# SINOPSE

**3 UNIVERSITIES || 2 COUNTRIES || 1 GOAL**

The Sino-Norwegian Partnership on Sustainable Energy

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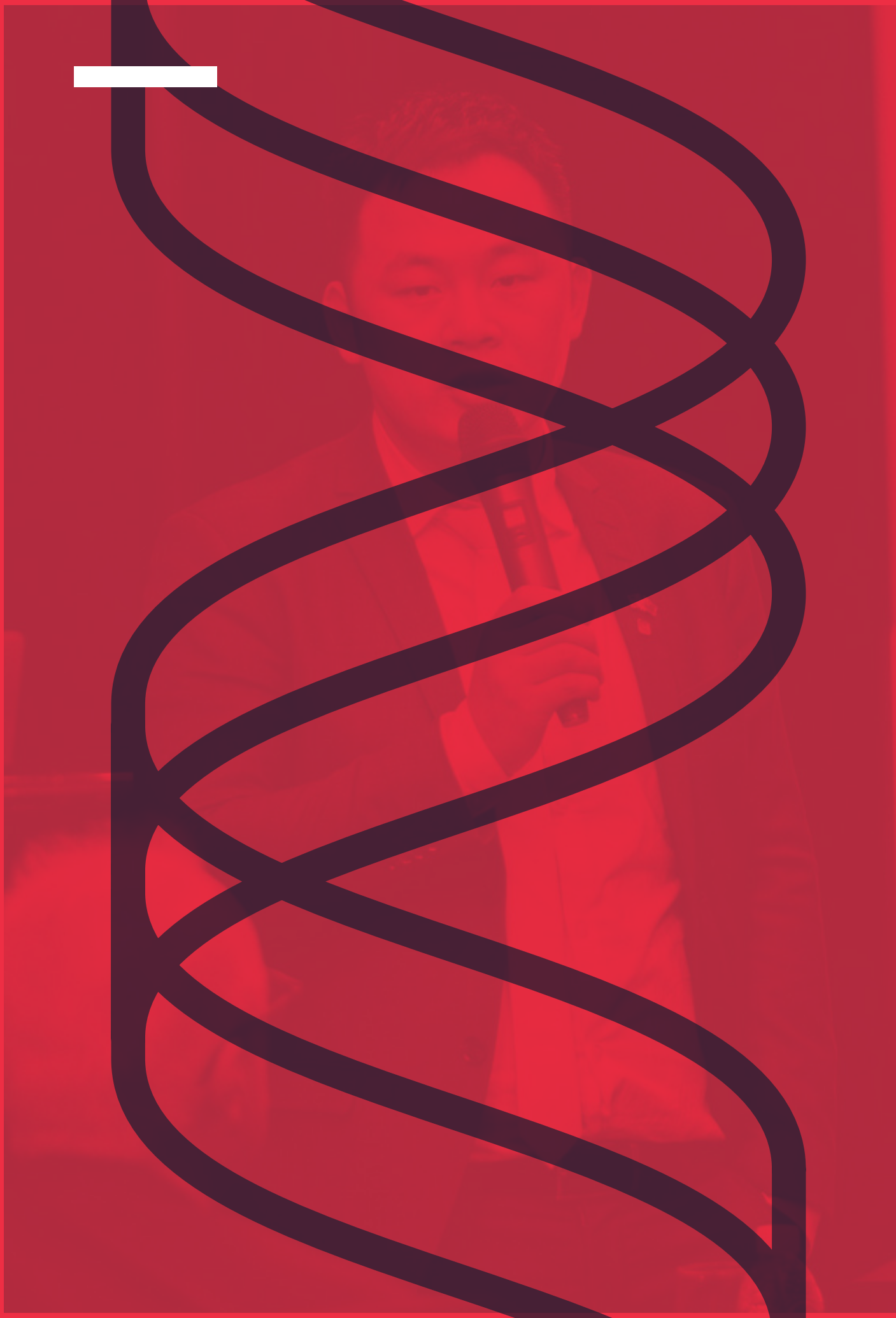
# List of Acronyms

| | |
|---|---|
| **BERC** | Building Energy Research Centre |
| **CEDREN** | Centre for environmental design of renewable energy |
| **CenBIO** | Bioenergy Innovation Centre |
| **CenSES** | Centre for Sustainable Energy Studies |
| **DIKU** | Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education |
| **FME** | Norwegian Centres for Environment-Friendly Energy |
| **IRES-8** | Investigation of Research and Innovation Partnership on Renewable Energy, Energy Efficiency and Sustainable Energy |
| **JRC** | Joint Reseach Centre |
| **JRP** | Joint Research Program |
| **NTNU** | Norwegian University of Science and Technology |
| **RCN** | Reseach Council of Norway |
| **SeniC** | Sustainable Energy in Cities |
| **SiNoPSE** | Sino-Norwegian Partnership on Sustainable Energy |
| **SJTU** | Shanghai Jiao Tong University |
| **THU** | Tsinghua University |
| **WP** | Work Package |
| **ZEB** | Zero emission buildings |



# Summary

# Summary

## English summary

The Sino-Norwegian Partnership on Sustainable Energy SiNoPSE represents an interdisciplinary approach to sustainable energy. It merges technology, design and society, in which the Norwegian University of Science and Technology (NTNU), Shanghai Jiao Tong University (SJTU) and Tsinghua University (THU) have proven excellence. They are active contributors to industrially focused research and innovation activities, are involved in collaborative projects and provide high-calibre graduates and researchers.

SJTU and THU are the leading Chinese universities in sustainable energy, from a technology and societal perspective respectively. THU and SJTU have substantial activities in the energy area with internationally recognised research groups in strategically important science fields and are thus in a good position to contribute to the global transition process towards sustainable energy.

China is one of the world's largest markets for low-carbon energy technologies, and plays an important role in driving down prices and increasing the usage of these technologies. How China chooses to position itself within low-carbon technologies and sustainable consumption will have great consequences for Norwegian industry interests. In times when contacts on a political level are challenging, it is especially significant to have knowledge about Chinese energy policy and transition strategies, as well as functioning networks with researchers in China and researchers studying China.

This project created a triple helix collaboration on sustainable energy between NTNU, THU and SJTU, and their local networks of research, industries and cities. The basis for this collaboration were the existing individual institutional partnerships between NTNU, THU and SJTU and the merging of these towards more structured and integrated research, education and innovation collaboration. Shanghai Jiao Tong University and Tsing Hua University combined, provided a perfect match for NTNUs thematic strategic research area of Energy. The partnership was mainly based on peer-to-peer physical and virtual interfaces between the three universities and their local support clusters of industry, city, research and education networks. As an added value to the research and education cooperation, the university partners used their cities and industries as living laboratories to conduct empirical validation trials for sustainable energy.

An open annual joint Symposium was held to promote the results of the research and education cooperation and to keep a dialogue with our local support networks, including the results of established double degree master's programmes and sandwich PhDs on sustainable energy, and annual summer schools on sustainable energy in cities were organised.

# Norsk sammendrag

I det norsk-kinesiske partnerskapet i bærekraftig energi (SiNoPSE) utvikler Norges teknisk-naturvitenskapelige universitet (NTNU), Shanghai Jiao Tong University (SJTU) og Tsinghua University (THU) en tverrfaglig tilnærming til bærekraftig energi som integrerer teknologi, design og samfunn. De tre universitetene er aktive bidragsytere til forsknings- og innovasjonsaktiviteter innenfor bærekraftig energi, er involvert i samarbeidsprosjekter og utdanner studenter, unge forskere og fremtidige endringsagenter av høyt kaliber.

SJTU og THU er de ledende kinesiske universitetene innen bærekraftig energi, fra henholdsvis et teknologi- og samfunnsperspektiv. THU og SJTU har betydelige aktiviteter på energiområdet med internasjonalt anerkjente forskningsgrupper innen strategisk viktige vitenskapsfelt, og er dermed godt posisjonert til å bidra til den globale omstillingsprosessen mot bærekraftig energi.

Kina er et av verdens største markeder for lavkarbon-energiteknologier, og spiller en viktig rolle i å redusere prisene og øke bruken av disse teknologiene. Hvordan Kina posisjonerer seg innenfor lavutslippsteknologier og bærekraftig forbruk, vil ha store konsekvenser for norske industriinteresser. Derfor er det spesielt viktig å ha kunnskap om kinesisk energipolitikk og overgangsstrategier, samt fungerende nettverk med forskere i Kina og forskere som studerer Kina.

SiNoPSE-prosjektet har skapt et såkalt “triple helix”-samarbeid innen bærekraftig energi mellom NTNU, THU og SJTU, og deres lokale nettverk av forskning, næringer og byer. Grunnlaget for dette samarbeidet var de eksisterende individuelle institusjonelle partnerskap mellom NTNU, THU og SJTU og sammenslåingen av disse mot mer strukturert og integrert forsknings-, utdannings- og innovasjonssamarbeid. Kombinasjonen av Shanghai Jiao Tong University og Tsing Hua University er en perfekt match for NTNUs tematiskesatsingsområde Energi. Partnerskapet var hovedsakelig basert på fysiske samlinger samt nettbasert samarbeid mellom de tre universitetene og deres lokale støtteklynger for industri, by, forskning og utdanningsnettverk. Som en merverdi for forsknings- og utdanningssamarbeidet brukte universitetspartnerne byene og næringene sine som levende laboratorier for å gjennomføre empiriske valideringsforsøk for bærekraftig energi.

Det ble avholdt et åpent årlig felles symposium for å fremme resultatene av vårt forsknings- og utdanningssamarbeid i dialog med våre lokale aktør-nettverk, der vi presenterte, blant annet, resultatene fra etablerte mastergradsprogrammer, PhD-samarbeid, utveksling av studenter og ansatte, og sommerskoler om bærekraftig energi i byer.

# Visions & goals

# Vision and Goals of SiNoPSE

## 3 universities, 2 countries, 1 goal

NTNU follows an international research approach in order to ensure high-quality research and to create long-lasting global research collaboration. SiNoPSE[1] builds on a decade-old relationship between NTNU and two Chinese universities, Shanghai Jiao Tong University (SJTU) and Tsinghua University (THU), and aims to bring these three universities even closer together. With this more integrated approach, NTNU strives to make existing cooperation more robust and institutionalised, support the establishment of strong international relations between China and Norway, and create a one-stop shop for sustainable energy research.

## Ambition

From the outset, it has been SiNoPSE's ambition to establish a strong international partnership between NTNU, SJTU and THU as a «one-stop shop» for Sino-Norwegian cooperation on sustainable energy. The project was set out to engage key research, education and industry partners on sustainable energy in Norway and China. There was a desire to build a strong integrated and multi-disciplinary research network to facilitate knowledge transfer and mutual learning about sustainable energy between the two countries.
SiNoPSE's objective has been to create international excellence in sustainable energy research, innovation and education.

The following three approaches were key for SiNoPSE's success:

**EXPERTS IN TEAMS[2]**
This is an interdisciplinary training of students and staff. We used NTNU's teaching approach to make use of the various cultural and discipline backgrounds of the participants.

**TRIPLE HELIX**
We created a triple helix collaboration between NTNU, THU and SJTU, and their local networks of research, industries and cities. This ensured feedback from local society through the project developers, municipalities, and the industry.

**OUT OF THE LAB, INTO THE CITY**
We used all three university cities as Urban Labs for gathering empirical evidence and developing solutions. It was our goal to make our research directly applicable to industrial and societal challenges.

1 *https://www.ntnu.edu/smartcities/sinopse*
2 *https://www.ntnu.edu/eit*

## Vision

*Cooperation and alignment between NTNU, THU and SJTU to strengthen international excellence in sustainable energy research, innovation and education.*

For the alignment of research and education activities on sustainable energy, we organised peer-to-peer physical and virtual meeting places to create a joint research alliance, extend successful cooperation practices from SJTU to THU and vice versa, and discuss how to overcome challenges in terms of cultural understanding and funding. It is our belief that strong networks on the institutional and the personal levels lead to higher quality research results.

Though the core of SiNoPSE was to create a more intensive interlinkage between sustainable energy research in Norway and China, we wanted to go further than that: SiNoPSE's results are to be intertwined with society. It is our ambition to use our local city and industry partners as living laboratories to conduct empirical validation trials for sustainable energy.

Key representatives were identified at each of the universities and the corresponding Research Centres and have, from the start of the project, acted as multipliers towards their respective research, industry, city, policy, and education groups.

The desire to connect SiNoPSE's research to society comes natural to us, since NTNU has a tradition of working on the entire technology chain from source to end-user, thus acting as a support for local communities. We found it important to connect with both SJTU and THU, as they bring in different perspectives on sustainable energy: SJTU focuses on the technology, whereas THU has a socio-economic perspective, both equally valuable for SiNoPSE.

## Outcome and Deliverables

1

**TRIANGULAR COOPERATION**

With SiNoPSE, we have created a triangular cooperation between the three universities NTNU, SJTU, and THU. Prior to this project, we already had ongoing research and education cooperations with each of the Chinese universities individually. Between NTNU and SJTU, a Joint Research Centre (JRC) was established in 2010, and between NTNU and THU a Joint Research Programme (JRP) was initiated in 2014. With SiNoPSE we brought these closer together. The triangular cooperation was pivotal for a more integrated approach on sustainable energy: zero emission buildings and districts, leading up to smart cities; sustainable transitions in policy and innovation in energy systems, sustainable consumption and smart cities, using Living Labs, and interactions between energy system transitions in Europe and China; value chains of virgin biomass and biodegradable waste fractions, including production, harvesting and transportation, conversion to heat, power and biogas, and handling and upgrading residues to valuable products; sustainable development of hydropower, and adapting to the future energy mix with increased shares of unregulated, renewable energy from wind and solar sources.

During SiNoPSE, as many as six Norwegian Centres for Environment-friendly Energy Research (FME)[3] were involved. We have created a strong cooperation on a common goal such as the annual symposia and the summer schools, to help align and integrate the work of these six FME Centres and their Chinese partners.

2

**THE LINK BETWEEN HIGHER EDUCATION AND RESEARCH COOPERATION**

SiNoPSE helped us establish new double master's degrees, run several summer schools, and enable sandwich PhDs with joint supervision and joint publications, to name just a few tangible outcomes for all three universities in terms of education and research quality. This peer-to-peer interaction serves to improve quality of research. The research cooperation and involvement in double degree master's and summer courses was performed by the same staff at NTNU, THU and SJTU, thus enabling easy inclusion of students into research and innovation work, and transfer of research and innovation results towards education and training. Students were also included, and their work was exhibited and presented in the annual symposia.

*3 https://www.ntnu.edu/research/centres-for-environment-friendly-energy-research*
*They are described in the next chapter.*

3

**THE LINK TO INCREASED QUALITY IN EDUCATION AND RESEARCH**

SiNoPSE helped the Research Centres align their interests on sustainable energy, not only in cooperation with China but also with each other – simply by providing an arena in which they had to interact and work together towards a common goal. Participating in an educational experience in China gives students and teachers on both sides new perspectives – in particular in terms of pedagogical methods which tend to be more teaching-based in China, and more learning-based in Norway. On the other hand, the Chinese students work closely with their teachers' research and innovation projects throughout their education, a type of mentorship that can be inspiring for Norwegian participants.

Furthermore, many joint publications on cooperation products and processes in research, education and innovation came out of the project. On top of that, we created further joint applications to national and European funding opportunities.

4

**THE LINK TO LOCAL INDUSTRY AND CITIES**

The industry and public governance partners of the Research Centres were invited to the annual symposium, and cooperated with project topics and guidance in the double degree master's, sandwich PhDs, student and staff exchanges, and summer courses. THU and SJTU identified local support networks in Beijing and Shanghai which provided similar cooperation. The Norwegian diplomatic representations in China – the Royal Norwegian Embassy in Beijing and the Norwegian Consulates General in Shanghai and Guangzhou – and the Chinese diplomatic representation in Norway – the Embassy of the People's Republic of China in the Kingdom of Norway – as well as Innovation Norway, offered to provide additional connections and make our activities known in their local networks. The students welcomed a closer connection to the industry during their visits in China – for the experience, a potential summer engagement, or even a future job offer. To support the triple helix cooperation also in the students' education, we used NTNU's "Experts in team" education model as the basis for the cooperation.

