

SJTU-NTNU Joint Research Centre on Sustainable Energy

Progress report October 1st 2014 to June 30th 2016 for all the JRC-areas

The document contains the progress reports of the research areas:

Research area	Leader
Energy System Analysis (ESA)	Marius Korsnes
Energy in Buildings (EIB)	Annemie Wyckmans
Refrigeration (REF)	Trygve M. Eikevik
Offshore Wind and Smart Grids (OWG)	Marta Molinas
Catalysis for Renewable Energy (CAT)	De Chen

In the period it has been organized two workshops, one in Shanghai and one in Trondheim. The programs for the individual workshops are included in Appendix A and Appendix B.

SJTU-NTNU Joint Research Centre on Sustainable Energy

Progress report October 1st 2014 to June 30th 2016
Energy System Analysis Group

Marius Korsnes,
 Department of Interdisciplinary
 Studies of Culture
 NTNU

Background

The Energy System Analysis group collaboration between NTNU and SJTU started in 2010, focusing on energy user behavior and energy system analysis. Research cooperation was established with Ass. Prof. Xiaojun HU, Department of Mechanical Engineering, Energy Modeling & Policy, Energy Research Institute, Shanghai Jiaotong University. Collaboration has been on two main fields: Energy modelling and energy policy especially related to renewable energy. During the course of the joint research centre period we amongst other things have had long-term exchange of a PhD student, and organized a summer school on energy, environment and society. The total group of collaborators is as following:

From SJTU:

- Ass. Prof. Xiaojun HU, Department of Mechanical Engineering, Energy Modeling & Policy, Energy Research Institute, Shanghai Jiaotong University
- Prof. Xu ZHAO, Associate Dean of Antai College of Economics & Management (ACEM), Shanghai Jiaotong University (Joined 2015)

From NTNU

- Prof. Marianne Ryghaug, at the Department of Interdisciplinary Studies of Culture & Deputy director of CenSES
- Assoc. prof. Ruud Egging, Department of Industrial Economics and Technology Management (joined 2014).
- Dr. Marius Korsnes, Post.doc at the Department of Interdisciplinary Studies of Culture
- (2010-2014) Dr. Gard H. Hansen
- (2012-2015) Dr. Henrik Karlstrøm

1: Progress report for the final period from 20141001 to 20160630

The PhD that was initiated as a part of the joint research centre defended his thesis on December 1st, 2015: Marius Korsnes, with the thesis title: 'Chinese Renewable Struggles: Innovation, the Arts of the State and Offshore Wind Technology'. Moreover Pål Aune's master thesis written as part of the JRC collaboration was finished in 2016.

We participated in the Shanghai Workshop in January 21-24 2015 and the Trondheim Workshop in April 20. In the Shanghai 2015 workshop the Energy System Analysis group was strengthened by another person: Professor ZHAO Xu, Associate Dean of Antai College of Economics & Management (ACEM), Shanghai Jiaotong University who has worked much on energy and environment policy. At the Trondheim 2016 workshop the Energy System Analysis group laid out the plans for the future, where the idea is to generate a new Energy System Analysis group between NTNU, SJTU in conjunction with the Tsinghua University as part of the Sino-Norwegian Partnership on Sustainable Energy (SiNoPSE). The groundwork has already been laid, and we met the main collaborators from the Tsinghua University at the SiNoPSE Kick-off meeting at Tsinghua University in May 2016 in Beijing.

There were no joint-publications between SJTU and NTNU in the Energy System Analysis group in the period. Below we list the publications and lectures that have been associated with the SJTU-NTNU Joint Research Centre.

Energy System Analysis group publications, presentations and lectures 2014-2016

Number	Year	Type	Title
1	2014	Conference Presentation	Korsnes, M. (2014), 'The Rapid Growth of China's Wind Industry – An Institutional Analysis'. Shanghai Social Studies Colloquium (SSSC), Shanghai, China
2	2014	Conference Presentation	Korsnes, M. (2014), 'The creation of China's offshore wind industry: Catching up in design but not in time?'. 5th International Sustainability Transitions (IST) Conference, Utrecht, Netherlands
3	2014	Workshop Presentation	Korsnes, M. (2014), 'Perceptions and visions of China's emerging offshore wind industry'. Workshop: 'Social construction of technology coming of age: new challenges and opportunities ahead', Department of Interdisciplinary Studies of Culture, NTNU, Trondheim, Norway
4	2014	Conference Presentation	Korsnes, M. (2014), 'Offshoring Offshore Wind: A Norwegian (ad)venture in China'. Society for Social Studies of Science (4S) / ESOCITE, Buenos Aires, Argentina
5	2014	Conference Presentation	Korsnes, M. (2014), 'Globalising Standards? A Narrative Analysis of Offshore Wind Standardisation in China'. CenSES Årskonferanse, Oslo, Norway
6	2014	Workshop Presentation	Korsnes, M. (2014), 'Creating paths for China's offshore wind industry: Supply chain logics and a mentality change from swiftness to thriftiness'. ETH PhD-Academy on Sustainability and Technology 2014. Toward a Renewable Future? Technological, Organizational and Institutional Change in the Energy Sector
7	2014	Conference Presentation	Korsnes, M (2014), 'China's Offshore Wind Industry'. Science Meets Industry - Offshore Wind Conference, Bergen, Norway.

