

# JRC SJTU – NTNU Meeting Minutes

## Energy in Buildings Group

**Time & Location:** Trondheim, 20 – 21 April 2016

### **Energy in Building Experts:**

- SJTU: Ruzhu WANG, Yanjun DAI, Yong LI, Xiaoqiang ZHAI, Tianshu GE  
Jinfeng CHEN, Rui LI, Chengyang JIANG
- NTNU: Annemie WYCKMANS , Vojislav NOVAKOVIC, Arild GUSTAVSEN, Gabriele LOBACCARO, Yu WANG, Salvatore CARLUCCI, Luca FINOCCHIARO, Tone WOIE ALSTADHEIM

**Additional participants 21 April:** Energy Systems Analysis group



上海交通大學

Shanghai Jiao Tong University



NTNU  
Norwegian University of  
Science and Technology

# Priorities for 2016 - 2018

- Impact: visibility, dissemination, transfer, using our networks,
- Entrepreneurship, technology transfer, demand side, training camps, smart cities, students (Climate-KIC) Shanghai Climathon? (linked to Summer School?)
- Summer School + publications + visibility
- Double degree, summer school: added value for students, industry cooperation
- Living Lab, different uses of energy, demonstration villages (incl modelling of user behaviour)
- Cooperation on laboratory infrastructures
- More weight on joint publications and applications
- Joint PhD on different energy systems, possibility to initiate research
- MSC Marie Skłodowska Curie exchange of staff and PhD (H2020) more staff to follow Voja's example
- Research on specific technologies of common interest and intensify cooperation => prepare H2020 application (e.g. ground-source heat pump / ZEB)
- Solar energy + ZEN + behaviour + smart grids + architecture => low carbon city/region

Good, C.	Environmental impact assessments of hybrid photovoltaic-thermal (PV/T) systems – A review.	Renewable & Sustainable Energy Reviews	2016 Volum 55. s. 234-239	
Good, C.; Andresen, I.; Hestnes, A. G.	Solar energy for net zero energy buildings – A comparison between solar thermal, PV and photovoltaic-thermal (PV/T) systems.	Solar Energy	2015 ;Volum 122. s. 986-996	
Good, C.; Andresen, I.; Hestnes, A. G.	Solar energy for zero energy buildings - a comparison between solar thermal, PV and photovoltaic-thermal (PV/T) systems.	CISBAT 2015	2015-09-09 - 2015-09-11	
Good, C.; Chen, J.; Dai, Y.; Hestnes, A. G.	Hybrid photovoltaic-thermal systems in buildings – a review.	Energy Procedia	2015 ;Volum 70. s. 683-690	
Good, C.; Chen, J.; Dai, Y.; Hestnes, A. G.	Hybrid photovoltaic-thermal systems in buildings – a review.	International Conference on Solar Heating and Cooling for Buildings and Industry	2014-10-13 - 2014-10-15	
Good, C.; Kristjansdottir, T.; Houlihan W.; Aoife A. M.; Georges, L.; Hestnes, A. G.	A comparative study of different PV installations for a Norwegian net zero emission building concept.	Eurosun 2014	2014-09-16 - 2014-09-19	
Good, C.; Lobaccaro, G.; Hårklau, S.	Optimization of solar energy potential for buildings in urban areas – a Norwegian case study	Energy Procedia	2014 ;Volum 58. s. 166-171	
Good, C.	Building integrated solar energy systems, Using solar energy in northern latitudes.	International Summer School on Sustainable Energy	2013-07-28 - 2013-08-09	
Good, C., Kristjansdottir, T. F., Houlihan Wiberg, A., Georges, L., & Hestnes, A. G.	Influence of PV technology and system design on the emission balance of a net zero emission building concept.	Solar Energy (accepted)	25.09.2015	
Good, C.	Embodied emissions of PV/T systems – a case study of ZEB Living Lab (ongoing)	TBC	TBC	
Chen, J.; Dai, Y.; Good, C.; Wyckmans, A.	Experimental and theoretical study on solar assisted CO2 heat pump for space heating.	Renewable Energy	2015	
Sun, X.; Dai, Y.; Novakovic, V.; Wu, J.; Wang, R.	Performance Comparison of Direct Expansion Solar-assisted Heat Pump and Conventional Air Source Heat Pump for Domestic Hot Water.	Energy Procedia	2015 ;Volum 70. s. 394-401	
Chen, J.; Dai, Y.; Good, C.; Wyckmans, A.	Experimental and theoretical study on solar assisted CO2 heat pump for space heating.	International Conference on Solar Heating and Cooling for Buildings and Industry	2014-10-13 - 2014-10-15	
Carlucci, S.; Lobaccaro, G.; Lucchino, E. C.; Ramaci, R.;	The effect of the randomization of stochastically-generated occupancy schedules on the energy performance of a multi-residential building; Special Issue: Occupant behavior in buildings: modeling, simulation and application, Energy & Buildings (peer review)	Energy & Buildings	2015	2015 NTNU-SJTU summer school on Sustainable Energy in Cities
Carlucci, S.; Finocchiaro, L.; Lobaccaro, G.;	Increasing the solar potential of urban district and the use of building integrated solar energy technology in Shanghai (ongoing)	TBC	TBC	2015 NTNU-SJTU summer school on Sustainable Energy in Cities
Ludvig N.	Analysis of the radiant heating and cooling System in the Green Energy Laboratory	NTNU Master thesis	2015	JRC exchange student
Marte W. N.	Analysis of the novel solar heating wall installed as building envelop in the Green Energy Laboratory	NTNU Master thesis	2015	JRC exchange student

