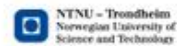
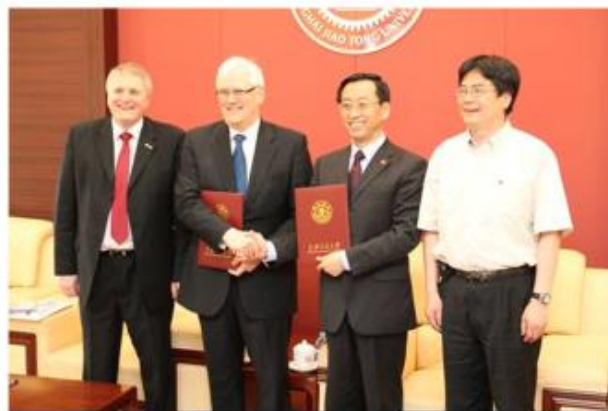


SJTU-NTNU Joint Research Centre (JRC) on JRC - Sustainable Energy Final report

Signing JRC Agreement in May 2010



JRC Meeting SJTU - August 2013



Official JRC Opening Ceremony and Seminar at SJTU June 4th - 5th 2012

Historic development leading up to JRC-project start January 1, 2013

International cooperation was a central part of the development of the strategic area “Energy and Environment” starting up in 2000. NTNUs strong position in the energy area should be utilized to develop research cooperation with selected universities in countries put on the agenda by the Norwegian government, ie. EU, USA, China and Japan.

In USA we started up research cooperation with MIT already in 2002, supported by Hydro. We carried out the TRANSES project and started up MIT-NTNU cooperation on Gas Technology in 2006. The cooperation was based on professor pairs working together on a common project with PhDs supplied by MIT and NTNU.

In China Shanghai Jiao Tong (SJTU) and Tsinghua University (THU) were selected after a broadly organized NTNU delegation trip together with other Strategic Areas. “The NTNU China Study Tour 20th -27th March 2004”. Here we met Professor Ruzhu Wang for the first time and started to develop further systematic contact. On March 28th 2007 we were able to organize together with Statoil a Workshop and Seminar on “Utilization of Natural Gas” at SJTU Campus in Shanghai. The Workshop was opened by the Norwegian Minister of Trade and Industry, Dag Terje Andersen, and Kari Kveseth from the Research Council of Norway also participated. After the Seminar we had a “Face to Face” meeting with Professor Ruzhu Wang, and a first proposal for a cooperation between SJTU and NTNU was formulated in October 2007.

Later on, in August 2007, a high level delegation from SJTU headed by Madame Professor Ma Dexiu (Chairperson of University Council) visited NTNU and had meeting with NTNUs Rector. Likewise our Minister of Research and higher Education visited SJTU in November 2008.

After a presentation in “China Meeting Place” in Oslo in November 2009, the Chinese Ambassador strongly advised Rector Torbjørn Digernes that NTNU should develop Joint Research Centres with key partners in China. This gave new momentum to the process, and we set the goal of being able to sign a JRC-agreement during the already planned visit of a large NTNU delegation to World Expo in May 2010. Thanks to all preparations and excellent cooperation between Professor Ruzhu Wang and Nina Sindre, we were successful in bringing forward the JRC-agreement for signing.

So on May 25th 2010 the JRC-agreement was signed in Shanghai by the president of SJTU, Professor Jie Zhang and Rector of NTNU, Professor Torbjørn Digernes (see picture). The State Secretary of the Ministry of Research and Education Kyrre Lekve attended the signing ceremony. And because the NTNU delegation included several “energy professors” we were able to organize the first preparation workshop already on May 28th with 20 participants from SJTU and NTNU.

Based on these first contacts and preparations an application for a **pilot project** was brought forward to RCN already on October 29th 2010. The goal was to plan and prepare the start up of the JRC in 2011. The Pilot project was granted by RCN (500.000 NOK), making us able to carry out three preparatory workshops in 2011:

Workshop 1: May 2nd - 5th 2011 at SJTU (13 from SJTU – 9 from NTNU): First preparatory workshop to agree on areas to be started and establish working groups to bring forward the first plans. We also agreed that the research cooperation on the MIT-model, i.e. should be based on PhDs at SJTU and NTNU working together on a joint research area coached by the professors. These PhDs should

be financed by strategic positions allotted by SJTU and NTNU, so that we may be able to start up at once and not rely on research project proposals to financing bodies.

