understand the economic advantage of a new type of hydro storage, we did an in deep calculation of the Gravity Storage system. Gravity Storage is a novel way to use the well understood and widely used pumped hydro technology in arid and desert areas. This is especially interesting for Very Large Scale Photovoltaic systems in the desert area, like Gobi desert of Mongolia, because they have a daily cycle of power production. The technology is based on the excavation of a large piston of natural rock in the underground that is sealed against its natural environment. During a storage cycle, water is pumped, using cheap electricity, below the piston, to lift the piston and store thereby the energy in potential energy in the gravitation field. During energy demand, the piston is lowered and a water turbine generates AC power for the grid. The main cost to construct such a system are civil work to cut the piston, using advanced diamond wire saws, develop a small reservoir and connect the system to the grid. The paper provides insights of comprehensive studies of the gravity storage system and broader assessment of the Levelized Cost of Storage of the Gravity Storage system depending on interest rates.

O-ESSI-003

ENERGY MANAGEMENT ON GER WITH AREAL PV AND ELECTRIC THERMAL STORAGE IN THE ULAANBAATAR, MONGOLIA

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We are testing the insulation improved five lattice-wall-ger(yurt) heated by 5 kW electric thermal storage (ETS) in the Ulaanbaatar. Our improved insulation can reduce a heat loss of approximately 37 %, moreover there are the possibility of 45 % heat loss reduction by improving insulations as preliminary estimation. The parameters consisting of indoor and outdoor air temperature, power consumption, global horizontal irradiance (GHI), and wind speed and direction that with 2 minutes resolution, are being measured since October 2017. The output power estimation of areal PV that a rated capacity has been ranged from 2 to 9 kW and fixed at various tilt angles, as well as the operational simulation of the system consisting of areal PV, ger, and ETS, has been performed. The simulation period was a one month. The system indices such as self-consumption, and surplus power when there are the three different patterns of electric consumption, were presented. In this study, we will present the optimal capacities and tilt angles of areal PV, in addition to, the clustering of electric demand and solar irradiation.

O-ESSI-004

FACTORS AFFECTING STABILITY OF GRID FREQUENCY BY SIMULATION OF GENERATOR DROPOUT IN IEEE 14 BUS MODEL

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As the renewable energy sources increases due to the policy to achieve the 3020 goal, it is necessary to study how much renewable energy sources can be accommodated while maintaining grid stability. For this study, it is necessary to first analyze the factors affecting grid stability in existing system. The system stability can be classified into voltage, frequency, and phase, and among them, the frequency stability depends on the active power balance. It is necessary to pay attention to the frequency stability when considering the situation that the conventional generators, which plays the role of adjusting the active power balance In order to maintain frequency stability, are replaced with the renewable energy sources. In this paper, the factors affecting the frequency stability by simulating the frequency fluctuation situation as generator dropout in the simulation system is analyzed. Among the factors, inertia, type, and governor gain of synchronous generators are analyzed with emphasis. The simulation model is based on the 14-bus grid model proposed by IEEE and is implemented using the DIGSILENT Power Factory simulation tool.

HVDC GRID SUPPORT CAPABILITY IN JEJU GRID

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In this paper, HVDC grid support operation and grid reinforcement by HVDC was discussed. By its device characteristics, HVDC often connected to renewable energy sources such as windfarms and it can operate as a power source in power system. It can also provide some benefit to the grid. By integrating AC grids with HVDC, power system stability can be enhanced if HVDC was properly controlled. Firstly, VSC HVDC technologies for grid support was introduced. By its d-q decoupled controller, active and reactive power can be controlled independently. Through that controller, frequency control and inertia control can be done in d axis controller and voltage support control can be done in q axis controller. Secondly, grid reinforcement by connecting two isolated AC grids with VSC HVDC was simulated. By connecting two AC grid with VSC HVDC, transient stability was enhanced. In PSS/E simulation, it is verified in Jeju grid connected by HVDC has advantage in transient stability. Furthermore, benefits from wind turbine connected VSC HVDC in Jeju was also simulated.

STUDY ON BATTERY CELL BALANCER

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In recent years, a rapid growth of electric vehicle has been leaving large amount of chemical battery waste due to an expiration of their lifetime, and increase of cell imbalance and internal resistance. Those wasted batteries are impossible to be reused in electric vehicle application depending on a degradation of powering and capacity characteristic. However, it is still available to be utilized as a power source in the residential system since its energy requirements are much less. This study proposes an active battery cell balancer with enables to equalize those of state of charge, SOC, of the nickel metal hybrid (NiMH) batteries based on a generation control circuit to balance the each PV module voltage. The active battery cell balancer can automatically transfer the energy from the high-SOC battery cell to the low-SOC battery cell. By developing the battery cell balancer, reduction of the amount of chemical waste as well as extension of the battery lifetime will be available. This paper presents a simulation study to verify the feasibility of the proposed circuit with PSIM simulation software. Simulation results prove that each initial unbalanced cell is equally balanced by the proposed battery cell balancer circuit.

O-ESSII&HS-002

SCREENING PROCESS OF MAZAALAI SATELLITE'S NIMH BATTERY

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Electrical Power Subsystem (EPS) is one of BIRDS satellite bus subsystems. Basically, EPS includes Solar Panels, a rechargeable Battery, and Power Distribution Unit. Five main requirements should be fulfilled in the battery design of satellite, charging and discharging characteristics, storage life, cycle life and safety requirements of launcher. Charging and discharging characteristics was verified comprehensively on each individual cell and for each battery pack. The storage life was verified by estimating. The cycle life and safety requirements are proved by appropriate design of charge regulator. The screening process of the battery includes the selection of the individual cells before packs and battery box assembly, and the battery preparation procedures before satellite delivery. The each battery cells were selected after going under general characterization processes which includes, checking of Charging and discharging characteristics and measuring of the internal impedance. The purpose this was to define the most identical battery cells to battery packing. Before sending MAZAALAI to launcher, the battery was fully charged and examined by the safety point crew of JAXA. The charging process was done under similar conditions to in-orbit operation. After in-orbit operation, we could analyze the battery performance by using data. In this paper, we present the details of battery screening procedures.

O-ESSII&HS-003

SELF-POWERED HYBRID NANOGENERATOR FOR SIMULTANEOUSLY HARVESTING MECHANICAL AND SOLAR ENERGY

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Interest in renewable energy, as well as in eco-friendly embedded-system, is growing due to environmental concern and development of communication technology. To meet the needs of human society as a whole, sustainable energy harvesting has been widely studied; and hybrid-type nanogenerators, one of energy harvesting, have been suggested because external input energy we can get from environment is not singular but integrated each other. Herein, we report a self-powered hybrid nanogenerator for simultaneously harvesting mechanical and solar energy in a system. The main part of this one system is composite film which was synthesized by combining piezoelectric polyvinylidene fluoride-trifluoroethylene polymer P(VDF-TrFE) and photovoltaic perovskite material. By analyzing the material properties and generation performances in various condition, we have carefully considered the working mechanism for hybrid nanogenerator. We believe that this study will be helpful to understand integrated hybrid system, and it can be seen that this hybrid nanogenerator has taken one step further in order to utilize them as self-generated power systems.

O-ESSII&HS-004

A SIMPLE FABRICATION OF PIEZOELECTRIC ENERGY HARVESTER WITH ELECTRICALLY CONDUCTIVE METAL TAPE

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Generally, a flexible piezoelectric energy harvester has used thin film metal electrodes deposited by evaporating systems. However, it is not suitable for the flexible piezoelectric energy harvesters because it has low reliability under extreme bending or vibrating conditions. Also, it spent much time during the deposition processes. To solve these problems, we introduce the flexible electrically conductive metal tapes(ECMTs) due to several advantages of cost-effective simple process, high reliability and enhancing the output performance of the flexible piezoelectric energy harvester in this study. At first, we dissolved PVDF-TrFE(70-30%) powder in DMF(Dimethylformamide) solution and stirred for 6 hours at 30°C. And the prepared PVDF-TrFE solution was spin-coated on PET/Au substrate and finally covered with ECMTs, including the combinations of Au, Cu, and Al. The piezoelectric layer, PVDF-TrFE, was characterized by using XRD, and the electrical performance was carried out by electrometer and oscilloscope. As a result, the output performance of piezoelectric energy harvester showed the open-circuit voltage of 2 V and the closed-circuit current of 2μA. Furthermore, the reliabilities of deposited metal electrode and ECMTs were tested by the bending machine. These results indicate that the ECMTs can be enhanced simultaneously electrical performance, reliability and durability.

HYDRAULIC DESIGN FOR PERFORMANCE IMPROVEMENT BY LOSS ANALYSIS IN HYDRO TURBINE AND MULTI-STAGE CENTRIFUGAL PUMP

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The loss analysis on the hydraulic design for the performance improvement is very important. According to the component loss analysis, the performance of each component can be detected. In this study, there are three different blade loadings conducted to compare the loss analysis. The loss distribution on casing, stay vane, guide vane and leakage part are similar by different blade loading. The runner passage with front loading causes the larger loss than that with rear loading. However, the front loading runner has the minimum loss on the draft tube passage, and the loss increases significantly on the draft tube passage by the rear loading. This is why the efficiency of rear loading is lower in comparison to other blade loadings. Moreover, the loss analysis on the centrifugal pump was conducted by CFD analysis. The internal flow characteristics were investigated.

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NUMERICAL AND EXPERIMENTAL ANALYSIS OF MICRO-CLASS HYDRO FRANCIS TURBINE

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A draft tube is the main part of Francis turbine where is the turbine can reduce pressure to higher extent without fear of back flow from tail race but there are several issues like vortex rope when turbine operates in part-load condition. This phenomenon results in efficiency reduction. This study focused on prediction of vortex behavior at the draft tube and numerical results obtained the hydraulic performance of 3kW micro-class Francis turbine with the inlet pipe, a spiral casing with 12 guide vanes, 6 stay vanes and runner having 13 blades and draft tube. Ansys CFX software used to simulate for the numerical analysis of micro-class Francis turbine. 3 misaligned guide vane (MGV) openings with 5 different position were chosen to analyze the influence of the pressure pulse in the turbine. From the performed experiment on performance test of Francis turbine using the Francis turbine experimental set-up in the Flow Informatics Laboratory at Korea Maritime and Ocean University. The experimental analysis of the turbine showed significant result. The turbine operated at different vane angle setting were obtained and tested by varying the parameters as a guide vane angle in the 6 different range of between 2-12 degrees, speed, and 500-1700 rpm respectively. The lowest difference between the experimental and numerical results was 2.03% and maximum difference was 6.12%.

Additionally, the Particle image velocimetry (PIV) technique was used to investigate or re-circulating flow in the draft tube.