8	2014	Conference Presentation	Korsnes, M. (2014), 'Visions and perceptions of China's emerging offshore wind industry'. 20th Annual International Sustainable Development Research Conference: Resilience - The New Research Frontier. Trondheim, Norway
9	2014	Report	Korsnes, M. (2014), 'China's Offshore Wind Industry 2014: An overview of current status and development'. Trondheim, Norway: CenSES (ISBN 978-82-93198-04-8) 38 p.
10	2014	Journal Paper	Korsnes, M. (2014), 'Fragmentation, Centralisation and Policy Learning: An Example from China's Wind Industry'. China aktuell - Journal of Current Chinese Affairs, Volum 3. pp. 175-205
11	2014	Journal Paper	Ydersbond, I.; Korsnes, M. (2014) 'Wind Power in China and in the EU: Comparative Analysis of Key Political Drivers'. Energy Procedia; Volum 58. pp. 95-102
12	2015	Conference Presentation	Korsnes, M. (2015), 'Ambition and Ambiguity: Expectations and imaginaries developing offshore wind in China'. NESS 2015, Nordic Environmental Social Science Conference, Trondheim, Norway
13	2015	Conference Presentation	Korsnes, M. (2015), 'China's Offshore Wind Industry: Catch-Up and the role of certification'. EERA Deepwind 2015, Trondheim, Norway
14	2015	Workshop Presentation	Ryghaug, M.; Hansen, G.H. (2015), 'Joint research Centre SJTU - NTNU: Energy System Analysis Group. Joint research centre Shanghai Jiao Tong University, Shanghai, China
15	2015	PhD Thesis	Korsnes, M. (2015), 'Chinese Renewable Struggles: Innovation, the Arts of the State and Offshore Wind Technology'. PhD Thesis, NTNU, Trondheim: NTNU Trykk (ISBN 978-82-326-1300-7) 232 p.
16	2016	Journal Paper	Ydersbond, I. M.; Korsnes, M. (2016), 'What drives investment in wind energy? A comparative study of China and the European Union'. Energy Research & Social Science, Volum 12(2) pp. 50-61
17	2016	Journal Paper	Korsnes, M. (2016), 'Ambition and ambiguity: Expectations and imaginaries developing offshore wind in China'. Technological forecasting & social change, volum 107. pp. 50-58
18	2016	Journal Paper (in press)	Korsnes, M. (2016), 'A sustainable Chinese catch-up? Product quality and interactive learning in the offshore wind industry'. International journal of technological learning, innovation and development, in press.
19	2016	Lecture	Korsnes, M. (2016), 'Doing Research in China: There and Back Again'. DION 2016 Annual General Meeting & Board Election, Trondheim, Norway
20	2016	Master thesis	Aune, P. (2016), 'Kull, utvikling og miljø – Kinas sosio-tekniske problem – eller hvordan snu verdens største supertanker i tide', Master thesis in «Knowledge, Technology and Society», Department of Interdisciplinary Studies of Culture, NTNU, Trondheim, Norway

SJTU-NTNU Joint Research Centre on Sustainable Energy

Progress report and Final Report from the Energy in Buildings Group

Annemie Wyckmans,
Faculty of Architecture and Fine Art
NTNU

Background

The Energy in Buildings group collaboration between NTNU and SJTU started in 2010, focusing on education, research and innovation on zero emission buildings and districts, leading up to smart cities. This includes energy systems and services (including heat pump processes and technologies), integration and optimization of solar energy in buildings and districts, and smart ICT-based solutions for buildings and cities (including modelling of user behavior and human-technology interface). The cooperation includes quantitative assessments, cooperation on research infrastructure and laboratories, and urban living labs.

The Energy in Buildings group consists of the following participants:

From SJTU:

- Prof. Ruzhu WANG, School of Mechanical Engineering
- Prof. Yanjun DAI, School of Mechanical Engineering
- Assoc. Prof. Yong LI, School of Mechanical Engineering
- Assoc. Prof. Tianshu GE, School of Mechanical Engineering
- Prof. Xiaoqiang ZHAI, School of Mechanical Engineering
- Mr. Ryan CAO, School of Mechanical Engineering
- Jinfeng CHEN, PhD candidate, School of Mechanical Engineering
- Rui LI, PhD candidate, School of Mechanical Engineering

From NTNU

- Prof. Annemie WYCKMANS, Faculty of Architecture and Fine Art, Vice Dean of Research (Acting Dean January-June 2016)
- Prof. Vojislav NOVAKOVIC, Faculty of Engineering Science and Technology
- PhD Researcher Clara GOOD, Faculty of Architecture and Fine Art
- Dr. Gabriele LOBACCARO, Faculty of Architecture and Fine Art
- Dr. Yu WANG, Faculty of Architecture and Fine Art
- Assoc. Prof. Salvatore CARLUCCI, Faculty of Engineering Science and Technology
- Assoc. Prof. Luca FINOCCHIARO, Faculty of Architecture and Fine Art, Head of the MSc in Sustainable Architecture
- Assoc. Prof. Rolf André BOHNE, Faculty of Engineering Science and Technology

- Prof. Arild GUSTAVSEN, Faculty of Architecture and Fine Art, Director of the Research Centre on Zero Emission Buildings
- Assoc. Prof. Laurent GEORGES, Faculty of Engineering Sciences and Technology
- Assoc. Prof. Aoife Houlihan WIBERG, Faculty of Architecture and Fine Art, Deputy Head of Department
- Prof. Hans-Martin MATHISEN, Faculty of Engineering Science and Technology
- Prof. Bjørn Petter JELLE, Faculty of Engineering Science and Technology
- Dr. Usman DAR, Faculty of Engineering Science and Technology

1: Progress report for the final period from 20141001 to 20160630

We have had a sandwich PhD (one at SJTU and one at NTNU) on “Photovoltaic-thermal systems for zero emission residential buildings”, with mutual exchange between the PhD candidates and their supervisors. The disputation of the NTNU candidate, Clara Good, takes place 28 June 2016 in Trondheim.

In Autumn 2015 we opened a new study track on “Sustainable energy use in buildings” within the 2-year double degree on Sustainable Energy between SJTU and NTNU. The main responsible for this programme, Professor Vojislav Novakovic, was a visiting scholar at SJTU for half a year in Spring 2015 to prepare for the double degree. Several master students have also been on short-term scientific exchange trips at SJTU and NTNU, respectively.

We were invited by SJTU to contribute to the Handbook of Energy Systems in Green Buildings, edited by Ruzhu WANG and Xiaoqiang ZHAI, and to be published by Springer Science + Business Media Singapore Pte Ltd. Prof Vojislav Novakovic is section editor of Section 7 “Passive building design”; Prof. Annemie Wyckmans is section editor of Section 1 “Introduction to green building concepts”.

We have participated in the SJTU Summer School on Sustainable Energy in July 2013, which gave rise to plans for a joint summer course on “Sustainable energy in cities” (SEniC) between SJTU and NTNU. NTNU obtained funding to the SIU UTFORSK programme for this summer course for the period of 2015-2016, building on and beyond the JRC cooperation. The first SEniC Summer School was held in July 2015 with 69 students (of which 14 Norwegian/European). The next SEniC Summer School will take place 18-29 July 2016, in cooperation with universities from Germany, US and South Korea in addition to SJTU and NTNU. As part of the SiNoPSE project (see next paragraph), Tsinghua University will also send students and teachers to this summer school.

Cooperation with SJTU on Energy in buildings and cities is also included in the new INTPART-funded project “Sino-Norwegian Partnership on Sustainable Energy” (SiNoPSE). The summer course and double degree programme are embedded in this new project. Activities are expanded towards Tsinghua University in Beijing which provides complementary competency on energy in buildings and cities. The kick-off meeting was held in Beijing 13-14 May 2016.