5 areas of interest were identified:

- Energy use in buildings
- Gas technology (Process technology – LNG technology – Heat exchanger)
- Use of CO₂ as (natural) working fluid in refrigeration
- Offshore Wind and Grids
- Energy System Analysis

Gas technology and Natural working fluids were later on handled together under “Refrigeration”.

We also agreed on a working structure based on teamwork and development of personal relation, and NTNU's motto for international cooperation: **Knowledge – Friendship and Team work** was approved. And we took the “JRC-wave” together for the first time. Further, we agreed to develop the JRC by organizing Family workshops where all the research areas should meet regularly, present results and agree on further work, setting targets for joint publications, new developments.

Workshop 2: September 19th - 21st 2011 at NTNU (13 from SJTU – 36 from NTNU): Second Preparatory workshop where the JRC Board was established, approving 4 areas to start up activity and recruit PhDs. At this workshop Director Rune Volla from RCN participated and also gave a presentation.

Workshop 3: November 28th – 29th 2011 at SJTU (8 from SJTU and 5 from NTNU): This workshop was dedicated to “Education”. Here a Particular Agreement for a Double Degree JRC-NTNU Master education was worked out and agreed upon. This was the toughest part in the cooperation development, because education goes to the core of how we do things...

At this stage the PhD-students were allotted and under recruitment, so that we knew we would have activity. We received signals that funding for operating the RCN could be possible from January 2013. So it was decided by NTNU to allocate 500.000 NOK ourselves to cover running costs in 2012. This opened up for additional funding of 150.000 NOK from Norwegian Ministry of Trade and Industry. So we were able to carry out the following events in 2012:

Official Opening Ceremony and Seminar at SJTU in June 4th – 5th 2012 (see picture)

JRC-workshop at NTNU November 28th – 29th 2012 (preparations for the project)

Some things are worth mentioning when it concerns the Official Opening Seminar in June.

The Rector of NTNU, Torbjørn Digernes, participated in the delegation and signed an Agreement on the Double Degree Education SJTU-NTNU with SJTU President Xie. Also RCN director Fridtjof Unander participated and gave a presentation. We also organized a JRC Board meeting, where a new area “Catalysis for New Energy Technology” was decided on. So we entered the present JRC-project, well prepared...It should also be mentioned that the JRC-team made a one day trip to the quiet water town Wuzhen, the “Venedig” of China, where all of us crossed the famous “Three bridges”, to

bring good luck and to assure success for our JRC-application which was to be submitted. This in fact became useful! See below..

Because: In parallel with all these activities and preparations we were successful in bringing forward an application to the RCN (Application No: ES404870 Project No: -1) on May 30 2012, which were awarded, and made it possible to develop the JRC in this 3 year project from 2013-2015.

All relevant information about the JRC from this time may be found on our web-site:

<http://www.ntnu.edu/jrc/jrc>

The carrying out of the JRC-project

So we were ready to start up the JRC-activity in January 2013. Some PhD positions were already allocated by both NTNU and SJTU, and professors were engaging themselves. The resources from RCN should be to organize and carry out the meeting placed (workshops) where team work families could be developed. At these workshops results were presented and discussed, and plans for further work was agreed upon, within the target areas decided by the Board.

It should be mentioned that the time needed for recruiting of PhD-candidates was longer than expected in some areas, but in the end we were successful.

It was an important issue that the whole family (all the research groups) should be able to meet by the **JRC workshops**. So that they may enjoy networking, building of relationships (friendship), sharing ideas and knowledge (by presenting results) and make plans together for further work. An important point to be recognised is that most of the SJTU and NTNU professors from the different research areas participated actively in the planning and preparation process, so that we could start up the JRC-project well prepared. They gave priority to the JRC, because it was useful and inspiring.

It was further decided by the JRC Board that the JRC should give priority to

- Summer Courses carried out at SJTU, where they have a strong tradition
- Double Degree Master education (diploma from both SJTU and NTNU)
- Joint Research activity, targeting paired PhDs, joint projects and publications

We also had ambitions to involve industry actively in the JRC-activity, but on that part, we were not able to succeed (use sufficient energy). This may, however, be improved in the new SiNoPSE-project which has been approved by SiU and RCN and which will involve NTNU, SJTU and THU in a further development of our cooperation, and where Innovation Norway in China has been brought into the planning process.

