## iiESI Workshop Report

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# ICT Enabling Thermal Energy Flexibility

The workshop included participants from Korea, Japan, Europe and the United States and enabled the sharing of international experience on energy systems integration with focus on information and communications technologies (ICT) enabled heat and electricity systems. Presentations (available on www.iiESI.org) and discussions covered commercial operation, business strategy and state-of-the-art research.

This brief report is not intended to summarise the presentations, but to highlight important lessons learnt during the workshop.

## Korea energ system an policy background

"Every system is different"

Korea has seen strong economic growth over the past decades mostly due to heavy industries (today 13th largest economy in absolute GDP terms) putting Korea at the same level with the United States in terms of industrial energy use per capita and considerably above OECD average (cf. presentation Sang-Doug Park, MOTIE).

Population density (487 persons/km2) is highest in OECD and living is mostly urban. In comparison, Japan, 337, Germany 230 and the United States in 85 persons/km2.

Korea is geographically isolated (island system) with no network interconnections and heavy reliance o fossil fuel imports (96%).

The electricity system is mainly based on coal, nuclear and natural gas (LNG). Opportunities for solar and wind exist, but the resource potential is moderate for mainland Korea. Korea is preparing the transition to low-carbon electricity systems on some of the islands where the renewable resource is considerably better (Jeju, Ulleungdo, Gasado).

District heating networks are already an important asset with around 3500 km of heat networks installed. The main motivation is to improve energy efficiency and further expansion is expected.

The economy is centrally-planned by the government which leads to very specific physical and institutional framework for energy systems:

- The government owns or has majority stakes in most energy companies, so they are strategically well-aligned.
- Energy prices for households and industry are very affordable and among the lowest in the OECD.
- Land-use planning organises related industries and businesses (e.g. heavy industry in Ulsan, government research in Daejeon) in different clusters across Korea.
- Innovation, science and business development are core part of industrial policy to create jobs.

- Government supports transition from reliance on heavy industry to "light" industry (e.g. electronics) and service industry.

## Lessons learned

Heat and cooling matter! While heat is already the largest demand in many countries today, cooling is growing quickly. However engineering, economics and policy remain focussed on optimising fuel and electricity supply.

Heating is mostly provided by natural gas or electricity in OECD countries. The heat demand in buildings or industry is rarely managed using ICT equipment to minimise consumer expenses and optimise according to supply system conditions. Decades of experience in district heating networks from many countries including Denmark and Korea has demonstrated the benefits of these systems in providing efficient and cost-effective heat supply. Long-term perspectives are required not only to attract the capital for the construction and reap the operational benefits, but also to ensure public support and social acceptance during the construction phase in existing districts.

Cooling often lacks a systems approach. Electric cooling loads are connected to the grid in a uncoordinated manner, but systems solutions should be promoted and considered: the use of district cooling networks (e.g. heat absorption chillers in Korea), intelligent management of electric cooling loads (e.g. exploit synergies with solar PV, cf. presentation Akira Yabe, NEDO) or a more holistic approaches to thermal networks (e.g. combined cooling and heat networks).

No one thermal system integration approach is cost-effective in all countries, since demand is strongly weather related and often highly variable between seasons and/or day and night.

Thermal networks come in all sizes from regions (cf. presentation Jong Jun Lee, KDHC), cities, and districts to factories (cf. presentation Weon-Ho Kim, Infotrol)

Integration of heat and electricity systems is recognised as a key nexus to optimise energy system operation and planning. Integration of variable renewables into electricity systems is one of the primary drivers to integrate heat and electricity systems in Europe, Japan and US. For Korea, the primary motivation is fuel conservation and industrial process efficiency.

Power systems have since their conception been operated in real-time to instantaneously balance supply and demand, which explains the large amount sensing and control equipment in place as well as methodologies to plan, design and control the electricity systems. Energy Systems Integration can borrow many of these methods and expand them to thermal generation, networks and demand (cf. presentation Young-Jin Baik, KIER). However very fast control and activation for example, on a sub-second level is probably superfluous for thermal systems due to the slower dynamics.

Industrial plant owners often ignore the potential of system integration to save resources and costs or are averse to further integrate their processes due to concern of production disruption. In Korea, large government project has successfully overcome this by providing independent advise on process integration to industries which consequently resulted in implementation (cf. presentation Hung-Suck Park, Ulsan University).

Multi-energy devices (e.g. combined heat and power, hybrid heaters) are supplied by different fuels and/or can meet different energy demands. They physically interlink different parts of the energy systems, but ICT equipment enables to optimise their operation, potentially in combination with thermal stores (cf. presentation Jae-Hyeok Heo, KIER Steve Heinen, UCD)

Simulation and control of loads or system components is important to plan and operate any individual system, and even more any large integrated system. For operations purposes, the models (e.g. grey-box models, cf. presentation Henrik Madsen, DTU) must be able to run in real-time and be activated directly or indirectly.

## Conclusion

All systems are different but each systems' uniqueness provides a rich source of specialized knowledge and experience to the international community. In the case of Korea this is in the ICT enabled thermal integrated systems within industry and local communities.