SJTU is an international partner in the new Research Centre on Zero Emission Neighbourhoods in Smart Cities (2017-2024) (FME-ZEN).

We have also started to cooperate with Innovation Norway (Beijing and Shanghai offices) to better include industry partners, and towards the Joint Programme on Smart Cities (European Energy Research Alliance). Cooperation on H2020 applications should be sought out. Chinese applicants can apply for Chinese co-funding. Up to 200 million RMB, or 28 million euro, will be made available annually by the Chinese Ministry of Science and Technology (MOST).

In addition to the activities described above, we organised several outreach activities and site visits:

Workshop 26-28 June 2014, Trondheim. The group attended the PhD disputation of Usman Dar on the “Influence of Occupants’ Behaviour in the Performance of Net-Zero Emission Buildings”.

Workshop 22-23 January 2015, Shanghai. We visited the Green Energy Laboratory and discussed cooperation with the ZEB Living Lab and Test Cell, under development at NTNU.

Workshop 20-23 April 2016, Trondheim. During the final SJTU-NTNU workshop, the Energy in buildings and cities group organized a joint workshop with the Energy System Analysis group, to discuss joint development of further cooperation on energy in the built environment. We discussed experiences of the past years, and priorities for further cooperation. This includes cooperation on the Research Centre on Zero Emission Neighbourhoods in Smart Cities (FME-ZEN), on laboratory infrastructures (Green Energy Laboratory at SJTU, ZEB Living, Lab and Test Cell at NTNU), and in the SEniC and SiNoPSE projects.

From 2014 to 2016, we have facilitated student exchange of a range of double degree and MSc students:

- 2014/15
 - MSc to SJTU: 1
- 2015/16
 - DD to NTNU: 3
 - MSc to SJTU: 1
- 2016/17
 - DD to NTNU: 1 (+1)
 - MSc to SJTU: 2

Below is the list of publications and lectures associated with the SJTU-NTNU Joint Research Centre.

Energy in Buildings group publications, presentations and lectures 2014-2016

Number	Year	Type	Title
1	2014	Conference Presentation	Jinfeng Chen, Yanjun Dai, Clara Good, Annemie Wyckmans (2014), Experimental and theoretical study on solar assisted CO2 heat pump for space heating, International Conference on Solar Heating and Cooling for Buildings and Industry, SHC, Beijing

2	Conference presentation	Clara Good, Jinfeng Chen, Yanjun Dai, Anne Grete Hestnes (2014), Hybrid photovoltaic-thermal systems in buildings – a review, International Conference on Solar Heating and Cooling for Buildings and Industry, SHC, Beijing
3	Conference presentation	Optimization of solar energy potential for buildings in urban areas – a Norwegian case study (Clara Good, Gabriele Lobaccaro, Siri Hårklau) Presented at Renewable Energy Research Conference (RERC) 2014, Oslo
4	Conference presentation	A comparative study of different PV installations for a Norwegian nZEB concept (Clara Good, Aiofe Houlihan Wiberg, Torhildur Kristjansdottir, Laurent Georges) Oral presentation at Eurosun 2014, Aix-les-bains
5	Poster presentation	To zero with solar – comparison between PV, solar thermal and hybrid PV/T systems for a Norwegian zero energy building (Clara Good); Poster presentation at Eurosun 2014, Aix-les-bains
6	Seminar presentation	Summer School on Sustainable Energy in Cities, SIU UTFORSK Seminar, Oslo, March 2015
7	Workshop presentation	Cooperation with China in the Energy field, workshop with Norwegian Consulate in Shanghai, 14 May 2015 (Annemie Wyckmans and Yu Wang)
8	Seminar presentation	Sustainable Energy in Cities (SJTU-NTNU): Cooperation with Climate-KIC? Climate-KIC kick-off seminar, 24 September 2015, Trondheim (Annemie Wyckmans)
9	Journal publication	Good, Clara Stina; Andresen, Inger; Hestnes, Anne Grete. Solar energy for net zero energy buildings - A comparison between solar thermal, PV and photovoltaic-thermal (PV/T) systems. Solar Energy 2015; Volume 122. pp. 986-996
10	Conference presentation	Good, Clara Stina; Andresen, Inger; Hestnes, Anne Grete. Solar energy for zero energy buildings - a comparison between solar thermal, PV and photovoltaic-thermal (PV/T) systems. CISBAT 2015; 2015-09-09 - 2015-09-11
11	Journal publication	Good, Clara Stina; Chen, Jinfeng; Dai, Yanjun; Hestnes, Anne Grete. Hybrid photovoltaic-thermal systems in buildings – a review. Energy Procedia 2015; Volume 70. pp. 683-690
12	Journal publication	Sun, X.; Dai, Y.; Novakovic, V.; Wu, J.; Wang, R.: Performance Comparison of Direct Expansion Solar-assisted Heat Pump and Conventional Air Source Heat Pump for Domestic Hot Water. Energy Procedia. 2015, Vol. 70.
13	Journal publication	Good, Clara (2016), Environmental impact assessments of hybrid photovoltaic–thermal (PV/T) systems – A review, Renewable & Sustainable Energy Reviews, Volume 55, pp. 234-239
14	Conference proceedings	Good, Clara, Goia, Francesco (2016), Integrated ground source heat pumps and solar thermal systems for zero energy buildings. In: CLIMA 2016 - proceedings of the 12th REHVA World Congress: volume 3. Aalborg: Aalborg University, Department of Civil Engineering.

15	Journal publication	Good, Clara, Kristjansdottir, Torhildur, Houlihan Wiberg, Aoife Anne Marie, Georges, Laurent, Hestnes, Anne Grete (2016) Influence of PV technology and system design on the emission balance of a net zero emission building concept. Solar Energy 2016, Volume 130, pp. 89-100
16	Journal publication	Jinfeng Chen, Yanjun Dai, Clara Good, Annemie Wyckmans, Experimental and theoretical study on solar assisted CO2 heat pump for space heating, Renewable energy (under review)
17	Journal publication	Clara Good, Jinfeng Chen, Yanjun Dai, Anne Grete Hestnes, Hybrid photovoltaic-thermal systems in buildings – a review, Energy Procedia (accepted)
18	Journal publication	Carlucci, Salvatore; Lobaccaro, Gabriele; Li, Yong; Catto Lucchino, Elena; Ramaci, Roberta. The effect of spatial and temporal randomness of stochastically generated occupancy schedules on the energy performance of a multiresidential building. Energy and Buildings 2016
19	Journal publication	Yu, Wang; Lobaccaro, Gabriele; Carlucci, Salvatore; Ruzhu, Wang; Yong, Li; Luca, Finocchiaro; Yanjun, Dai; Trygve, Magne Eikevik; Annemie, Wyckmans; sustainable energy in cities: methodology and results of a summer course providing smart solutions for a new district in Shanghai, Energy Procedia (accepted)