The special relations between China and Norway in the JRC-period created a special challenge, since we had to operate “under the official radar” to carry out the JRC workshops. Here the decisive role of professor Ruzhu Wang, the leader at SJTU, must be mentioned. He was present at the signing (see

picture), and he was very good at finding ways to do things, so that we were able to carry out our workshops, both at SJTU and NTNU. But due special circumstances we were only able to organize 5 workshops instead of 6 which was the target in our application. And the last workshop, which was originally planned for November-December 2015, had to be postponed to April 2016, because of Chinese New Year and SJTU 120 year jubilee celebration. So we made an application to RCN for an extension of the project period to June 2016, and this application was accepted.

We would like to emphasize that the cooperation and communication with RCN has been extremely good during the whole JRC project. Both Fridtjof Unander and Rune Volla have participated actively and given presentations at JRC-workshops, and Trygve Riis has been a good contact point for our team.

So to the activities: During the JRC project we have been able to organize the following workshops (place, date, participants and presentations/activity):

Table 1: Workshops within Joint Research Centres

Place	Dates	Participants	Presentations
SJTU	July 30 to August 3 2013	6 SJTU + 12 NTNU	18
NTNU	November 19-22 2013	16 SJTU + 27 NTNU + 2 industry	45
NTNU	June 25 – 29 2014	18 SJTU + 35 NTNU	53
SJTU	January 22-24 2015	16 SJTU + 23 NTNU	39
NTNU	April 20 – 23 2016	16 SJTU + 26 NTNU	42

As can be seen, the JRC-workshops has become an important meeting place. The PhDs allotted were an important starting point. But the workshops also became an attractive market place where areas for joint research between the involved professors could be identified, leading to several joint projects and joint papers. And also the topics for the project and master thesis of the double degree students were discussed and agreed upon.

The social part was also emphasized. At every workshop a special programme has been developed for the last day, where we were able to visit unique places and activities in China and Norway, which are “far from the airports”. Fishing trips at sea was exceptionally popular for our Chinese friends. Especially when they were able to land their own fish. And the Norwegian team enjoyed visits to ancient cities and beautiful places (like Wuzhen), which we never would have found on our own. All of them experiences which we never will forget.

However, science is the main thing, and the JRC-project have created a considerable scientific activity. The total results are presented in the following, mainly by the reports from the leaders for the different areas, i.e.

Table 2: 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

These reports show in more detail all the interesting activities which have been carried out and should therefore be studied carefully. **They show that the number of professor and researchers involved in the JRC-activity amounts to 49 professors and researchers (22 at SJTU and 27 at NTNU).** The hours that they have decided to use on the development of the JRC represent a large economic investment from SJTU and NTNU, and only a small part is visible in the final cost of the JRC-project.

In addition comes **14 PhD candidates educated (7 at SJTU and 7 at NTNU)**, which are also financed by the universities.

As the reports show the JRC-team has been able to carry out **4 summer courses, of which SENIC is the most comprehensive**, integrating all disciplines.

Further **13 Double Degree Master students have been educated** (so far).

On the joint research side we will educate 14 PhDs, we have delivered 67 presentations at workshops and conferences, and brought forward 35 Joint publications.

This amounts to a considerable scientific activity, and the table below shows how the different research areas have contributed to these results.

Table 3: The main results in the program period 2013 – 2016

Activities	ESA	EIB	REF	OWG	CAT	Total
Summer Courses carried out	1	1	2			4
Double Degree Education Students		3	10			13
PhDs carried out (completed and on-going)	1	3	4	4	2	14
Presentations at workshops and conferences (presentation of conference papers)	19	19	16	7	6	67
Joint Publications	0	6	15	7	6	36

It should be mentioned that research area Energy System Analysis has been more complicated to develop because SJTU is differently organised than NTNU on the Energy side. This means that we were not able to involve professors and PhD-students at SJTU in the first critical phase. Marius Korsnes was the only PhD educated from this area without a matching PhD at SJTU. However, his

work has been very valuable for our collaboration with SJTU and ESA will be an important topic to be followed up in the continued collaboration.

Concerning summer courses, SENIC should be especially mentioned. During the first summer course carried out by the Energy System Group at SJTU in July 2013, the NTNU “Experts in team” model was tried out successfully. This gave rise to plans for developing the joint summer school “Sustainable energy in cities” (SEniC) between SJTU and NTNU based on this model, obtaining funding from the SiU UTFORSK Programme. The first SEniC Summer Course was held successfully in July 2015 with 69 students (14 from Norway/Europe). Professor Annemie Wyckmans had an important role in the planning and implementing this course involving many of the JRC-team.