# Facts and Background Information

# Funding

SiNoPSE was funded by the Research Council of Norway (RCN). The contents reflect the work of the authors and does not reflect the view of the RCN.

**Project No.:** 250146/H30
**Funding:** NOK 4,050,000
**Project period:** 1 January 2016 – 31 December 2018, extended to 31. August 2019

Project period: 1 January 2016 – 31 December 2018, extended to 31. August 2019
We applied under the INTPART[4] programme which aims to support Norwegian education and research institutions to develop multiple international relationships with scientific institutions in 8 priority countries: Brazil, Canada, India, Japan, China, Russia, South-Africa and USA.

INTPART is a cooperative programme between the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (Direktoratet for internasjonalisering og kvalitetsutvikling i høgare utdanning, Diku)[5] and the RCN.
INTPART's goal is to support international partnerships between research and educational institutions in Norway with institutions outside the EU. Outcomes should be joint study programmes with these institutions, an increased mobility among students and scientists, joint articles and publications, and stronger cooperation with the industry and society.

While INTPART funded the direct costs, all three universities and the involved FME centres made in-kind contributions, such as working hours of staff or the use of existing research equipment. Further funding came from the European mobility project IRES-8, which funds outgoing mobility for PhD and postdoctoral researchers.

4 *https://diku.no/programmer/intpart*
5 *https://diku.no/en*

# Project Partners

China is one of the world's largest markets for low-carbon energy technologies, and plays an important role in driving down prices and increasing the usage of these technologies. How China places itself within low-carbon technologies and sustainable consumption will have great consequences for Norwegian industry interests. It is crucial for Norway to have knowledge about Chinese energy policy and transition strategies, as well as functioning networks with researchers in China and researchers studying China.

SiNoPSE created a triple helix collaboration on sustainable energy between the Norwegian University of Science and Technology (NTNU), Shanghai Jiao Tong University (SJTU) and Tsing Hua University (THU), and their local networks of research, industries and cities. As a basis for this collaboration, the existing individual institutional partnerships between NTNU, THU and SJTU were merged towards more structured and integrated research, education and innovation collaboration.

SJTU and THU are the leading Chinese universities in sustainable energy, from a technology and societal perspective respectively. THU and SJTU have substantial activities in the energy area with internationally recognised research groups in strategically important science fields and are thus well-placed to contribute to the global transition process towards sustainable energy.

NTNU has selected SJTU and THU as institutional strategic partners in the energy field. Combined, they provide a perfect match for NTNU's thematic strategic area "Energy". SJTU is one of the leading Chinese universities with a strong emphasis on technology and energy, on which they advise Chinese policy. THU is a trusted adviser to Chinese policy makers in energy societal questions, pushing for real-world implementation of environmental solutions in China. They have expressed an interest in increasing their understanding of socio-economic aspects and climate considerations.


NTNU
Trondheim


THU
Beijing
SJTU
Shanghai

# Shanghai Jiao Tong University(SJTU)

**SHORT OVERVIEW**[7]

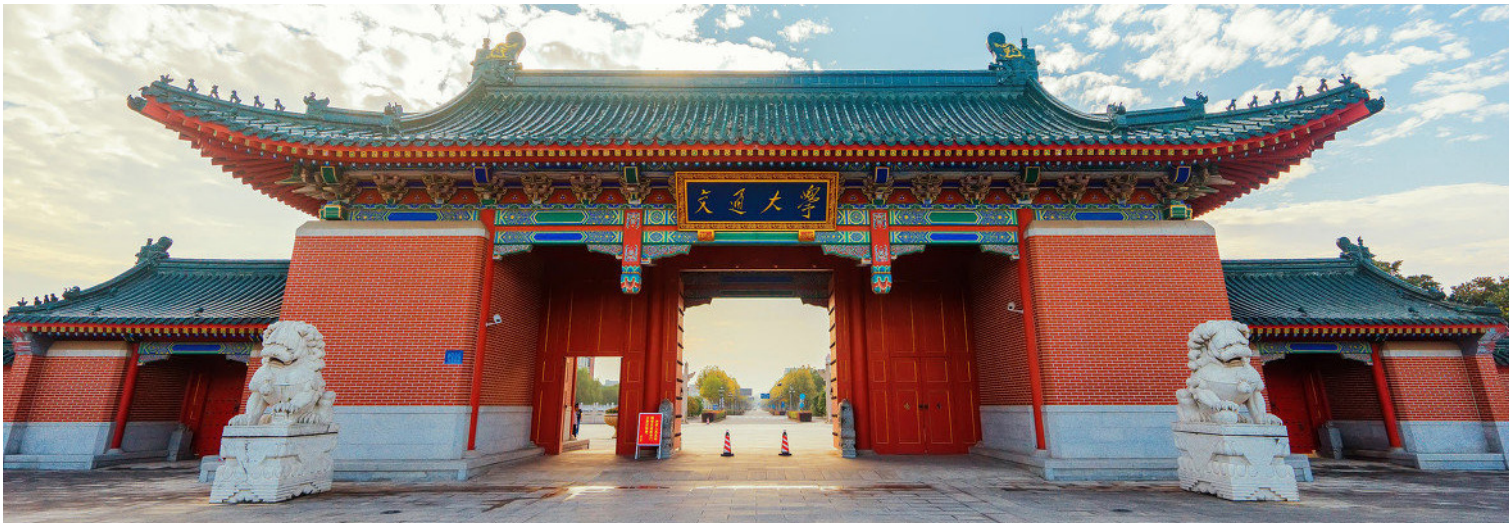
| | |
|---|---|
| **Established:** | 1896 |
| **Location:** | Shanghai |
| **Students:** | 40 711, including |
| **Academic Staff:** | 2 722 international students |
| | 3 061 full-time, including 982 professors |

**Programmes:**

| | | | | | |
|---|---|---|---|---|---|
| 30 | Schools/ Departments | 13 | Affiliated Hospitals | 12 | Directly affiliated units |
| 31 | Research Institutions | 2 | Affiliated medical reseach institute | 6 | Directly affiliated enterprises |

**The name “Jiao Tong” comes from a book. Literally translated, “Jiao” means “to unite” and “Tong” means “harmony”. The book describes how, when heaven and earth unite in deep harmony, peace and blessing descend upon all living things. SJTU believes when leaders and people unite and combine their influences, the nation enjoys universal flourishing and prosperity.**

**LOCAL SUSTAINABLE ENERGY RESEARCH CENTRE**
SJTU established the Centre for Combustion and Environmental Technology, a prodigious research institute on both fundamental and applied research of internal combustion engines. Furthermore, they established the Sino-Italian Green Energy Laboratory (GEL).



6 *Shanghai Jiao Tong University (2010). About SJTU – Facts & Figures. Retrieved 23 September 2019 from http://en.sjtu.edu.cn/about-sjtu/facts-figures*

# Tsinghua University (THU)

**SHORT OVERVIEW**[7]

| | |
|---|---|
| **Established:** | 1811 |
| **Location:** | Beijing |
| **Students:** | 48 739, including |
| **Academic Staff:** | 2 587 international students |
| | 3 485 full-time |

**Programmes:**

**20** **Schools/** **58** **Departments**

## THU operates under the motto “Self-Discipline and Social Commitment” and the spirit of “Actions Speak Louder than Words”.

### LOCAL SUSTAINABLE ENERGY RESEARCH CENTRES

THU collaborates closely with the Building Research Centre. Both are leading Chinese research institutes in building energy efficiency and sustainability. They recognise that social issues (human behaviour, lifestyle, etc.) impact the energy consumption in buildings and almost every aspect of society, and have accordingly initiated studies in this field, within THU and as international projects with, amongst others, the International Energy Agency.

THU hosts the Centre for Combustion Energy (CCE), the leading research centre on combustion energy and science in China, established to meet the two major challenges facing humanity: energy sustainability and climate change. Special attention has been devoted to solid fuels (biomass and coal) to energy, waste to energy, and combustion emission control. The CCE offers various educational programmes related to combustion theory and technology on both master’s and PhD levels.

7 *Tsinghua University (Dec. 2018). About – Facts and Figures. Retrieved on 23 September 2019 from https://www.tsinghua.edu.cn/publish/thu2018en/newthuen_cnt/01-about-6.html*

## Further supporters in China were:

– Beijing Jiaotong University,
– China Academy of Building Research
– Gree Electric Appliances Inc of Zhuhai
– Solareast Holdings Co. Ltd.
– Lanzhou University of Technology (LUT),
– North China Electric Power University (NCEPU),
– Qingdao Somir Energy Science and Technology Co. Ltd.
– Xi'an University of Architecture and Technology (XAUAT)

*Haibo CHEN vice chair of NTNU Alumni China at SiNoPSE Symposium 2018 Shanghai*

# Project Supporters

SiNoPSE has received great support, both internationally and nationally. Innovation Norway, Diku and the Norwegian diplomatic representations in China – The Royal Norwegian Embassy in Beijing and the Norwegian Consulates General in Shanghai and Guangzhou, and the Chinese diplomatic representation in Norway – The Embassy of the People's Republic of China in the Kingdom of Norway have all contributed.
These supporters have played a vital role in mobilising local support networks of industry, city, research and education to join and participate in SiNoPSE, especially in the summer schools and symposia. All project supporters have provided additional connections and have made our activities known in their local networks.

## Innovation Norway

Innovation Norway is a state-owned agency and the Norwegian Government's most important instrument for innovation and development of Norwegian enterprises and industry. They support companies in developing their competitive advantage and enhance innovation.

## Diku

The Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (Diku) aims to strengthen the quality of Norwegian education. They promote development and innovation in education, encourage international cooperation and digital learning methods.

## Embassies and Consulates in China and Norway

The Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (Diku) aims to strengthen the quality of Norwegian education. They promote development and innovation in education, encourage international cooperation and digital learning methods.

NTNU focuses on internationalisation, aiming to collaborate with excellent institutions. As the focus and competencies of SJTU and THU are a fit for NTNU, this international collaboration started over a decade ago.

## 2004

NTNU decides to develop strategic long-term cooperation with selected Chinese universities within the energy sector. Funding and support come from Innovation Norway and the Research Council of Norway (supported by BILAT projects).

## 2005

First NTNU rector visit to Tsinghua University and Shanghai Jiao Tong University

## 2006

NTNU visits and organises a joint workshop at the Building Energy Research Centre (BERC) at THU.

## 2009

A collaboration between NTNU and THUs on Renewable and New Energy is initiated, initially funded by RCN.enables us to run three preparation workshops for the opening of the JRC.

## 2010

Joint Research Centre (JRC) on Sustainable Energy agreement signed between NTNU and SJTU with initial funding from RCN: 6 thematic research cooperation areas and corresponding sandwich PhDs, 2-3 joint workshops per year, 3 joint summer schools
First preparation workshop in Shanghai with 20 participants from NTNU and SJTU, leading to an application for a pilot project for the start-up of the JRC in 201, granted by RCN and funded with NOK 500,000, enabling three preparation workshops.

*8 https://www.ntnu.edu/jrc/first-double-degree-graduates-2014*

## 2011

Official opening of the JRC.

On 30 May 2012, the RCN (Application No: ES404870 Project No: -1) accepts the application for further funding for the JRC. This enables the further development of the JRC from 2013 – 2015.

## 2012

NTNU and SJTU develop a double degree master's on Sustainable Energy Funding from UTFORSK (project number UTF-2014/10069) and start of "SeniC - Sustainable Energy in Cities", a key support for two summer schools plus research and student exchanges.
14 PhD candidates and 13 double degree master's students are educated. JRC runs 4 summer schools, delivers 67 presentations, and yields 35 joint publications.

## 2013

A collaboration between NTNU and THUs on Renewable and New Energy is initiated, initially funded by RCN.

## 2014

Application for SiNoPSE is filed in order to merge the work of JRC and JRP for a more integrated approach, and to make these existing cooperations more robust and institutionalised.

## 2015

The project starts under Prof. Olav Bjarte Fosso (NTNU, Trondheim, Norway), Director of NTNU Energy, on 1 January 2016. On 12 December 2016, Prof. Annemie Wyckmans (NTNU, Trondheim, Norway) takes over as project coordinator.

## 2016

# Sustainable Energy Research – Norway and the bigger picture

On 1 January 2016, the 17 Sustainable Development Goals[10] (SDGs) were officially launched by the United Nations (UN). They address the global challenges the world is facing, including those related to poverty, inequality, climate, environmental degradation, prosperity, and peace and justice. The aim is to achieve each goal by 2030. The SDGs were adopted by 150 world leaders in September 2015 at a historic UN Summit in New York.


*UN Sustainability goals*

All research, education and innovation activities of the SiNoPSE project have explored further development, integration and feasibility of sustainable energy and as such directly supported several of the UN SDGs. It was important for SiNoPSE to be embedded in international research to address global challenges.

NTNU is a UN Habitat university[11], cooperating closely with UN Habitat in China[12]. For example, the students who attended our SiNoPSE summer school in Trondheim in August 2018 were invited to participate in the UN Habitat Placemaking Week in Wuhan in December 2018. This cooperation is now embedded in new INTPART[13] project URBAN-NORWAY-CHINA, with sustainable urbanisation as its scope including, but not restricted to, energy.

*10 UN (2019). About the Sustainable Development Goals. Retrieved on 23 September 2019 from https://www.un.org/sustainabledevelopment/sustainable-development-goals/*
*11 http://uni.unhabitat.org/?uni-partner=norwegian-university-of-science-and-technology-ntnu*
*12 https://new.unhabitat.org/where-we-are/china*
*13 https://www.forskningsradet.no/en/about-the-research-council/programmes/intpart/*

## Research Council of Norway

The Research Council of Norway[14] works to promote research and innovation of high quality and relevance and to generate knowledge in priority areas to enable Norway to deal with key challenges to society and the business sector.
Hydropower is the backbone of the Norwegian energy supply, and petroleum is one of Norway's largest industries. Other energy technologies such as solar power, offshore wind power and maritime transport solutions are developing rapidly. Energy systems will be undergoing radical changes in the years ahead.

The Research Council of Norway funds several big projects in the energy field and is one of the most important national supporters of NTNU. RCN has established long-term support for FME Centres, funding 8 technological and 3 social science FME Centres .

## NTNU Energy

NTNU Energy[16] is one of four strategic research areas (TSO) at Trondheim University for the period 2014 – 2023. A strategic research area is defined by a multi-disciplinary approach, from source to end-user, bringing together society, technology and humanity, and focused on international collaboration while simultaneously enhancing national collaboration.
The other strategic research areas are Health, Oceans and Sustainability.

Energy is the largest of the four: 6 out of 7 faculties are involved, a total of 30 departments (out of 52), which sums up to about 60 research groups.

– *Vision: Energy for a better society!*

**NTNU Team Wind**

**NTNU Team Energy Transition**

**NTNU Team Carbon Capture and storage**

**NTNU Team Hydrogen**

*14 Forskningsrådet (2019). Tasks and organising. Retrieved on 23 September 2019 from https://www.forskningsradet.no/en/about-the-research-council/Tasks-and-organising/*
*15 https://www.forskningsradet.no/en/about-the-research-council/programmes/fme/*
*16 NTNU (2019). NTNU Energy. Retrieved on 23 September 2019 from https://www.ntnu.edu/energy*

Furthermore, NTNU Energy is part of 10 Centres for Environment-friendly Energy Research (FME[17]) in Norway. These Centres develop expertise and promote innovation by supporting long-term research on environment-friendly energy and carbon capture and storage in collaboration between leading research groups and users. Each Centre is appointed for eight years and selected via a detailed process administered by the Research Council of Norway.