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Progress report October 1st 2014 to June 30th 2016
Refrigeration Group

Trygve Eikevik,
Department of Energy and Process
Technology
NTNU

Summer school 2015 (period: July 3rd to July 19th 2015):

“Sustainable Energy in Cities”

Presentation: Prof. Trygve M. Eikevik: “Smart Energy use”

Double degree master program:

The following students have fulfilled the double degree master program within “Sustainable Energy” in this period:

Name	Defense month	Home university	Master thesis title
Andersen, Hanne Thorshaug	Dec 2014	NTNU	Study on the performance of central solar heating plants with seasonal storage using underground soil in North China
Mann, Jakob Aljoscha	Dec 2014	NTNU	Preliminary experimental investigation on a multi-stage cryogenic heat pipe heat exchanger
Ye, Jingjing	Dec 2014	SJTU	Solar Assisted natural Working Fluids Heat Pump for Chinese Buildings
Chen, Weiqing	Dec 2014	SJTU	Heat Transfer and Pressure Drop for New natural Working Fluids
Xiong, Jie	Dec 2014	SJTU	Use of Ejectors to Increase the Energy Efficiency of Heat Pump and Refrigeration Systems
Zhao, Geping	Dec 2014	SJTU	Solar Driven Power Production using CO ₂ as Working Fluid
Kjellsen, Per	Dec 2015	NTNU	Concept description of a Solar-Assisted Heat Pump (SAHP) with photovoltaics (PV) and phase change material (PCM) integrated in heat pump evaporator(s)
Thue, Dan-Hermann	Dec 2015	NTNU	Simulation on falling film evaporation in coil-wound heat exchanger on LNG-FPSO
Solberg, Erik Langaard	Dec 2015	NTNU	LNG Regasification System with Propane Intermediate Fluid Vaporizer
Zhang, Jinrui	Dec 2015	SJTU	Theoretical and experimental analysis of different two-phase R744 ejector cycles

Presentation of popular scientific presentations of results and activities

Presentations on the workshops:

Workshop January 23rd to 25th 2015

Dr. Ignat Tolstorebrov; Energy efficiency by vapor compression in superheated steam drying systems

Jingjing Ye; Performance analysis of solar assisted R744 ground source heat pump in different climates

Dr. Ignat Tolstorebrov; The requirements of standards for HC and CO₂ systems

Xiaojun Xiong; Optimization of Natural Gas Pressurized Liquefaction Process with C3MR Refrigeration and CO₂ Cryogenic Removal

PhD-stud: Zhequan Jin; Energy performance of CO₂ hybrid ground-coupled heat pumping system for hotel application

Jianrui Li; Simulation on falling film evaporation in coil-wound heat exchanger on LNG-FPSO

Han Deng; Boiling and Condensation of Mixtures Considering Entrainment & Deposition of Droplets

PhD-stud Yifei Yang; Research on a CFD Model to Simulate Water Condensation in Fin-Tube Heat Exchanger under Dehumidifying Conditions

Workshop April 20th to 22nd 2016

Prof. Yonglin Ju: «A Novel Cold Box Design with BPHEs for mini-Scale module LNG Plant»

Dr. Ignat Tolstorebrov: “The requirements of standards for HC and CO₂ systems”

Dr. Ignat Tolstorebrov: “Energy efficiency by vapor compression in superheated steam drying systems”

PhD-stud Zhequan Jin: “Energy efficiency comparison of heat pumping systems using R744 and R410A”

Complete list of publications, joint publications, articles and lectures ++

Key note lecture at the Shanghai Refrigeration Association annual meeting, December 18th 2015.
Invited: Prof. Trygve M. Eikevik: «Latest development using CO₂ as working fluids in refrigeration and heat pump systems in Norway”

Presentation of joint papers at the following conferences:

- The 4th China LNG Forum. Shanghai, China, March 2015
- IIR Congress of Refrigeration, Yokohama, Japan, August 2015

- Shanghai Refrigeration Association annual meeting, December 18th 2015, Shanghai
- IIR Gustav Lorentzen Conference on Natural working Fluids, Edinburgh, August 2016
- ECOS 2016, Portoroz, Slovenia, June 2016

Joint publications:

- Hu H, Eikevik T.M., Neksa P, Hafner A, Ding G., Huang Q., Ye J. Performance analysis of a R744 ground source heat pump system with air-cooled and water-cooled gas coolers. *International Journal of Refrigeration*, 2016, 63: 72–86.
- XIONG Jie, WANG Ruzhu, EIKEVIK Trygve Magne. Mathematical Model and Experimental Validation for Mass Entrainment Ratio of Ejector System with Single Phase R744. *Chinese Journal of Refrigeration Technology*, 2015, 35(2): 1-7.
- ZHAO Geping, LI Yong, EIKEVIK Trygve Magne, et al. Experimental Study of Rankine Cycle Power Generation Driven by Low-grade Heat Source Using CO₂ as Working Fluid. *Chinese Journal of Refrigeration Technology*, 2015, 35(5): 1-6.
- YE Jingjing, HU Haitao, Ding Guoliang, EIKEVIK Trygve Magne. Performance Analysis on CO₂ Ground Source Heat Pump with Gas Cooler. *Chinese Journal of Refrigeration Technology*, 2015, 35(5): 14-19,24.
- YE Jingjing, HU Haitao, Ding Guoliang, EIKEVIK Trygve Magne. Performance Analysis on Solar Assisted CO₂ Ground Source Heat Pump. *Chinese Journal of Refrigeration Technology*, 2015, 35(5): 1-6.
- CHEN Weiqing, JU Yonglin, EIKEVIK Trygve Magne. Performance simulation of boiling heat transfer and pressure drop of R290. *Cryo. & Supercond.* 2015, 43(6): 55-60
- SOLBERG Erik, LIN Wensheng, EIKEVIK Trygve Magne. CFD simulation of LNG regasification with propane intermediate fluid vaporizer. The 4th China LNG Forum. Shanghai, China, March 2015
- Jin, zhequan; Eikevik, M. Trygve; Neksa, Petter; Hafner, Armin; Ding, Guoliang. Energy Performance of CO₂ hybrid ground-coupled heat pumping system for hotel application. I: proceedings of the 24th international congress of refrigeration. International institute of refrigeration 2015
- R.Z. Wang; Z.Q. Jin; X.Q. Zhai; C.C. Jin; W.L. Luo; T.M. Eikevik, Investigation on annual energy performance of a VWV air-source heat pump system, Proceedings of the 29th international conference on Efficiency, Cost, Optimization, Simulation and Environmental impact of Energy Systems, (ECOS) June 2016

Submitted Patent

H. Hu, J. Ye, G. Ding, T.M. Eikevik. Multi-source assisted R744 ground source heat pump system (in Chinese). **(Published)**.