2013 Energy, Environment & Society Summer School



• 10 Norwegian and 10 Chinese master students

SJTU - NTNU

Shanghai Jiao Tong University Joint Research Centre in Sustainable Energy

Summer Course «Sustainable Energy in Cities»
July 18th-29 th, 2016, School of Mechanical Engineering, Minhang Campus, Shanghai Jiao Tong University, Shanghai, China

2016 International Joint Graduate Course on Sustainable Energy
Each country brings one case

Course Objectives:

- a) Understanding of technologies for sustainable energy production, conversion and utilization
- b) Understanding of limitations and opportunities
- c) Gain experience in challenges and opportunities in designing sustainable energy systems
- d) Renewable energy system design and application in buildings**
- e) Develop your own vision for a future sustainable energy scenario and for the path that gets us there

Participants:

- Shanghai Jiao Tong University, China (Host)
- University of Maryland, College Park, U.S.A.
- Norwegian University of Science and Technology, Norway
- Hamburg-Marburg, Germany
- Korea University, South Korea

At this point the important role of the leaders for the 5 research areas at NTNU and SJTU should be underlined. They have been able to communicate and bring forward plans for the workshops, recruit participants and set up programs. Then to follow up on the results and plans for further work until next time, and follow up that the agreed plans are carried out. And to bring forward reports on the results achieved.

And at last some information on another important point: Where are we going from here? As can be seen from the Energy in Buildings report, Annemie Wyckmans and her team have been able to bring forward and create a new comprehensive INTPART-funded project “Sino-Norwegian Partnership on Sustainable Energy” (SiNoPSE). Here both SJTU and Tsinghua University are partners. So the contact and cooperation within both “Energy System”, “Energy in Buildings”, “Refrigeration” and “Renewable Energy” could be further developed. A kick-off meeting has already been organised in Beijing 13-14 May 2016. Professor Ruzhu Wang participated in this kick-off meeting.

It could also be mentioned that SJTU is partner in several of the new Research Centers for Environment Friendly Energy Research as well as in the existing CenSES.

At the last concluding JRC-workshop in April we used some time to plan further development of our cooperation. And on Thursday April at 16.30 the present JRC-project was finalized by the whole family, by taking the traditional human wave (JRC-Wave) together, for all we have achieved, and for further successful development of the cooperation in the future.

A last important point should be made: How does this relate to the goals brought forward in the original application?

- 1) Follow up on goals and strategies for the development of the JRC. This will include a “model project” on how to develop cooperation in new ways within the JRC to achieve more, both in research, education and innovation.
- 2) Make plans for and start up joint projects (both research and education) within the thematic research areas which have been identified. This research shall lead to increased scientific publication by joint papers.
- 3) Identify relevant financing sources and prepare applications for joint projects with funding from China and Norway
- 4) Identify industrial companies which may be long term partners of the JRC

The first two goals may be said to have been successfully achieved by the JRC-activity developed.

The last two goals became difficult to achieve because of the special situation between China and Norway, so we decided to use our energy on the areas of joint research between SJTU and NTNU.

SJTU-NTNU Joint Research Centre on Sustainable Energy

Final Report from the 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 Jiao Tong 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

2: Final report for the whole project

The Energy System Analysis group collaboration between SJTU and NTNU started in 2010, focusing on energy policy, energy user behavior and energy system analysis. Research cooperation was established with Ass. Prof. Xiaojun HU, Energy Research Institute, Department of Mechanical Engineering, Shanghai Jiaotong University. The collaboration has focused on two main fields: Energy modelling and Renewable energy policy. During the course of the joint research centre period we amongst other things have had long-term exchange of one PhD student who stayed one year in Shanghai, and organized a summer school on energy, environment and society. In addition, one master thesis has been finished, and several publications have been generated as an outcome of the joint research centre. In general, the main achievement for the group has been to lay a basis for collaboration between the two universities that is invaluable for the future collaboration that will be established as part of the Sino-Norwegian Partnership on Sustainable Energy. The contacts,

friendship and knowledge that have been exchanged throughout the whole period have been of utmost importance for the research results and valuable cultural exchanges on both sides of the collaboration.