## In SiNoPSE, we collaborated closely with the following 9 FME Centres:

**HOSTED BY NTNU:**

- Centre for Sustainable Energy Studies (FME-CenSES), established in 2009 and continued in 2017
- Centre for Hydropower Technology (HydroCEN), established 2017
- Centre on Zero Emission Neighbourhoods in Smart Cities (FME-ZEN), established 2017
- Centre on Zero Emission Building (FEM-ZEB), established 2009

**HOSTED BY SINTEF WITH NTNU AS A MAIN PARTNER:**

- Centre for Sustainable Bio-based Fuel and Energy (Bio4Fuels), established in 2017
- Centre for intelligent electricity distribution - Smart Grids (CINELDI), established in 2017
- Centre for Energy Efficiency in Industry (HighEff), established in 2017
- Centre for Bioenergy Innovation (CenBIO), established in 2009
- Centre for Environmental Design of Renewable Energy (CEDREN), established in 2009

17 *https://www.ntnu.edu/research/centres-for-environment-friendly-energy-research*

Centre for Bioenergy Innovation (CenBIO), Centre for Environmental Design of Renewable Energy (CEDREN), Centre for Sustainable Energy Studies (CenSES).

**CenSES**[18] conducts research that supports public and private decision makers in strategic decisions and policies that could promote environment-friendly energy technologies and lead to a sustainable energy system. The main objective is to strengthen the understanding of the economic, political, social and cultural aspects of the development and introduction of renewable energy and environmental technology.

**HydroCen**[19] aims to enable the Norwegian hydropower sector to meet complex challenges and exploit new opportunities through innovative technological solutions.

**ZEN**[20] sets out to create zero emission neighbourhoods (ZEN). A zero-emission neighbourhood aims to reduce its greenhouse gas emissions towards zero within its life cycle.

**ZEB**[21] research vision is to eliminate the greenhouse gas emissions caused by buildings. The main objective is to develop competitive products and solutions for existing and new buildings which will lead to market penetration of buildings with zero emissions of greenhouse gases related to their production, operation and demolition. ZEB was funded through RCN from 2009 – 2016.

**Bio4Fuels**[22] develops innovative technology and supports industries to realise economic and sustainable conversion of lignocellulosic biomass and organic residues to transportation fuels, along with added value chemicals, heat and power.

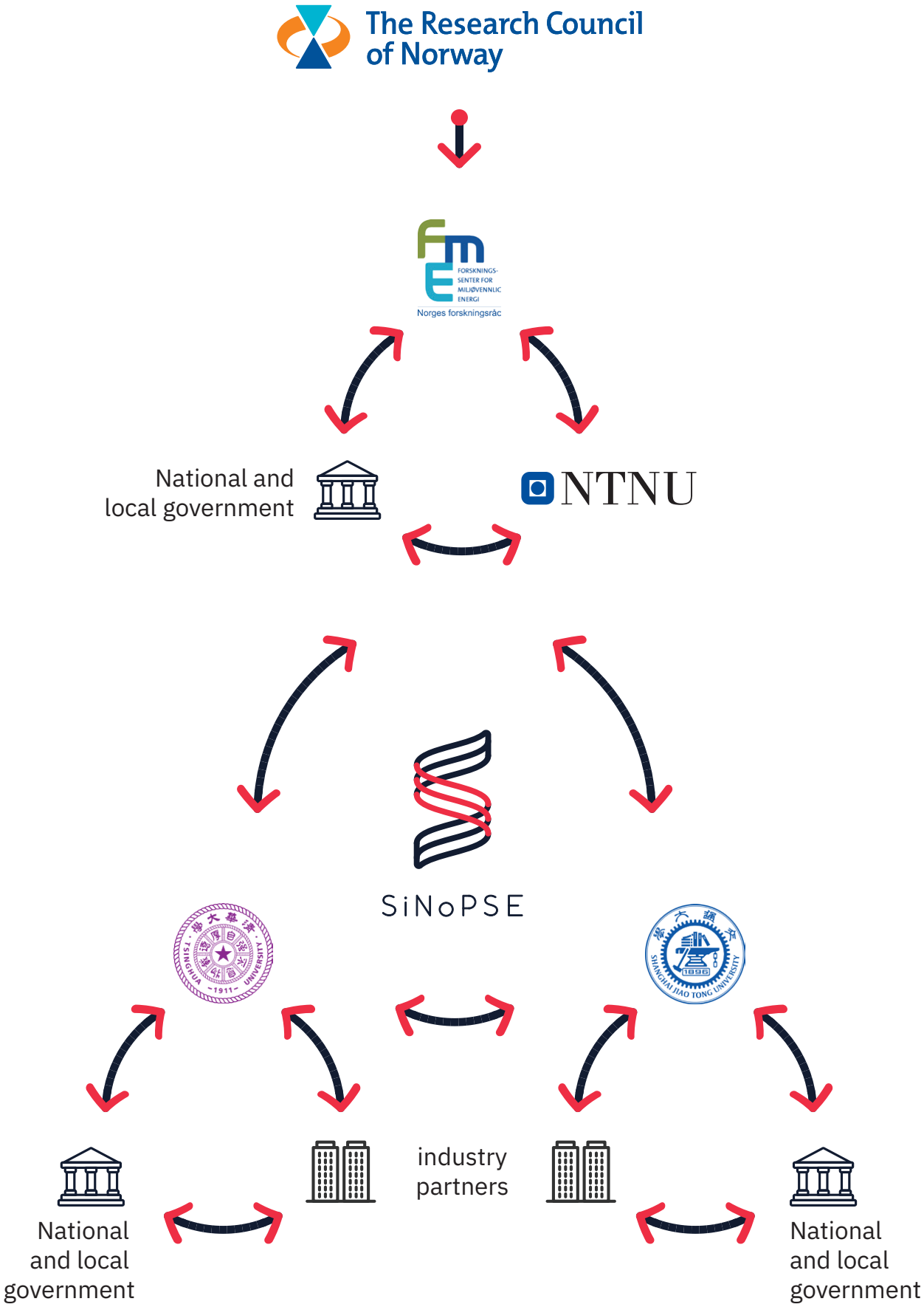
**CINELDI**[23] develops the electricity grid of the future, the so-called “smart grid”. It works towards digitalising and modernising the electricity distribution grid for higher efficiency, flexibility and resilience, and enables a cost-efficient realisation of the future flexible and robust electricity distribution grid.

**HighEFF**[24] seeks to develop expertise and promote innovation through focus on long-term research in selected areas of environment-friendly energy. They work to increase energy efficiency to ensure Norway the world’s greenest industries. SINTEF Energy Research hosts the Centre.

**CenBIO**[25] aims to enable sustainable and cost-efficient bioenergy industry in Norway. CenBIO was funded through RCN from 2009 – 2016.

**CEDREN**[26] is the interdisciplinary research centre for technical and environmental development of hydro power, wind power, power line rights-of-way and implementation of environment and energy policy. CEDREN was funded through RCN from 2009 – 2016.

18 *https://www.ntnu.no/censes*
19 *https://www.ntnu.edu/hydrocen*
20 *https://fmezen.no/what-is-a-zen/*
21 *https://www.zeb.no/index.php/en/*
22 *https://www.nmbu.no/en/services/centers/bio4fuels*
23 *https://www.sintef.no/projectweb/cineldi/*
24 *https://www.sintef.no/projectweb/higheff/*
25 *https://www.sintef.no/projectweb/cenbio/*
26 *https://www.cedren.no/english/*


The Research Council of Norway
FME
FORSKNINGS-SENTER FOR MILJØVENNLIG ENERGI
Norges forskningsråd
National and local government
NTNU
SiNoPSE
industry partners
National and local government
National and local government

# SiNoPSE in numbers

# SiNoPSE in numbers

3
Universities

2
Countries

1
Goal

4050
Funding NOK (in thousands)

## Involved parties

7
PhD Candidates

3
Post-doc Candidates

103
Summer school Students

3
Involved local projects

9
Norwegian Centres for Environment-friendly Energy Research (FME)

3
Cities / municipalities

*Lei QU project officer at Innovation Norway at SiNSoPE Symposium 2018 Shanghai*

# Outcomes

33
Number of publications

72
Conference presentations

3
Symposia

3
Summer Schools

3
Duration (In years)

3
Staff exchanges

16
Student Exchanges

# Work packages

# WP1: Joint SiNoPSE Symposium

At the core of the cooperation was the annual joint SiNoPSE symposium which, after an initial kick-off meeting, was held three times.

The symposia featured and promoted presentations of scientific results, joint student projects, peer-to-peer interaction with Norwegian and Chinese industry and local authorities, site visits, exhibitions etc. They were organised by the three universities, who invited their local support networks of industry, city, research and education to join and participate, as well as other interested parties mobilised through the Norwegian Consulates, Embassy and Innovation Norway.

The Symposia and their side events were open to all, and set the stage for face-to-face storytelling and live exchange of successful developments within the SiNoPSE project and its support networks. The activities were designed to create visibility, awareness and engagement, illustrating important SiNoPSE concepts, making them clear and easy to absorb, linking the various sustainable energy topics. The events provided an opportunity to zoom out of the daily details, look at the bigger picture and at the kind of progress the project really makes. Where possible, the Symposia and their side events built on existing activities and networks among the three universities, thus reaching more people and creating more long-term commitments. They had the additional value of creating synergistic alliances between different actors within each university and across the support networks, who were previously not aware of their mutual interests.

Side events included a Young Researchers Forum, a student reference group meeting, and an exhibition of results from double degree master's programmes, Summer Schools, and sandwich PhDs. SiNoPSE also facilitated internal joint workshops where each partner's knowledge and experience were captured and used to improve the joint projects. The SiNoPSE workshops created an arena for testing half-finished ideas, common challenges and potential for innovation, and cover definition, visioning, feedback, and evaluation and monitoring practices within and across the various sustainable energy fields. They were held for SiNoPSE partners only, to conjure up multiple perspectives and draw on everyone's experience, ensure all potential scenarios were being explored and opportunities and limitations for doing things differently were accounted for before making – even routine – decisions.

# 1. Symposium in 2016, in Zhuhai

The first joint symposium was held on 20-22 November 2016 in Zhuhai. It was organised as a parallel event of the 4th International Symposium on Refrigeration Technology[27] , hosted and organised by SJTU through the National Engineering Research Centre of Green Refrigeration Equipment (ERCGRE), which had been held three times since 2010.

This session, under the theme “Green, Innovation and Application”, discussed the technology development trends and cutting-edge innovation achievements of important fields in the industry, focused on technology industrialisation and cross-industry integration, lead industry technology progress and explored new direction of industry development.

Adhering to the purpose of building a technological communication and a cooperation platform, and promoting industrialisation of technological innovation, the symposium conducted in-depth discussions on air conditioning, refrigeration, heat pump system, compressor and motor, comprehensive utilisation of new energy, environmental technology, etc. Furthermore, it discussed the development and transformation of theoretical research and application technology, promoted the transfer and extension of advanced scientific and technological achievements towards manufacturers, and played a bridging role in promoting the exchange and interaction between colleges and universities, research institutes and enterprise. It obtained broad support and appreciation in the industry.

NTNU and THU sent delegations to participate and present their local research partners. Prof. Annemie Wyckmans was part of the scientific committee and presented SiNoPSE. There was also a public forum about the difference in variable climate zones for heat pump application, where SiNoPSE project members from NTNU, THU and NTNU held presentations.

*Symposium in Zhuhai*


27 *Agenda in the Appendix*

# 2. Symposium 2018 in Trondheim

The second joint symposium was held on 17 August 2108 at the NTNU Gløshaugen Campus Trondheim, on the last day of the 2018 SiNoPSE summer school. The main topic was „Positive Energy Cities“.

SJTU and THU presented the Chinese perspective on „the future of sustainable energy and positive energy cities in China, and the importance of cooperation with Norway”. NTNU presented “EU’s target to create 100 Positive Energy Districts[28] by 2025”, and the potential contribution of Sino-Norwegian cooperation, and the cooperation with the +CityxChange[29] project.

Local representatives from the public and private sectors were invited to share their impressions on “Trondheim’s contribution to 100 Positive Energy Districts”, specifically the +CityxChange Lighthouse Project. We invited Bjørn Ove Berthelsen, Chief engineer at Trondheim Municipality and Lead of the Trondheim demonstration activities in +CityxChange, as a keynote speaker.

This was also a time to reflect on the Sino-Norwegian Cooperation on Sustainable Energy so far and on the day before the symposium, a joint SiNoPSE partner meeting was held. Group meetings between the involved FME Centres ZEN, CENSES, Bio4Fuels, HzdroCEN, HighEFF, CINELDIG and THU and SJTU were held and the outcomes of the cooperations were showcased in the plenum. During the afternoon, all involved parties strategically discussed future plans after SiNoPSE funding stops, shared ideas on new funding opportunities and discussed the final symposium in China. The symposium also provided a platform for the summer school students to present their group works[30].

*NTNU Campus Gløshaugen*

28 *https://jpi-urbaneurope.eu/ped/*
29 *https://cityxchange.eu/*
30 *See next sub-chapter*

# 3. Symposium 2018 in Shanghai

The final joint symposium was held In Shanghai on 14-15 December 2018, hosted by SJTU. All our project partners and sponsors were invited.

Day one consisted of two parts. The first part was a SiNoPSE partner meeting, where we critically discussed the NTNU-SJTU-THU cooperation on sustainable energy, and reviewed SiNoPSE from 2016 to 2018. Further local research partners were invited to give an update on their experience of this strategic Sino-Norwegian partnership on sustainable energy:

– Zero Emission Buildings and Neighbourhoods (ZEB/ZEN)
– Bio4Fuels (CENBIO / BIO4FUELS)
– Energy Efficiency in Industry (HIGHEFF)
– Smart Grids (CINELDI)
– Sustainable Energy in Society (CenSES)
– SJTU-NTNU Double Master's degree program

The second part of the day was the SiNoPSE Young Researcher Seminar, where the joint PhD students and their supervisors presented their plans and preliminary results. In 2017, NTNU Energy funded six PhD and two Post-doc positions, all featuring a 6- to 12-month exchange programme with SJTU or THU. These eight positions are meant to build a community of Chinese collaboration among young researchers, where they can exchange their ideas and experiences of their time in China. They will also be seen as models for our future collaboration with China. Seven of these students presented the status of their research on sustainable energy:

Energy Policy and Consumer Behaviour: New Pathways for Deep Decarbonisation
by Thea Marie Valler, NTNU and Xin Su, THU

Autonomous control of stability in wind farms and smart grids
by Chen Zhang, NTNU and Shun Sang, Haoxiang Zong, SJTU

Energy Related Occupant Behaviour – Modelling for improved design and operation of buildings.
by Masab Khalid Annaqeeb, NTNU and Yuan JIN, THU

Off-Grid Zero Emission Building Concepts for Warm Climates
by Daniel Satoła, NTNU and Audun Kristiansen, SJTU

Development and Optimization of High Temperature Heat Pumps (HTHP) in Su b- and Transcritical Operations
by Marcel Ulrich Ahrens, NTNU and Hongzhi Yan, SJTU

Scouring and flow around offshore wind-turbine foundation
by Yucheng Jie, THU

UN-Habitat Placemaking week 2018 in Wuhan
by Alexander Finsnes, Eirik Lund, Elisabeth Henjum, Sai Varshaakavarapu, Zwestin Welfry

*Annemie Wyckmans at the symposium in Shanghai*

**The second day was the actual symposium on sustainable energy, summarising the importance of Sino-Norwegian cooperation on sustainable energy.**

Sino-Norwegian cooperation on sustainable energy
by Ruzhu Wang, professor, director at Institute of Refrigeration & Cryogenics SJTU

How to build a positive energy city in Norway and China
by Annemie Wyckmans, professor, director at NTNU smart city group

Zero emission buildings and neighbourhood
by Arild Gustavsen professor, director at ZEB/ZEN centre NTNU

Sino-Norwegian energy education cooperation
by Vojislav Novakovic professor at dept. of Energy and Process Engineering NTNU

HVAC & Heat Pump of Rail Vehicles in China
by Zhenggen WANG Chief Engineer at Merak-Jinxi Air Conditioning System (Wuxi) Co. Ltd

Heat pump research cooperation between Norway and China
by Trygve Eikevik professor at dept. of Energy and Process Engineering NTNU

Sino-Norwegian offshore wind cooperation
by Lei Qu, Senior Energy & Environment Officer at Royal Norwegian Embassy – Commercial Section, Norwegian Energy & Environment Consortium Manager/ Innovation Norway China

Risk and reliability in the Energy industry in China
by Haibo Chen Principal Consultant Lloyd's Register, vice-chair NTNU Alumni China

The evening saw the "NTNU Alumni China and NorAlumni annual gathering", where representatives of the Norwegian Consulate General Shanghai, NTNU and Innovation Norway opened the meeting. NTNU Alumni China and East Chapter of NorAlumni members presented their future plans and the NTNU-China cooperation in 2018 was discussed by NTNU directors and NTNU Alumni China. The evening closed with a glance on Alumni in China with representatives of NTNU Alumni and BI-Fudan MBA Alumni and the awards ceremony.

