

Research background and current research topics in EAD, I²CNER

Hadi Farabi-Asl

Postdoctoral Research Associate, Energy Analysis Division, I²CNER

My presentation in I²CNER IISS will have two parts. In the first part, I will talk about my research background in “development and evaluation of the semi-open loop ground source heat pump (GSHP) systems”, during my doctoral studies in Akita University, Japan. Buildings have considerable share in final energy consumption worldwide. In Japan, 27.3% final energy in 2015 was consumed in buildings. In the period of 1990-2015 in Japan, the energy-related CO₂ emission change for Industry and Transport sections is -10.3% and 6.5%, respectively. However, this factor is 44.5% for Residential and 44.0% for Commercial buildings. It shows the importance of the energy management strategies and policies in buildings energy sector.

GSHP systems are serving the heating and cooling demands of buildings worldwide. However, the widespread usage of these systems is limited because of their higher initial costs compared with conventional heating and cooling systems, especially in countries with high drilling costs like Japan. The semi-open loop GSHP system will be introduced and the results of thermal response tests (TRTs), heating and cooling tests, numerical modelling, and economic analysis will be presented. This system comprises two ungrouted vertical ground heat exchangers (GHEs) in which groundwater is pumped from one well and injected to another using a water pump. The purpose of the water pumping and injection is to create an artificial groundwater flow around the GHEs to increase the heat advection between the GHEs and the surrounding environment. Finally, results of economic analysis of the proposed systems will be presented.

In the second part of this presentation, I briefly will introduce the main research topics in EAD which currently I am involved. The first topic is “global hydrogen deployment assessment”, to assess the future engineering potential for hydrogen and provide insight to areas of research to help lower economic barriers for hydrogen adoption. A global energy system model developed by Komiyama and Fujii (DNE21) is employed. This model accounts for 82 regions in the world, including CO₂ restrictions, resource and infrastructure costs, energy conversion and use, capacity factors and renewable energies intermittency, as well as energy imports and exports between regions. Different technical and economic modification and constrains are applying on the model and it optimizes the energy system from a total system cost perspectives until 2050.

The second topic is “TIMES-Japan framework energy analysis”. The TIMES model generator was developed as part of the IEA-ETSAP (Energy Technology Systems Analysis Program), an international community which uses long term energy scenarios to conduct in-depth energy and environmental analyses. In a nutshell, TIMES is used for, “the exploration of possible energy futures based on contrasted scenarios “. The TIMES-Japan energy system model was initially developed by Japan Atomic Energy Research Institute in order to analyse the future potential of reducing carbon dioxide emission. The model was later updated by Kurosawa & Hagiwara from the Institute of Applied Energy. The main objective of this study will be understanding the costs and effect of carbon capture and storage (CCS) in Japan, both in industrial and power sectors, under different technical and economic circumstances.