Complete list of publications, joint publications and lectures

There were unfortunately no publications that were produced jointly between NTNU and SJTU in the Energy System Analysis group. However, the group had several joint-presentations and arrangements, such as the 2013 Summer School, and there have been several publications, presentations and lectures generated as a direct outcome of the group work. These are listed in the table below. In total, five journal papers have been published, and one paper is accepted but still under final review. There have been 16 conference and workshop presentation in relation to the topic, nine lectures, one report, one PhD thesis, one master's thesis and two articles in popular media.

Energy System Analysis group publications, presentations and lectures associated with the SJTU-NTNU Joint Research Centre, 2010-2016

Table 4: Publicationsm presentations and lectures

Number	Year	Type	Title
1	2011	Workshop Presentation	Ryghaug, M. (2011), 'Joint research Centre SJTU - NTNU: CenSES activites. Joint research centre Shanghai Jiao Tong University, Trondheim, Norway
2	2011	Workshop Presentation	Hansen, G.H. (2011), 'JRC project proposals: Analysing the Chinese turbine industry and the encounter between Chinese and Norwegian actors. Shanghai Jiaotong-NTNU JRC workshop, Trondheim, Norway
3	2012	Workshop Presentation	Korsnes, M. (2012), 'Policy innovation in China's experimentation with wind energy'. Workshop and PhD course: Innovation and learning in energy policy: new pathways to sustainability?, Trondheim, Norway
4	2012	Conference Presentation	Korsnes, M. (2012), 'Institutions and wind energy decisions in China and Norway'. MILEN International Conference, Oslo, Norway
5	2012	Article	Korsnes, M. (2012), 'Med vindkraft til havs skal verdi skapast'. PUTSJ : et magasin fra Natur og ungdom
6	2012	Workshop Presentation	Ryghaug, M.; Hansen, G.H. (2012), 'Joint research Centre SJTU - NTNU: Energy System Analysis Group. Joint Research Centre Shanghai Jiao Tong University, Shanghai, China
7	2013	Lecture	Hansen, G.H. (2013), "Energy, Environment & Society - Summer course" Introductory presentation to the summer school, SJTU – NTNU Summer Course, Shanghai, China.
8	2013	Lecture	Karlstrøm, H. (2013), "User perspectives on energy consumption", SJTU – NTNU Summer Course, Shanghai, China.
9	2013	Lecture	Hansen, G.H. (2013), "Global energy production and consumption: current status of technologies and challenges", SJTU – NTNU Summer Course, Shanghai, China.

10	2013	Lecture	Karlstrøm, H. (2013), "Energy controversies: public engagement and how to assess it?", SJTU – NTNU Summer Course, Shanghai, China.
11	2013	Lecture	Korsnes, M. (2013), 'Catch-up Strategies and Green Innovation in China', SJTU – NTNU Summer Course, Shanghai, China.
12	2013	Lecture	Korsnes, M. (2013), 'Energy Governance and Wind Power in China', SJTU – NTNU Summer Course, Shanghai, China.
13	2013	Lecture	Hansen, G.H. (2013), 'Transition management and the multi-level perspective', SJTU – NTNU Summer Course, Shanghai, China.
14	2013	Lecture	Hu, X. (2013), 'Energy systems: modeling, challenges and practices', SJTU – NTNU Summer Course, Shanghai, China.
15	2013	Article	Korsnes, M. (2013), 'Havvind er framtidsretta'. Teknisk Ukeblad 2013 ;Volum 12.
16	2014	Conference Presentation	Korsnes, M. (2014), 'The Rapid Growth of China's Wind Industry – An Institutional Analysis'. Shanghai Social Studies Colloquium (SSSC), Shanghai, China
17	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
18	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
19	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
20	2014	Conference Presentation	Korsnes, M. (2014), 'Globalising Standards? A Narrative Analysis of Offshore Wind Standardisation in China'. CenSES Årskonferanse, Oslo, Norway
21	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
22	2014	Conference Presentation	Korsnes, M (2014), 'China's Offshore Wind Industry'. Science Meets Industry - Offshore Wind Conference, Bergen, Norway.
23	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
24	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.