# WP 2: Summer Schools on Sustainable Energy

The summer schools were at the core of SiNoPSE. They were jointly organised by NTNU, SJTU and THU.

The courses were taught by staff from all participating universities, along with their local support clusters from industry, cities and research institutions.

It was decided to hold these courses in the summer as it is the easiest season to ensure that all students and staff can be available. The summer schools were compulsory for the double degree master's students. Each summer school saw 30 - 35 participants and lasted two weeks. On the last day, the students' work was judged by an expert panel, consisting of university partners and local supporting organisations from industry, city and policy.

All summer schools included the following pedagogical approach:

**EXPERTS IN TEAMS**
This is an interdisciplinary training of students and staff. We used NTNUs teaching approach to make use of the various cultural and discipline backgrounds of the participants.

**TRIPLE HELIX**
Local industry and municipality officials suggested specific challenges for the students to address and solve in cooperation with researchers from the universities. This ensured feedback from local society through the project developers, municipalities, and the industry.

**OUT OF THE LAB, INTO THE CITY**
Each summer school used the hosting city as an Urban Lab for gathering empirical evidence and developing solutions. It was always a real project on ongoing development in the host city. It was our goal to make our research directly applicable to industrial and societal challenges.

We tried to inspire all participants with the following challenges: Their projects should be unique and related to climate, and achievable only with multidisciplinary collaboration. The results of the summer schools were posted in online database[31], and published in scientific articles.

The summer schools have proven to be especially helpful in creating new perspectives on science and research and add value for Norwegian researchers and students. They provided a low-threshold activity for Norwegian students to become more familiar with Chinese society, markets, and opportunities for future education and employment.

*31 https://www.slideshare.net/senicsummerschool/edit_my_uploads, https://sinopsesummerschool2017.wordpress.com, https://www.ntnu.edu/smartcities/sinopse*

# 1. Summer School in 2016, at SJTU in Shanghai

The topic of the interdisciplinary and multi-cultural summer course, from 10-29 July 2016, was “Sustainable Energy in Cities (SeniC)[32].

**HIGHLIGHTS:**
- one site visit: Chong Ming Island, a pristine wetland island in Pudong, Shanghai
- two workshops on Solar potential analysis (Gabriele Lobaccaro) + Building Energy Simulation (Salvatore Carlucci & Amin Moazami) + User behaviour (Marius Korsnes)

**STUDENTS TOTAL** 35 **FEMALE STUDENTS** 8 **LECTURES HELD** 9

**NATIONALITIES**
Germany, Russia, China, Korea, Norway, USA, India, Turkey, Bulgaria, Sweden, Mexico

**UNIVERSITIES**
Hamburg University of Technology (5), Korea University (8) University of Maryland (1), NTNU (12), THU (4), SJTU (5)

**STUDY BACKGROUNDS**
Mechanical Engineering
Aeronautical Engineering
Material Science and Engineering
Refrigeration Cycle
Sustainable Architecture
Civil Engineering
Building Physics and Energy
Optimisation of Buildings
Science and Technology Studies
Industrial Ecology
Building Environment and Energy Engineering

35 master students from 11 countries, 17 lecturers from 6 universities participated, and NTNU sent 5 teachers who have experience with China, sustainable energy and with “experts in team”. NTNU sent 12 students from various master’s programmes, funded by SiNoPSE and SENIC. For the first time, 5 THU students and several THU professors were included in this joint summer school. The SJTU double degree master’s students joined the summer school and spent the following semester at NTNU as exchange students.

The school consisted of a two-week programme with lectures, site visits, group work, presentations and jury feedback. The students were divided into four groups with mixed disciplinary and cultural backgrounds, and with an equal gender proportion. Combining this heterogeneous set-up with the experimental teaching method of ‘Experts in Team’, all groups dealt with the same task: designing a research facility for a small group of researchers based on pristine wetland islands in Pudong, Shanghai (see below). Students were challenged to prove that their design was sustainable.

## The real-life research case:

A young island, emerged in the 1950s. Located at the mouth of the Yangtze river (31°03'N~-31°17'N; 121°46'E-122°15'E), area: 423.2 sq. km above -6 m, 114.6 sq. km at the elevation of sea level.

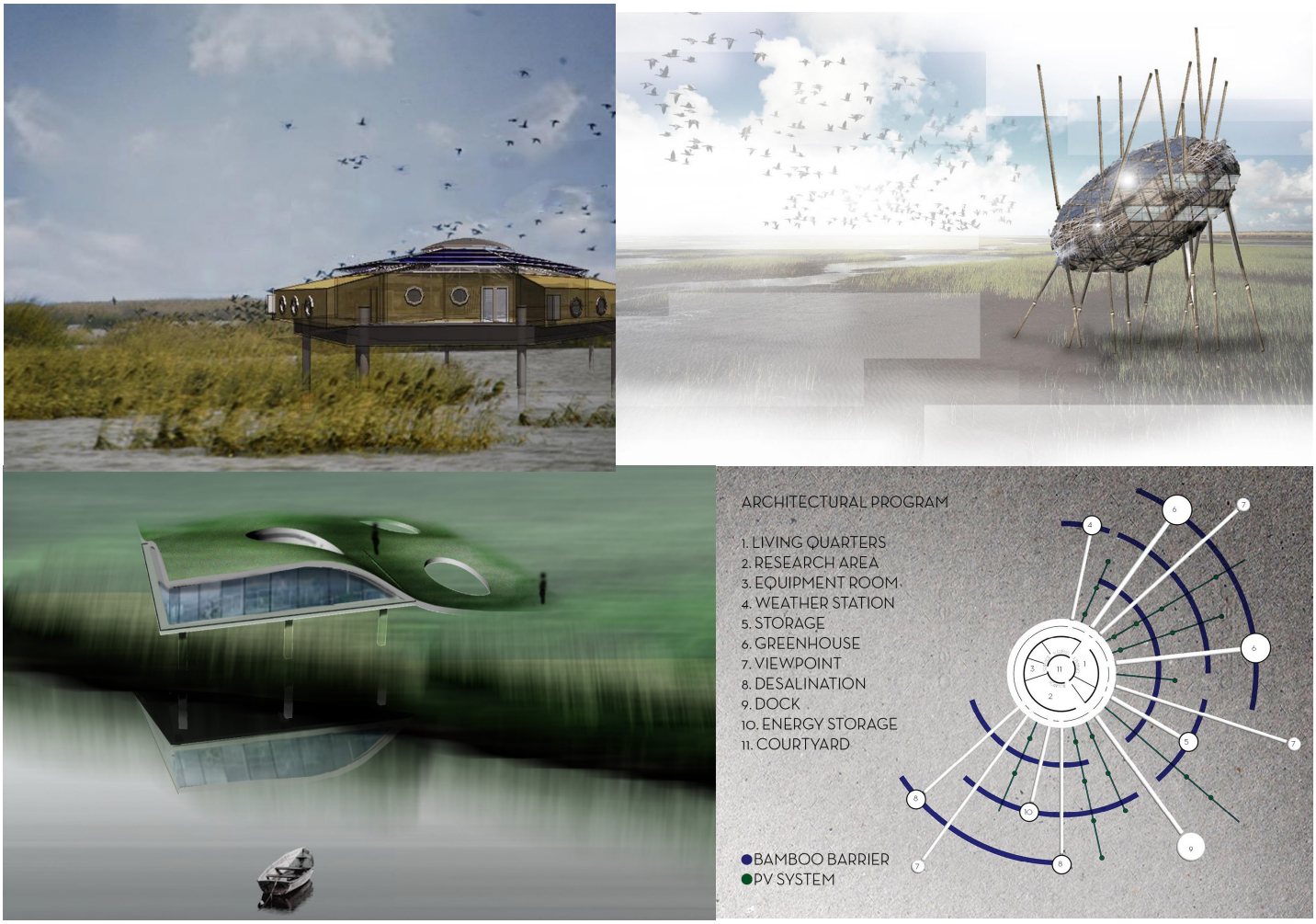
It was a representative of coastal ecosystems in eastern China, high ecosystem service value, sensitive to global change (sea level rise), simplicity of ecosystem structure, influence of compositional changes (exotic plants, Spartina alterniflora), an excellent model ecosystem for addressing many ecological issues like community succession and nutrient cycling and ecosystem ecology.

The goal was to design a scientific facility in Jiuduansha for 2-5 researchers to live in for several days. The floor area had to be included in the range of space of 150-200 m2. Functions of the building: mixed use of living and working space (housing + office + laboratory). Use of bioclimatic strategies and renewable energy sources integrated in the building's design from the early design phases. Local climate-adaptation: the building design had to consider the adaptation of climate change in Shanghai. The building needed to be environment-friendly and in harmony with the ecosystem of Jiuduansha Wetland, then and in the future scenario. Using appropriate energy supply systems and integrate renewable energy sources to maximise the energy efficiency of the building and reach a low-carbon or zero-emission target then and in the future scenario.

The students' observations were based on the following categories: the localisation, visibility and impact, technological choices and which types of visualisations were chosen to communicate the design principles, the energy strategies and the social impacts. A group of participants later published the article "The Sustainability Challenge: How Multi-Cultural and Interdisciplinary Groups of Master Students Achieve Sustainable Architecture in Shanghai".

**MEMBERS OF THE JURY WHO JUDGED THE WORK OF THE STUDENTS ON THE LAST DAY:**

- Dr. Ruzhu Wang, professor, at Shanghai Jiao Tong University
- Dr. Reihard Radermacher, professor at University of Maryland
- Ms. Ying Shun, director of Jiuduansha Wetland Reserve
- Dr. Charles Chun Yang, Professor at Nanyang Technological University
- Dr. Jie Zhu, professor at Nottingham University
- Ms. Simone Chen, Associate Editor-in Chief & Feature Director at IDEAT, Modern Media
- Dr. Ming Liu, researcher at Disney Research
- Mr. Anhua Feng, Director at Linuo Paradigma Solar Energy




*Summer School in 2016, at SJTU in Shanghai*

## 2. Summer School in 2017, at THU in Beijing

The interdisciplinary and multi-cultural SiNoPSE Summer School on Sustainable Energy in Cities[33], from 7-18 August 2017, was held in Beijing and hosted by THU.

**HIGHLIGHTS:**
- Visit to Norwegian Embassy in Beijing
- Site visit of the 2022 Winter Olympic site in Zhangjiakou
- Study Trip to the old Winter Olympic site in Beijing, The Olympic Park

**STUDENTS TOTAL** 32 **FEMALE STUDENTS** 13 **LECTURES HELD** 15

**NATIONALITIES**
Norway, UK, USA, China, India, Sweden, Mexico, Spain, Hong Kong

**UNIVERSITIES**
NTNU (14), THU School of Architecture (5), THU INET (4), SJTU (9)

**STUDY BACKGROUNDS**
Science and Technology Studies
Sustainable Architecture, Mechanical Engineering
Civil Engineering, Architecture
Heating/ Ventilation and Air-Conditioning (HVAC)
Inorganic Materials, Biomass
Nuclear Engineering
Power Engineering and Engineering Thermophysics
Alternative Energy Science and Engineering

32 students from NTNU, SJTU (Shanghai Jiao Tong University) and THU (Tsinghua University) attended lectures on smart cities, energy systems, green buildings, and renewable energy during the two-week summer school. As a case study, the 2022 Winter Olympic Village was used to develop a proposal based on the approach of Experts in Team. One exchange PhD from Tsinghua joined the summer school after having studied at NTNU for one year.

The students were given the task to design and plan the Village in Zhangjiakou for the 2022 Winter Olympics. The project assignment stated that the town should use solar power, wind power, a rainwater harvesting system, wetland, natural ventilation, natural daylight, green roof and passive housing design. It should be a smart, low-carbon sponge town[34], i.e. a town designed to passively absorb, clean and use rainfall in an ecology-friendly way. Sponge towns reduce the frequency and severity of floods, improve water quality and reduce water consumption. The aim is to have characteristic features, use renewable energy and create a sustainable village.

33 *Agenda in the Appendix*
34 *https://simplicable.com/new/sponge-city*

**MEMBERS OF THE JURY WHO JUDGED THE WORK OF THE STUDENTS ON THE LAST DAY:**

- Tao WANG, PhD, Vice-Chief editor of Community Design
- Annemie Wyckmans, Professor and Head of NTNU Smart and Sustainable Cities NTNU
- Peng GAO, PhD, Project Manager, Innovation Norway
- Ruzhu WANG, PhD, Director, Institute of Refrigeration & Cryogenics,
- Chair professor, SJTU
- Xianting LI, PhD, Professor, School of Architecture, Tsinghua Uni.
- Jianlong WANG, PhD, Professor, deputy director, iNET, Tsinghua Uni.
- Yong ZHANG, PhD, Professor, iNET, Tsinghua Uni.
- Selim Atak, Architect, Architectural Design & Research Institute of Tsinghua University

*Beijing City*

# 3. Summer school in 2018, at NTNU in Trondheim

The interdisciplinary and multi-cultural SiNoPSE Summer School on Sustainable Energy in Cities[35] from 6-17 August 2018 took place in Trondheim and was hosted by NTNU. This summer school was not only part of SiNoPSE, but also a part of the SSCRI – Smart Sustainable City Regions project in India funded by the UTFORSK programme of the Norwegian Centre for International Cooperation in Education.

**HIGHLIGHTS:**
- Fieldwork at Sluppen, the Trondheim area designated to become one of the first Positive Energy Districts
- One-day summer school excursion (blueberry picking in Bymarka)
- Participation at NTNU's annual U semester opening ceremony

**STUDENTS TOTAL** 36 **FEMALE STUDENTS** 16 **LECTURES HELD** 20

**NATIONALITIES**
China, India, Belarus, Kurdistan, Norway, Philippines, Iran, France, Pakistan

**UNIVERSITIES**
SJTU (11), THU (10), School of Planning and Architecture New Delhi (5), NTNU (10)

**STUDY BACKGROUNDS**
Refrigeration and Cryogenic Engineering, Building Energy
Chemical Engineering, Environmental Planning
Urban Ecological Planning
Civil and Environmental Engineering
Material Science and Engineering
Urban Design
Energy Engineering
Building Technology
Environmental Engineering
Sustainable Architecture
Industrial Design, Architecture
Management Science and Engineering
Science and Technology Studies
Sustainable Energy

Students from the Norwegian University of Science and Technology, Shanghai Jiao Tong University, Tsinghua University and guests from the School of Planning and Architecture in New Delhi worked in interdisciplinary groups to develop energy strategies for Sluppen in Trondheim, a transformation area aiming to become a positive energy district.

**THE GROUPS COULD CHOOSE ONE OR MORE OF THE FOLLOWING CHALLENGES TO WORK ON:**
- Improved energy performance of buildings
- Energy system integration between buildings and energy networks
- Prosumers & citizen participation
- Renewable energy systems
- Smart mobility & e-mobility as a service

35 *Agenda in the Appendix*

The summer school took place within the framework of the TRD3.0 University-City Agreement between Trondheim municipality and NTNU, a national pilot project that is to provide long-term strategic access to knowledge, expertise and technology for development of sustainable societies.