MONGOLIA'S HYDRO POWER URGE AND DEVELOPMENT

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As Mongolia`s Economy grows, the Energy sector is facing challenges both in economics and technologically. Although Mongolia has promised to achieve 20% of installed capacity by renewables by year 2020, already almost 14% of installed capacity will be produced by Solar and Wind alone by year 2019. For the system with long spread electricity transmission line, with 15% of energy loss and altered substations supplied with electricity by almost 80% from coal fired combined heat and electricity power plants, Mongolia faces new challenges to adopt, integrate Renewable energy source to the grid.

Solely stabilization of the GRID will face new dimensions of challenges especially for grid operators and utility providers. CHP`s flexibility on generation and reaction to fluctuated Renewable energy are almost to zero, where in peak load, Mongolia must import electricity from Russia budgeting the and impacting the economy of energy sector heavily.

It is not only the Renewable energy causing the challenges but steadily increase of Energy demand (2012 Energy demand growth rated 16%, 2016 by 9%, 2018 forecast it will be increased again due to economic growth and mining economic recovery), energy shortage by almost 10% and highly inefficient energy production. So with deficit of energy, high energy loss with inefficient CHP production, highly dependency of import from Russia and China, Mongolia is facing immense pressure on adapting new energy source such as Flexible and efficient source: Hydro Power plant and Pumped hydro power plant.

The high dependency from neighbors, the continues pressure from Russia to seize Hydro power plant, China`s state grid`s expensive contract between OT mine causes and plays crucial Role in economic impact to Mongolia`s energy sector. Finding the new sources of energy such as HPP or PHPP and preparing a master plan on hydro development is crucial fundament for strategic development of Mongolia`s growing energy demand.

Serious studies must be conducted to ensure Mongolia`s energy security, but most of all grid stabilization, to ensure more integration of Renewables to the system.

OPTIMUM MOORING SYSTEM DESIGN FOR UNDERWATER FLOATING TIDAL CURRENT POWER DEVICE

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With the increased focus on renewable energy in response to the global warming problem, tidal current power(TCP), one of the ocean energy resources, is acknowledged as an alternative energy source because of its high energy density, predictability and reliability. TCP devices are classified into gravity base type, pile fixed type, and floating type. Among them, the floating type can be applied without any limitation of water depth and has a simplified supporting structure. Since the behavior of the floater has a significant effect on the total power production rate, it is essential to minimize the power production loss and optimize the system efficiency. In order to maintain the optimal incidence angle of the flow to the turbine and to support the buoys, the motion response of the tidal power system was analyzed. DNV Wadam V 4.8-01 and OrcaFlex 10.1a were respectively used for the frequency and time domain analyses. The designed TCP system had pitching and yawing fluctuation values within about 4°.

This research was a part of the project titled ‘Manpower training program for ocean energy’, funded by the Ministry of Oceans and Fisheries, Korea.

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LAB-SCALE EXPERIMENT OF HAWT BLADE PERFORMANCE TEST USING DIGITAL WIND TUNNEL

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This study suggests the performance evaluation test of a HAWT blade model using the lab-scale experiment. A 30 cm wind turbine blade model has been designed based on the newly developed airfoil, KA2. A 3-blade rotor, based on the blade model, has been tested using the digital wind tunnel. The performance of the rotor has been estimated by measuring the rotor-induced shaft torque at different rotation speed. The torque shows different characteristic depending on the rotational speed. To estimate the performance properly, we used two different experiment setups depending on the blade rotation speed. Experiment results are compared with the theoretical estimation, calculated by BEM. This study provides the methodology to the performance test of wind turbine blades using lab-scale experiment. Moreover, results represent the applicability of the KA2 airfoil to wind turbine blades. This project is supported by the Korea Institute of Energy Technology Evaluation and Planning (KETEP) and the Ministry of Trade, Industry & Energy (MOTIE) of the Republic of Korea (No.20173010024870, 20174030201670) and by the Ministry of Education (NRF-2017R1D1A3B06032145)

O-WE-002

A STUDY ON BEARING LIFE PREDICTION FOR WIND TURBINE GENERATOR

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In order to examine the possibility of bearing life prediction for a wind turbine generator, actual data from bearings of wind turbines was calculated according to ISO 281 in Hankyeong and Seongsan wind farms on jeju Island, Korea. The wind turbines have been operated during approximately 10 years and the specification of rolling element bearing (SKF) of generators were used to predict the basic and modified rating life. Also, the radial load on bearing was calculated using the vibration value of vibration sensor installed on generator and the axial load on bearing was calculated using wind speed data from SCADA(Supervisory Control And Data Acquisition) System. The basic rating life (L10) was calculated by the ratio of dynamic equivalent radial load to basic dynamic radial load rating. The modified rating life (Lnm) was calculated by applying modification factor to L10. As a result, among the wind turbines tested, the bearing life of the wind turbine experiencing at high wind speed was expected to be relatively short.

DESIGN AND ANALYSIS OF A SMALL WIND TURBINE WITH A WIND SPEED AUGMENT DEVICE

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Increasing the wind speed aids to improve the turbine power significantly since extractable power in wind is proportional to cube of its velocity. 2 kW wind turbine was designed according to BEM theory using “NACA 634421” and “FX 76 MP 140” airfoils. Wind turbine was numerically analyzed using finite volume based commercial software STARCCM+. Maximum efficiency of the turbine was found as 48% at a tip speed ratio of 7.5. Power output of the turbine at its design wind velocity 7.5 m/s and 7.5 TSR was 2.273 kW.

Then, four different diffusers were designed and analyzed for their ability to improve the wind conditions. First three diffuser models are same in size with different internal shapes. Fourth diffuser model is further compacted for half of the length of other models. Turbine performances were again analyzed with each of these diffusers. It was found that all four diffuser models are capable of improving the power output of the turbine. First three diffuser models increased the power output of the turbine by a factor of 2. Diffuser model 1 and diffuser model 3 indicated similar behavior while diffuser model 2 indicated slightly lower performance. Diffuser model 4 increased the power output by a factor of 1.6. It is recommended to use suitable model according to the required power output, manufacturing cost and handling capability.

O-SGMG-001

CURRENT CONTROL OF POWER CONVERTER USING CURRENT SENSORS INSIDE POWER MODULE FOR SMART GRID APPLICATION

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Power converter circuit for renewable energy is one of the most important equipment. Recently, higher power-density and reliability of the power converter circuits have been discussed. In addition, the power converter circuit has to control the output AC current for connecting a utility grid. In order to control the output current, the converter circuit has to detect the current using a current sensor. The downsizing of the current sensor is also discussed, and there are many papers of current sensor for measuring current inside power modules. The main purpose of the sensors inside the module is to protect the overcurrent. And such power modules including protection current sensor is gradually spreading. On the other hand, the current sensor such as CT and Hall element is attached to control the output current, but it is difficult to realize a high power density converter circuit. Thus if the current sensor built in the power module can be properly used for control, an additional current sensor is not necessary. This paper proposes a current control method of the output current for inverter circuit using sensors in series with power devices. This paper shows experimental verification of the control method and the influence on the control by the position of the current sensor.

O-SGMG-002

SECURITY CONSTRAINED OPTIMAL POWER FLOW BASED ON DC POWER FLOW MODEL CONSIDERING VARIATION IN RENEWABLE ENERGY PENETRATION

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In power systems, there is a need for secure and optimal operation. Secure operation is achieved by taking into account contingency scenarios and optimal operation is achieved by maximizing the total expected net benefits over a certain planning horizon. In this study, the intermittent nature of renewable energy resources, such as wind and solar energy, are taken into consideration as part of the generation mix. The study is deemed important since the goal is to calculate the highest allowable amount of renewable energy penetration without compromising secure operation of the power system network. The method is tested on a medium-sized power system network.

RELIABILITY AND ECONOMIC STUDY ON PV-WIND HYBRID SYSTEM IN ISOLATED LOCALITY

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The purpose of this article is to optimize off-grid PV-Wind hybrid system in Mongolian condition considering both reliability and economic efficiency. The annual hourly energy yield data of PV-Wind hybrid system with 200kW nominal capacity installed in Mandakh soum (isolated locality), Dornogovi province was used to analyze the PV and WTG operational performance and system reliability. The analysis shows that system reliability was low because wind turbines can not operate at full capacity (wind turbine capacity factor was 8.5%) due to lack of battery capacity. The higher the reliability of the system, the more likely to consider economic potentials. Therefore, the system reliability was evaluated using Monte Carlo simulation by varying the capacity of battery, PV array and WTG. Monte Carlo Simulation requires hourly climate data for a year so HOMER software was used to generate hourly synthetic radiation data of Mandakh soum. Finally, Economic efficiency were evaluated by calculating IRR and NPV of each combination of the system.

Key words: PV-Wind hybrid system, isolated locality, reliability, economic efficiency, Monte Carlo Simulation, LOLP (Loss of Load Probability)

STATUS OF GEOTHERMAL ENERGY STUDY IN MONGOLIA

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This paper describes an update of geothermal energy study in Mongolia in last three years. The previous update of geothermal energy development of Mongolia is presented on the World Geothermal Congress 2015 in Melbourne, Australia.

Generally, Mongolia has existing 43 hot spring fields and most of them are just used for balneology and as attractive tourist sites.

The main geothermal activity is located beneath the Khangai mountain area, central part of Mongolia. Recently, the Institute of Geophysics and Astronomy of Mongolia is collaborating with Geothermal Energy and Geofluids, Institute of Geophysics, Zurich, Switzerland were done "Electrical structure beneath the Khangai Dome, Mongolia, from magnetotelluric data" in 2016. Also, the Institute of Geophysics and Astronomy done "The estimation of Curie point depth and heat flow nearby Ulaanbaatar via magnetic anomalies of lithosphere" in 2016.

GEOMECHANICAL REVIEW ON INDUCED SEISMICITY OF HYDRAULIC STIMULATION IN ENHANCED GEOTHERMAL SYSTEM: ROLE OF DIFFERENTIAL STRESS

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Enhanced Geothermal System (EGS) has been a prospective option to exploit the vast earth heat resource for electricity generation. One major long term challenge for EGS development is to artificially improve the reservoir hydraulic conductivity to allow the fluid circulation at rates of commercial interest through massive hydraulic stimulation. The induced seismicity associated with the hydraulic stimulation operation has been widely documented during the EGS development and its impact has attracted increasing public concern, especially the possible occurring of large magnitude events. We reviewed previous hydraulic stimulation tests with a geomechanical perspective in existing EGS projects where massive volume of fluid was injected. Specifically, we investigated the stress regimes and their correlation with the induced seismicity, including the onset of seismicity and the large magnitude events. The analysis and discussion indicated that the differential stress condition played important roles in induced seismicity of hydraulic stimulation in EGS development.