25	2014	Journal Paper	Korsnes, M. (2014), 'Fragmentation, Centralisation and Policy Learning: An Example from China's Wind Industry'. <i>China aktuell - Journal of Current Chinese Affairs</i> , Volum 3. pp. 175-205
26	2014	Journal Paper	Ydersbond, I.; Korsnes, M. (2014) 'Wind Power in China and in the EU: Comparative Analysis of Key Political Drivers'. <i>Energy Procedia</i> ; Volum 58. pp. 95-102
27	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
28	2015	Conference Presentation	Korsnes, M. (2015), 'China's Offshore Wind Industry: Catch-Up and the role of certification'. EERA Deepwind 2015, Trondheim, Norway
29	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
30	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.
31	2016	Journal Paper	Ydersbond, I. M.; Korsnes, M. (2016), 'What drives investment in wind energy? A comparative study of China and the European Union'. <i>Energy Research & Social Science</i> , Volum 12(2) pp. 50-61
32	2016	Journal Paper	Korsnes, M. (2016), 'Ambition and ambiguity: Expectations and imaginaries developing offshore wind in China'. <i>Technological forecasting & social change</i> , volum 107. pp. 50-58
33	2016	Journal Paper (in press)	Korsnes, M. (2016), 'A sustainable Chinese catch-up? Product quality and interactive learning in the offshore wind industry'. <i>International journal of technological learning, innovation and development</i> , in press.
34	2016	Lecture	Korsnes, M. (2016), 'Doing Research in China: There and Back Again'. DION 2016 Annual General Meeting & Board Election, Trondheim, Norway
35	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

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: Report for the full period from January 2013 to June 2016

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

Table 5: Publications, presentations and lectures 2014 - 2016

Number	Year	Type	Title
1	2014	Conference Presentation (Joint)	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	2014	Conference presentation (Joint)	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	2014	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	2014	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	2014	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	2015	Seminar presentation	Summer School on Sustainable Energy in Cities, SIU UTFORSK Seminar, Oslo, March 2015
7	2015	Workshop presentation	Cooperation with China in the Energy field, workshop with Norwegian Consulate in Shanghai, 14 May 2015 (Annemie Wyckmans and Yu Wang)
8	2015	Seminar presentation	Sustainable Energy in Cities (SJTU-NTNU): Cooperation with Climate-KIC? Climate-KIC kick-off seminar, 24 September 2015, Trondheim (Annemie Wyckmans)
9	2015	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	2015	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	2015	Journal publication (Joint)	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	2015	Journal publication (Joint)	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	2016	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	2016	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	2016	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	2016	Journal publication (Joint)	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	2016	Journal publication (Joint)	Clara Good, Jinfeng Chen, Yanjun Dai, Anne Grete Hestnes, Hybrid photovoltaic-thermal systems in buildings – a review, Energy Procedia (accepted)
18	2016	Journal publication (Joint)	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	2016	Journal publication (Joint)	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)

SJTU-NTNU Joint Research Centre on Sustainable Energy

Final Report from Refrigeration (including “Use of CO₂ as working fluid” and “LNG”)

Trygve M. Eikevik
Department of Energy and Process Technology
NTNU

Activities:

Summer school activity:

SJTU Summer school 2013 (period: July 27th to August 9th 2013):

International Graduate Summer School Course on “Sustainable Energy”

Lectures: **Prof. Trygve M. Eikevik:**

1. Thermodynamic loss analysis using T-s diagram (3 hours lecture)
2. CO₂ in Refrigeration and Heat Pumping Systems (3 hours lecture)

SJTU Summer school 2014 (period: June 30th to July 25th 2014):

Graduate summer school: “Heat Pumping Processes and Systems”

Full course given by Prof. Trygve M. Eikevik

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

“Sustainable Energy in Cities”

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

Co-operation professors:

NTNU:

Prof. Trygve M. Eikevik

Prof. Armin Hafner

Prof. Maria Fernandino

Prof. Truls Gundersen

Prof. Arne M. Bredesen

Adjunkt Professor Petter Nekså

Post.Doc. Ignat Tolstorebrov

SJTU:

Prof. Ruzhu Wang

Prof. Guoliang Ding

Prof. Yonglin Ju

Prof. Jiangping Chen

Prof. Jianjun Yuan

Prof. Jingyi Wu

Associate Prof. Haitao Hu

Associate Prof. Wensheng Lin

Associate Prof. Yong Li
 Assistant Prof. Zhaogang Qi

PhD-candidates:

Zhequan Jin (NTNU): Investigation on CO₂ hybrid ground-coupled heat pumping system for warm climate (Defense February 2017)

