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Sustainable energy in cities: methodology and results of a summer course providing smart solutions for a new district in Shanghai

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Abstract

A systemic approach for integrated urban energy planning and design can increase energy efficiency, the use of renewable energy sources and bioclimatic strategies to lower the energy footprint at building, district and city scale. Such approach requires experts that are not just proficient in their distinct energy-related disciplines, but, above all, that are trained in interdisciplinary project cooperation. This approach was adopted in the summer course entitled *Sustainable energy in cities*. Held in Shanghai, China in July 2015, it provided international and interdisciplinary training as a learning environment for students and staff. It consisted of plenary presentations from researchers, local urban decision-makers and industry, discussions, and student group work with the final goal to develop smart sustainable strategies for a new residential district in Shanghai.

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1. Introduction

China has pledged to reduce its carbon dioxide (CO_2) emissions per unit of gross domestic product by 40 - 45% compared to the 2005 level by 2020, as a part of the Copenhagen Accord of 2009 [1]. During the last Conference of Parties summit (COP 21) in 2015, China participated in the joint effort to launch Mission Innovation "to reinvigorate and accelerate public and private global clean energy innovation with the objective to make clean

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energy widely affordable" [2]. To achieve the reduction of energy wastage and greenhouse gas emissions, many policies and national standards have been put in place in the last decade by the Chinese Government with the aim to impel residential buildings to waste less energy with the target of 50% reduction compared to the 1980s [3]. In a review of the 11th five-year plan, Kong, Lu and Wu [4] showed the slowness of China in developing building energy codes on a regular basis. In fact, despite the optimistic previsions within the five-year, the period between the code revisions still remains too long to do not permit a consistent and rapid development in the field of building energy saving policies. Negative cascading effects in urban energy systems are arising with higher intensity. Energy usage by industry, urban infrastructure, buildings, and private citizens affect each other with severe consequences for human comfort and health. In Summer 2013, Shanghai was experiencing the warmest weather conditions in the previous 140 years: 25 days with air temperatures higher than 35 ℃. At least 10 people dead as a direct consequence of high temperatures [5]. In order to prevent additional deaths and provide sufficient power for cooling and ventilation, industry in Shanghai was ordered to temporarily reduce its energy usage. A systemic approach to integrate urban energy planning helps to mitigate this cascading effect through better energy efficiency, more use of renewable energy sources and bioclimatic design strategies to lower energy demand. With a high construction rate of new residential areas in China, it is vital that new construction features robust, low carbon, energy-efficient solutions to prevent lock-in of high energy usage and air pollution. Chinese Premier Li Keqiang has recently "declared war" on pollution, describing it as a "blight" on people's quality of life [6]. At 277.6 Mtoe[†], residential energy consumption comprised 11% of the total energy consumption in China in 2012 [7]. In 2012, the annual per capita energy consumption of households was 205.7 toe/a. It nearly tripled since 1983 (74.6 toe/a), and nearly doubled since 2003 (107.4 toe/a) [7]. This is mainly due to the large amount of built area, and a dramatic increase in household appliances and air conditioning [8]. To promote more efficient use of energy the Chinese government embedded the concepts of Circular Economy in the 12th five-year plan. Circular Economy is also known as the 3R-principle, including reduction, reuse, and recycling of materials, energy and other resources [9]. Experiences show that public participation, awareness and information are vital to achieve the circular economy principles [9,10]. Such a systemic approach requires experts that are not just proficient in their distinct energy-related discipline, but, above all, that are trained in interdisciplinary project cooperation. The Summer Course on Sustainable Energy in Cities (SEniC) 2015 aimed to provide this type of training, by creating an international, interdisciplinary learning environment for students and staff.

2. Methodology

The summer course SEniC 2015 was jointly developed and organized by the Norwegian University of Science and Technology (NTNU) and Shanghai Jiao Tong University (SJTU) staff, and implemented in Shanghai in July 2015. Sixty-seven students from Europe and China (20 from Europe, 27 from SJTU, and 20 from other Chinese universities) with different academic backgrounds participated in the summer course SEniC 2015 [11]. During two weeks (July 6-17, 2015), students exchanged ideas and shared methods and experiences across cultures and disciplines in order to develop smart and energy-efficient strategies for the new residential neighborhood *Zhoukanghang (周康航)* in Shanghai. In collaboration with local Chinese industries and municipal partners, students and staff exchanged Asian and Nordic knowledge and expertise on topic such as the potential role of buildings, solar energy, refrigeration, and energy systems and services in obtaining energy-efficient cities with high quality of life and smart solutions for sustainable cities. The pedagogical methodology used in the summer course SEniC 2015 was structured in three distinct elements:

- *Experts in teams*: interdisciplinary training of students and staff;
- *Triple helix*: local industry and municipality officials suggested specific challenges for the students to address and solve in cooperation with researchers from NTNU and SJTU;

[†] Mtoe = Million tonnes of oil equivalent. Chinese data are recorded in tonnes of Coal Equivalent. According to the International Energy Agency, 1 tonne of Standard Coal Equivalent corresponds to 0.7 tonnes of Oil Equivalent.