Acknowledgement

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A STUDY ON LANDFILL ACCEPTANCE CRITERIA TO ENHANCE ENERGY RECOVERY AND RECYCLING OF WASTE IN KOREA

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For Zero waste policy, Korean government has prepared newly Fundamental Law for Resource Circulation enforced from 2018. There are no numeric acceptance criteria except moisture content for wastes discarded to landfill sites in Korea. In the study, industries were categorized to select representative waste according to the industry standard classification of Korea. To understand the characteristics of landfilled waste, industry-specific kinds were sampled and analyzed. In addition, various academic documents related to Higher Heating Value (HHV), Loss of Ignition (LOI), TOC ratio, moisture, volatile contents and chemical composition were collected and surveyed. In order to compare parameters for waste as fuel, each correlation between calorific value, carbon content and combustibility ratio were evaluated. It can be considered, as waste acceptance criteria to landfills, that the wastes having a calorific value over 6MJ/kg and the wastes over 10% LOI be recovered as fuels or prohibited disposal into landfills.

O-WEU-002

PRELIMINARY STUDY FOR CONSTRUCTION OF POWER PLANT USING LANDFILL GAS AT NARANGIIN ENGER DISPOSAL SITE, IN ULAANBAATAR, MONGOLIA

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We have studied the possible effects of waste power generation plant and gas recovery from landfill at Narangiin Enger Disposal Site (NEDS) in Ulaanbaatar, Mongolia, as a case study. First, we investigated household waste generation rate, waste composition, and treatment ratio in the respective areas from 2005 to 2015 using field survey data, in Ulaanbaatar, Mongolia. Second, we have studied the field survey research such as review landfill structure, amount of landfilled waste, leachate generation rate, landfill method, ventilation facility, covering method, characteristic of landfill gas (LFG) concentration including CH_4, CO_2, O_2, H_2S, and N_2, and amount of LFG until 2035 using LandGEM model. Finally, we evaluated amount of predicted electric power generation at NEDS landfill and operation feasibility for LFG power generation plant. In conclusion, we conclude that landfill power generation plant at NEDS landfill in Ulaanbaatar could be operated by minimum 2 MW

Keyword: Preliminary study, Landfill gas, LandGEM model, Power generation plant, Narangiin Enger Disposal Site

DEVELOPMENT OF MILK COOLING PROTOCOLS TO INTEGRATE RENEWABLE ENERGY FOR MILK PRESERVATION

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Cooling is the major preserving method used in milk industry. It is critical to control microorganism reaction for the preservation and fundamentally the milk temperate is highly influential to the growth of microorganisms. Rural framers frequently face troubles due to unavailability of proper cooling facilities and hence considerable amount of milk is wasted. The main objective in this research is to provide affordable solutions to rural milk farmers through cooling systems powered by renewable sources of energy (Solar Wind hybrid power systems). Early studies identified that 4 ^{o}C is the best temperature to maintain the milk. Instead, maximum possible temperature of 12^{o}C was suggested in some of later studies to minimize the cooling energy. As an alternative to the single value, this study suggests number of optimal temperature profiles (with the time) considering all the climatic and initial milk contamination factors. It is also identified that characteristics of these temperate profiles vary with the nature of operations and the climate. Through field and literature surveys, the necessary data were collected from selected Sri Lankan dairy farms to derive such temperature profiles. So derived temperature profiles were used to identify cooling strategies throughout the milk preservation process (milk collection to delivery point). This also includes primary estimations to utilize wind/solar hybrid refrigeration system to make required amount of thermal mass (ice) for milk cooling.

SUBSYSTEM LEVEL FAULT DETECTION AND DIAGNOSIS OF A POLYMER ELECTROLYTE FUEL CELL SYSTEM

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This paper describes a scheme for on-line fault detection and diagnosis (FDD) at the subsystem level in a polymer electrolyte fuel cell(PEFC) systems. In order to commercialize a polymer electrolyte fuel cell system, it is necessary to improve the operating reliability and lifetime in addition to performance improvement and cost reduction. A fuel cell system is composed of complex sub-systems Various issues related to BOP(Balance of Plants) can affect the reliability and safety of the stack. This problems can be overcome by introducing a supervisory control system to detect and diagnose the faults of the fuel cell components. In this paper, sub-system level diagnose technology is introduced using model based methods. The approach consists of process estimation, residual generation, and fault detection and diagnosis using artificial neural networks. Residuals are the difference between the analytical redundancies and the measured values. Analytical redundancies are derived using characteristics equations for each subsystem. Different patterns of residuals were trained by neural networks for fault diagnosis. Several faults were considered. The experimental results show the effectiveness of the proposed method for detecting and diagnosing faults in a PEFC.

O-H&FC-002

THERMOMECHANICAL STABLE FLEXIBLE SOLID OXIDE FUEL CELLS

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A novel approach for the fabrication and assembly of a solid oxide fuel cell system is described which enables effective scaling of the fuel delivery, manifold, and fuel cell stack components for applications at high temperature. In this study, new design of flexible thin film electrolyte was introduced with some factors of flexibility. We suggested that smooth and large grain sized 3YSZ film which is transformable tetragonal structure mainly contribute to form stable and flexible film. Using this flexible and stable electrolyte support, careful consideration of manufacturing F-SOFC has led to adopting separate methods. Entire methods were facile approaches which lessen the scale-up problems. For the electrolyte, tape-casting method was selected to form flexible film support and for the anode and cathode, a screen-printing method and co-firing were used. These novel F-SOFC system led to have durability extension in harsh condition. The F-SOFC achieves remarkable zero degradation rate in on-off cycles for 500 h, producing reasonable power density. Maximum power density was recorded at 0.15 W cm^{-2} at 800 ^{o}C. It is expected to be commercialized by its property and possibly applicable for research area of flexible substrate.

FAULT DIAGNOSIS OF FUEL CELL AIR SUPPLY SYSTEM

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As energy, environment, and safety issues arise, fuel cells are increasingly being used for transportation and building power generation systems. In order to promote the commercialization of fuel cells, it is necessary to solve problems such as price (efficiency), infrastructure, and durability. Following this trend, our research group is carrying out a project on fault diagnosis of fuel cell system to increase system durability and reduce maintenance cost. In this study, we focus on the fault of the air supply system and investigate how to diagnose the cause of such fault. Increasing air flow or pressure improves stack performance, but increases power consumption by blower as well. Thus, in the aspect of total fuel cell system efficiency and cost, proper maintenance of the air supply system is required. In addition, since air filter is used to suck the ambient air and purify it, filter clogging may occur in the system. Generally, pressure signal is used to detect the fault of air supply system. However, with this signal alone, it is difficult to classify the various causes of fault such as air leakage, clogging, sensor failure, and blower performance degradation. Therefore, we suggest a method to diagnose the cause of the fault more accurately by using signals of the blower control and the stack load, which can be obtained without additional sensor.

POLYMER ELECTROYTE FUEL CELL OPERATION OF HIGH FUEL UTILIZATION BY ANODE RECYCLE OF EJECTOR

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When pure hydrogen is used as fuel in polymer electrolyte fuel cells (PEFCs), anode dead-end or anode recycle is applied in the anode fuel supply system in order to increase the fuel utilization, and in consequence the fuel cell efficiency. Anode recycle is more efficient than dead-end, because it prevents from water and impurity accumulation continuously and prolong the purge period, so that it throw away less hydrogen. In this study we developed a hydrogen ejector for 10 kW fuel cell by CFD and experiments, we applied this 10 kW PEFC stack. And by varying the operating current from zero to 160 A, we tested ejector and fuel cell stack performance. Ejector showed different entrainment ratio at different current, so that purge period was varied, because ejector is a passive device, neither active nor controllable. By varying operation condition we tried to find the optimal operation strategy according to the varying load of the end system.

O-ST-001

RESEARCH AND DEVELOPMENT ON THE SOLAR AIR HEATER

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We are aiming to design a solar air heating device suited for the severe climate in Mongolia. As a result of experiments and CFD analysis, the solar air heater module IV has been developed and has a surface area of A = 0.64 m^2, an air gap inside the plastic frame of d=35mm and with V-down shaped artificially roughened ribs on the absorber plate. The relative roughness width is w/e=1.2, relative roughness pitch is P/e=20, relative roughness length of discrete ribs is B/s=12,5, an angle of attack $\alpha = 60^0$ and the airflow will be placed on the bottom of the absorbent board and in front of the absorber. The IV model has an air purification function with $\beta = 0.383$ mg/m^3*h. These designs, including improvement function, made our research result efficiency reach 46%.

O-ST-002

ANALYTICAL STUDY OF CSP INSTALLATION SCENARIO IN MONGOLIA USING AN ENERGY PERFORMANCE MODEL

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Due to the Fukushima nuclear accident in 2011 advanced countries like Japan and Germany are reconsidering nuclear power generation, therefore, Renewable Energy technology market is expected to grow rapidly. Asia Super Grid concept was an idea to utilize the vast amount of solar and wind resource available in Gobi Desert area of Mongolia to power North and North-Eastern Asian countries in the future.

CSP is one of the promising technologies due to its ability to follow the load or to supply electricity during the peak hour periods occur either in the afternoon or in the evening. In frame of the current study work, 4 pieces of automatic metrological stations equipped with rotating shadow band pyranometer have been installed at four sites of Mongolia and measuring gloabal horizontal irradiance GHI, direct net irradiance DNI, ambient temperature, air pressure, wind speed, wind direction and relative humidity for 1 year to do a technical and economic estimation to determine the expected annual output of a CSP plant, levelized cost of energy, total capital cost and find out necessary technological solutions for some difficulties that may encounter in Mongolian specific conditions and make recommendation on selection of the most appropriate CSP technology favorable to be used in our country. Mongolia has extremely harsh continental climate that CSP technologies applied in other parts of the world needs to be fitted differently to operate normally in Mongolian weather condition.

EVALUATION OF DUST DEPOSITION ON EVACUATED SOLAR THERMAL COLLECTORS IN MONGOLIA

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In this study investigated the effects of dust deposition on transmittance of glass tubes of a solar thermal collector in capital city Ulaanbaatar of Mongolia, during winter season. We will presents the results based on exposure tests conducted between October 2015 and May 2016. The dust deposition on glass tubes was empirically modeled using the test results and the environmental data such as wind speed and direction, daily average airborne dust rate, snow, and rain. Based on observation of long- and short-term tests, snow was deduced to be able to clean dust accumulation on the glass tubes even if the ambient temperature is below zero. Also, the snow was found to be more effective in decreasing dust accumulation than rain according to the estimation.