Yifei Yang (SJTU): Research on numerical model to simulate water condensation in enhanced fin-and-tube heat exchanger under dehumidifying condition (Start up in August 2014)

Han Deng (NTNU): Boiling and Condensation Heat Transfer of Zeotropic Mixtures in Smooth Tubes (Defense October 2016)

Xiaojun Xiong (SJTU): Research on frost point and pressurized liquefaction process of CO₂ contained natural gas (Defense September 2016)

Post.Doc

Associate Professor Haitao Hu (SJTU) stayed as Post Doc at NTNU in the period from June 2012 to June 2013 working with CO₂ as working fluid in refrigeration and heat pump systems in warm climate.

Double degree master program:

The master program in “Sustainable Energy” was developed in 2012 and started up with the first group of students from both universities in the fall semester in 2013. In the beginning it was only one study direction “Sustainable Heat Pumping Processes and Systems”. From the fall 2015 a new study direction “Energy systems in Buildings” was included.

The students are at the home university the first year of the 2 year master program and take the specialization courses and project/master thesis at the host university the 2nd year. The master program at SJTU have 2.5 years period, which imply that the students from NTNU stay 18 months at SJTU. Students from SJTU go back to SJTU University after one year at NTNU and finalize the master thesis at SJTU.

In the project period, the following students either have fulfilled the program or are in the finalization of the master program.

Table 6: Master students

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-	Dec 2015	NTNU	Simulation on falling film evaporation in coil-wound heat exchanger on

Hermann			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
Han, Yi	Dec 2016	SJTU	Energy-Efficient Supermarket CO ₂ Compressor Pack with Ejectors
Wang, Yuyuan	Dec 2016	SJTU	Experimental Investigation of a Heat Pump Assisted Drum Drying System Using Propane (R290) as Working Fluid
Chen, Song	Dec 2016	SJTU	Investigation of Heat Transfer and Pressure Drop in Small Pipes using Propane (R290)

Presentation of joint papers at the following conferences:

- XV European Conference, Milano, Italy, June 7-8, 2013
- IIR Gustav Lorentzen Conference on Natural Working Fluids (GL2014), Hangzhou, China, August 2014
- The 4th China LNG Forum. Shanghai, China, March 2015
- IIR International Congress of Refrigeration, Yokohama, Japan, August 2015
- Shanghai Refrigeration Association annual meeting, December 18th 2015
- IIR Gustav Lorentzen Conference on Natural Working Fluids (GL2016), Edinburgh, August 2016
- ECOS 2016, Portoroz, Slovenia, June 2016

Due to our close cooperation SJTU became an international partner in the new Research Centre on Energy Efficiency (2017-2024) (FME-HighEFF).

Table 7: Publications and presentations:

Number	Year	Type	Title
1	2013	Conference Presentation (Joint)	H. Hu, T.M. Eikevik, P. Neksa, A. Hafner, Q. Huang, J. Ye; Performance and economy analysis of a R744 heat pump system with an ambient air-cooled gas cooler and a ground heat exchanger to avoid unbalance of traditional ground source systems under different climatic conditions. Proceedings of XV European Conference "The latest technology in air conditioning and refrigeration industry", June 7-8, 2013, Milano, Italy.
2	2013	Conference Presentation (Joint)	H. Hu, T.M. Eikevik, P. Neksa, A. Hafner, D. Zhuang; Parametric study on the performance of vertical ground source U-tube heat exchanger with long tube length. Proceedings of XV European Conference "The latest technology in air conditioning and refrigeration industry", June 7-8, 2013, Milano, Italy.
3	2014	Conference Presentation (Joint)	J. YE, T.M. Eikevik, P. Neksa, A. Hafner, G. Ding, H. Hu; Performance and Economy Analysis of a Solar Assisted CO ₂ Ground Source Heat Pump with Air-Cooled Gas Cooler under Different Climate Conditions, 11th IIR Gustav Lorentzen Conference on Natural Working Fluids, September 2014, Hangzhou, China