# Summer Course «Sustainable Energy in Cities»

60 students: 20 NTNU/Europe, 20 Shanghai Jiao Tong Univ, and 20 from other Chinese schools  
2015-2016: Shanghai

- Key performance indicators for smart sustainable cities and communities
- Near-zero emission buildings: life cycle design, greenhouse gas emission evaluation
- Increasing solar potential of urban districts
- Energy-efficient construction, operation, maintenance and refurbishment of buildings
- Energy systems and services
- Interaction between buildings and users (professional and end users)
- Building and district heating and cooling
- Building integrated solar energy technologies
- Waste-to-energy conversion
- Smart buildings and grids technologies

**+ 4Rs: Reduce – Reuse – Recycle – Renew  
(Circular Economy since 2002)**



Zhoukanghang (周康航) Residential Development Project; Illustration courtesy of Y. DAI

New joint publication in Autumn

# Summer Course «Sustainable Energy in Cities»

July 18th-29 th, 2016, School of Mechanical Engineering, Minhang Campus, Shanghai Jiao Tong University, Shanghai, China

## 2016 International Joint Graduate Course on Sustainable Energy

*Each country brings one case*



NTNU – Trondheim  
Norwegian University of  
Science and Technology

TUHH

Technische Universität Hamburg-Harburg



### Participants:

Shanghai Jiao Tong University, China (Host)

University of Maryland, College Park, U.S.A.

Norwegian University of Science and Technology, Norway

Hamburg-Harburg, Germany

Korea University, South Korea

### Course Objectives:

a) Understanding of technologies for sustainable energy production, conversion and utilization

b) Understanding of limitations and opportunities

c) Gain experience in challenges and opportunities in designing sustainable energy systems

d) Renewable energy system design and application in buildings

e) Develop your own vision for a future sustainable energy scenario and for the path that gets us there



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NORWEGIAN CENTRE FOR  
INTERNATIONAL COOPERATION  
IN EDUCATION



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# The effect of the randomization of stochastically-generated occupancy schedules on the energy performance of a multi-residential building

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## Keywords

Mathematical optimization, multi-residential building, occupancy models, quality assurance, spatial randomness, time randomness, Shanghai.

## Abbreviations

ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
BAS	Building Automation System
BMS	Building Management System
CO <sub>2</sub>	Carbon dioxide
C <sub>v</sub> (RMSE)	Coefficient of variation of the Root Mean Square Error