THE CLIMATE AND RENEWABLE ENERGY RESOURCES IN MONGOLIA

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Mongolia has plentiful of renewable energy, including solar, wind and hydropower. There is a great potential to produce electricity using renewable sources of energy not only to meet domestic consumption need but also for export. In respect of available resources at present commonly used the figures as 270-300 sunny days with 1400kWh per square meter per year and 70% of the country's land area receives solar insolation at the rate of 5.5-6.0 kWh. The US Department of Energy estimates the Mongolian part of the Gobi Desert has renewable energy capacity around 2600TWh, with 1100TWh for wind and 1500TWh for solar. The hydro potential of the country was estimated to be at 6400MW. It is important to note that these figures mostly based on the current climate condition and mixed sources of data from direct continuous measurement and indirect modelling exercises. On order to design big scale project as the Asian super grid the resource information on renewable energy in the country needs to be updated taking into account improvement of the weather monitoring system and possible impact of global climate change.

O-E&LCT-002

A POTENTIAL OF END-OF LIFE BATTERIES FOR HYBRID VEHICLES: FOCUS ON THE SECONDHAND VEHICLES FROM JAPAN

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Japan is the first country to sell Hybrid Vehicles (HV) and owns the biggest market around the world. In 2016, about 70% of HV in the world were sold in Japan. Meanwhile, within Japan, Hybrid Vehicles occupied 40% of total vehicle market. The sales of Hybrid Vehicles are expected to keep increasing fast.

On the other hand, since hybrid technology in Japan is quite mature, Japanese secondhand Hybrid Vehicles are considered to have high quality. Indeed, a huge amount of aged Next-Generation Vehicles (NGVs) were being exported to developing countries; therefore, End-of-Life Next-Generation Vehicles in advanced countries are much less than expected. In this research, generation status of End-of-Life HV, the exportation situation of old Hybrid Vehicles and it issues in Japan will be introduced.

That is to say, along with the exportation, End-of-Life Hybrid Vehicles and NiMH batteries will not emerge inside Japan, instead; these scrap cars and used parts will emerge in developing countries such as Mongolia. Therefore, to prevent resource wasting and environmental pollution, not only End-of-Life Hybrid Vehicles in Japan, but also proper treatment and recycling of exported Hybrid Vehicles, as well as international resource recycling should be discussed. And this research will be considered its responsibility and global cooperation.

Key words: Hybrid Vehicle, End-of-Life Vehicle, NiMH battery, Secondhand Vehicle, Reuse and Recyling

LOW CARBON GREEN DEVELOPMENT OF MONGOLIA

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Tackling global climate change and sustainable development necessitates the countries to transform to a green economy that is resource efficient, low carbon and socially inclusive. Mongolia has joined international commitment to reduce greenhouse gas emissions through transformation to a green development: sustainable production and consumption, green urban planning, sustainable infrastructure, clean energy production and transmission, reduced building heat loss and lower energy consumption. The low carbon development model of Mongolia has been reflected in key national long term policy documents of Mongolia such as the National Green Development Policy (NGDP), Sustainable Development Vision 2030 (SDV) and Intended Nationally Determined Contribution of Mongolia (INDC). The concept has further been elaborated in economic sectors' policies including energy sector policy and urban planning and development. The localization of the SDGs and long term national policies at regional and subnational levels (aimag) implies the concepts of green economy with emphasis on sustainable production and energy efficiency. This paper starts with an analysis of GHG emission of Mongolia and national policies for climate change and low carbon development. It further examines implications of development policies for climate change mitigation and GHG emission cuts from energy and provides a reference for diversification of financing for low carbon development and further elaborate on public private partnership and sustainable financing options for low carbon energy.

Key words: GHG emission inventory, inclusive green economy, low carbon development, climate change mitigation, low carbon energy, sustainable finance.

Poster Sessions

ASSESSMENT OF HIGH EFFECTIVE SEPARATION SYSTEM TO PROMOTE URBAN MINING

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Urban mining is comprised of collection, pretreatment, and recovery. There are many improvement in the scientific approaches to enhance the recovery as well as in the political and systematic approaches to enhance the collection. To dramatically promote the feasibility of urban mining, it is essential to invent a new approach in the pretreatment step which detects and separates the targeted valuable metals. In this study, we determined the metal (Cd, Cr, and Pb) concentrations of urban solid waste using a highly sensitive and rapid method, laser-induced breakdown spectroscopy (LIBS). To enhance the accuracy of the measurements, buffer gases such as He and Ar are applied. In addition, data processing methods such as Savitzky-Golay data smoothing and partial least square regression (PLSR) model are utilized to obtain significant linear calibration between results from LIBS and results from original data. Based on the results of the experiments, this study assessed the induced analysis of the developed high effective separation system using sate of the art technique, LIBS, in the field of industrial and environmental sectors.

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INDONESIA’S NEW & RENEWABLE ENERGY POLICY NETWORK ANALYSIS

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The energy policy decision-making process is done by a number of policy actors, and there is a complex interrelationship among them. By examining who these policy actors are and what their relationship is, they can understand the energy policy decision-making process and predict the results of the policy. This study examined the relationship, i.e. cooperation and conflict, between government and other actors in the process of implementing new and renewable energy policies in Indonesia. As the Indonesian government aims to achieve 23% new and renewable energy use by 2025 (IRENA, 2017), the analysis of the relationship between actors is more important. This study conducts network analysis based on the survey data of policymakers who participate in renewable energy policy in Indonesia and suggests policy implications on the relation structure of the renewable energy policy network.

AN ECONOMIC ANALYSIS OF SOLAR PV SYSTEMS UNDER THE HOUSEHOLD SUPPORTING PROGRAMS IN KOREA

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This study conducted an economic analysis of solar PV system which is installed in households considering supporting programs of the Korean government. In Korea, the two programs named "New and Renewable Energy Home Subsidy" and "PV Rental Business" have been implemented representatively for the household sector. In the "New and Renewable Energy Home Subsidy" program, the government provides subsidies to households that desire to install new and renewable energy facilities. On the other hand, in the "PV Rental Business" program, households rent solar PV systems from rental service operators, who install, operate, and maintain the solar PV systems, and households pay rental fees. These two different programs, however, have a common point that the economic feasibility is crucial to making households participate. Thus, to promote the solar PV in the household sector more effectively in Korea, it is necessary to conduct an economic analysis and compare them. This study also can give a policy implication to countries that try to implement similar programs.

P-PS&B-004

THE IMPACTS OF ELECTRIC VEHICLE IN KOREA

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People develop technology to solve problems. But, sometimes unprepared new technology can cause unconscious troubles. Globally, electric vehicle is expected as an alternative to solve problems of internal combustion vehicle. Such as emission of carbon dioxide. EU and many OECD countries have studied on the impact of electric vehicle for more than 10 years. Korea made a plan for supplying electric vehicles, but their previous studies of the impacts of electric vehicle are not sufficient. To build basement of policy making and improve previous studies, this study is aimed at showing impacts of adopting electric vehicle in Korea in a 2 points of view. For showing environment effect of electric vehicle, this study uses the methods and data of JRC(2008)[1] and PE(2018)[2] which is LCA method. And, in a different view, the study employs Qien et al.(2011)[3]'s methods to show the impact of electric vehicle to load demand. Our expected results can be a basic references to policy makers and help supplying electric vehicle in a proper way in Korea.

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CHOICE BETWEEN NUCLEAR AND RENEWABLES IN DEVELOPING COUNTRIES

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This study analyzed the decision making structure of nuclear power and renewable expansion in developing countries − Cambodia, Myanmar, Indonesia, Kenya, Kazakhstan. Our analyzed countries are considering expanding their energy supply to meet growing energy demand. Nuclear and renewable energy can be supply options, but their preferences may differ in terms of technology, economics, social, and political institutions. Thus using the Analytical Hierarchical Process (AHP), we asked what factors are more important for the government officials in developing countries for each of nuclear and renewable energy. The survey was conducted from October 2017 to May 2018 and was conducted for officials from the energy or resource departments of Cambodia, Myanmar, Indonesia, Kenya, and Kazakhstan.

HYDROELECTRIC POWER AND NATURAL GAS ELECTRIC POWER USE - ECONOMIC GROWTH NEXUS: THE CASE OF MYANMAR

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In order to develop electricity generating, several scenarios of energy mixed have been embracing a renewable energy or a non-renewable energy in Myanmar. Accordance with the green energy policy, hydroelectric power consumption is clean and more economical than natural gas electric power. Increasing hydroelectric power generating and emerging economic growth are creating the good opportunity for the county renewable energy policy. This study analyzes the empirical model of cointegration estimate the hydroelectric power consumption and natural gas electric power consumption, real GDP per capital, foreign direct investment and consumer price index during the period 1971−2015.The results of this study show the increasing in hydroelectric power consumption with the increase the GDP per capital in the long term, however, increasing the natural gas electric power consumption has a significant negative effect on the economic growth.

RESEARCH AND DEVELOPMENT ON PARTIAL HEATING DEVICE FOR MONGOLIAN GER

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Heating is biggest issue in Mongolia due to long and harsh climate. Specially, it is hard to keep the inside temperature of Mongolian ger such as traditional dwelling where herders often live in countryside. High air exchange inside of Ger is reason why hard to keep the temperature as constantly. During the cold season, herders have higher heat demand, but there is relatively less heating source. Most of herder households are applying small sized PV system due to nomadic life style. This research is aimed to develop a partial heating solution for the comfortance of the elder and younger children who stay longer in a Ger. The heating pad was modelled with the felt and heating material and measurement and experiment was conducted. In the experimentation, heater was supplied by small sized PV system as an electricity supply that herder households use commonly. The electrical energy for heat pad is optimized during the experiment dependent on ambient and indoor temperature. Moreover, a controller device that modifies pad temperature relating to ambient temperature was developed and it can fully satisfy the safety and the reliability.

Key words: Heat demand, electricity consumption of herder households, partial heating solutions, felt

OPERATION CHARACTERISTICS USING AN ESS-EHP PACKAGE FOR A PEAK-OFF MANAGEMENT PROGRAM IN KOREA

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This paper presents development on Peak-Off management programs with a converged product of ESS (Energy Storage System) and EHP (Electric Heat Pump) in Korea. The Peak-Off management program, which uses mid-night electric power generally converts electrical energy into thermal energy, stores it at mid-night hours from 23:00 p.m. to 9:00 a.m. In KEPCO (Korea Electric Power Corporations), the Peak-Off management program was developed using EHP combined with ESS (hereafter that designated as ESS-EHP package) using mid-night electric power. We give results on heating and cooling operation in the test site using the ESS-EHP package. that package consisted of an EHP and an ESS. The EHP in ESS-EHP package has a heating capacity of 58 kW and a cooling capacity of 63 kW and the ESS in that package has PCS (Power control system) with the maximum power of 50 kW and B/S (Battery system) with the charging energy of 91 kWh. These tests were conducted under actual conditions in a winter period and a summer period. In one of a winter period, ESS-EHP package operated for 5.7 hours under the average outdoor temperature of −4.5 ℃. In a total winter period, it was shown as average operation time from 5.7 hours to 9.5 hours using the ESS-EHP package while the ESS in that package was fully charged.

