ICT infrastructure supporting smart local energy systems

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Highlights and recommendations

- Information and communications technology (ICT) infrastructure is essential to achieving the 'smartness' of local energy systems, but currently it is not receiving the attention it needs. Describing and characterising ICT infrastructure in Smart Local Energy Systems (SLES) is a first step towards understanding the state of the art and guiding its development in the future.
- We have surveyed more than 90 academic papers and 62 practical projects on SLES both within and beyond the UK. Based on the survey, we have summarised and categorised the measurements and communications technologies used in SLES.
- There is no 'silver bullet' ICT solution that fits all. The configuration of ICT infrastructure varies with 1) energy vectors, 2) technology mix, 3) objectives and constraints and 4) time horizons and resolutions of management of the SLES.
- We have mapped the type of ICT infrastructure that will be needed for certain types of SLES. This will help researchers and practitioners to more effectively design, analyse and operate ICT infrastructure for SLES.
- Most existing ICT solutions are dedicated to specific devices, system configurations or objectives. Future ICT infrastructure of SLES needs to be designed and operated from a 'whole system' perspective to be more efficient, effective and economical and from a 'forward-looking' perspective to be more open and flexible to changes.
- Cyber security of the ICT infrastructure in SLES is still understudied and rarely focused on in practical projects, but it may become a significant issue if SLES are widely deployed in the future.

Key results

From the survey of academic studies and practical projects, we found that the ICT infrastructure of an SLES mainly includes measurements of generation/demand/storage devices as well as energy networks, and communication technologies and networks which transmit measurements, data and control signals between devices, data concentrators and storage, and control centres.

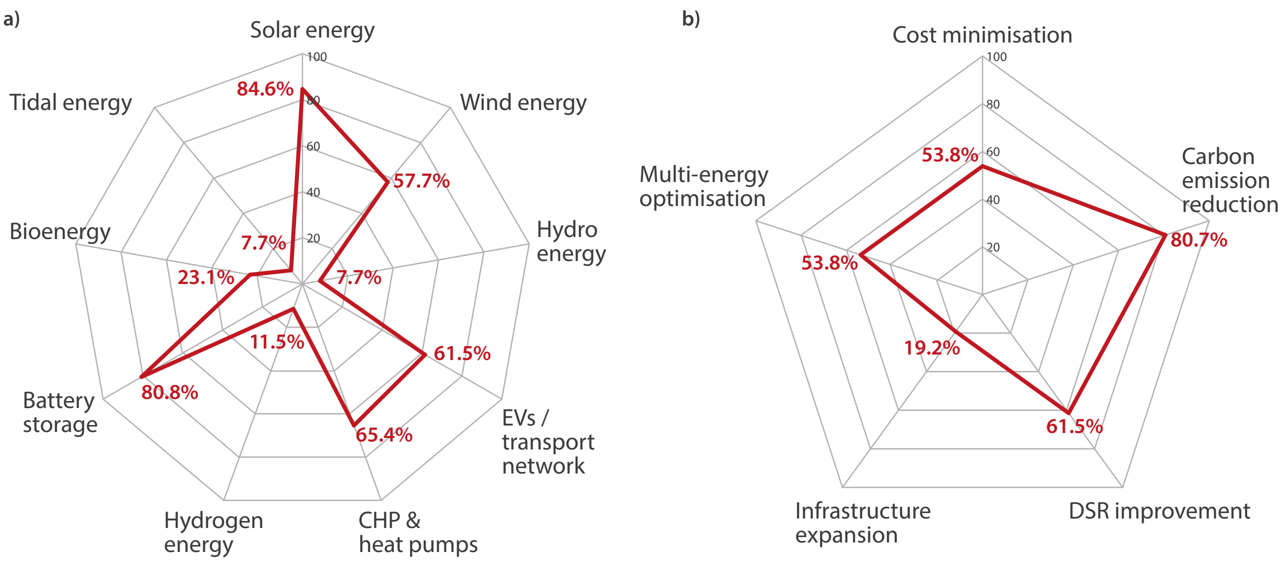
The configuration of an SLES is closely related to a number of SLES features, including 1) energy vectors, 2) technology mix, 3) objectives and constraints, and 4) time horizons and resolutions of management. These features are broken down in the following tables.

As shown in Figure 1(a), solar photovoltaic (PV) systems and battery storage systems are the two most common technologies deployed (both over 80%) in the SLES projects in the UK. Combined heat and power (CHP) units, heat pumps, electric vehicles (EVs) and wind generators are in the second most common group (all around 60%). There are also some projects utilising bioenergy, hydrogen, hydro energy and tidal energy. Differernt measuring units may need to be installed for different technologies to monitor, control and manage the devices by measuring the various input, output and internal states of the devices.