The summer school aimed to provide a learning environment for sustainable energy for Norwegian, Chinese and Indian students. During 2 intensive weeks, the students and teachers developed new knowledge together with Trondheim municipality, industry partners and researchers to identify the best solutions to combine sustainable energy with high quality of life, using Sluppen as a test case.
Based on their study interests, the students were divided into groups of 5-6 to work around their challenge for two weeks. Plenary lectures took place in the mornings and group work in the afternoons, based on an Experts in Team approach. In addition to their project work, the students visited and learned from local industries and development projects, urban decision makers and energy experts. The Summer School kicked off with two days of intensive activities to allow the students and teaching staff to get to know each other, to clarify intended learning outcomes and expectations regarding participation, outcomes and ambitions, and to get familiar with the case for the group work. Group work was defined in dialogue with participating students and staff, and could include field studies, investigations of local climate and site, energy and sustainability assessment of Sluppen, interviews with the industry, the municipality and research experts.

The interdisciplinary student groups later pitched their presentations to an expert panel during the second SiNoPSE symposium. In addition, several participants of the summer schoola and SiNoPSE project staff joined the UN Habitat's Placemaking week in Wuhan[36].

The real-life research case: Sluppen as a Positive Energy District
By 2050, Trondheim will have achieved the goal of a Positive Energy City based upon 100% renewable energy sources, where the entire city produces more carbon-free energy than it consumes. Trondheim Municipality has adopted the Climate and Energy Action Plan to 2030, which sets an ambitious climate goal of 80% reduction of GHG emissions by 2030 (from a 1991 baseline). The city is aiming for a per capita 20% decrease in stationary energy consumption by 2030 based on a 2013 baseline. Trondheim Municipality has recently also initiated programmes for energy efficiency measures and renewable energy for cultural heritage buildings and areas. A bold city vision, public incentive schemes, and open innovation with industry partners and the national Research Centres on Environment-friendly Energy within Zero Emission Neighbourhoods in Smart Cities, Smart Grids, Energy Efficiency in Industry and Sustainable Energy in Society will be important instruments for reaching these goals.

Trondheim has selected Sluppen as one of the first areas to become a Positive Energy District[37] in cooperation with local and European solution providers.

*36 https://www.placemakingweek.org/wuhan. Please find more details in chapter IMPACT.*
*37 http:// cityxchange.eu*

The Sluppen demonstration project will contribute to the creation of a common energy market, connected communities and recommendations for new policy interventions, market regulations and business models that can ultimately be scaled up and replicated across Norway, Europe, China, India and the rest of the world.

**MEMBERS OF THE JURY WHO JUDGED THE WORK OF THE STUDENTS ON THE LAST DAY:**

- Mai Susegg, Project Manager at R. Kjeldsberg AS
- Björn Ove Berthelsen, Trondheim Kommune
- Meenakshi Dhote, Professor at School of Planning and Architecture, New Delhi, India
- Ruzhu WANG, PhD, Director, Institute of Refrigeration & Cryogenics, Chair professor, SJTU
- Xianting LI, PhD, Professor, School of Architecture, Tsinghua Uni.
- Jianlong WANG, PhD, Professor, Deputy Director, iNET, Tsinghua Uni.
- Annemie Wyckmans, Professor and Head of NTNU Smart and Sustainable Cities NTNU

*Summer school in 2018, at NTNU in Trondheim*

# WP 3: Joint Research Centre on Sustainable Energy

The agreement on the Joint Research Centre (JRC) on Sustainable Energy between NTNU and SJTU was signed in 2010, and was a result of the long-term relationship that started in 2004. In 2014 and 2015, we received funding for this cooperation from UTFORSK[38] for our SeniC project.
The ambition of the JRC is to join the efforts and resources of the partners to create a world-leading scientific and technological collaborative research, innovation and education centre for sustainable energy.

## **Vision:** Sufficient and clean energy for a sustainable and peaceful society.

**JRC INCLUDES THE FOLLOWING RESEARCH AREAS WHICH CORRESPOND WITH NTNUS ACTIVITIES WITHIN THE FMES AND WITH THE CHINESE ENERGY STRATEGY:**

- Gas technology to support utilisation of natural gas to substitute coal (LNG technology)
- Carbon Capture and Storage - use of CO2 as a working fluid
- Renewable energy (solar energy, wind energy)
- Energy use in Buildings/Zero Emission Buildings (energy efficiency)
- Energy System Analysis
- Sustainable Energy Studies

Since 2010 approximately 2 workshops were held per year, either in Shanghai or in Trondheim. Before the start of SiNoPSE, more than 12 PhD students had already started. Many joint articles were published, and a summer course has been held every year since 2013.

The sandwich PhD research areas were in correspondence with the JRC thematic research cooperations.

**THIS IS THE PHD SANDWICH MODEL WE HAVE USED:**

- Professor – Professor collaboration
- PhD (NTNU) – PhD (SJTU): New positions (+ existing positions)
- Exchange bilaterally: min 3 months
  Participation in each other's research groups
- Supervisors and co-supervisors: tutoring on exchange stays and workshops
- Joint publications
- PhD degree from home University

38 *https://diku.no/en/programmes/utforsk2*

The double degree master's programme on Sustainable Energy already existed since 2013, before SiNoPSE as a cooperation between NTNU and SJTU. It consisted of the study track Sustainable Heat Pump Processes and Systems. In 2015, the study track Energy Systems in Buildings was established. The students are at the home university the first year of the 2-year double degree master's programme and take the specialisation courses and project/master thesis at the host university in the second year. The master's programme at SJTU has a 2,5 years period, which implies that the students from NTNU stay at SJTU for 18 months. Students from SJTU go back to SJTU after one year at NTNU and finalise their master's thesis at SJTU.

We increased the average number of participating students per cycle and assessed the potential for developing a third study track within this programme. All participating students presented their projects during the annual Symposium. During their stay abroad, the double degree master's programme was meant to introduce them to industries and municipalities in the local support clusters, and to facilitate summer jobs and internships where possible.

In 2017, a rector-led delegation of NTNU visited SJTU and THU, and the Chair of the Board of SJTU in turn visited NTNU with a delegation, during which 5 new agreements were signed – one of which was the first joint PhD agreement between Norway and China. We agreed on common PhD topics with parallel (sandwich) positions at each university and joint supervision. This principle had been tested earlier, during the JRC NTNU-SJTU. The PhD researchers participated and presented their work during the annual symposium, and organised a young researchers forum as a side event.

*NTNU-Tsinghua-SJTU group meeting 2018 Trondheim*

# WP 4: Joint Research Partnership on Renewable and New Energy

SiNoPSE aimed to extend the positive experiences from NTNU-SJTU cooperation towards THU for a more integrated approach, while making existing cooperation more robust and institutionalised. Based on the model of the JRC SJTU-NTNU, NTNU and THU developed their partnership, investigating opportunities for a double degree master's programme and sandwich PhDs.

SiNoPSE built on cooperation between NTNU and THU in the European mobility project IRES-8, which funds outgoing mobility for PhD and postdoctoral researchers from NTNU to THU and its local support network. SiNoPSE integrated the participants and results of IRES-8 into the institutional cooperation between NTNU and THU, and provided a broader framework in which to document experiences, discuss challenges and learn from practices by others in the partnership (successes as well as glorious mistakes). During the annual joint symposium, NTNU, THU and SJTU discussed in an internal meeting in which manner experiences from IRES-8 could be transferred to SJTU, as preparation for new project applications and improved institutional cooperation. THU students were given the opportunity to participate in the double degree master's programme at the JRC.

# WP 5: Project Management, Knowledge Transfer and Learning

NTNU provided project management of SiNoPSE, which included the coordination by staff members who are familiar with Chinese language and culture as well as Norwegian context.
To optimise knowledge transfer and learning, SiNoPSE activities were coupled with surveys, interviews and diaries to capture experiences and practices. The output of the inquiries was constantly fed back into the project to improve dialogue and cooperation between SiNoPSE partners and their support clusters .
The universities created an exchange forum for the double degree master's students, PhD researchers, summer school participants and their supervisors across the three participating universities. The students met once a year during the joint Symposium. During the rest of the year, they shared their knowledge, discussed common challenges and cooperated on student projects using social media. We used LinkedIn and WeChat groups which were shared by Norwegian and Chinese students and teachers. Where possible, lectures and presentations were recorded into an online database facilitating virtual classrooms .

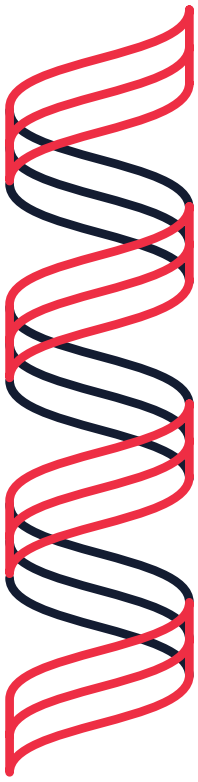
*Nidelven, Trondheim, Norway*

*39 Please see quotes from participants and partner institutions in chapter "Impact".*
*40 https://www.slideshare.net/senicsummerschool*

# Impact

# The Impact of SiNoPSE

SiNoPSE has contributed in building a triple helix cooperation between NTNU, THU and SJTU, and their local support networks of research, industries and cities. It has impacted the three networks not only on an institutional level, but also on a personal level. Moreover, SiNoPSE has contributed to even bigger societal questions as we brought our research alive within the local networks.



## Impact on Local Industry

During the whole project, local businesses from the three involved cities were included as partners. In 2016, 2017 and 2018 Norwegian businesses were involved in symposia and summer schools, which also included travels to China. Students worked on real-life cases using NTNUs interdisciplinary EiT approach. Especially during the final presentations of the summer schools, local businesses played an important role, as they were invited to be part of the expert panel to form a jury to review the students' work.

The 2016 summer school jury included industry members from Jiuduansha Wetland Reserve, IDEAT / Modern Media, Disney Research, and Linuo Paradigma Solar Energy.

The 2017 summer school jury included members from Beijing Community Design and Innovation Norway. The 2018 summer school jury included members from R. Kjeldsberg AS[41] and Trondheim Kommune. The 2018 summer school opening day was held at the property of R. Kjeldsberg AS at Sluppen, the site of the student project.

41 *https://www.kjeldsberg.no/*

## Impact on the Involved Cities

Our motto has been to go out of the lab, into the city. This was especially important during the summer schools, where the students had lectures in the mornings and visited local municipality projects in the afternoons and evenings while working on their real-case projects.

During the first summer school, participants designed a facility for a small group of researchers on the wetland islands in Pudong, Shanghai. This was a real-case study and the students went to visit the islands during the summer school. At the final day of that summer school the students presented their solutions to the local authorities. One student group published a paper[42] about the group work afterwards.

One illustrative example is the Beijing summer school of 2017. The students' task was to design the 2022 Winter Olympics village. Since THU was the major research and innovation partner for the 2022 Winter Olympics, the results were directly applicable to the building of the village Then there was the summer school 2018 in Trondheim, where we invited Bjørn Ove Berthelsen, Chief engineer at Trondheim Municipality, as a keynote speaker on "Trondheim's contribution to 100 Positive Energy Districts". The ideas of the students had a direct influence on the city of Trondheim.

THU and SJTU are international partners in several FME Research Centres, and during SiNOPSE we collaborated closely with these Centres and their local industry and public networks. There were stimulating effects in both directions, and SiNoPSE brought in a new perspective on collaborating with China on sustainable energy. SiNoPSE truly created a bridge to connect research with cities and the industry.

Moreover, SiNoPSE was linked to the Nordic Edge China Conference[43] 9-10 April 2019 in Beijing, where NTNU is a main partner. Nordic Edge is a non-profit corporation owned by private companies working in close cooperation with municipalities and city administrations to promote solutions for smarter cities and communities. During Nordic Edge China, we brought Norwegian professional stakeholders to China to showcase their knowledge and experience, and find matching Chinese counterparts.

SiNoPSE was also linked to the annual UN Habitat Placemaking Week[44], from 6-12 December 2018 in Wuhan. Several of the SiNoPSE 2018 summer school students participated in the Placemaking Week. Chinese cities like Wuhan are growing at an unprecedented pace, and during this Placemaking Week we started to lay the foundation for these cities to be shaped around better public spaces for all. The goal was to support cities like Wuhan to nurture the creation of public spaces as sociable and welcoming, but also as hubs for active transport and green infrastructure. The Wuhan Placemaking Week also marked the launch of the Chinese Placemaking Network.

*42 Korsnes, M., Wang, Y., Lobaccaro, G., Moazami, A., & Carlucci, S. (2017). The Sustainability Challenge: How Multi-Cultural and Interdisciplinary Groups of Master Students Achieve Sustainable Architecture in Shanghai.*

*43 https://www.nordicedgechina.org/*

*44 https://www.placemakingweek.org/wuhan*

# Impact on Research and Education

SiNoPSE focused on joint research and education on sustainable energy. We have experienced that all participants, on the personal and institutional levels, gained knowledge and input throughout this cooperation. The joint work in the JRC together with SJTU was knit together even closer, and we were able to transfer experience to the newly founded JRP with THU . This had an effect also on the university level, as the Norwegian-Chinese collaboration on sustainable energy was placed more in the spotlight of research.

SiNoPSE positioned itself as a role model within the Norwegian scientific landscape. Especially for international projects carried out under the Diku umbrella, SiNoPSE can share many lessons learned. We were invited to present SiNoPSE at annual conferences at the Centre for International Cooperation in Education (SIU)  and later at Diku.


This was also acknowledged through an award we were granted. The SeniC project won the 2016 World Green Design Contribution Award , founded by the World Green Design Forum to honour individuals and institutions who have made outstanding contributions to protecting the environment by applying green design to promote the wide adoption of green technology, green materials, green energy and green appliances.

Not only did SiNoPSE affect the research at all three universities and their local research partners, it also had a major effect on educational programmes. In addition, we continued the two double degree master's programmes at JRC:

1. **SUSTAINABLE HEAT PUMPING PROCESSES AND SYSTEMS**
2. **SUSTAINABLE ENERGY USE IN BUILDINGS**

*45 See also the Work Packages chapter.*
*46 SIU was merged on 1 January 2018 with the Norwegian Agency for Digital Learning in Higher Education (Norgesuniversitetet), and the Norwegian Artistic Research Programme (PKU) to become DIKU.*
*47 http://www.wgdo.net*

The effects for the participating students, in the double degree master's programmes and the summer schools, were tremendous. While they explored a different culture outside Europe, they learned completely new ways of thinking and processing. We are especially proud that we were able to pass on NTNU's Experts in Team pedagogical approach to help interdisciplinary groups make the most out of each other's experience and competence.

Not only was it possible for the involved double degree students and sandwich PhD and Postdoc participants to spend some time to study and research abroad: SiNoPSE also enabled the following exchanges:

- 10 NTNU students and PhDs went to China (4 to THU, 6 to SJTU)
- 2 Chinese students came to NTNU in 2018, 1 came in 2019
- 4 double degree master students from SJTU studied two semesters at NTNU
- 2 staff exchange from NTNU to THU
- 1 staff exchange from NTNU to SJTU

The impact on research resulted in a cooperation in IEA Annex 66[48] , many peer-to-peer meetings between professors of the 3 universities, participation in joint conferences, and the development of future joint centre applications.
During SiNoPSE we created 33 joint publications[49] .
Furthermore, NTNU, SJTU and THU organised the following joint events:

- 3 summer schools
- 3 symposia
- 1 Young Researcher Seminar (2018, SJTU)
- 1 Workshop on High Performance Building Technology (2018, THU)
- 1 NCEPU-NTNU Scholarly Conference: North China Electric Power University (NCEPU) and NTNU
- 1 NTNU Alumni China and NorAlumni Annual Gathering (SJTU, 2018)
- 2 SiNoPSE partner meetings (2017, 2018) prior to Symposia
- 1 Joint PhD seminar (SJTU, 2018)

Also, the first NTNU-China Forum is an outcome of SiNoPSE. It was held on 12 March 2019. NTNU established a forum for cooperation with China and we invite all NTNU employees involved in cooperation with China, or interested in establishing cooperation with China, to join the forum. The plan is to organize a China Forum seminar once a semester. The aim of the seminars is to create a meeting place among NTNU colleagues to share the latest updates and experiences in the cooperation between NTNU and China. We will share information, best practices and opportunities, and we will bring in external and internal expert.
Further Impact of SiNoPSE

48 *https://www.annex66.org/*
49 *See appendix.*

# Further Impact of SiNoPSE

## Impact on Norwegian authorities

SiNoPSE has managed to establish strong personal and institutional relations between China and Norway, thus further strengthening diplomatic relations. This has contributed to a new era of the Norway-China cooperation.