FACTORS FOR RENEWABLE ENERGY TECHNOLOGY ASSESSMENT: ON THE CASE OF MONGOLIA

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Mongolia is recognized as a country with abundant renewable energy resource. Renewable energy has been recognized as one of the most promising options for domestic energy needs and distributed users in Mongolia in the recent decade. That significant attractiveness put Mongolia as an observable region for regional cooperation, joint projects and for investment opportunity. Therefore, the paper investigates into the renewable energy technology assessment methodologies developed by different intergovernmental institutions and organizations around the world by using qualitative study. Through the study, the author intends to find out the most impactful factors for the renewable energy technology assessments. Also, the study compiles and gives comprehensive recommendations based on the available data from assessments done in Mongolia in terms of attractiveness and drawbacks. Furthermore, the paper provides learning lessons based on various criteria and measures developed by different institutions. May policymakers find this explorative study helpful as it investigates in a wide range of assessment tools and factors. Researchers, technology developers, and scholars find this paper valuable as it delivers learnings, comprehensive evaluation methodologies with measurements for renewable energy technology.

AN ECONOMIC ANALYSIS OF NEW AND RENEWABLE ENERGY BUILDING SUBSIDY IN KOREA

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In this study, an economic analysis was conducted to evaluate "new and renewable energy building subsidy" which is a supporting program to promote new and renewable energy by the Korean Government. The "new and renewable energy building subsidy" program has been implemented since 1993 to promote using new and renewable energy in general buildings, not dwelling houses, such as commercial buildings, colleges, and social welfare buildings in Korea. In this program, the Korean government subsidizes buildings which desire to install new and renewable energy facilities by giving a certain portion of the installation costs of new and renewable energy facilities. Through this program, the Korean government intends to expand the supply of new and renewable energy and the relevant market. In order to achieve this goal, the active participation of buildings is important, so it is necessary to examine whether the program provides sufficient economic incentives. Through this study of an economic analysis, policy implications can be provided to the Korean government to adjust and correct this subsidy program.

SURVEY ON CONSTRAINTS ON NUCLEAR POWER IN DEVELOPING COUNTRIES -FOCUSED ON MYANMAR AND CAMBODIA

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As the need for greenhouse gas reduction to prevent global warming increases and the energy price fluctuates, many developing countries, including oil producing countries are interested in expanding the use of nuclear energy for domestic energy supply. Each country different environmental, economic, and technological conditions. In addition, the government's position, polices, and systems for the introduction and expansion of nuclear power are also very diverse. This study surveyed public officials in the energy and resources ministries of the governments of Myanmar and Kazakhstan to identify governmental intent to expand energy and the associated constraints. A total of 26 questionnaires in 8 categories of constraints (technical constraints, economic constraints, geographic constraints, social issues, environmental issues, natural risk issues, governmental issues, and international relations) was derived through previous research and reports. The survey results show that there is a difference in the recognition of the constraint and it is necessary to establish the strategy for introducing and expanding nuclear power by the country.

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BEHAVIOR OF SPECULATORS ON ALUMINUM STOCKS

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This study aims to analyze the speculative use of aluminum stocks of London Metal Exchange (LME) for the period from 2008 to 2018. After the global financial crisis, LME base metal inventories including aluminum and copper skyrocketed unprecedentedly. The abnormal surge in stocks have risen the possibility of speculative traders who pursuits monetary profit, which contradicts the original purpose of stocks to mediate deliveries of stocks and to secure precautionary volumes against emergencies. Market participants have questioned whether speculators intervened in the base metal market by artificially adjusting stocks for excessive profits. Therefore, this study examines potential existence of speculative behavior by analyzing the relation between aluminum stocks and prices. Our theoretical frame is the theory of storage to explain the relation between stocks and convenience yields, and the econometric analysis follows Bayesian approach.

RESOLVING ENERGY EXPANSION CONSTRAINTS IN ASEAN COUNTRIES

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The purpose of this study is to identify the constraints of national energy expansion in Myanmar, Cambodia and Indonesia. The ASEAN countries are continuing to invest in the energy sector to support the growing population and economic scale, and governments are actively encouraging energy supply facilities and expansion of power generation facilities. As a result of this expansion trend, developed countries are expected to have cooperation and investment opportunities with ASEAN countries. This study conducted an empirical analysis to derive the constraints and obstacles to the entry of ASEAN countries into energy sources.

The analysis of this study consists of two major parts. The first part is a survey which asked the constraints of the expansion of energy sources (oil, gas, coal, nuclear energy, renewable energy) to government officials in the energy related sector. In the second part, we analyzed the correlation between the willing to expand and the constraint which is based on an ordered logit model.

ASEAN countries have a lot of opportunities to enter the country due to lack of technology and capital compared to abundant resources. However, in order for investment and business to succeed, it is necessary to seek a strategy to overcome the inherent risk in each country. The suggestions and results of this study can help developed countries' advance into the ASEAN energy industry.

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P-PV-001

LOW-COST PRODUCTION PROCESS FOR CU(IN,GA)SE_2 THIN FILM SOLAR CELL

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In spite of the excellent performance of $Cu(In_{1-x}Ga_x)Se_2$ (CIGS) solar cells, the high production costs of conventional vacuum-based fabrication processes are hurdles to the widespread commercialization of CIGS thin film solar cells. Thus, non-vacuum-based CIGS fabrication processes have been investigated over the past several years. However, the non-vacuum solar cell efficiency has been still lower than that from vacuum-based process due to the poor quality of CIGS absorber film.

Here, we propose a new approach to solve the issue previously described. To reduce the production cost, we have developed a new hybrid process combining vacuum and non-vacuum method. Carbon-free CuS nano-particle precursors are used as a Cu source material. $(In, Ga)_2 Se_3$ precursor was stacked by thermal evaporation at low temperature. This stacked CuS/ $(In, Ga)Se_3$ thin film was selenized to make dense and large-grained CIGS thin film absorber layer.

We present a high quality of CIGS thin film absorber from our hybrid process by examining the morphologies, crystal structures, and compositional distributions. And also, we demonstrate its practical possibility by measuring the conversion efficiency and the external quantum efficiency for the completed solar cells.

P-PV-002

ESTABLISHMENT OF BIFACIAL SOLAR CELL MEASUREMENT TECHNIQUE AT THE KOREA INSTITUTE OF ENERGY RESEARCH (KIER)

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A bifacial solar cell measurement technique recently established at the Korea Institute of Energy Research (KIER) in Korea is introduced. This measurement technique is an indoor method that uses a continuous-type irradiance adjustable solar simulator and a bifacial cell mounting JIG of a novel design. A precise system configuration and measurement procedure are introduced along with precise uncertainty analysis. The uncertainty analysis indicates that the measurement technique has an expanded uncertainty of approximately 2.5 % with a coverage factor of k = 2 for the measurement of the power generation gain under the outdoor operation. In addition, the developed measurement technique was compared with a foreign accredited test laboratory to verify its validity and reliability, and the results of the comparison showed a good agreement with each other. The results of the comparion are also introduced with a precise analysis.

ELECTROCHROMIC PROPERTIES OF SOL-GEL DERIVED TITANIUM DOPED WO_3 FILM

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We investigated the effect of titanium coupling agent(TCA) on coating solution of sol-gel derived WO_3 precursor, peroxotungstic acid(PTA).[1,2] Here, we prepared various TCA doped PTA solutions for fabricating Ti-doped WO_3 films via a simple dip-coating route and the electrochemical properties of resultant films annealed at different temperature were investigated. Addition of TCA into ethanolic solution of PTA was found to significantly improve the long-term storage of precursor solution which can be ascribed to the prevention of self-hydrolysis via complexation of TCA to PTA. While PTA itself undergoes the crystallization above 450°C, addition of TCA retards the crystallization of PTA. Although results from both SEM and EDS analyses does not conclusively reveal the presence of titanium element in the WO_3 films, we speculate that the doping of tiny amount of titanium in WO_3 electrochromic films modifies the 3-D networks which are more porous enough to transport the lithium ion. Thus, compared to the pristine WO_3 films, TCA doped WO_3 films show the improved electrochromic properties.

ENHANCED ELECTROCHROMIC PROPERTIES OF TITANIUM OXIDE NANOCRYSTAL EMBEDDED AMORPHOUS TUNSTEN OXIDE FILMS

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We investigated the effect of nanocrystalline TiO_2 doping on the electrochormic properties of tungsten trioxide (WO_3) films.[1,2] Here, we prepared various TiO_2 nanocrystal-embedded amorphous WO_3 films by a simple one-step dip-coating method. XRD data of the films show amorphous nature for both undoped and nanoparticle TiO_2 doped WO_3 films with anatase phase of TiO_2 having (101) plane, which were further confirmed by TEM measurements. XPS of TiO_2 doped WO_3 film shows +6 oxidation state of W atom, implying the stoichiometric WO_3 composition. The electrochromic properties of the films were investigated by in situ spectroelectrochemical methods, showing the markedly different behaviors of the films depending on the amount of nanocrystalline TiO_2 doped. In particular, charge deintercalation kinetics of the films were significantly affected by the content of nanocrystalline TiO_2 in amorphous WO_3 matrix with 7 times faster deintercalation process by 30 wt% of TiO_2 doping into WO_3 at the expense of the reduced bleaching transmittance. This phenomenon may be associated with the effect of nanaocrystalline TiO_2 particles on blocking accessibility of Li ions to the trapping sites which has to be de-trapped if the ions are to be released.

PLANAR HOLE-CONDUCTOR FREE PEROVSKITE SOLAR CELLS WITH CARBON ELECTRODE

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We report in this work a hole-conductor free planar perovskite solar cells with low-temperature processing carbon based counter electrode. The device structure consists of FTO/SnO_2/Perovskite/Carbon which is markedly different from the monolithic perovskite solar cells with carbon electrode in that the former required higher temperature sintering process to fabricate the multilayer TiO_2/ZrO_2/Caron followed by the infiltration of perovskite precursor. In our case, the device structure is much simpler and all layers can be fabricated at lower temperature below 100°C which would decrease the manufacturing cost. In this study, we optimize the morphology and thickness of electron selective SnO_2 layer which play a key role in the devices' performance matrix. Moreover, the uniform and highly crystalline perovskite layer can be fabricated by sequential two step spin coating method. More importantly, the intimate contact between perovskite and cabon layer is one of key parameters in determining high efficiency of devices.