As shown in Figure 1(b), over 80% of SLES projects in the UK take 'carbon emission reduction' as an objective, while cost minimisation and demand side management (DSR) improvement are also widely considered. More than 50% of the projects consider 'multi-energy optimistion', which involve measurements beyond the electricity sector, such as those for gas/heat/cooling networks. The time horizons of management, such as real-time control, day-ahead/intraday scheduling with hourly time steps and long-term energy efficiency, will also pose different requirements on the measurements.

Various communications technologies are used in SLES for establishing different scales of communication networks to transmit various measurements and control signals between devices, data concentrators and storage, and control centres. These networks might include home/premise/local area networks, field/neighbourhood area networks and wide area networks. Communications technologies used are categorised into wired communications such as fiber-optic communication, and power-line communication, and wireless communications, such as WiFi, Zigbee, and LTE enhanced 4G and 5G networks. Different features are decided according to the specific configuration and purposes of a SLES.

Figure 1: Key SLES features related to the ICT infrastructure: (a) Statistics on technologies deployed, and (b) Objectives of SLES.



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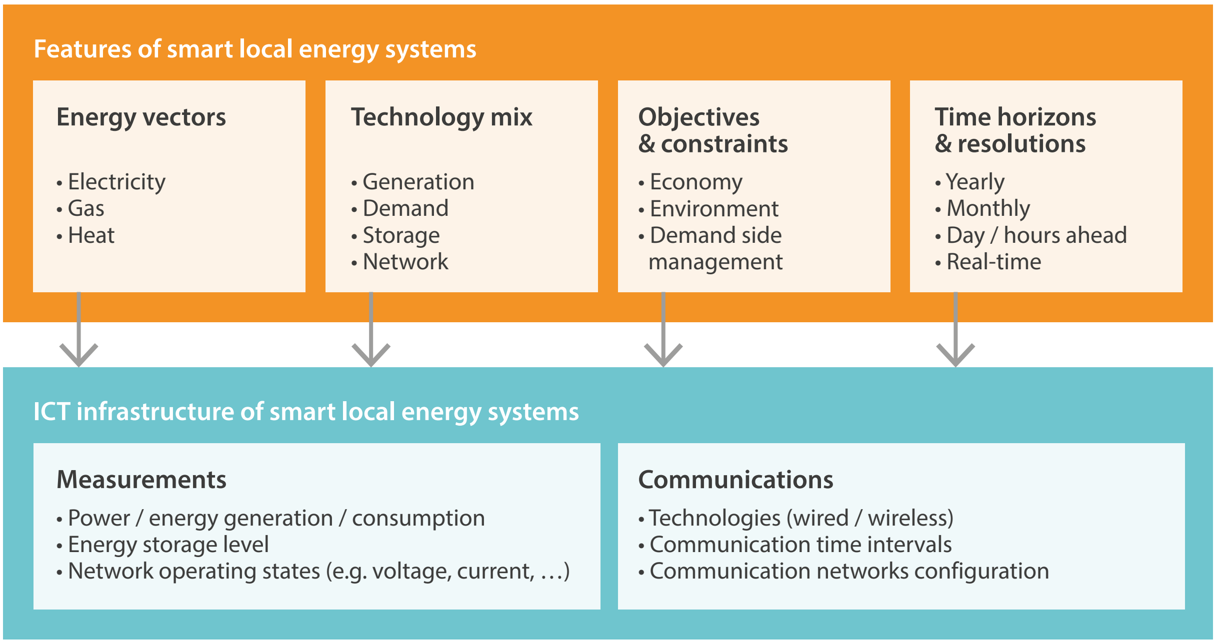

Figure 2: The mapping between SLES features and the corresponding ICT infrastructure.

Based on the survey of both academic studies and practical projects across the world, we have mapped the types and features of the ICT infrastructure to some key features of SLES. This picture provides state-of-the art information on what kind of ICT infrastructure will be needed for certain types of SLES. By checking the mapping relationship, both researchers and practioners can identify the measurements and communications needed for the specific SLES they focus on. This supports more effective design, analysis and operation of the ICT infrastructure of SLES. Also it helps policy makers to obtain a better understanding of the ICT aspects of various types of SLES.

As seen in Figure 2, with the features of SLES identified, the corresponding measurements and communications required can be identified.

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Note: The content revealed in this briefing note is based on the following document:

Lakshmi Srinivas V., Zhou Y., & Wu J. 2020. Working paper – ICT infrastructure supporting smart local energy systems: a review. The document can be sent on request: Prof. Jianzhong, Wu WuJ5@cardiff.ac.uk

About EnergyREV

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