SENIC



WWR



Thesis  
ERASMUS+



PhD



SENIC16

*#Authors:*

*S. Carlucci, G. Lobaccaro, E. Catto Lucchino, R. Razaqi*

*#Journal:*

*Energy and Buildings*

*#Status:*

*Revised version to be submitted on the first week of May*

*#Topics and contributions from BioSol Team:*

*1 Introduction*

*2 Methodology*

*2.1 The summer school Sustainable Energy in Cities*

*2.2 Description of the case study*

*2.2.1 Climate of the Shanghai region*

*2.2.2 The study area*





SENIC



WWR



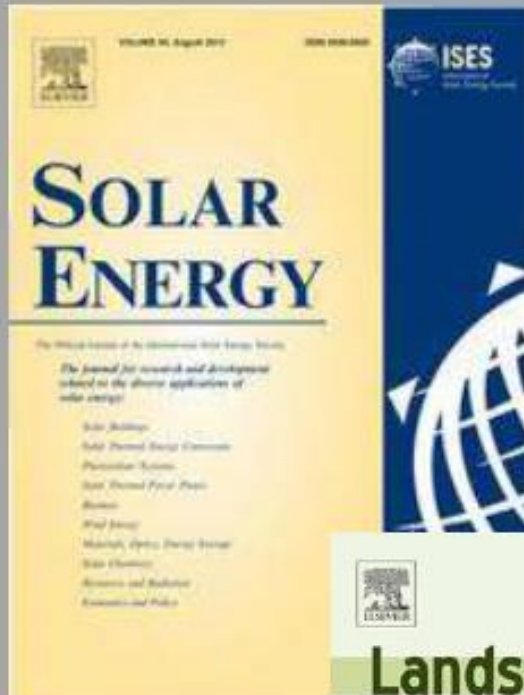
Thesis  
ERASMUS+



PhD



SENIC16



Special Issue- Intervening in Health:  
The Place of Urban Green Space

### *#Authors:*

*G. Lobaccaro, S. Carlucci, L. Finocchiaro, (students)*

### *#Topics:*

- Bioclimatic design strategies for a sustainable neighborhood in Shanghai*
- Increasing the solar potential of urban district; building integrated solar energy technology*

### *#Journal:*

*Solar Energy or Urban Planning and Landscape*

### *#Status:*

*to be submitted asap*

*(hope before the summer course 2016)*

# PhD/Postdoc Projects

## Recruitment:

### •NTNU:

- Clara GOOD (JRC funding) **PhD Defence 28 June 2016**
- Gabriele LOBACCARO (NTNU funding, Postdoctoral researcher Smart Cities / Solar Energy)

### •SJTU:

- Jinfeng CHEN (Master + PhD) Solar cooling in buildings
- Rui Li (Master + PhD) Envelope of solar house



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# Staff exchange

- **Professor Novakovic – visiting scholar at SJTU**
  - February – June 2015
  - March 2016
  - Eight lectures for students and academic staff
  - Mentoring of Master thesis students
  - One common publication



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**ZEB** The Research Centre on  
Zero Emission Buildings



NTNU  
Norwegian University of  
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# DD and MSc Student Exchange

## Sustainable Energy Use in Buildings

### – 2014/15

- MSc to NTNU - 0
- MSc to SJTU - 1

### – 2015/16

- DD to NTNU - 3
- DD to SJTU - 0
- MSc to NTNU - 0
- MSc to SJTU - 1

### – 2016/17

- DD to NTNU - 1 (+1)
- DD to SJTU - 0
- MSc to NTNU - ?
- MSc to SJTU - 1 (+1)



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# The 6 DD students from SJTU at NTNU

- Heat pumping technology
  - Song Chen
  - Yuyuan Wang
  - Yi Han
- Energy in buildings
  - Kang Wen
  - Ji Peng
  - Peng Xiong



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**ZEB** The Research Centre on  
Zero Emission Buildings



NTNU  
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- **Handbook of Energy Systems in Green Buildings**
  - **Editors: Ruzhu WANG and Xiaoqiang ZHAI**
    - 9 sections
    - 49 chapters
  - **Section 1: Introduction to green building concepts**
    - **Section editor: Annemie Wyckmans**
  - **Section 7: Passive building design**
    - **Section editor: Vojislav Novakovic**



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# SINO-ITALIAN GREEN ENERGY LABORATORY

## 中意绿色能源实验室

- DD and student exchange
- Joint research
  - Solar Energy potential in urban environment
  - Zero energy/emission building
  - Passive house for heating, ventilation
  - PVT, heat recovery
- Summer school
- Funding from both sides



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# New Cooperation Possibilities: SJTU Green Energy Lab & ZEB Living Lab / Test Cell

Development, research and testing of Building Integrated Solar Systems

- NTNU: Building Physics (climate robustness – e.g. frost and rain)
- SJTU: Component Performance