During the three-year SiNoPSE project, three official delegations from Norwegian authorities travelled to China. Leaders and researches of the SiNoPSE universities were an important part of each delegation holding panel discussions and presentations.

## Norwegian Prime Minister in China 2017

On 6-7 April 2017, Prime Minister Erna Solberg visited China together with business leaders to attend the Norwegian Business Delegation meeting in Beijing. This two-day event was managed by Innovation Norway and led up to the Norway-China Business Forum on 8 April 2017 in Shanghai.
During the Norwegian Business Delegation meeting, seven parallel sessions were held, one of which was on „Green Shift & Green Smart Cities“ where Prof. Annemie Wyckmans presented the topic „Zero Emission Buildings and Neighbourhoods in Smart Cities – Examples of 20 years of NTNU-China Cooperation on Education, Research and Innovation”.

# Norwegian Ministry of Education to China, 2017

From 16 to 20 April 2017, on the occasion of the visit of the Norwegian Minister of Research and Higher Education, Ms. Iselin Nybø, a Norwegian Education and Research Delegation travelled to China. The visit was organised by the Norwegian Centre for International Cooperation in Education (SIU) and RCN.
On 18 April in Beijing, NTNU and SiNoPSE delegates contributed to the “Seminar and round table on Smart and Sustainable Cities”. This round-table seminar showcased the long-standing cooperation and commitment, recommended the development of a Sino-Norwegian centre on smart sustainable cities and highlighted Norway as a key actor in the EU-China collaboration. Participants from NTNU were Prof. Gunnar Bovim, Prof. Bjarne Foss, Prof. Annemie Wyckmans, Dr. Yu Wang, and Nina Sindre.
The agenda included the presentation of key Sino-Norwegian cooperation projects on smart sustainable cities funded by Norway, the EU and China; the signing ceremony of a cooperation agreement on Nordic Edge China with CAUPD, CCUD China Centre of Urban Development, and EUCCC EU-China Chamber of Commerce.
On 20 April, at SJTU in Shanghai, SiNoPSE participants from NTNU and SJTU held a seminar on “NTNU – China collaboration in the Sustainable Energy Area” NTNU and SJT, under Session I: Ocean Space, Energy and Sustainability.

# His Majesty the King of Norway visits China in 2018

The theme of the Norway-China Business Summit in Beijing in 2018 was „Pioneering Sustainable Solutions“, which His Majesty the King of Norway attended.

During the China World Summit Wing on 16 October, organised by Innovation Norway and the China Council for the Promotion of International Trade (CCPIT), SiNoPSE delegates ran one of eight sessions. The topic was „China-Norway Green Smart City Forum“, and Prof. Annemie Wyckmans, Project Coordinator of +CityxChange, URBAN-EU-CHINA and EERA JP Smart Cities, presented „The +CityxChange Smart City Lighthouse Project and potential cooperation towards China“.

Among other research projects and business cooperation, SiNoPSE has contributed to consolidate the relationship between Norway and China. The visit of his Majesty the King of Norway was a great tribute to this.

# Relevance and benefit to society

China is one of the world's largest markets for low-carbon energy technologies and plays an important role in driving down prices and increasing the usage of these technologies. The way China chooses to position itself within low-carbon technologies and sustainable consumption will have far-reaching consequences for Norwegian and global industry interests.
Knowledge about Chinese energy policy and transition strategies is pivotal, and well-functioning networks with researchers in China are crucial.
With the „out of the lab, into the city"-approach, we provided directly applicable results for local societies.

**ENVIRONMENTAL IMPACT**
To reduce the carbon footprint of air travel between Norway and China, the symposium and internal meetings were as much as possible aligned in time, reducing the need for travel. Meetings where travel time was no longer than actual meeting time were avoided.
On the other hand, SiNoPSE influenced the education and future job alternatives of Norwegian and Chinese students in the direction of sustainable energy. This may have a long-term positive effect on the environment.

**ETHICAL PERSPECTIVES**
Norwegian and Chinese cultures are different and interdisciplinary cooperation on a common project is not a natural given. Even pedagogical methods and the manner in which teachers and students interact can cause misunderstandings.
In the summer schools, we had time to get to know each other's cultures even better. Personal meetings were of the utmost importance for establishing contact between Norwegian researchers and Chinese industry, and vice versa.
Throughout SiNoPSE, we worked with PhD candidates and other sources familiar with Norwegian and Chinese culture, to quickly detect and deflect misunderstandings.

**GENDER BALANCE**

There are few women in the research field of energy, particularly in the case of the Chinese partners, as can be detected from the names of key partners identified in the project description. SiNoPSE encouraged women to participate, where appropriate in leading roles, and organised meetings, communication and cooperation with equal opportunities.

We were proud to have Prof. Annemie Wyckmans as the overall project coordinator from 2016 onward, when she took over from Prof. Olav Bjarte Fosso.

The number of female participants during the SiNoPSE summer schools was increased from 8 to 16 in the course of the project. SiNoPSE has supported the sandwich PhD studies and the Postdoc position of 3 women (from NTNU). The female ratio of participants in the double master's degrees has increased. In the three summer schools, a total of X women, out of X students, have participated.

SiNoPSE lectures held by women: 14

SiNoPSE joint publications where women have contributed: 24 (out of 33)

In our JRC and JRP collaboration with China, we hope to attract even more female students and researches for the field of sustainable energy.


MIRAE ASSET

# Conclusions

# Conclusions and What's Next for SiNoPSE

During the three-year project, we were able to contribute to a new era for Norway-China cooperation. SiNoPSE strengthened the long-term collaboration between the three universities. We managed to bring the JRC and JRP closer together, providing a good framework for long-term institutional cooperation where we will continue to tackle global challenges and offer solutions for the cities involved.

Throughout the project, all partners pursued joint applications for additional funding, as travel funding formed a considerable cost in Sino-Norwegian cooperation. In addition to national funding, we aimed to position ourselves for European mobility programme, and received one scholarship, IRES- 8[50]. However, this was only for outgoing mobility from Norway to China for PhD and postdoctoral researchers.

Already during the SiNoPSE project, we were aiming to develop the existing collaboration with China, namely with SJTU and THU, and we want to extend it to Japan, namely AIST and KIFEE, Europe, with DTU, TU Delft, TU Berlin, and to Singapore and South Korea.

During SiNoPSE, we applied for a grant under EU Horizon 2020. January 2017 saw the beginning of the «EU-China Innovation Platform on Sustainable Urbanisation». Prof. Annemie Wyckmans, NTNU, became its Project Coordinator and Dr. Yu WANG its Project Manager. This project promotes and develops Joint Policy Strategies and Funding Instruments for EU-China cooperation on sustainable urbanisation. It created a Nursery of Joint Projects, from a broad range of low-threshold to a few high-performance projects, between European and Chinese cities, and it promoted Brokerage of City-Industry-Science Partnerships using virtual and face-to-face meeting places.

Additionally, we started a new URBAN-NORWAY-CHINA[51] project on sustainable urbanisation including energy, funded by INTPART. This will support the Norway-China cooperation on sustainable urbanisation, within the framework of the EU-China Partnership for Sustainable Urbanisation and the related Horizon2020 projects URBAN-EU-CHINA and TRANS-URBAN-EU-CHINA, and extend their scope to include cross-disciplinary educational activities.

We also cooperated with the Joint Programming Initiative Urban Europe (JPI Urban Europe)[52] to support their creation of a China programme. This cooperation led to the first joint JPI Urban Europe and Nordic Science Centre Association (NSFC)[53] call on sustainable urbanisation including energy.

50 *https://www.urbaneuchina.eu/evidence-base-entry/ires-8/*
51 *https://www.ntnu.edu/web/smartcities/urban-norway-china*
52 *https://jpi-urbaneurope.eu/*
53 *http://www.nordicscience.net/*

After the SiNoPSE project conclusion, and based on its activities and relations, NTNU, SJTU and THU employees applied for a joint research project with funding from the RCN and the Ministry of Science and Technology (MoST), China, with the title “Key technologies and demonstration of combined cooling, heating and power generation for low-carbon neighbourhoods/buildings with clean energy – ChiNoZEN”. The application was submitted on 12 June 2019.

We will apply for further joint funding programmes under Horizon 2020 and Horizon Europe (international funding), European Energy Research Alliance (EERA) & SET-Plan (Strategic Energy Technology Plan) , and the European University Association (EUA) with its Energy & Environment Platform (EPUE) .

With the experience and knowledge we have shared in this report, we hope to engage a broad audience, not only within science, but also within Norwegian municipalities and businesses, and the general interested public. The project was considered successful and was put forward as a role model for further international scientific collaborations. The Norwegian SiNoPSE partners were invited to present to Diku at their International Cooperation on Education Conference 2018 in Bodø. Prof. Trygve Eikevik (NTNU) contributed to the session “Increasing Student Mobility between Norway and China: Strategies, Opportunities and Best Practice”.

54 *https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020*
55 *https://www.eera-set.eu/*
56 *https://energy.eua.eu/*
57 *https://www.nord.no/en/news-events/calender/Pages/International-cooperation-in-education-conference.aspx#&acd=67e3ea85-6724-a8a8-1778-0217099f857c&acd=28152144-ba62-3a18-3b90-f47e49f0eae0&acd=c09a9f1d-6f0f-bb4a-c010-771d28ae6ea6*

# Appendix

# List of Lectures

## Lectrure presentations 2016

| Author | Title | Event Name |
|---|---|---|
| **Ruzhu WANG** | Green building energy system | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Salvatore Carlucci** | Smart Zero Emission Buildings, Districts and Cities | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Yu Wang** | Summer School introduction | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Gabriele Lobaccaro** | Solar potential analysis | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Salvotore Carlucci & Amin Moazami** | Building EnergySimulation | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Gerhard Schmitz** | Impact of energy con-versions on environment | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Gerhard Schmitz** | Energy trans-mission & storage | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Shizhong LI** | biomass energy | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Shizhong LI** | Biofuels | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |

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|---|---|---|
| **K Reinhard Radermacher** | HVAC for net zero energy home | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **K Reinhard Radermacher** | Wind energy | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Hoseong Lee** | Ocean Energy and Advanced Heat Pump System | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Yong LI** | Solar energy | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Jin Taek Chung** | Geothermal Energy or Energy Storage System part 1 | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Jin Taek Chung** | Geothermal Energy or Energy Storage System part 2 | 2016 SiNoPSE summer school: Sustainable Energy in Cities (Shanghai) |
| **Annemie Wyckmans** | Sino-Norwegian Partnership on Sustainable Energy | The 4th International Symposium on Refrigeration Technology (Zhuhai) |
| **Trygve Eikevik** | Heat pump heating technology | The 4th International Symposium on Refrigeration Technology (Zhuhai) |

## Lectrure presentations 2017

| Author | Title | Event Name |
|---|---|---|
| **Annemie Wyckmans** | Smart Zero Emission Buildings Districts and Cities | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Yu Wang** | Summer School Case Study and Assignment | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Rolf André Bonhe** | Sustainable buildings/ infrastructure and LCA assesment | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Yong LI** | Renewable energy in China | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Shizhong LI** | Biomass for Winter Olympic Village | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Yehao SONG** | Green buildings in China | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Marius Korsnes** | Energy system in social cultural perspective | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Fei TENG** | Energy policy in China | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Bjørn Aas** | Sport and leisure facilities: Operation management and energy use | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Trygve Eikevik** | Snow production and energy recovery | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |

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|---|---|---|
| **Jianlong WANG** | Waster and water management | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Xianting LI** | HVAC in Winter Olympic Village | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **De CHEN** | Energy storge in smart homes | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Tian LI** | Towards carbon-neutral transportation –– Thermochemical conversion of biomass to drop-in biofuels | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |
| **Ruzhu WANG** | Green energy technology | 2017 SiNoPSE summer school: Sustainable Energy in Cities (Beijing) |

## Lectrure presentations 2018

| Author | Title | Event Name |
|---|---|---|
| **Annemie Wyckmans** | Europe's ambition to create 100 Positive Energy Districts by 2025, and our contribution through the +CityxChange Lighthouse Project | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Dirk Ahlers** | The Sluppen Positive Energy District | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Daniela Baer** | Transformation of Sluppen into a Zero Emission Neighbourhood - Challenges and opportunities with focus on stakeholder engagement | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Judith Borsboom** | FLEXI - Flexible Visioning and Facilitation of Sustainable Urban Development Sluppen as a case | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Arild Gustavsen** | Zero emission buildings and neighbourhoods – from concepts to real projects | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Vojislav Novakovic** | Energy supply to ZEB/ZEN | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Marius Korsnes** | Prosumers and Citizen Engagement in Positive Energy Districts: Perspectives from Social Science | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |

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|---|---|---|
| **Rolee Aranya** | Urban Transformation Initiatives in Trondheim | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Alenka Temeljotov-Salaj,** | Urban Value Ecosystem | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Tian Li** | Overview of Renewable Energy | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Klaus Livik** | Powel and its energy ambitions in the Sluppen District | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Niki Gaitani** | Integrated Micro-climatic Design at Neighborhood Scale | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Tainshu GE** | Hybrid Energy System | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Gabriele Lobaccaro** | Solar Energy in urban environment: Opportunities, Challenges and Barriers in Nordic Climate | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Baolong WANG** | Heat Pump: A Solution for Clean House Heating | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Dirk Ahlers** | ICT Approaches and Architectures in Smart Cities | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Mohamed Hamdy** | Improving the building performance by using simulation and automatic optimization | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |

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|---|---|---|
| **Marianne Ryghaug** | electric cars in Norway | 2018 SiNoPSE summer school: Sustainable Energy in Cities (Trondheim) |
| **Ruzhu WANG** | The future of sustainable energy and positive energy cities in China, and the importance of cooperation with Norway | SiNoPSE symposium on Sustainable and Positive Energy Cities in China and Norway |
| **Annemie Wyckmans** | EU's target to create 100 Positive Energy Districts by 2025, and the potential contribution of Sino-Norwegian cooperation | SiNoPSE symposium on Sustainable and Positive Energy Cities in China and Norway |
| **Bjørn Ove Berthelsen** | Trondheim's contribution to 100 PEDs: the +CityxChange Lighthouse Project | SiNoPSE symposium on Sustainable and Positive Energy Cities in China and Norway |
| **trygve Eikevik, Vojislav Novakovic, Olav B Fosso, Marius Korsnes** | Sino-Norwegian Cooperation on Sustainable Energy: Joint presentations by NTNU, THU and SJTU to showcase their cooperation the past years, and the road ahead | SiNoPSE symposium on Sustainable and Positive Energy Cities in China and Norway |
| **Johan Hustad** | Introduction to NTNU-THU-SJTU joint PhD programmes | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |
| **Thea Marie Valler, Xin SU** | Energy Policy and Consumer Behavior: New Pathways for Deep Decarbonization | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |

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|---|---|---|
| **Chen ZHANG, Haoxiang ZONG** | Autonomous control of stability in wind farms and smart grids | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |
| **Masab Khalid Annaqeeb, Yuan JIN,** | Energy Related Occupant Behaviour – Modelling for improved design and operation of buildings. | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |
| **Nikolaos Tsakoumis** | Energy Related Occupant Behaviour – Modelling for improved design and operation of buildings | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |
| **Daniel Satoła, Audun Kristiansen** | Off-Grid Zero Emission Building Concepts for Warm Climates | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |
| **Marcel Ulrich Ahrens, Hongzhi Yan** | Development and Optimization of High Temperature Heat Pumps (HTHP) in Sub- and Transcritical Operations | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |
| **Yu Wang** | SiNoPSE 2016-2018 | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |
| **Yucheng Jie** | Scouring and flow around offshore wind-turbine foundation | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |

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|---|---|---|
| **Alexander Finsnes, Eirik Lund, Elisabeth henjum, Sai Varshaakavarapu, Zwestin Welfry** | UN-Habitat Placemaking week 2018 in Wuhan | SiNoPSE partner meeting and Joint PhD seminar (Shanghai) |
| **Ruzhu WANG** | Sino-Norwegian cooperation on sustainable energy | SiNoPSE Symposium on Sustainable Energy: The Importance of Sino-Norwegian Cooperation (Shanghai) |
| **Annemie Wyckmans** | How to build a positive energy city in Norway and China | SiNoPSE Symposium on Sustainable Energy: The Importance of Sino-Norwegian Cooperation (Shanghai) |
| **Arild Gustavsen** | Zero emission buildings and neighborhood | SiNoPSE Symposium on Sustainable Energy: The Importance of Sino-Norwegian Cooperation (Shanghai) |
| **Vojislav Novakovic** | Sino-Norwegian energy education cooperation | SiNoPSE Symposium on Sustainable Energy: The Importance of Sino-Norwegian Cooperation (Shanghai) |
| **Zhenggen WANG** | HVAC & Heat Pump of Rail Vehicles in China | SiNoPSE Symposium on Sustainable Energy: The Importance of Sino-Norwegian Cooperation (Shanghai) |
| **Trygve Eikevik** | Heat pump research cooperation between Norway and China | SiNoPSE Symposium on Sustainable Energy: The Importance of Sino-Norwegian Cooperation (Shanghai) |
| **Lei Qu** | Sino-Norwegian offshore wind cooperation | SiNoPSE Symposium on Sustainable Energy: The Importance of Sino-Norwegian Cooperation (Shanghai) |
| **Haibo Chen** | Risk and reliability in the Energy industry in China | SiNoPSE Symposium on Sustainable Energy: The Importance of Sino-Norwegian Cooperation (Shanghai) |

# List of Joint Publications

| Title of the paper/ Presentation | Name of the journal or conference | Authors and their institutes |
|---|---|---|
| Occupant migration monitoring in residential buildings with the use of a depth registration camera. | 11th International Symposium on Heating, Ventilation and Air Conditioning, ISHVAC 2017, October 2017, Jinan, China. / Procedia Engineering. 2017. Vol. 205. | **Dziedzic, J. W.; NTNU<br>Yan, D.; THU<br>Novakovic, V.: NTNU** |
| Measurement of Dynamic Clothing Factor (D-CLO) – Received Best paper award | 4th International Conference on Building Energy, Environment, COBEE2018, February 2018, Melbourne, Australia. | **Dziedzic, J. W.; NTNU<br>Yan, D.; THU<br>Novakovic, V.: NTNU** |
| Real Time Measurement of Dynamic Metabolic Factor (D-MET) | Cold Climate HVAC 2018 - Sustainable Buildings in Cold Climates. Springer 2019 ISBN 978-3-030-00662-4. s. 677-688 | **Dziedzic, J. W.; NTNU<br>Yan, D.; THU<br>Novakovic, V.: NTNU** |
| Indoor occupant behaviour monitoring with the use of a depth registration camera. | Building and Environment. 2019. vol. 148. | **Dziedzic, J. W.; NTNU<br>Yan, D.; THU<br>Novakovic, V.: NTNU** |
| Framework for transient energy-related occupant behaviour agent-based model | 13th REHVA World Congress CLIMA 2019, May 2019, Bucharest, Rumania | **Dziedzic, J. W.; NTNU<br>Yan, D.; THU<br>Novakovic, V.: NTNU** |

Korsnes, M. (06.06.2018): STS Perspectives on Energy and Environment in Norway and China, Seminar at Chinese Academy of Science and Technology for Development (CASTED), Beijing China

Korsnes, M. (03.09.2018): Innovation and State Entrepreneurship in Low-Carbon Energy Projects: The cases of wind energy in China and energy prosumers, International Research and Training Center for Science and Technology Strategy (CISTRAT), UNESCO, Beijing, China

Valler, Thea M. (23.03.2018): Sustainable transport policies in Norway and China, Shanghai Jiao Tong University, Department of Transportation & Shipping

Valler, Thea M. (09.11.2018): Intelligent Transport Systems in Urban China, Sustainable Urban Energy Systems Conference (TU Delft)

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|---|---|---|
| Control of a Type-IV Wind Turbine With the Capability of Robust Grid-Synchronization and Inertial Response for Weak Grid Stable Operation | IEEE Access | **Author: Shun Sang (SJTU) ; Chen Zhang (NTNU) ; Xu Cai(SJTU) ; Marta Molinas (NTNU); Jianwen Zhang(SJTU) ; Fangquan Rao(SJTU).** |
| Accurate Aggregated Modelling of Wind Farm Systems in Modified Sequence Domain for Stability Analysis | Electric power system research | **Haoxiang Zong (SJTU) ; Jing Lyu (SJTU) ; Chen Zhang (NTNU) ; Xu Cai (SJTU) ; Marta Molinas (NTNU); Fangquan Rao(SJTU).** |
| Harmonic Transfer-function-based Impedance Modelling of a Three-phase VSC for Asymmetric AC Grids Stability Analysis | IEEE Transactions on Power Electronics. | **Chen Zhang (NTNU), Marta Molinas (NTNU), Atle Rygg (NTNU), Jing Lyu (SJTU), Xu Cai (SJTU)** |
| Impedance-based Analysis of Interconnected Power Electronics Systems: Impedance Network Modeling and Comparative Studies of Stability Criteria | IEEE Journal of Emerging and Selected Topics in Power Electronics. | **Chen Zhang (NTNU), Marta Molinas (NTNU), Atle Rygg (NTNU), Xu Cai (SJTU)** |

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|---|---|---|
| On the Impedance Modeling and Equivalence of AC/DC Side Stability Analysis of a Grid-tied Type-IV Wind Turbine System. | IEEE Transactions on Energy Conversion | **Chen Zhang (NTNU), Xu Cai (SJTU), Marta Molinas (NTNU), Atle Rygg (NTNU)** |
| Sequence Domain SISO Equivalent Models of a Grid-tied Voltage Source Converter System for Small-Signal Stability Analysis | IEEE Transactions on Energy Conversion | **Chen Zhang (SJTU), Xu Cai (SJTU), Marta Molinas (NTNU), Atle Rygg (NTNU)** |
| Frequency Domain Modelling and Stability Analysis of a DFIG-based Wind Energy Conversion System Under None-compensated AC Grids: Impedance Modelling Effects and Consequences on Stability | IET Power Electronics | **Chen Zhang (SJTU), Xu Cai (SJTU), Marta Molinas (NTNU), Atle Rygg (NTNU)** |
| Properties and Physical Interpretation of the Dynamic Interactions between Voltage Source Converters and Grid: Electrical Oscillation and Its Stability Control | IET Power Electronics | **Chen Zhang (SJTU), Zheng Li (SJTU), Xu Cai (SJTU), Marta Molinas (NTNU), Atle Rygg (NTNU)** |
| A Modified Sequence-Domain Impedance Definition and Its Equivalence to the dq-Domain Impedance Definition for the Stability Analysis of AC Power Electronic Systems | IEEE Journal of Emerging and Selected Topics in Power Electronics. | **Atle Rygg (NTNU), Marta Molinas (NTNU), Chen Zhang (SJTU), Xu Cai (SJTU)** |
| On the Equivalence and Impact on Stability of Impedance Modeling of Power Electronic Converters in Different Domains | IEEE Journal of Emerging and Selected Topics in Power Electronics. | **Atle Rygg (NTNU), Marta Molinas (NTNU), Chen Zhang (SJTU), Xu Cai (SJTU)** |

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|---|---|---|
| Harmonic State-Space Based Small-Signal Impedance Modeling of a Modular Multilevel Converter With Consideration of Internal Harmonic Dynamics | IEEE Transactions on Power Electronics. | **Jing Lyu (SJTU), Xu Cai (SJTU), Marta Molinas (NTNU)** |
| Frequency domain stability analysis of MMC-based HVDC for wind farm integration | IEEE Journal of Emerging and Selected Topics in Power Electronics | **Jing Lyu (SJTU), Xu Cai (SJTU), Marta Molinas (NTNU)** |
| Impact of power flow direction on the stability of VSC-HVDC seen from the impedance Nyquist plot | IEEE Transactions on Power Electronics | **M Amin (NTNU), Marta Molinas (NTNU), Jing Lyu (SJTU), Xu Cai (SJTU),** |
| Optimal design of controller parameters for improving the stability of MMC-HVDC for wind farm integration | IEEE Journal of Emerging and Selected Topics in Power Electronics | **Jing Lyu (SJTU), Xu Cai (SJTU), Marta Molinas (NTNU)** |
| Sub-synchronous oscillation mechanism and its suppression in MMC-based HVDC connected wind farms | IET Generation, Transmission & Distribution | **Jing Lyu (SJTU), Xu Cai (SJTU), M Amin (NTNU), Marta Molinas (NTNU)** |
| Frequency-dependent source and load impedances in power systems based on power electronic converters | Power Systems Computation Conference (PSCC) | **Atle Rygg (NTNU), Marta Molinas (NTNU), Chen Zhang (SJTU), Xu Cai (SJTU)** |
| Understanding the Nonlinear Behavior and Synchronizing Stability of a Grid-tied VSC Under Grid Voltage Sags | IET RPG Conference | **Chen Zhang (NTNU), Marta Molinas (NTNU), Jing Lyu (SJTU), Haoxiang Zong (SJTU), Xu Cai (SJTU)** |

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| Analysis of Bifurcation Behaviors in MMC Connected to a Weak Grid | Industrial Electronics Society Annual Meeting (IECON) | **Haoxiang Zong (SJTU) ; Jing Lyu (SJTU) ; Chen Zhang (NTNU) ; Xu Cai (SJTU) ; Marta Molinas (NTNU); Fangquan Rao(SJTU).** |
| Modified Sequence Domain Impedance Modelling of the Modular Multilevel Converter | IET RPG Conference | **Haoxiang Zong (SJTU) ; Jing Lyu (SJTU) ; Chen Zhang (NTNU) ; Xu Cai (SJTU) ; Marta Molinas (NTNU); Fangquan Rao(SJTU).** |
| MIMO Impedance Based Stability Analysis of DFIG-Based Wind Farm with MMC-HVDC in Modified Sequence domain | IET RPG Conference | **Haoxiang Zong (SJTU) ; Jing Lyu (SJTU) ; Chen Zhang (NTNU) ; Xu Cai (SJTU) ; Marta Molinas (NTNU); Fangquan Rao(SJTU).** |
| Impedance modeling of modular multilevel converters | Industrial Electronics Society Annual Meeting (IECON) | **Jing Lyu (SJTU), Xu Cai (SJTU), Marta Molinas (NTNU)** |
| Oscillatory phenomena between wind farms and HVDC systems: The impact of control | IEEE 16th Workshop on Control and Modeling for Power Electronics | **M Amin (NTNU), Jing Lyu (SJTU), Xu Cai (SJTU),** |
| Stabilization control methods for enhancing the stability of wind farm integration via an MMC-based HVDC system | IEEE International Conference on Compatibility, Power Electronics | **Jing Lyu (SJTU), Xu Cai (SJTU), Marta Molinas (NTNU)** |
| Harmonic State Space Modeling and Analysis of Modular Multilevel Converter | IEEE International Power Electronics and Application Conference | **Jing Lyu (SJTU), Xu Cai (SJTU), X Zhang, Marta Molinas (NTNU)** |

# Agendas for all 3 Summer Schools

## Time schedule International Joint graduate Course, July 18 – July 29, 2016, Shanghai Jiao Tong University (SJTU) - Sustainable Energy in Cities

| Time | Monday, July, 18th | Tuesday, July, 19th | Wednesday July, 20th | Thursday, July, 21th | Friday, July, 22th |
|---|---|---|---|---|---|
| **08.00-10.00** | | | | | Mid Term presentation |
| **09.00-10.30** | Opening Remarks: Green building energy system (Ruzhu Wang) & NTNU and Smart Zero Emission Buildings, Districts and Cities (Salvatore Carlucci) | Workshop on Solar potential analysis (Gabriele Lobaccaro) + Building EnergySimulation (Salvotore Carlucci & Amin Moazami) + User behaviour (Marius Korsnes); and Group work | Impact of energy con-versions on environment (Gerhard Schmitz) | Workshop on Solar potential analysis (Gabriele Lobaccaro) + Building EnergySimulation (Salvotore Carlucci & Amin Moazami) + User behaviour (Marius Korsnes); and Group work | Site visit: Chong Ming Island |
| **10.30-12.00** | Summer School introduction (Yu Wang) & Student self-introduction and dividing the groups | | Energy trans-mission & storage (Gerhard Schmitz) | | |
| **12.00-13.00** | lunch | lunch | lunch | lunch | |
| **13.00-18.00** | Interdisciplinary approach (NTNU Teacher Team) & Group Work | Group work | Group work | Group work | |
| **18.00-22.00** | | | | | |

| Time | Monday, July, 25th | Tuesday,July, 26th | Wednesday, July, 27th | Thursday, July, 28th | Friday, July, 29th |
|---|---|---|---|---|---|
| **08.00-10.00** | | | | | |
| **09.00-10.30** | biomass energy (Li Shizhong) | HVAC for net zero energy home (K Reinhard Radermacher) | Ocean Energy and Advanced Heat Pump System (Hoseong Lee) | Geothermal Energy or Energy Storage System (Jin Taek Chung) | Final Presentations by each group (Minghang Campus) |
| **10.30-12.00** | Biofuels (Li Shizhong) | Wind energy (K Reinhard Radermacher) | Solar energy (Yong LI) | Geothermal Energy or Energy Storage System (Jin Taek Chung) | |
| **12.00-13.00** | lunch | lunch | lunch | lunch | lunch |
| **13.00-18.00** | Group work | Group work | Group work | Group work | Final Presentations by each group (Minghang Campus) |
| **18.00-22.00** | | | | | Farewell party - Karaoke session (Minghang Campus) |

## Summer School Schedule Aug. 7- Aug. 18 2017

## Week 1

| Time | Aug. 07 Monday | Aug.08 Tuesday | Aug.09 Wednesday | Aug.10 Thursday | Aug.11 Friday |
|---|---|---|---|---|---|
| **09.00-10.30** | "1.Openning remarks 2.Course introduction: Smart Zero Emission Buildings Districts and Cities by prof. Annemie Wyckmans NTNU Wang Zesheng Hall School of Architecture " | Case Study Site Visit in Zhangjiakou | Sustainable buildings/ infrastructure and LCA assesment by prof. Rolf André Bonhe NTNU Energy Sciences Building A 114 | Biomass for Winter Olympic Village by Prof. LI Shizhong THU INET Energy Sciences Building A 114 | Energy system in social cultural perspective by dr. Marius Korsnes NTNU Energy Sciences Building A 114 |
| **10.30-12.00** | " 3. Summer School Case Study and Assignment by dr. Yu Wang 4.Dividing groups Wang Zesheng Hall School of Architecture " | | Renewable energy in China by prof. Yong Li SJTU Energy Sciences Building A 114 | Green buildings in China by Prof. Yehao SONG THU School of Architecture Energy Sciences Building A 114 | Energy policy in China by associate professor Fei TENG THU INET Energy Sciences Building A 114 |
| **12.00-13.00** | Lunch | Lunch | Lunch | Lunch | Lunch |
| **13.00-17.00** | Go to Zhangjiakou, one night stay in Tongli, Zhangjiakou | Study Trip in Beijing Olympic Park | Group work Group Group 1 ,2 Energy Sciences Building Group 3, 4, 5 Old Cilvil Engineering Building | Group work Group 1 ,2 Energy Sciences Building Group 3, 4, 5 Old Cilvil Engineering Building | 13.00-14.30 midterm presentation Energy Science Building A 114 14.30-17.00 Group work Group 1 ,2 Energy Sciences Building Group 3, 4, 5 Old Cilvil Engineering Building |