SJTU-NTNU Joint Research Centre on Sustainable Energy

*Progress report October 1st 2014 to June 30th 2016
Offshore Wind and Smart Grids*

Professor Marta Molinas,
Department of Engineering Cybernetics
NTNU

Summary:

During the workshop at NTNU on November 2012, it was decided to start a new research group on Offshore Wind & Smart Grid under the JRC SJTU-NTNU.

The focus within the topic of **Offshore Wind & Smart Grid** was on Methods and Tools for the Estimation of Stability in Systems with High Penetration of Power Electronics Components like in Offshore Wind Installations and Smart Grids.

The effective start of the joint research in this new topic was January 2015 with the first PhD student stay from SJTU at NTNU, Jing Lyu. Jing Lyu came for a stay of 3 month to NTNU to perform research in Offshore Wind at the NTNU Department of Engineering Cybernetics under the Supervision of Prof. Marta Molinas.

Two research groups were established under the join supervision of a team of professors from SJTU and NTNU. One Group was composed by PhD candidates Atle Rygg (NTNU) and Zhang Chen (SJTU). The second group was composed by PhD candidate Mohammad Amin (NTNU) and Jing Lyu (SJTU). Both groups were supervised by Professors Marta Molinas (NTNU), Olav Fosso (NTNU), Zheng Li (SJTU) and Xu Cai (SJTU) as shown below:

Summary of Research Activities and Results for period 2015-2016						
Topic: Offshore Wind & Smart Grid	PhDs NTNU	PhDs SJTU	Supervisors NTNU	Supervisors SJTU	Exchange	Joint Publications
Group 1	Mohammad Amin	Jing Lyu	Marta Molinas	Zheng Li, Xu Cai	1 to SJTU 1 to NTNU	3 ISI Journals 2 IEE Conf.
Group 2	Atle Rygg	Zhang Chen	Marta Molinas, Olav Fosso	Zheng Li, Xu Cai	1 to NTNU	1 ISI Journal 1 IEE Conf.

There were three exchanges of PhD candidates during the period January 2015 to April 2016. PhD candidate Mohammed Amin visited SJTU for a period of 2 months in 2015 and performed experimental work together with PhD candidate Jing Lyu. One IEEE Journal paper and one IEEE Conference paper are the results from this exchange (see list of publications at the end).

PhD candidate Zhang Chen visited NTNU for a period of 3 months in 2015 and worked with PhD candidate Atle Rygg in a theoretical model for impedances for offshore wind applications. One IEEE Journal paper and one IEEE Conference paper are the results from this collaboration (see list of publications at the end).

In addition to these results, the collaboration between PhD candidate Jing Lyu and Professors Marta Molinas and Xu Cai gave as a result two joint papers; one IEEE Conference and one IEEE Journal in the topics of Stability of Multi-level Converters (see list of publications at the end).

As part of the exchanges, Prof. Marta Molinas was invited by Prof. Xu Cai to give a keynote talk at the Fourth CIGRE-China Annual Conference on HVDC and Power Electronics in Shanghai, on October 22, 2015. The presentation title was Stability of power electronics multi-converter systems: from Land-based Microgrids to Offshore Grids. In June 2016, NTNU Department of Engineering Cybernetics is hosting the IEEE Conference COMPEL 2016 (<http://sites.ieee.org/compel2016/>) where the team from SJTU got accepted two papers in the topic of the collaboration and are going to present them in collaboration with the team from NTNU.

Offshore Wind and Grids: Activities and Results for the period:

The activities are reported below for each of the 2 Groups.

Group 1: Impedance Analysis for Offshore Wind Applications	
PhD candidates:	Jyng Lyu, Mohammed Amin
Supervisors:	Marta Molinas, Zhen Li, Xu Cai

PhD Candidate Jing Lyu (SJTU)

Research Activities: Jing Lyu has focused on the impedance based stability analysis of MMC-based HVDC system for wind farms integration during his stay at NTNU. He has derived the impedance model of the MMC converter and the impedance model has been verified in the simulation. The impedance model has been used to determine the stability of a MMC-based HVDC system for large-scale wind integration.

Research stay at NTNU: Jing Lyu visited NTNU for a period of 2.5 months in 2015 from 1st January to 15th March, 2015.

Joint Papers:

1. **Jing Lyu**, Xu Cai, Marta Molinas, "Impedance modeling of modular multilevel converters," IECON 2015, 2015.11, Yokohama, Japan.
2. **Jing Lyu**, Xu Cai, Marta Molinas, "Frequency Domain Stability Analysis of MMC-Based HVDC for Wind Farm Integration," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 4, no. 1, pp. 141-151, March 2016.

PhD Candidate Mohammad Amin (NTNU)

Research Activities: Mohammad Amin has carried out experiments at SJTU. The experiment is to verify the theoretical analysis that has been done during the stay of Jing Lyu at NTNU. The experiments have been carried out on the impedance-based stability analysis of MMC-based HVDC system for wind farms integration. In addition, some other experiments have been carried out on two-level VSC-based HVDC system to verify the theoretical analysis that Amin has previously published in a conference paper.

Research stay at SJTU: Mohammad Amin visited NTNU for a period of 1.5 months in 2015 from 22 May to 9 July, 2015.

Joint Papers (2):

1. **Mohammad Amin**, Jing Lyu, M. Molinas "Oscillatory Phenomena Between Wind Farms and HVDC Systems: The impact of Control" 16th IEEE COMPEL, 12-15 July 2015, Vancouver, BC Canada
2. **Mohammad Amin**, Jing Lyu, Xu Cai. Marta Molinas, Impact of Power Flow Direction on the Stability of VSC-HVDC seen from the Impedances Nyquist Plot. Accepted for publication in IEEE Trans. on Power Electronics.

Group 2:	Impedance Analysis for Power Electronics Systems
PhD candidates:	Zhang Chen, Atle Rygg
Supervisors:	Marta Molinas, Zhen Li, Xu Cai, Olav Fosso

PhD Candiates Zhang Chen (SJTU) & Atle Rygg (NTNU)

The collaboration between PhD-student Atle Rygg (supervisor M. Molinas/ Olav Fosso) and PhD-student Zhang Chen (supervisor X. Cai / L. Zheng) was initiated in April 2015. Mr. Chen visited NTNU for a period of 2.5 months between April-June 2015.