# River Sunvelop: A Solar Eco House







**7. Zero Emissions Laboratory, ZEB, NTNU, Trondheim Norway**



**1. Living Lab, ZEB, NTNU, Trondheim, Norway**



**2. FLAXLAB, Berkeley Lab, California, USA**



**3. Green Building Research Center, XAUAT, Xi'an, China**



**4. Sustainable Buildings Research Center Building, Wollongong, Australia**



**5. Sustainable Building, Tsinghua University, Beijing, China**



**6. Sino-Italy Lab, SJTU, Shanghai**

# Sino-Norwegian Partnership on Sustainable Energy (SiNoPSE) SJTU – NTNU – THU

Kick-off  
meeting 13-  
14 May 2016  
in Beijing

**SiNoPSE will establish NTNU, SJTU and THU as «one-stop shops» for Sino-Norwegian cooperation on sustainable energy.**

An integrated approach towards sustainable energy requires cooperation and communication between many different types of partners, stakeholders and public. A strong partnership between NTNU, SJTU, THU in SiNoPSE will be able to:

- engage key research, education and industry partners on sustainable energy in Norway and China
- facilitate knowledge transfer and mutual learning
- document ongoing experiences
- promote cooperation through peer-to-peer activities: double degrees, summer Schools, and sandwich PhDs with joint supervision



# Sino-Norwegian Partnership on Sustainable Energy (SiNoPSE)

- Planning of kick-off meeting in Beijing 13-14 May 2016
- Summer course: location, topic, number of students, experts involved
- Importance of Double degree (more students and more topics)
- Communication plan; Make activities more visible
- Include more leaders to ensure priorities, available staff and resources;
- Young Researchers Forum;
- Joint publications on cooperation (not just specific research outcomes)
- Entrepreneurship and innovation – cooperation with industry partners
- Cooperation between Energy in Buildings / Energy Systems Analysis



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The Research Centre on  
Zero Emission Buildings



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# SiNoPSE Cooperation with Energy Systems Analysis group

- LINKS: Linking Global and Local Energy Strategies:
  - **Energy, Environment and Economy Institute (3E), Tsinghua University, Beijing.**
  - NTNU, SINTEF, University of Maryland, Joint Global Change Research Institute, Hydro
- Energy use (buildings, end use) and climate knowledge
  - **Building Energy Research Centre (BERC), Tsinghua University**
  - Meetings and Workshops at NTNU and BERC, 2006-2009
  - Exchange of PhD students
  - **Science, Technology, Society Unit, SHSC, Tsinghua University**
  - Master thesis.: Norwegian environmental technology firms in China, environmental focus of civil engineering education in Norway and China



