Smart strategies for the transition in coal intensive regions

Project No: 836819

Fact Sheet: Smart Cities

September 2019

Description

A smart city is a municipality that uses **information and communication technologies (ICT)** to increase operational efficiency, share information with the public and improve both the quality of government services and citizen welfare.

The overarching mission of a smart city is to optimize city functions and drive economic growth while improving quality of life for its citizens using smart technology and data analysis. Value is given to the smart city based on what they choose to do with the technology, not just how much technology they may have. (Rouse, 2019)

Nine major **characteristics** are used to determine a city's smartness. These characteristics include:

- a technology-based infrastructure;
- environmental initiatives;
- a high functioning public transportation system;
- a confident sense of urban planning and
- humans to live and work within the city and utilize its resources. (Rouse, 2019)

Positive Energy Block/District

A **Positive Energy Block (PEB)** is a group of at least three connected neighbouring buildings producing on a yearly basis more primary energy than what they use. These buildings must serve different purposes (housing, offices, commercial spaces...) to take advantage of complementary energy consumption curves and optimise local renewable energy production, consumption and storage.

Another key advantage of the concept is that by creating a **functional and social mix**, they will contribute to **urban regeneration**. PEBs, mainly focussed on energy, can also help with taking-up bioclimatic architecture, advanced materials, Information and communication Technologies (ICT) with on-site renewable energy production. (EIP- SCC, n.d.)

Countries **involved** in the **PEB/ PED** Programme:

- Austria
- France
- Sweden
- Netherlands
- Italy etc. (Urban Europe, n.d.)

Example: Currently a pioneering best practice pilot is in operation in Europe, the HIKARI in Lyon Confluence. https://eu-smartcities.eu/initiatives/71/description

Smart City Technology

Smart cities use a combination of the **internet of things (IoT)** devices, **software solutions**, **user interfaces (UI)** and **communication networks**.

The **IoT** is a network of connected devices -- such as vehicles, sensors or home appliances -- that can communicate and exchange data. Data collected and delivered by the IoT sensors and devices is stored in the cloud or on servers. The connection of these devices and use of data analytics (DA) facilitates the convergence of the physical and digital city elements, thus improving both public and private sector efficiency, enabling economic benefits and improving citizen's lives.

Other smart city **technologies** include:

- application programming interfaces (APIs)
- artificial intelligence (AI)
- cloud computing
- dashboards
- machine learning (ML)
- machine to machine (M2M)
- mesh network

Smart city technologies also bring efficiencies to urban manufacturing and urban farming, including job creation, energy efficiency, space management and fresher goods for consumers. (Rouse, 2019)

Heat/Cooling

In a big city like for example Vienna, heat accounts for around two-thirds of the energy demand. It would be not very smart now, if heat would be produced in each building with high use of primary energy. That would mean high emissions and low efficiency. Instead, it is extremely smart to use **existing waste heat** (power plants, industry) and increasingly renewable energy sources (geothermal, solar thermal, waste) and to transport the heat in well planned networks. (Fernwärme Gernwärme, n.d.)

Example: A demonstration network, operated by Mijnwater BV in the south of the **Netherlands**, uses very low temperatures making use of water from flooded **former coal mines** for heating and cooling. In this network the objective was to balance the consumption of the buildings to the **available excess heat** in the clusters of the network. Decentralized heat pumps are used to boost the temperature of the ground water (about 28°C), to the required level for space heating and domestic hot water production. (DBDH, 2019)

Contribution to the 2nd generation, smart thermal grids renewable, intelligent and efficient:

- Geothermal heat pump for individual and tertiary buildings
    - for low-temperature heating and cooling

- Underground thermal energy storage: BTES or ATES
    - for heat or cold storage (low and medium temperature)

- Geothermal district heating and other direct uses
    - for low to medium temperature heating
    - for district cooling via absorption chillers

- Geothermal combined heat and power (CHP)
    - for medium to high temperature heating
    - for electricity (Prof. Robert Gavriliuc, p. 16)

https://eua.eu/component/attachments/attachments.html?task=attachment&id=1604

In the future, a holistic point of view will be necessary in order to better approach the **cooling requirements** of residential districts. The development of smart district cooling systems aims to improve the management and use of energy demands.

The district cooling systems applied to smart cities are based on the supply of cooling streams by connecting a network of customers to a cold source via a pipe network. Chilled water is distributed to the customers, extracting heat and thus cooling the building.

One method currently used in district cooling systems is to use local resources like **sea** or **lake water** (free cooling) or to **combine** different **renewable energy sources**. (Araner, 2019) https://www.araner.com/blog/district-cooling-smart-cities/

Electricity

The construction of an **intelligent power grid** can directly contribute to a reduced energy consumption. It also supports other networked systems, such as charging stations for electric vehicles.