Research Activities: The collaboration focused on the following items:

- Gaining basic understanding of impedance-based stability analysis through discussions and simulation analysis
- Deriving a large set of analytic relations on the impedance-method in different domains
- Developing joint models/scripts for obtaining impedance models by simulation
- Comparing accuracy of various techniques for impedance simulation
- Main contribution: Deriving the equivalence between impedance models in dq - and sequence domain

The joint work during his visit resulted in two publications, one IEEE journal and one conference paper (see list below).

The collaboration has continued by e-mail and Skype after the visit. From June through September the focus was to complete the joint journal paper. From September through March, the collaboration has been relatively idle since the focus of Atle has been to develop an experimental setup to verify the findings from simulation/analytic expressions. In April, the collaboration was boosted by defining a goal of two new joint publications:

- Finding the impact of the mirror frequency effect. First author Atle Rygg. Journal paper
- Electrical oscillations in grid-connected VSCs. First author Zhang Chen. Journal paper

The work has been started by e-mail discussions. Mr. Z. Chen has completed his first draft, while Atle is more on the idea stage.

Research stay at NTNU: Mr. Zhang Chen visited NTNU for a period of 2.5 months between April-June 2015

Joint Papers (2):

A. Rygg, Z. Chen, M. Molinas and X. Cai, "Frequency-dependent source and load impedances in power systems based on power electronic converters", PSCC 2016, Genoa

A. Rygg, Z. Chen, M. Molinas and X. Cai, "A modified sequence domain impedance definition and its equivalence to the dq -domain impedance definition for the stability analysis of AC

power electronic systems”, Accepted for publication in IEEE Journal of Emerging and Selected Topics in Power Electronics.

In addition to the above joint papers, PhD candidate Atle Rygg has produced 3 more papers that are related to the research but are not jointly prepared with Mr. Chen. Those papers are listed under the heading “Publications and Presentations” below among the non-joint publications.

Publications and Presentations:

Joint Publications (7):

- **Rygg, M. Molinas, C. Zhang** and X. Cai, “A modified sequence domain impedance definition and its equivalence to the dq-domain impedance definition for the stability analysis of AC power electronic systems”. Submitted to IEEE Journal of selected and emerging topics of power electronics
- **Rygg, M. Molinas, C. Zhang** and X. Cai, “Frequency-dependent source and load impedances in power systems based on power electronic converters”. Submitted to the 19th Power Systems Computation Conference, June 2016, Genoa Italy
- **Mohammad Amin, Jing Lyu, M. Molinas** "Oscillatory Phenomena Between Wind Farms and HVDC Systems: The impact of Control" 16th IEEE COMPEL, 12-15 July 2015, Vancouver, BC Canada
- **Mohammad Amin, Jing Lyu, Xu Cai, Marta Molinas**, Impact of Power Flow Direction on the Stability of VSC-HVDC seen from the Impedances Nyquist Plot . (IEEE Trans. on Power Electronics, First review)
- **Jing Lyu, Xu Cai, Marta Molinas**, "Impedance modeling of modular multilevel converters," IEEE IECON 2015, 2015.11, Yokohama, Japan.
- **Jing Lyu, Xu Cai, Marta Molinas**, "Frequency Domain Stability Analysis of MMC-Based HVDC for Wind Farm Integration," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 4, no. 1, pp. 141-151, March 2016.
- **Jing Lyu, Xu Cai, Mohammad Amin, Marta Molinas**, "Stability analysis of MMC-based HVDC for offshore wind farms: impacts of control parameters," in IEEE Trans. Power Delivery, 2015 (Sumbitted).

Publications within the JRC SJTU-NTNU (5):

- **Jing Lyu, Qiang Chen and Xu Cai**, “Impedance Modeling of Modular Multilevel Converters by Harmonic Linearization,” in IEEE COMPEL 2016, 27-30 June 2016, Trondheim, Norway
- Qiang Chen, **Jing Lyu, Rui Li and Xu Cai**, “Impedance modeling of Modular multilevel converter based on harmonic state space,” in IEEE COMPEL 2016, 27-30 June 2016, Trondheim, Norway
- **Atle Rygg, Espen Skjong and Marta Molinas**, “Handling system harmonic propagation in a diesel-electric ship with an active filter”, in ESARS 2015, March 2015, Aachen
- **Atle Rygg and Marta Molinas**, “Real-time stability analysis of power electronic systems”, in IEEE COMPEL 2016, 27-30 June 2016, Trondheim, Norway
- **Atle Rygg, Mohammad Amin, Bjørn Gustavsen and Marta Molinas**, “Apparent Impedance Analysis – a new method for power system stability analysis”, in IEEE COMPEL 2016, 27-30 June 2016, Trondheim, Norway

Keynote Presentation (1):

Marta Molinas, “Stability of power electronics multi-converter systems: from Land-based Microgrids to Offshore Grids,” Keynote presentation at the Fourth CIGRE-China Annual Conference on HVDC and Power Electronics in Shanghai, October 22, 2015.

Plans for the Future (2016-2018):

An ERCIM Post Doctoral application was presented by PhD candidate Jing Lyu to continue the collaboration with NTNU. The application was successful and Dr Jing Lyu will continue with the research in collaboration with NTNU during the period November 2016 to 2019. The research topic of the collaboration will remain in Offshore Wind Stability Analysis Methods and Tools.

In addition to the above, Group 1 and Group 2 will continue the joint research under the sponsorship of their respective Universities.

SJTU-NTNU Joint Research Centre on Sustainable Energy

*Progress report October 1 2014 to June 20 2016
Catalysis for Renewable Energy*

Professor De Chen
Department of Chemical Engineering
NTNU

The joint project has focused on in on synthesis gas conversion to light olefins, which is a promises process to produce building block chemicals (C₂-C₄ olefins) from biomass. The project is a joint effort from three universities, namely SJTU, NTNU and ECUST (East China University of Science and Technology, China). The PhD students Miss. Yu Wang, Miss. Yalan Wang and Miss. Di Wang have been placed in SJTU, NTNU and ECUST, respectively, where Prof. Wede Xiao, Prof. De Chen and Prof. Xinggue Zhou are the responsible professors for SJTU, NTNU and ECUST, respectively. The ultimate goal of the project is to identify the principles for rational design of the catalysts to maximize the C₂-C₄ olefin formation and minimize the methane formation from synthesis gas with different hydrogen to CO ratios, by combining competences from different groups.