# Centres for Environment-friendly Energy Research (FME) application



## The Research Centre on Zero Emission Neighbourhoods in Smart Cities – ZEN

Buildings – Users – Energy systems – Demonstration

**Energy in Buildings + Energy Systems**

**Analysis + Smart Grids**

International cooperation

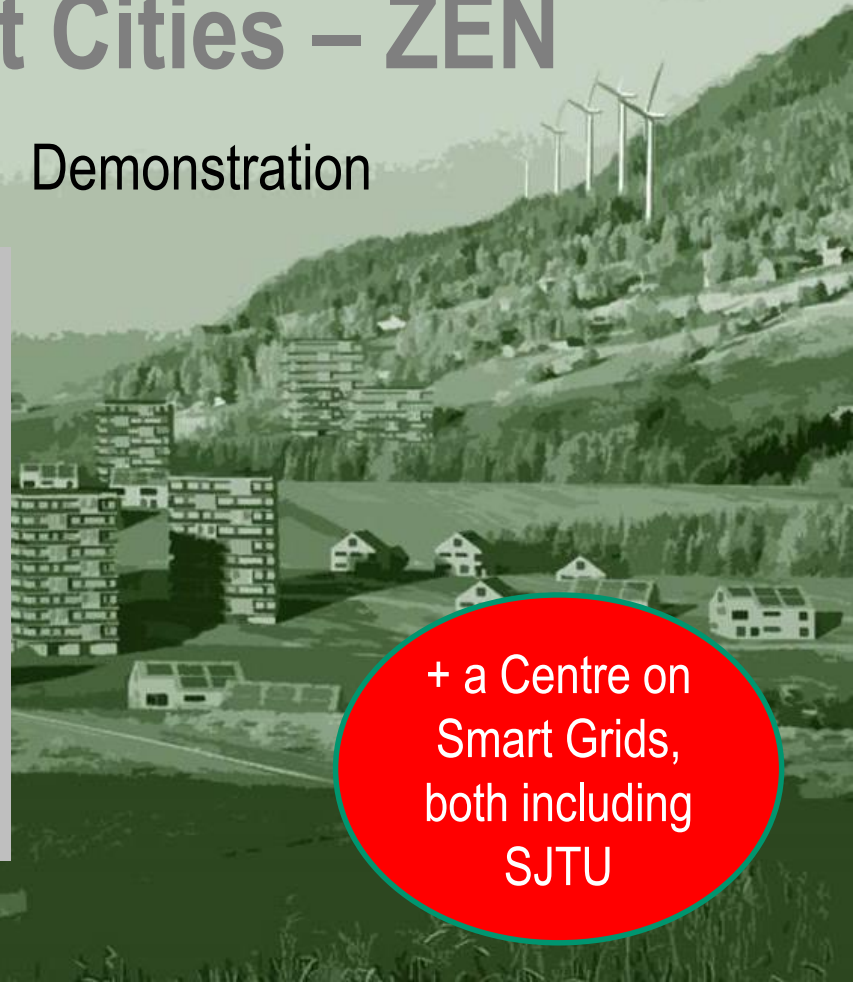
International cases

Exchange of experts

Lab infrastructures

PhD, postdoc and master students

Joint applications and publications



+ a Centre on  
Smart Grids,  
both including  
SJTU

# Carbon Track and Trace (CTT) – Climate-KIC LoCaL programme

Helping cities source and use better data for tracking and  
reducing their GHG emissions



TRONDHEIM  
KOMMUNE



# Cooperation with Innovation Norway



## Zhangjiang Hi-tech Park Shanghai

- Established in July 1992
- 29 Square Miles
- 9164 Enterprises
- 270,000 Employees (60% of whom hold higher than undergraduate degree)
- \$68 billion in combined operating income
- \$3 billion in tax revenue







SINO-NORWEGIAN  
ARCHITECTURE  
FORUM

北京国际  
设计周

BEIJING  
DESIGN  
WEEK



**Sponge city,**  
hydrology,  
biodiversity,  
flooding

**Green city,**  
green  
infrastructures

**ECO-smart city:**  
data mapping, understand  
& compare, choose case  
districts in Xian/  
Trondheim, test concepts,  
district scale: Xian  
campus, historic  
district, Qujiang,  
Xixian, Trondheim  
Knowledge axis,  
campus

**Solar city,**  
light, shadow

**Low carbon  
city2:**  
building stock,  
upgrading  
historic, existing  
and new  
districts

**Low carbon  
city1:**  
Land use  
planning,  
mobility, urban  
planning

**Smart city,**  
ICT data and  
tools



URBAN-EU-CHINA  
EU-CHINA Innovation Platform on Sustainable Urbanisation



# H2020 + Chinese co-funding (CFM)

- To support joint projects between European and Chinese universities, research institutions and companies.
- Up to 200 million RMB, or 28 million euro, will be made available annually by the Chinese Ministry of Science and Technology (MOST) on the Chinese side for the benefit of China-based entities that will participate in joint projects with European partners under Horizon 2020.
- The European Commission expects to continue spending over 100 million Euros per year for the benefit of Europe-based entities in joint projects under H2020 with Chinese participants.
- The CFM will be primarily used for Horizon 2020 topics targeting China but it will also be open to many other areas of Horizon 2020.

# H2020 + Chinese co-funding (CFM)

In particular the CFM is expected to provide competitive funding to the successful China-based applicants that passed the evaluations from both sides in the following Horizon 2020 areas:

- Leadership in Enabling and Industrial Technologies (ICT, nano, new materials, biotechnology, manufacturing and processing, space)
- Societal Challenges (health, food/agriculture, energy, transport, climate/environment, inclusive societies)
- Future and Emerging Technologies
- Research Infrastructures
- Marie Skłodowska-Curie Actions/Research and Innovation Staff Exchange
- Nuclear Energy