P-PV-006

IMPROVING WATER RESISTANCE OF PEROVSKIOTE SOLAR CELLS WITH AN ENCAPSULATION OF POLYDIMETHYLSILOXANE

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In order to extend the outdoor photovoltaic application and commercialization of perovskite solar cells (PSCs), a kind of flexible elastomer, polydimethylsiloxane (PDMS), is used for their encapsulation. In this study, we demonstrate a simple method to enhance the long-term stability of PSCs by adding PDMS protection layers and/or some other subsidiary materials (glass, cytop). PDMS is supplied in two parts, mixed in a 10:1 ratio by weight. This process is optimized, considering the performance degradation of the encapsulated PSCs. The PSCs, ITO/ZnO/perovskite materials/P3HT/Au/PDMS, were soaked in de-ionized water and their water-stability was characterized by the photovoltaic performance. For a compact and stable protection layer, it is important to control the curing process of PDMS. The results suggest that the lifetime of the encapsulated perovskite solar cells was extended significantly compared with non-encapsulated ones. Moreover, the efficiencies of the tested devices were very stable during the PDMS curing period at 75°C. The PSCs retain 90% of their initial efficiencies after 40h in water at room temperature. Based on this work, we present a simple and feasible way for protecting the perovskite solar cells from water and improving their long-term stability with a passivation of PDMS.

USING RENEWABLE ENERGY AS A HOUSEHOLD HEATING: CASE STUDY IN MONGOLIA

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This article discusses ways to reduce air pollution by using electricity as heating in low-emission house in Mongolian climate conditions. More than 60 percent of air pollution in Ulaanbaatar is caused by coal dust and ash from traditional heating of ger districts. The government of Mongolia has been promoting households to use electric heating while reducing tariffs on night time. This case study was done on 5kW floor plate heating system installed in a house with area of 56m2 located in Songinokhairkhan district, Ulaanbaatar city. Based on electrical consumption of the floor heating system, economic and environmental efficiencies were analyzed. Our chosen test object faces problems related to quality of power supply during peak load time. Therefore we optimized stand-alone PV system for the household using HOMER software.

Key words: household heating, floor heating system, air pollution, electricity tariff, stand alone PV system

P-PV-008

CHARACTERIZATION ANALYSIS OF OPTIMIZED $SiO_2/SiON_X$ STACK PASSIVATION LAYER AND STUDY ON APPLICATION OF HIGH EFFICIENCY N-TYPE C-SI SOLAR CELL

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High quality surface passivation is an essential element for high efficiency of n-type crystalline silicon (c-Si) solar cell. The passivation layer can reduce the dangling bond that causes carrier recombination from the surface, which contributes to increase in carrier lifetime. Generally, SiO_2, SiNx, Al_2O_3 are used for the passivation layer, but in this study, SiON layer which can be applied to ARC (anti-reflection coating) is optimized by PECVD (plasma enhanced chemical vapor deposition) we conducted experiments. In order to confirm the optimized SiON layer, deposition was carried out by varying the SiH_4 / NH_3 / N_2O gas ratio at a substrate temperature of 300 °C. SiON exhibits Neutral charge compared to SiNx through each conditional CV analysis, has better passivation characteristics, and simultaneously satisfies charge effect and surface passivation. In addition, SiNx has a value of 10.23 % / 80.36 % in reflectance and transmittance measurements, while SiON confirmed an increase in IQE due to a short wavelength using a result of 5.8% / 88.6%. SiH_4 45 sccm / NH_3 25 sccm / N_2O 45 sccm to establish optimum passivation conditions. Under these conditions, deposition was performed on p type and n type bare wafer respectively, and FGA (Foaming gas annealing) was carried out at 470 °C for 15 minutes in H_2 (15% H_2 / Ar) atmosphere to measure lifetime and implied Voc. After that, after the heat treatment (firing) process, lifetime and iVoc were re-measured to establish conditions applicable to the passivation layer. Using this established SiON optimum condition, it can be applied to highly efficient n-type c-Si solar cell.

FABRICATION OF COPPER/NICKEL OXIDE NANOPARTICLES ON ACTIVATED CARBON VIA A LIQUID PHASE PLASMA METHOD AND ITS APPLICATION AS SUPERCAPACITOR

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To improve the electrochemical performance of bare activated carbon, the bimetallic nanoparticles composed of copper and nickel element were precipitated on the surface of activated carbon using liquid phase plasma method in aqueous solution. The effect of initial concentration ratio of metal precursor on physicochemical and electrochemical properties was investigated. The morphology and chemical state of nanoparticles were characterized by analytical instruments such as SEM, XPS, XRD, and TEM. The bimetallic nanoparticles generated by liquid phase plasma method showed the amorphous shaped with several tens of nanometer. Their composition was influenced by the concentration ratio of metal precursor in aqueous solution. The electrochemical properties of as-prepared composites were measured by cyclic voltammetry and galvanostatic charge-discharge process and were compared with those of bare activated carbon. As a result, the specific capacitance of as-prepared composites was increased with increasing the amount of bimetallic nanoparticle on the activated carbon surface, and their cyclic performance was also improved. Moreover, the resistances of as-prepared composite were reduced than that of bare activated carbon.

P-ESS-002

SOC BALANCE STRATEGY OF LI-ION BATTERY SYSTEM BY USING FUZZY LOGIC CONTROL SYSTEM

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Li-ion battery stack can supply a large amount of power to the variable load but due to irregular charging technique it can't provide the constant energy to the load. In order to protect the batteries from over charging and over discharging and to increase the life of batteries in a certain limit, a Fuzzy Logic Controller (FLC) is used. By the use of FLC, series connected multi battery string's voltage will be balanced efficiently by adjusting equalizing current of each cell dynamically. It also provides the constant output to the variable and transient load. The model is simulated in MATLAB Programming and performance was measured by using experimental and simulation results. The simulation results shows that FLC charging system can charge the individual battery with higher efficiency and improved the performance of charging system as compare to conventional converter. It also decrease the temperature of the controller and shorten the charging time with optimal frequency.

STUDY ON POSSIBILITY OF PROVIDING HEATING AND ELECTRICITY DEMAND OF A HOUSEHOLD USING GRID CONNECTED PV SYSTEM WITH ENERGY STORAGE

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This article presents the possibility of providing electricity and heating demand of a household in Ulaanbaatar using PV system with energy storage. We estimated electricity demand of households based on electricity consumption data of households in Khan-Uul district, Ulaanbaatar. It was assumed that heating demand of households is being provided from electric heating device and energy required for heat supply is determined by using Casanova software. Moreover, Homer software was used to optimize grid connected PV system with battery bank. Two models of PV system were modeled based on different consumption feature of household. Each system consists of photovoltaic modules, inverters and battery banks. System A has capacity of 13kW and with battery storage of 18 kWh. This system was modelled to provide all of electricity demand during the heating season and supply excess electricity into grid. System A has capacity of 6kW and with battery storage of 18 kWh. For this system, It is not possible to fully supply the household energy consumption during the heating season and required energy is supplied from the grid. It is possible to work independently during the summer season. Finally, these two systems were compared from the view of economic benefit.

A STUDY ON THE CONSTRUCTION OF HORIZONTAL AND VERTICAL AXIAL MODEL TURBINE TEST FACILITIES

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The development and rehabilitation for the hydraulic turbine have to go through trial and error and it takes too much cost and time consumption if the tests have been by prototype hydraulic turbine. Instead of prototype performance test, we can validate and develop hydraulic characteristics through the model turbine laboratory test. The facilities for the performance test of model turbine is constructed to be able to perform the detailed test item in accordance with the International standard IEC 60193. The performance test equipment of model turbine basically consist of pump, valve, tail tank, dynamometer, model turbine, piping system, etc. In this study, the entire operating range of prototype turbine in Korea is configured to be tested in a model turbine test facility. The test of vertical and horizontal axis turbine can be carried out. The model turbine evaluation range can be tested up to net head of 100 m and a flow rate of 2.1 m^3/s depending on the single and series/parallel combination driving of the pump. The maximum specification of the capacity and rotational speed for the electric dynamometer is 450 kW and 2000 rpm. The model turbine performance test was conducted for a 45 MW level prototype hydro turbine, and the uncertainty was derived.

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OPTIMIZE THE DIFFUSER OF A TIDAL CURRENT TURBINE USING RESPONSE SURFACE METHOD

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Purpose of this project is to develop a 5 kW tidal power generation system which can be employed in low flow rate regions. It mainly targets island areas which are isolated from the national electrical grid. Project target is to improve the flow velocity which turbine experience. A diffuser was designed to improve the flow conditions. Surface response method of Ansys Workbench was used to optimize the diffuser shape with targets of minimizing the diffuser size while improving the performance. Free stream velocity of 1.5 m/s was increased up to 1.8 m/s using this diffuser. CFD analysis was done to optimized diffuser including the turbine and the performance of the turbine was observed. These results will be compared later with an experimental study.

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GEOTHERMAL HEAT PUMP RESULTS IN ULAANBAATAR

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We have prepared highly efficient solar cell using a simple sol-gel process. The p-type material is prepared by hydrothermal method, where the precursor solution is heated to 200 ^{o}C for 12 h. The n-type material is prepared by chemical combustion method. The prepared materials are characterized using XRD, SEM, TEM and XPS. SEM micrograph confirms that n-type material has columnar structure (Fig. 1). The well defined materials are sandwiched using hot-compression method. The metal contacts are made using silk screen method. The photovoltaic property of the prepared solar cell is measured under AM 1.5 G simulated light and the results are listed in Table 1. The photocurrent density is 40 mA/cm^2, voltage is 1 V and fill factor is 0.8. As a result, the overall conversion efficiency reaches 32%. The spectral response is also measured and quantum efficiency derived from the spectral responsivity reflects well the observed photocurrent density. The observed efficiency is higher than the previous result [1].

In nature, the thermal energy of the lower potential is huge, almost everywhere. This ground resource, such as geothermal heat, is capable of solving all the houses, construction heating and hot water demand with heat pumps. Heat supply is the fastest-growing sector of all traditional energy solutions. In some developed countries, heat pump for heat supply system is developing as a main competitor with organic fuel-based power generation.

The Government of Mongolia is actively supporting the use of heat pumps for ground course. In recent years, some studies have been conducted on the use and introduction of geothermal pumps in Mongolia and are being used in a number of areas, including the Zuunmod city school in Tuv aimag and the in ASEM villa town in Ulaanbaatar. Also, people are starting to use warm-up in their apartment building.

Although Mongolia has been operating for a decade for thermal pumps, its efficiency is very limited, with subsequent work being done without baseline data. Therefore, the purpose of the study is to investigate the efficiency of the thermal pump heating system in your country.