- 1) Preparation of Fe and Co and their alloys with well controlled sizes and surface compositions.
- 2) Correlate chain growth or termination probability to the catalyst properties.
- 3) Apply the gained scientific insights to optimize the catalysts to maximize C₂-C₄ olefin yield.
- 4) Enhance the cooperation between NTNU and SJTU by joint the project

SJTU worked on Fe catalysts on ceramic catalyst supports, while ECUST worked on the Fe catalysts on carbon supported and promoters were tested. The high yield of light olefins (40-50%) has been achieved. NTNU worked on the theoretic kinetic modeling of the synthesis gas conversion to olefins. During the project, three seminar were organized, where all the students and researchers working on the Fischer-Tropsch synthesis participated and recent results and knowledge related were exchanges. The three partners are highly integrated. The NTNU catalysis group hosted one PhD student (Di Wang) from ECUST supported by Chinese scholar council (09.2015-08.2016).

Joint publications

Number	Year	Type	Title
1	2015	Journal (Joint)	D. Wang, X. Zhou, J. Ji, X. Duan, G. Qian, X. Zhou, D. Chen, W. Yuan, Modified carbon nanotubes by KMnO ₄ supported iron Fischer-Tropsch catalyst for the direct conversion of syngas to lower olefins, Journal of Materials Chemistry A 3 (2015) 4560-4567.
2	2016	Journal (Joint)	D. Wang,, J. Ji, X. Duan, G. Qian, X. Zhou, X. Zhou, D. Chen, NanoFe catalysts on CNTs for the direct conversion of syngas to lower olefins, Journal of Energy Chemistry, invited, submitted.
3	2016	Conference presentation (Joint)	Yu Wang, Jiachi Chen, Wende Xiao, De Chen, A catalyst for Fischer-Tropsch olefin reaction with MgO modified Al ₂ O ₃ support. Submitted to The 11th Natural gas conversion symposium, Tromsø, Norway
4	2016	Conference presentation (Joint)	Y. Wang, Y. Zhu, Wende Xiao, D. Chen, Mechanism research of of light olefin formation in Fischer-Tropsch synthesis by combination of DFT calculations and microkinetic analysis, Submitted to The 11th Natural gas conversion symposium, Tromsø, Norway
5	2016	Journal (Joint)	Xun Huang, Hu Li, De Chen, Wen-De Xiao, Kinetic modeling of the side reactions in methanol-to-olefin process over HZSM-5: an extended study of the previous model, Chem. Eng. J. accepted.
6	2016	Conference presentation (Joint)	Xianzhi Tang, Yu Wang, Wende Xiao, De Chen, Macroporous α -Al ₂ O ₃ support preparation and application in the CO oxidative coupling carbonylation for dimethyl oxalate synthesis, Submitted to The 11th Natural gas conversion symposium, Tromsø, Norway

APPENDIX A

SJTU-NTNU JOINT RESEARCH CENTRE IN SUSTAINABLE ENERGY

WORKSHOP SJTU Minhang Campus Program, January 22-24 2015

(Version-0119)

Pick up Pudong Airport by bus January 21 (Wednesday), 11:45 SK 997

Thursday January 22

07:40 Pick up from the hotel (Radisson New World – Shanghai, 88 Nanjing West Road, Shanghai)

09:00 – 9:45 Plenary Opening Session JRC Workshop at F210 A building, School of Mechanical Engineering

Speeches by

Professor Lifeng Xi Dean, School of Mechanical Engineering, Shanghai Jiao Tong University (SJTU)

Professor Olav B Fosso Director of Strategic Thematic Area Energy, NTNU-SJTU JRC, Norwegian University of Science and Technology (NTNU)

Professor Ruzhu Wang Director, NTNU-SJTU JRC, Shanghai Jiao Tong University (SJTU)

Professor Arne M Bredesen Norwegian University of Science and Technology (NTNU)

09:45 Photo session at Gate of A Building

10:00 : SJTU Group Leaders escort their groups to their respective venues

10:15 : Start of parallel workshops and programs (individual groups)

- Management
- Energy Use in Buildings Research Group
- Refrigeration Research Group (Use of CO₂ and LNG)
- Energy System Analysis Research Group
- Offshore Wind & Smart Grids Research Group
- Catalysis Research Group

12:00 Lunch (Arranged by each group)

13:00 Parallel workshops and programs (individual groups)

15:00 – 17:00 Planning and preparation of the Summer School (Green Energy Lab)

17:00 End of day

17:30 Dinner (Xiao Tian Yuan)

Friday January 23

07:40 Pick up from the hotel

09:00-12:00 *First part: Parallel workshops for different activities*

12:00 Lunch (Arranged by each group)

13:00 –15:30 *Second Part: Plenary Session with Reports from the different groups*

Key words of content:

Research projects progress, Exchange of personnel, Education, Joint Publications, Conferences, etc.

13:00 Energy System Analysis

13:15 Energy Use in Buildings

13:30 Refrigeration Research Group (Use of CO₂ and LNG)

13:45 Offshore Wind Power incl SmartGrids

14:00 Catalysis

14:15 Coffee Break

14:30 Education & Administration, incl. Summer School

14:50~15:00 Speech by first graduate double degree students

15:00~15:30 Free discussion for future work, Concluding remarks by SJTU and NTNU

15:30: Close – up

17:00 Dinner (Shanghai Lao Fan Dian No. 242 Fuyou Rd. Shanghai, Near Old Temple)

Saturday January 24

- “Spare” day – occasion / possibility for extra meetings (?)
- Cultural event, visit interesting place

The following areas will be handled in the individual workshops

Management

SJTU: Prof. Ruzhu Wang, Vice dean He Lin, Yang Cao,

NTNU: Prof. Dr. ing. Olav Bjarte Fosso, Prof. Arne Bredesen

Energy Use in Buildings Research Group

SJTU: Prof. Yanjun Dai, Tianshu Ge, Xiaoqiang Zhai, Yong Li

NTNU: Prof. Annemie Wyckmans, Prof. Arild Gustavsen, Associate prof. Laurent Georges, Prof. Vojislav Novakovic, Associate prof. Rolf André Bohne, Dr. Gabriele Lobaccaro, PhD cand. Yu Wang, PhD cand. Clara Stina Good

Refrigeration Research Group

SJTU: Prof. Guoliang Ding, Wensheng Lin, Yonglin Ju, Haitao Hu

NTNU: Prof. Trygve Magne Eikevik, Dr. Ignat Tolstorebrov, PhD cand. Zhequan Jin, PhD candidate Han Deng