## Week 2

| Time | Aug.14 Monday | Aug.15 Tuesday | Aug.16 Wednesday | Aug.17 Thursday | Aug.18 Friday |
|---|---|---|---|---|---|
| **09.00-10.30** | Sport and leisure facilities: Operation management and energy use by Senior Engineer Bjørn Aas NTNU Energy Sciences Building A 114 | Waster and water management by Ptof. Jianlong WANG THU INET Energy Sciences Building A 114 | Energy storge in smart homes by Prof. De CHEN NTNU Energy Sciences Building A 114 | Green energy technology by prof. Ruzhu WANG SJTU Energy Sciences Building A 114 | Final Presentation Wang Zesheng Hall School of Architecture |
| **10.30-12.00** | Snow production and energy recovery by prof. Trygve Eikevik NTNU Energy Sciences Building A 114 | HVAC in Winter Olympic Village by Prof. Xianting LI THU School of Architecture | Towards carbon-neutral transportation –– Thermochemical conversion of biomass to drop-in biofuels by Dr. Tian LI NTNU Energy Sciences Building A 114 | Group work Group 1 ,2 Energy Sciences Building Group 3, 4, 5 Old Cilvil Engineering Building | |
| **12.00-13.00** | Lunch | Lunch | Lunch | Lunch | Lunch |
| **13.00-17.00** | Group work Group 1 ,2 Energy Sciences Building Group 3, 4, 5 Old Cilvil Engineering Building | Group work Group 1 ,2 Energy Sciences Building Group 3, 4, 5 Old Cilvil Engineering Building | Group work Group 1 ,2 Energy Sciences Building Group 3, 4, 5 Old Cilvil Engineering Building | Group work Group 1 ,2 Energy Sciences Building Group 3, 4, 5 Old Cilvil Engineering Building | Final Presentation Wang Zesheng Hall School of Architecture |

2018 Summer School

Week 1

| Time | Aug. 06 Monday | Aug. 07 Tuesday | Aug. 08 Wednsday | Aug. 09 Thursday | Aug. 10 Friday | Aug. 11 Saturday |
|---|---|---|---|---|---|---|
| 09.00 - 10.30 | Summer School openning day seminar at Kjeldsberg offices Sluppen | Zero emission buildings and neighbourhoods – from concepts to real projects by Prof. Arild Gustavsen at R4 Realfagbygget | Prosumers and Citizen Engagement in Positive Energy Districts: Perspectives from Social Science by Dr. Maius Korsnes at R4 Realfagbygget | Urban Value Ecosystem by prof. Alenka Temeljotov-Salaj at R4 Realfagbygget | Overview of Renewable Energy by Dr. Tian LI at R4 Realfagbygget | Summer school excursion (blueberry picking tbc) |
| 10.30 - 12.00 | | Energy supply to ZEB/ZEN by prof. Vojislav Novakovic at R4 Realfagbygget | Urban Transformation initiatives in Trondheim by Prof. Rolee Aranya at R4 Realfagbygget | New Energy System by prof. Tianshu GE at R4 Realfagbygget | Efficient End Use of Energy by prof. Trygve Eikevik at R4 Realfagbygget | |
| 12.00 - 13.00 | Lunch | Lunch | Lunch | Lunch | Lunch | |
| 13.00 - 17.00 | fieldwork at Sluppen | Group work at room 313, 315, 317 Sentralbygg | Group work at room 313, 315, 317 Sentralbygg | Group work at room 313, 315, 317 Sentralbygg | Mid-term pr esentation at room 313, 315, 317 Sentralbygg | |

Week 2

| Time | Aug.13 Monday | Aug.14 Tuesday | Aug.15 Wednesday | Aug.16 Thursday | Aug.17 Friday |
|---|---|---|---|---|---|
| 09.00 - 10.30 | 09.00-10.00 Heat Pump: A Solution for Clean House Heating by porf. Baolong WANG at R 90 Realfagsbygg | 08.15-09.00 Powel in Sluppen by Mr. Klaus Livik at R90 Realfagsbygg 09.00-10.30 NTNU New semester opening ceremony at Den store plena bak Hovedbygnngen | Integrated Micro-climatic Design at Neighborhood Scale By Dr. Niki Gaitani at R 90 Realfagsbygg | Group work at room 313, 315, 317 Sentralbygg | Group work at room 313, 315, 317 Sentralbygg |
| 10.30 - 12.00 | 10.00-11.00 Solar Energy in urban environment: barriers, challenges and opportunities in Nordic Climate by Dr. Gabriele Lobaccaro 11.00-12.00 lecture by Dr. Dirk Ahlers at R 90 Realfagsbygg | A socio-technical perspective on e-mobility and the role of (user) practices by Prof. Marianne Ryghaug at R 90 Realfagsbygg | Improving the building performance by using simulation and automatic optimization by prof. Mohamed Hamdy at R 90 Realfagbygget | | |
| 12.00 - 13.00 | Lunch | Lunch | Lunch | Lunch | Lunch |
| 13.00 - 17.00 | Group work at room 313, 315, 317 Sentralbygg | Group work at room 313, 315, 317 Sentralbygg | Group work at room 313, 315, 317 Sentralbygg | Group work at room 313, 315, 317 Sentralbygg | final presentation at Kjeldsberg office, Sluppen |

# List of Summer School Participants

## 2016

| NO | Last name, first name | Gender | University | Status | Major | Nationality |
|---|---|---|---|---|---|---|
| 1 | Marius, König | M | Hamburg University of Technology | MSc | | Germany |
| 2 | Robin, Meinert | M | Hamburg University of Technology | MSc | | Germany |
| 3 | Evgenia, Makhova | F | Hamburg University of Technology | MSc | Mechanical Engineering | Russia |
| 4 | Erna Anne, Senkel | F | Hamburg University of Technology | MSc | | Germany |
| 5 | Paula, Segelken | F | Hamburg University of Technology | MSc | | Germany |
| 6 | Thomas Key, Darren | M | University of Maryland | MSc | | |
| 7 | Sukyoung, Lee | F | Korea University | MSc | mechanical engineering | Korean |
| 8 | Gyeongjin, Youn | M | Korea University | MSc | | Korean |
| 9 | Taeok, Kang | M | Korea University | MSc | Mechanical Engineering, Aeronautical Engineering | Korean |
| 10 | Donghwan, Kim | M | Korea University | MSc | Materials Science and Engineering | Korean |

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|---|---|---|---|---|---|---|
| 11 | Seyoung, Choi | M | Korea University | MSc | refrigeration cycle | Korean |
| 12 | Sungho, Yun | M | Korea University | MSc | | Korean |
| 13 | Kangsub, Song | M | Korea University | MSc | | Korean |
| 14 | Seonggi, Park | M | Korea University | MSc | | Korean |
| 15 | Janice, Lobo | F | Norwegian University of Science and Technology | MSc | Sustainable Architecture | Indian |
| 16 | M. Zorbey, Tuncer | M | Norwegian University of Science and Technology | MSc | Sustainable Architecture | Turkish |
| 17 | Mariya, Stoyanova | F | Norwegian University of Science and Technology | MSc | Sustainable Architecture | Bulgarian |
| 18 | Isabella, Netz | F | Norwegian University of Science and Technology | MSc | Sustainable Architecture | Swedish |
| 19 | Kristian, Boe | M | Norwegian University of Science and Technology | MSc | Sustainable Architecture | Norwegian |
| 20 | Marco Antonio, Aparicio Kirwant | M | Norwegian University of Science and Technology | MSc | Sustainable Architecture | Mexican |
| 21 | Fei, Ding | F | Norwegian University of Science and Technology | MSc | Sustainable Architecture | Chinese |
| 22 | Håkon, Eggebø | M | Norwegian University of Science and Technology | MSc | Civil Engineering | Norwegian |
| 23 | Mathias, Stensland Lillevold | M | Norwegian University of Science and Technology | MSc | Civil Engineering | Norwegian |

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|---|---|---|---|---|---|---|
| 24 | Tom-André, Olsen | M | Norwegian University of Science and Technology | MSc | Building physics and energy optimization of buildings | Norwegian |
| 25 | Pål, Jarle Aune | M | Norwegian University of Science and Technology | MSc | Science and Technology Studies | Norwegian |
| 26 | Eirik, Resch | M | Norwegian University of Science and Technology | PhD | Industrial Ecology | Norwegian |
| 27 | Guohui, Zhang 张国辉 | M | Tsinghua University | PhD | Building Environment and Energy Engeneering | Chinese |
| 28 | Lianrui, Ding 丁连锐 | M | Tsinghua University | MSc | Building Environment and Energy Engeneering | Chinese |
| 29 | Wei, Chen 陈炜 | M | Tsinghua University | PhD | Building Environment and Energy Engeneering | Chinese |
| 30 | Yunchen, Ding 丁云晨 | M | Tsinghua University | MSc | Building Environment and Energy Engeneering | Chinese |
| 31 | | M | Shanghai Jiao Tong University | MSc | Mechanical Engineer | Chinese |
| 32 | | M | Shanghai Jiao Tong University | MSc | Mechanical Engineer | Chinese |
| 33 | | M | Shanghai Jiao Tong University | MSc | Mechanical Engineer | Chinese |
| 34 | | M | Shanghai Jiao Tong University | MSc | Mechanical Engineer | Chinese |
| 35 | | M | Shanghai Jiao Tong University | MSc | Mechanical Engineer | Chinese |

# 2017

## NTNU

| NO | Last name, first name | Gender | Major | Nationality |
|---|---|---|---|---|
| 1 | Bård Torvetjønn Haugland | Male | Science and Technology Studies | Norwegian |
| 2 | Thomas Edward Sutcliffe | Male | Science & Technology Studies | United Kingdom/ Norwegian |
| 3 | Kristina Ruud | Female | MSTS | Norway |
| 4 | Oda Bjelland Mathiassen | female | MSTS | Norwegian |
| 5 | Claire McConnnell | Female | Sustainable Architecture | American |
| 6 | Yunyun Zhu | Female | Sustainable architecture | China |
| 7 | Nikita Chhajer | Female | Msc.Sustainable Architecture | Indian |
| 8 | Simen Roemo Skille | Male | Mechanical Engineering | Norway |
| 9 | Anne Karitine Berger | Female | Civil Engineering | Norwegian |
| 10 | Isabella Netz | Female | Sustainable architecture | Swedish |

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|---|---|---|---|---|
| 11 | Winnie Po Ting Poon | Female | MSc Sustainable Architecture | British Chinese (HongKong) |
| 12 | MARCO ANTONIO APARICIO KIRWANT | MALE | ARCHITECTURE | MEXICAN |
| 13 | Juan Manuel Cruz | Male | Master | Spain |
| 14 | Janice Lobo | Female | Architecture | Indian |

## THU School of Architecture

| NO | Name | Gender | Major | Nationality |
|---|---|---|---|---|
| 1 | Yang Yu | Male | HVAC | China |
| 2 | Mengdi Cui | Male | HVAC | China |
| 3 | Shuai Yan | Male | HVAC | China |
| 4 | Zixu YANG | Male | HVAC | China |
| 5 | Mengjia Liu | Female | ARCH | China |

THU INET

| NO | Name | Gender | Major | Nationality |
|---|---|---|---|---|
| 1 | 张天原 Tianyuan ZHANG | male | Inorganic Materials | China |
| 2 | 胡康佳 Jiakang HU | male | Inorganic Materials | China |
| 3 | 崔婷Ting CUI （PhD Candi） | Female | Biomass | China |
| 4 | 赵崇岩 Chongyan ZHAO | Male | Nuclear engineering | China |

## SJTU

| NO | Last name, first name | Gender | Major | Nationality |
|---|---|---|---|---|
| Jialing Chen | Female | Power engineering and engineering thermophysics | China | Norwegian |
| Fanli LU 陆繁莉 | Female | Power engineering and engineering thermophysics | China | United Kingdom/ Norwegian |
| Junqi Liu 刘俊奇 | Male | Power engineering and engineering thermophysics | China | Norway |
| Yuxuan ZHANG 张宇轩 | Male | Power engineering and engineering thermophysics | China | Norwegian |
| Tongwei FU付桐玮 | Male | Power engineering and engineering thermophysics | China | American |
| Yong Li | Male | Power engineering and engineering thermophysics | China | China |
| Hongzhi Yan 闫鸿志 | Male | Alternative energy science and engineering | China | Indian |
| Mo Zhou 周默 | Male | Alternative energy science and engineering | China | Norway |
| Qi Wang 汪奇 | Male | Power engineering and engineering thermophysics | China | Norwegian |

## 2018

| Given name | Family name | Gender | Nationality | Institution | Major | Nationality |
|---|---|---|---|---|---|---|
| Baiyang | Zhao | Male | Chinese | SJTU | Refrigeration and Cryogenic Engineering | Germany |
| Shaowei | Chai | Male | Chinese | SJTU | Refrigeration and Cryogenic Engineering | Russia |
| Xuannan | Wu | Male | Chinese | SJTU | Refrigeration and Cryogenic Engineering | Germany |
| Lingji | Hua | Female | Chinese | SJTU | Refrigeration and Cryogenic Engineering | Germany |
| Yifan | Cai | Female | Chinese | SJTU | Refrigeration and Cryogenic Engineering | |
| Mo | Zhou | Male | Chinese | SJTU | Refrigeration and Cryogenic Engineering | Korean |
| Dongwen | Chen | Male | Chinese | SJTU | Refrigeration and Cryogenic Engineering | Korean |
| Di | Wu | Male | Chinese | SJTU | Refrigeration and Cryogenic Engineering | Korean |
| Lei | Nie | Male | Chinese | SJTU | Refrigeration and Cryogenic Engineering | Korean |
| Jiajie | Peng | Male | Chinese | SJTU | Refrigeration and Cryogenic Engineering | |

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|---|---|---|---|---|---|
| Wenwen | Wang | Female | Chinese | SJTU | Refrigeration and Cryogenic Engineering |
| Fan | Bu | Male | Chinese | THU | Building Technology |
| Hongli | Sun | Male | Chinese | THU | Building Technology |
| Haowi | Yu | Male | Chinese | THU | Architecture |
| Shuai | Yan | Male | Chinese | THU | Building Energy |
| Zixu | Yang | Male | Chinese | THU | Building Energy |
| Zhangyuan | Zhao | Female | Chinese | THU | Material Science and Engineering |
| Shuting | Zhuang | Female | Chinese | THU | Environmental Engineering |
| Guang | Yang | Male | Chinese | THU | Environmental Engineering |
| Hongshen | Li | Male | Chinese | THU | Chemical Engineering |
| Xiaoyu | Zhou | Female | Chinese | THU | Management Science and Engineering |
| Ashima | Garg | Female | Indian | SPA | Urban Design |
| Manasa | Garikaparthi | Female | Indian | SPA | Urban Design |

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|---|---|---|---|---|---|
| Shamik Sambit | Chatterjee | Male | Indian | SPA | Urban Design |
| Sayali S. | Khokale | Female | Indian | SPA | Environmental Planning |
| Dhruv | Pasricha | Male | Indian | SPA | Environmental Planning |
| Azin | Rajaei | Female | Iranian | NTNU | Sustainable Architecture |
| Christian | Baloloy | Male | Filipino | NTNU | Urban Ecological Planning |
| Clarissa | Tubeo | Female | Filipino | NTNU | Urban Ecological Planning |
| Nataliya | Kandretsenka | Female | Belarusian | NTNU | Urban Ecological Planning |
| Trine | Flaarønning | Female | Norwegian | NTNU | Science and Technology Studies |
| Huiyang | Yu | Male | Chinese | NTNU | Industrial Design |
| Lisane | Carre | Female | French | NTNU | |
| Marthe | Fogstad Dynge | Female | Norwegian | NTNU | Energy Engineering |
| Rajan Luqman | Othman | Female | Kurdish | NTNU | Civil and Environmental Engineering |

# SINOPSE

NTNU

The Research Council of Norway