DESIGN AND SIMULATION OF TWO SMALL HORIZONTAL AXIS WIND TURBINE

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The most important alternative energy source is the wind power. Therefore, the international installed capacity is increasing radically every year. A wind turbine is one of the important devices to convert the wind power to a useful power like Mechanical or electrical power. During many decades ago, a lot of research has been done to develop wind turbines and reach their best efficiency. This paper considers as complementary to those ideas. The aim of this paper is divided into two steps. The first step representing the design of two small horizontal axis wind turbine with total output power 1 kW. These turbines will be installed in parallel on the same tower. So, the second step includes finding the best distance between these two turbines. The optimum distance takes into consideration achieving the best performance for both turbines by avoiding the vortices interaction effects that might occur between them. All the calculations were carried out by using Matlab code based on the Blade Element Momentum theory (BEM). Wind speed augment device (diffuser) had been used to improve the turbine performance. The performance of three-bladed wind turbine had been analyzed numerically based on the finite volume technique by using commercial software CCM+.

P-WE-002

STUDY ON OPTIMAL LAYOUT METAMODEL FOR SMALL OFFSHORE WIND FARM

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Layout-optimized design of offshore wind farms is a key factor in reducing investment costs and annual energy production and maintenance costs. A lot of research is going on to secure the economical efficiency of offshore wind farms. The layout design of an offshore wind farm is a key factor in the initial investment cost, annual energy production and maintenance costs. Various modeling has been carried out in order to optimize the arrangement of wind turbine according to turbine interval and turbine wind direction considering the wind speed and wind direction. By analyzing the sensitivity of the metamodel and deriving the optimal solution, it is possible to secure the economical efficiency of offshore wind farms. In this paper, we evaluated the impact of offshore wind farm design using three DOE scenarios for optimal turbine placement (pattern method, grid-based method, and unconstrained coordinate method). We proposed the optimal wind turbine layout for a small offshore wind farm

SCOUR RISK ASSESSMENT FOR OFFSHORE WIND TURBINE SUPPORT STRUCTURES

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One of the problems that arise in structures such as offshore wind turbines where bases are fixed on the seafloor are erosion phenomena caused by scouring. In other words, the scour phenomenon occurring at the bases exposed to currents and waves is defined as the phenomenon that the submarine particles are lost due to the interaction between the fluid flow and the structure, and it is an important factor to be considered in designing. If such scour occur, the stability of offshore wind turbines which endure horizontal loads and moment loads due to wind loads and wave loads is deteriorated. In this study, scour risk assessment of offshore wind turbines by type of support structure is performed. The upper structure was modeled with NREL 5MW, and the support structure evaluated the scouring risk for monofiles, jackets, and tripods. The load was analyzed by applying wind and wave loads, and the scour fragility curve for the scouring depth was calculated using this method. In addition, the risk of scouring was analyzed by combining the probabilistic distribution of the scouring depth and the scouring fragility curve of the structure.

P-WE-004

PHYSICAL PROPERTIES WITH POLYMERIZATION CONDITIONS OF T-RTM PROCESS FOR CFPA6 COMPOSITES BY RESPONSE SURFACE METHOD

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The paper aims to identify the physical properties of carbon fiber reinforced PA6 composites (CFPA6) as affected by the polymerization reaction conditions when a thermoplastic-resin transfer molding (T-RTM) process is applied, by using a response surface method. For this, firstly a T-RTM process was established with carbon fiber and caprolactam (PA6 monomer) as base materials. Secondly, the injection speed, C20 (activator) rate and C10 (catalyst) rate were selected as design variables that affect the physical properties of the CFPA6 composites. Experimental conditions for three design variables of the CFPA6 composites were set using central composite design (CCD) of DOE (design of experiments) method. The significance of the CCD was verified using ANOVA (analysis of variance) and sensitivity analysis. Finally, an optimal problem was solved with an objective function of mechanical properties, that is, tensile strength and a constraint of a polymer conversion rate to obtain the optimal CFPA6 polymerization reaction conditions.

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VIBRATION SUPPRESSION CONTROL FOR TWO-INERTIA SYSTEM

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We consider the vibration suppression control problem for a two-inertia system that consists of two inertias connected by a shaft. The compliance of the shaft produces torsional vibrations that usually result in limited tracking performance when conventional control strategies such as PI control are employed. Moreover, the control problem becomes far more challenging if the load-side speed and torsion torque developed in the shaft are not measurable. This paper presents a disturbance observer-based controller that suppresses vibrations due to torsion torque and external disturbance. This is done by constructing an observer that estimates the torsion torque, load speed, and load torque at the same time and a controller that can adjust the torsion torque as desired. The proposed idea is validated through numerical simulations.

P-WE-006

ACCURATE ESTIMATION OF GENERATOR SPEED IN VARIABLE SPEED WIND TURBINE

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A small wind turbine system usually uses the frequency of the voltage to estimate the rotor speed by measuring one phase of the output voltage of the generators instead of using an encoder. This method is difficult to know the voltage frequency when the load is small. Another method is sensor-less control based on Back electromotive force. These sensor-less methods require additional voltage and current sensors that are not needed in traditional power conversion topologies, which increases the cost of the system.

The system is a small wind turbine system based on a permanent magnet generator, consisting of a diode rectifier and a boost converter. The generator speed and the rectified generator voltage are proportional in no-load state but are not proportional to the voltage drop in the generator when there is load state. It is difficult to estimate the generator speed by calculating the voltage drop if the parameter error is caused by the temperature rise. In this paper, we propose a method to improve the reliability of speed estimation by using DC voltage without additional sensor.

CALCULATION OF POWER LOSSES OF TRASNMISSION LINE OF INTERNAL GRID IN A WIND POWER PLANT

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As the size of the wind power plant increases the length of power transmission line may increase to find the enough connection capacity of the grid. The power losses from the distribution lines of internal grid also increase as the area of the wind power plant increases according to the capacity of the power plant. Considering the long-term operation of a wind power plant, economic losses may be larger due to the reduction of generation power at the point of connection rather than the economic gain initially obtained by the reduction of the equipment cost. In this paper, several methods are compared to reduce the power loss from the wind power plant to the grid connection point and to make voltage fluctuation at the grid connection point satisfy the regulations. Such as the selection of power line or cable with higher current rating, and the selection of raised voltage level in the transmission can be a good choice with the correct estimation of the loss and cost if the size of the wind power plant is big and the distance to the grid connection point is long. In this paper power losses and voltage fluctuation are calculated by simulation using DigSilent Power Factory with actual wind power plant data to evaluate the performance of the plant in terms of efficiency and technical requirements such as voltage variation range.

A STUDY ON THE EFFECT OF VIBRATION REDUCTION BY COMPENSATING YAW MISALIGNMENTS OF WIND TURBINE USING NACELLE LIDAR

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The nacelle anemometer mounted behind the blade of a wind turbine measures distorted wind speed because of the wake effects caused dependent upon the operation of the wind turbine and the rotation of its blades. According to the results of previous studies, the wind energy that flows into the wind turbine decreases as the yaw misalignment of the wind turbine increases. And then power performance of the wind turbine also decreases. In order to improve the power performance and capacity factor related to the profitability, the importance of the analysis and study of yaw misalignment is increasing. Also, it is necessary to study the effect of yaw misalignment correction on the wind turbine. In this study, the effect of vibration reduction of wind turbine when misalignment is corrected according to the result of analyzing the yaw misalignment of the wind turbine using nacelle LIDAR is studied.

FLUID FLOW ANALYSIS OF AN EJECT CIRCULATOR

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A performance analysis on an ejector circulator was conducted in this study. The circulator was consisted with an ejector, an educt and a pump. Flange of the nozzle in the ejector is connected to the flange of the 3" pipe which was branched from main supply 8" pipe. The circulator is installed inside of the tank with 24m diameter. The working fluid inside of the tank is extracted through a return pipe located in inside of the tank and is supplied to the nozzle by a pump. The circulator discharge the working fluid to the tank through the educt which was brazed to the nozzle surface with three ribs. Between the nozzle and educt, the working fluid in the tank is entrained to the nozzle discharge by induced flow force which is droved by pressure difference. The induce flow of the working fluid and the discharge angle of the educt can make a mixing of the residual fluid in the tank.

The analysis has three assumptions; extract fillet of inlet flange, extract step of inlet flange, 50mm extension of inlet of the nozzle for stability of the flow. The calculation was based on 696,774 elements and 154,962 nodes grid generation.

As results, when flow from the flange is discharged at nozzle, the exit pressure of the nozzle reached at 0 and the flow rate of the oil maximized at 31.3 m/sec. The stream line of this analysis is based on calculated rib inlet pressure 1.17kg_f/cm^2, Nozzle outlet pressure 0 and induced flow rate through the rib is about 114 m3/hr.

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A NUMERICAL STUDY ON THE EFFECTIVE VARIABLE SPEED VENTILATION FLOWS FOR CONTAMINANTS AND TEMPERATURE CONDITIONS IN THE INDUSTRIAL FACILITY

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As the energy saving is recognized as a universal topic in various industrial fields, researches on improvement of the ventilation efficiency by means of variable speed and distributed control are being actively attempted for the ventilation system of the industrial facility. In this study, case studies have been performed using CFD (Computational Fluid Dynamics) method to predict the sufficient ventilation flow rate in a variable ventilation condition considering the temperature variations and released contaminants (e.g. CO2) according to the industrial facility operation conditions. The flow visualization experiment was carried out with a reduced scale model for the same industrial facility ventilation space as the CFD model, and the various flow phenomena predicted through the CFD analysis were practically demonstrated and compared. Conclusively, it is suggested that effective variable-speed ventilation scenario based on pollutant generation and temperature conditions corresponding to the utilization rate of the industrial facilities in the perspective of energy saving.

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P-LCT-002

A NUMERICAL STUDY ON A 330W WALL AXIAL FAN USING COMMERCIAL CFD CODE AND OPEN SOURCE CFD CODE

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Widely used for factory ventilation, the fan is the most energy-consuming device in the industry. By improving the efficiency of the fan, it is possible to save energy, reduce dependence on fossil fuels, and consequently contribute to reducing the greenhouse gas to below the appropriate level. With the recent development of computational fluid dynamics(CFD), it has become possible to analyze the efficiency and flow field of the fan through flow analysis. In the present study, flow analysis using the CFD was performed on a 330W wall axial fan, which is widely used for factory ventilation. The k-omega SST model was applied to simulate the turbulent flow. The incompressible full 3-D Navier-Stokes equation is solved with the frozen rotor method to consider the rotating motion of impeller of the wall axial fan. We compared the results with CFX, a commercial CFD code, and OpenFOAM, an open source code. The results of the present study could provide useful data for optimal aerodynamic design of the 330W wall axial fan. This work was supported by the Korea Institute of Energy Technology Evaluation and Planning(KETEP) and the Ministry of Trade, Industry & Energy(MOTIE) of the Republic of Korea (No. 20172010105070).