Energy System Analysis Research Group

SJTU: Prof. Xiaojun Hu, Xu Zhao

NTNU: Dr. Henrik Karlstrøm Prof. Marianne Ryghaug Assoc. prof. Ruud Egging PhD cand. Marius Støylen Korsnes Pål Aune MA

Offshore Wind & Smart Grids Research Group

SJTU: Prof. Xu Cai, Prof. Zheng Li

NTNU: Prof. Dr. ing. Olav Bjarte Fosso

Catalysis Research Group

SJTU: Prof. Wen-De Xiao

NTNU: Prof. De Chen, Dr. Cristian Ledesma Rodriguez, Prof. Ed Anders Blekkan

APPENDIX B

SJTU-NTNU JOINT RESEARCH CENTRE IN SUSTAINABLE ENERGY

FINAL WORKSHOP NTNU 20 – 23 April 2016

(Version–008)

Tuesday April 19

22:50 Arrival at Værnes on April 19 with flight KL1177
23:15 Pickup at airport by MaxiTaxi to Britannia Hotel

Wednesday April 20

09:00 Pickup from the hotel with MaxiTaxi

09:30 – 11:00 Plenary Opening Session JRC Workshop
(Main Building / H1)

Speeches by

09.30 – 09.40 Professor Ingvald Strømmen
Dean Faculty of Engineering Science
Norwegian University of Science and Technology (NTNU)

09.40 – 09.50 Department Director Rune Volla,
The Research Council of Norway

09:50 – 10:05 Professor Olav B Fosso
Director of Strategic Thematic Area Energy,
Director NTNU-SJTU JRC
Norwegian University of Science and Technology (NTNU)

10:05 – 10:20 Professor Ruzhu Wang
Director, NTNU-SJTU JRC
Shanghai Jiao Tong University (SJTU)

10:20 – 10:30 Coffee break

10:30 – 10:55 Professor Annemie Wyckmans
Norwegian University of Science and Technology (NTNU)
“Where are we going from here.”
Introduction to SiNoPSE
Horizon2020

10:55 – 11:00	Photo session outside Main Building
11:00 – 11:10	SJTU Group Leaders escort their groups to their respective venues (each group leader takes care of making meeting room reservations and serving break drinks/snacks)
11:10 – 12:20	Parallel workshops and programs (individual groups)

The individual workshops should address results so far and plans for preparation of final report, as well as plans for continued collaboration

- Management – Olav Bjarte Fosso
- Energy Use in Buildings Research Group – Annemie Wyckmans
- Refrigeration Research Group (Use of CO₂ and LNG) – Trygve Eikevik
- Energy System Analysis Research Group – Marius Korsnes
- Offshore Wind & Smart Grids Research Group – Marta Molinas
- Catalysis Research Group – De Chen

12:30 – 13:30	Lunch / Kjelhuset
13:30 – 17:00 (flexible)	Continued Parallel workshops and programs (individual groups)
19:30 ->	Dinner (Restaurant ELD, Kongens gate 30, 7012 Trondheim)

Thursday April 21

09:00 – 12:45	Each group decides when they want to start in the morning
12:50 – 13:50	Lunch / Kjelhuset
14:00 – 16:30/17:00	<i>Plenary Session with reports from the different groups (EL6)</i>
Key words of content:	Research projects progress, Exchange of personnel, Education, Joint Publications, Conferences, Double Degree, Summer Schools etc.
14:00 – 14:20	Energy System Analysis (Marius Korsnes)
14:20 – 14:40	Energy Use in Buildings (Annemie Wyckmans)

14:40 – 15:00	Catalysis (De Chen)
15:00 – 15:10	Coffee Break
15:10 – 15:30	Offshore Wind & SmartGrids (Marta Molinas)
15:30 – 15:50	Refrigeration Research (Use of CO2 and LNG) (Trygve Eikevik)
15:50 – 16:10	Education & Administration, incl. Summer School (Olav Bjarte Fosso)
16:10 – 16:30	Concluding remarks by SJTU and NTNU and Closing-up
19:00	Dinner (Restaurant UNA at Solsiden)

Friday April 22

Field trip – Fishing/Aqua Culture Visit/Lunch Frøya Hotel.
The buss will leave at 08:00 from NTNU Gløshaugen in front of Kjelhuset, pick up our Chinese guests at Britannia Hotel and then drive to Frøya.
We will be back in Trondheim at approx. 18:30.

Saturday April 23

Day-off

Sunday April 24

10:00	Pickup from Britannia Hotel to Værnes Airport by MaxiTaxi
12:15	Departure from Værnes on April 24 with flight KL1174

Participants of the individual workshops:

Management

SJTU: Prof. Ruzhu Wang, Mr. Yang Cao, Ms. Xia Ke

NTNU: Prof. Olav Bjarte Fosso, Prof. Arne Bredesen, Mrs. Debbie Koreman van den Bergh

Energy Use in Buildings Research Group

SJTU: Prof. Yanjun Dai, Tianshu Ge, Xiaoqiang Zhai, Yong Li



上海交通大学
Shanghai Jiao Tong University

SJTU - NTNU

Joint Research Centre in Sustainable Energy



NTNU – Trondheim
Norwegian University of
Science and Technology

NTNU: Prof. Annemie Wyckmans, Prof. Arild Gustavsen, Associate prof. Laurent Georges, Prof. Vojislav Novakovic, Dr. Gabriele Lobaccaro, Dr. Yu Wang, PhD cand. Clara Stina Good

Refrigeration Research Group

SJTU: Prof. Guoliang Ding, Yonglin Ju, Haitao Hu, Wensheng Lin

NTNU: Prof. Trygve Magne Eikevik, Dr. Ignat Tolstorebrov, PhD cand. Zhequan Jin, PhD candidate Han Deng

Energy System Analysis Research Group

SJTU: Prof. Xiaojun Hu, Xu Zhao

NTNU: Dr. Marius Korsnes, Prof. Marianne Ryghaug, Assoc. prof. Ruud Egging; MSc Pål Aune

Offshore Wind & Smart Grids Research Group

SJTU: Prof. Xu Cai, Prof. Chen Zhang

NTNU: Prof Marta Molinas, Prof. Dr. ing. Olav Bjarte Fosso, PhD cand. Atle Årdal Rygg, PhD cand. Mohammad Amin

Catalysis Research Group

SJTU: Prof. Wen-De Xiao

NTNU: Prof. De Chen, Dr. Cristian Ledesma Rodriguez, Prof. Ed Anders Blekkan, Yalan Wang, Di Wang