4	2014	Journal (Joint)	G. Zhao, T.M. Eikevik, Y. Li, T. Andersen, Y. Ladam; Solar Driven Power Production using CO ₂ as Working Fluids. 11th IIR Gustav Lorentzen Conference on Natural Working Fluids, September 2014, Hangzhou, China
5	2014	Conference Presentation (Joint)	J. Xiong, R. Wang, T.M. Eikevik; Use of ejectors to increase the energy efficiency of heat pump and refrigeration systems, 11th IIR Gustav Lorentzen Conference on Natural Working Fluids, September 2014, Hangzhou, China
6	2014	Conference Presentation (Joint)	Z. Jin, T.M. Eikevik, P. Nekså, A. Hafner, G. Ding, H. Hu. Transient simulation of R744 hybrid ground coupled heat pump with modelica, 11th IIR Gustav Lorentzen Conference on Natural Working Fluids, September 2014, Hangzhou, China
7	?	Journal (Joint)	H.T. Andresen, Y. Li; Modeling the heating of the Green Energy Lab in Shanghai by the geothermal heat pump combined with the solar thermal energy and ground energy storage.
8	2015	Journal (Joint)	Hu H, Eikevik T.M., Nekså 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.
9	2015	Journal (Joint)	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.
10	2015	Journal (Joint)	Zhao Geping, LI Yong, EIKEVIK Trygve Magne, et al. Experimental Study of Rankine Cycle Power Generation Driven by Low-grade Heat Source Using CO ₂ as Working Fluid. Chinese Journal of Refrigeration Technology, 2015, 35(5): 1-6.
11	2015	Journal (Joint)	Ye Jingjing, HU Haitao, Ding Guoliang, EIKEVIK Trygve Magne. Performance Analysis on CO ₂ Ground Source Heat Pump with Gas Cooler. Chinese Journal of Refrigeration Technology, 2015, 35(5): 14-19,24.
12	2015	Journal (Joint)	YE Jingjing, HU Haitao, Ding Guoliang, EIKEVIK Trygve Magne. Performance Analysis on Solar Assisted CO ₂ Ground Source Heat Pump. Chinese Journal of Refrigeration Technology, 2015, 35(5): 1-6.
13	2015	Journal (Joint)	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
14	2015	Conference Presentation	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
15	2015	Conference Presentation	Jin, Zhequan; Eikevik, M. Trygve; Nekså, Petter; Hafner, Armin; Ding, Guoliang. Energy Performance of CO ₂ hybrid ground-coupled heat pumping system for hotel application. I: proceedings of the 24th international congress of refrigeration. International institute of refrigeration 2015
16	2016	Conference Presentation	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), Slovenia 2016
17	2016	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

Final Report from “Offshore Wind and Smart Grid”

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 months 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 joint 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).

There were three exchange 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.

Publications and Presentations:

Publications and major presentations at conferences are shown in the table below. Additionally, presentations have been held at the workshops organized within the JRC.

Table 8: Publications and presentations

Number	Year	Type	Title
1	2016	Journal (Joint)	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". Accepted for publications in IEEE Journal of selected and emerging topics of power electronics
2	2016	Conference Presentation (Joint)	Rygg, M. Molinas, C. Zhang and X. Cai, "Frequency-dependent source and load impedances in power systems based on power electronic converters". The 19th Power Systems Computation Conference, June 2016, Genoa Italy
3	2015	Conference Presentation (Joint)	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
4	2016	Journal (Joint)	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.
5	2015	Conference Presentation (Joint)	Jing Lyu, Xu Cai, Marta Molinas, "Impedance modeling of modular multilevel converters," IEEE IECON 2015, 2015.11, Yokohama, Japan.
6	2015	Journal (Joint)	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.
7	2016	Journal (Joint)	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 (Submitted).
8	2015	Presentation (Keynote)	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 HVD and Power Electronics in Shanghai,

October 22, 2015.			
9	2016	Conference Presentation	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
10	2016	Conference Presentation	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
11	2015	Conference Presentation	Atle Rygg, Espen Skjong and Marta Molinas, "Handling system harmonic propagation in a dieselelectric ship with an active filter", in ESARS 2015, March 2015, Aachen
12	2016	Conference Presentation	Atle Rygg and Marta Molinas, "Real-time stability analysis of power electronic systems", in IEEE COMPEL 2016, 27-30 June 2016, Trondheim, Norway
13	2016	Conference Presentation	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

Plans for the Future (2016-2018):

An ERCIM Post Doctoral application was presented by PhD candidate Jing Lyu to continue the collaboration with NTNU. This application became successful and Dr Jing Lyu will continue with the research in collaboration with NTNU during the period December 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

Report from "Catalysis for Renewable Energy"

*De Chen
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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).

Table 9: 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 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