DEVELOPMENT OF SYNCHRONOUS RELUCTANCE MOTORS WITH SUPER-PREMIUM EFFICIENCY CLASS (IE4)

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Induction motors, which are widely used throughout the industry, account for a significant portion of the electrical energy consumption, however, it is very difficult to improve their efficiency. Synchronous reluctance motor (SynRM) is an electric motor composed only of a core in rotor, unlike an induction motor in which a conductor is inserted into a rotor. Therefore, no copper loss occurs in the rotor, and since it is easy to manufacture, it is attracting attention as a next generation high efficiency electric motor for reducing energy consumption. We have developed the super-premium efficiency (IE4) SynRM. The capacity of the designed models are 15kW and 37kW, and the International Electro-technical Commission (IEC) standard frames of conventional induction motors are used as they are, and only the rotor shapes are changed. The efficiency of these motors obtained by the temperature rise test under the rated load is 92.4% for the 15kW model and 95.4% for the 37kW motor, satisfying the IE4 class of the standard IEC 60034-30 (2014).

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EXPERIMENTAL STUDY ON ALKALINE ELECTROLYSIS OF CNF AQUEOUS SOLUTION

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This study was aimed at developing a new electrolyte solution for alkaline electrolysis. A CNF (Cellulose Nano Fiber) aqueous solution was considered as an alternative electrolyte to KOH and NaOH. The volume of hydrogen and current produced were measured according to the concentration change of the CNF aqueous solution. In the electrolysis experiment, a Hoffman electrolysis apparatus was used. The experiment was conducted at room temperature, and the concentration of an aqueous solution of A constant voltage of was applied to the cylindrical electrode. Platinum was used for the anode, and SUS 304 was used for the cathode. The average current densities for concentration change of CNF aqueous solutions was, and ; and the efficiency of hydrogen production was and, respectively. Before the electrolysis experiment, the pH of the CNF aqueous solution was in the range of to. The pH levels of to at the anode and to at the cathode were measured. The current density and efficiency have increased as the concentration change of aqueous solutions increased, and the pH difference between anode and cathode has been smaller as the concentration is higher.

TEMPERATURE MEASUREMENT INSIDE PEMFC CHANNEL USING INFRARED THERMOGRAPHY

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PEMFC(polymer electrolyte membrane fuel cell) is an energy conversion device that directly generates electricity using hydrogen and oxygen. The important issues to enhance the performance of PEMFC are uniform supply of hydrogen and oxygen, discharge of condensed water, and uniformity of current density over the entire active area. To improve the uniformity of the current density, it is required to exactly measure operating temperature and reaction temperature. Information of temperature distribution over the entire active region on fuel cell enables heat management, and thus prevents damage major components such as gas diffusion layer (GDL) and membrane electrode assembly (MEA), and degrades performance of the fuel cell. This study is intended to provide temperature distribution of the fuel cell according to operating conditions using Infrared Thermography. The temperature inside the fuel cell is measured by IR camera which calibrated with blackbody calibrator and IR window. This internal thermal visualization technique can be provided to better understand the water flooding and thermal distribution of PEMFC.

ELECTROSPUN TiO2/ZrO2 NANOFIBER REINFORCED MEMBRANES FOR HIGH TEMPERATURE PEMFC APPLICATION

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High temperature operation of Polymer Electrolyte Membrane Fuel Cell(PEMFC) comes with benefits to ensure faster commercialization of the system. Yet, even with such bright possibilities, numerous obstacles hamper PEMFCs to be functioned in the raised temperature region of over 100 °C. Low humidity results in a significant loss of conductivity in PEMs. Furthermore, the ionomer also can be deteriorated in such harsh conditions. The reasoning for this research comes with answering such issues. Along with its temperature stability oxides are hydrophilic and thus hygroscopic. These natures of the enforcement material mitigate the presented issues by maintaining a certain level of water content in the membranes along with the structural reinforcement aspects. Visualization of the benefits from the synthesized membrane is clearly depicted in the XRD, SEM, EIS data sets.

P-H&FC-004

THERMALLY TREATED GRAPHITIC CARBON NANOFIBER FOR HIGHLY EFFECTIVE AND DURABLE PEMFC ELECTROCATALYSTS

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Conventional electrocatalysts of polymer electrolyte membrane fuel cells (PEMFCs) are composed of platinum particles loaded on carbon allotropes to maximize the dispersion of platinum and boost up electron conductivity for facile electrochemical reactions. Although Pt/C is widely used, the catalytic activity of Pt/C in the oxygen reduction reaction (ORR) is decreased precipitously by carbon corrosion.

In this study, we prepared graphitic carbon nanofibers which are thermally treated at high temperatures, offering sub-100 nm diameters. As the annealing temperature is raised, surface defects of the obtained carbon matrix could be effectively reduced and graphitic layers thicken a long with the wall direction. After platinum particles were loaded on the CNF, the durability of prepared Pt/CNF electrocatalysts was confirmed by the following accelerated lifetime protocol: start/stop (e.g., 1.0 − 1.5 V vs SHE, scan rate 500 mV s^{-1}, 60,000 cycles at 80 °C, RH 100% and ECSA reduction < 40%), suggested from DOE, FCCJ. The results were directly proportional to the degree of graphitization which are dependent on the annealing temperature. As the degree of graphitization increased, the durability was steadily increased until 2500 °C. Therefore, 2500 °C treated Pt/CNF meets the crucial target for carbon corrosion.

HIGHLY STABLE AND PERFORMANCE-IMPROVED PT/TiO_2 NANOFIBER CATALYSTS

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Many researchers have shown great interest in high temperature polymer electrolyte membrane fuel cells (HT-PEMFC ≥100 ℃). But there are some problems to operate at high temperature. One of the problem is carbon corrosion which is further accelerated at high temperatures. In order to maintain excellent cell performance and durability, it is necessary to develop electrochemically stable materials under operating conditions. So, our approach utilizes the corrosion resistance of TiO2 and the electrochemical conductivity of carbon in the design of CNT-Pt/TiO2 catalysts. It shows that CNT-Pt/TiO2 catalyst improves performance and durability at the same time in single cell tests. All of these results by using of CNT-Pt/TiO2 catalyst confirmed by XRD, XPS, SEM, TEM and several electrochemical measurements [1].

STUDY ON HEATING SYSTEM BASED ON LENR AND PLASMA ELECTROLYSIS

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Heating the house during harsh winter with cost efficient way is one of the most challenging problem of Mongolia. In order to solve this problem we begun conducting research on getting extra heat energy from plasma electrolysis or so called LENR(Low Energy Nuclear Reaction). LENR is one kind of nuclear reaction, which can be operated at low temperature (at room temperature), compared with Hot Fusion and Fusion(at least sun surface temperature). LENR is also known as Cold Fusion. Number of scientists successfully conducted this kind of experiment with excess heat energy. We also made some experiment and got good result, in terms of heat energy. LENR is unique in that, it does not emit harmful level of alpha, betta, gamma radiation, if it does then it is consumed by transmutation of cathode metal, so there is no danger of nuclear radiation waste.

A NANOFIBROUS OXIDE-CARBON COMPOSITE SUPPORT FOR A HIGHLY ACTIVE AND STABLE PEMFC CATHODE CATALYST

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The unique electronic configuration and structural properties of electro catalyst modify the activity, stability and mass transport for improved catalytic reactions. We design a novel nanofibrous oxide-carbon composite by an in-situ method of carbon nanofiber (CNF) growth by highly dispersed Ni nanoparticles that are exsoluted from a $NiTiO_3$ surface. The nanofibrous feature has basically a 3D web structure with high surface area for better mass transfer at the electrode. Also, the CNF/TiO_2 composite support shows complex properties for great stability and activity from the TiO_2 oxide and high electric conductivity through the connected CNF, respectively. The CNF/TiO_2-Pt nanofibrous catalyst displays an exemplary ORR activity with great enhancement of the ECSA. Moreover, great resistance to carbon corrosion and Pt dissolution is evidenced by durability test protocols based on DOE. These results are well reflected to the single-cell experiments with even better performance at the kinetic region compare to the state of art Pt/C. CNF/TiO_2-Pt exhibits unique active state due to the strong synergetic interactions, which reduces the d-band vacancy of Pt due to an electron transfer from the support. The involved reaction mechanisms are also presented, and eventually gives an outlook in the design of novel ORR electro catalyst.

SO_2 SORPTION PROPERTY OF POTASSIUM-BASED DRY SORBENTS AT A LOW TEMPERATURE RANGE BELOW 70°C

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In this study, the potassium-based dry sorbents were prepared by the impregnation of potassium carbonate on metal oxide supports to remove SO_2 at low temperature. The abilities of SO_2 sorption as a function of H_2O concentrations and sorption temperatures were tested in a fixed-bed at low temperature conditions(30-60°C) in the presence of 5000 ppm of the SO_2). It was found that the SO_2 sorption capacities of potassium based sorbents increased with the H_2O concentration in our experimental range. In particular, the K_2CO_3/Al_2O_3 sorbent showed an excellent SO_2 sorption capacity (0.32 SO_2 g/sorbent g) even at 7 vol% H_2O and 30℃. Characterization of the sorbents using XRD and TPR (Temperature Programmed Reaction) were carried out and the results were discussed.

A STUDY ON PHASE ANGLE DETECTING ALGORITHM FOR GRID TIED INVERTER

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These days, grid tied distribution system is being expected to be greatly installed in Mongolia. Because this type of system is more reliable and give economic efficiency. However, It is impossible to expect legal environment and appropriate regulations for the grid tied distribution systems. Grid connected inverters have to meet with some requirements including current total harmonic distortion should be less than 5%, have an anti island mode, and inverter output current should be synchronous with phase voltage of utility grid. Phase locked loop (PLL) is used to detect phase angle of grid voltage and to synchronize grid voltage. In this paper, two algorithms are selected and compared. For the comparison, detailed mathematical calculation of selected PLL algorithms was done, confirmed using PSIM software and evaluated the reliability for each algorithm. Moreover, proposed algorithms were run with virtually designed grid connected inverter using simulation software.

OPTIMIZATION OF BIOGAS PRODUCTION FROM KITCHEN WASTE INSTALLED AT COLLEGE OF SCIENCE AND TECHNOLOGY, BHUTAN

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This paper presents an overview of the biogas plant and optimization of gas production installed near students' dining room at College of Science and Technology located in the Southern foothills of Bhutan. The mixed kitchen waste produced is collected and directly feed to the biogas plant. This research is installed in collaboration with Department of Energy and College of Science and technology as a pilot project with the aim "Waste-To-Energy Initiatives." It also aims to replace the use of liquefied Petroleum Gas (LPG) in students' mess kitchen. The detail studies of waste production and feasibility studies were carried out before installation of the plant. The maximum capacity of the plant is 4 m^3 per day. As production of gas from the plant depends on type of waste and surrounding temperature, gas yield was not as per the design criteria. To improve the gas production, various methodologies where applied.