Example: In **Amsterdam** one step in this direction, for example, is a **newly networked quarter**, each with 1,000 households connected - and very individual energy concepts. Sometimes, **photovoltaic systems** provide a whole neighbourhood with a stadium, sometimes residential buildings exchange electricity with each other, which they have each produced on their own roof. (Heckel, 2015) https://www.handelsblatt.com/technik/vernetzt/smart-city-intelligentes-stromnetz-hilft-energie-verbrauch-zu-reduzieren/11780518-2.html?ticket=ST-4203006-f6QYigHbQpbfkPOIHPe5-ap6

An "**energy sponge**" helps to compensate short-term electricity surpluses, heat energy shortages and fluctuations in renewable energies. (Erforschung eines flexiblen Energiesystems., 2015) https://smartcities.at/assets/Uploads/2015-06-22-New-Business-Smart-City-Ein-Energie-schwamm-hilft.pdf

Smart meters are already in use today, allowing consumers to flexibly adjust their electricity consumption in real time, depending on the tariff level. (Fraunhofer Fokus, 2019) http://www.ict-smart-cities-center.com/en/smart-cities/energie/

A **solar road** can also capture movement using piezoelectrics and vertical wind turbines down the centre of a road can harness wind from traffic. Another chapter appraises **electricity generating roads**, **paths**, **fences** and **road furniture**, and it concludes with an examination of urban blue energy from river and sea. (team, 2019) https://www.smartcitiesworld.net/news/news/can-smart-cities-power-themselves-3800

Smart grids are intelligent energy networks that connect all players in the energy system via a communication network.

They make it possible, based on the communication technologies, to create an energy and cost-efficient balance between a large number of electricity consumers, power generators and, in future, even more powerful electricity storage systems. In this case, it is necessary to ensure a sustainable, economical and secure supply of electricity. (Smart Grids Austria, n.d.) https://www.smartgrids.at/smart-grids.html

Achievements

While many cities across the world have started implementing smart technologies, a few stand out as the furthest ahead in development.

These cities include:

- Kansas City, Missouri
- San Diego, California
- Columbus, Ohio
- New York City, New York
- Toronto, Canada
- Singapore
- Vienna, Austria
- Barcelona, Spain
- Tokyo, Japan
- Reykjavik, Iceland
- London, England
- Melbourne, Australia
- Dubai, United Arab Emirates
- Hong Kong, China (Rouse, 2019)

Vienna, Austria

Smart City Vienna has set the goal to successfully overcome the challenges of the 21st century. This happens with a long-term and holistic strategy, which has the aim to guarantee the highest **quality of life** for all Viennese citizens and to save **resources** through comprehensive **innovations**. The goal for 2050 of Smart City Vienna thus reads as follows: The best quality of life for all inhabitants of Vienna, while minimising the consumption of resources. (Fernwärme Gernwärme, n.d.)

Technology projects:

- **Closed-loop systems** are more suitable for regenerative heat generation in some areas, such as systems with geothermal probes. In other areas, there are **open systems**, such as water-to-water heat pumps (it is evident in the geothermal potential cadastre whether and for which types of use a location is suitable.) https://smartcity.wien.gv.at/site/themenstadtplan-energie/

- **Wind power plants** https://smartcity.wien.gv.at/site/themenstadtplan-energie/

- **Waste heat flows** should be made visible and contribute to the sustainable, energy-efficient and economic energy supply of the (neighbouring) building stock (Smart City Wien, n.d.)

- **Power-2-Heat system**: couples electricity and district heating network, should be powered by wind turbines
  - Built in Leopoldau, December 2017, (Smart City Wien, n.d.) https://smartcity.wien.gv.at/site/power-2-heat/

- **Blockchain technology** (for decentralized, uncomplicated settlement of transactions in the energy industry), (Smart City Wien, n.d.)

- Energy from **underground braking force**
  - Test 2016 - 2018, completion U2 station Hardeggasse (Smart City Wien, n.d.) https://smartcity.wien.gv.at/site/energie-aus-u-bahn-bremskraft/

Challenges

Smart city initiatives must include the people they aim to help: residents, businesspeople and visitors. City leaders must not only raise **awareness** of the **benefits** of the smart city technologies being implemented, but also promote the use of open, democratized data to its citizens. If people know what they are participating in and the benefits it can bring, they are more likely to engage. (Rouse, 2019)

Other challenges are:

- Smart city opponents worry that city managers will **not keep data privacy** and **security top of mind**, fearing the exposure of the data that citizens produce on a daily basis to the risk of hacking or misuse. To address this, smart city data collected should be anonymized and not be personally identifiable information.
- Another challenge smart cities face is the **problem of connectivity**. The thousands or millions of IoT devices scattered across the city would be defunct without a solid connection and the smart city itself would be dead.
- **Furthermore**, public transit, traffic management, public safety, water and waste management, electricity and natural gas supply can be unreliable, especially as a system ages and grows. (Rouse, 2019)

Enabling conditions

The market for global 'smart city' solutions is expected to total almost USD 1.56 trillion by 2020. If a nation is to take a leading position in this market, we are dependent on ambitious local authorities, new collaboration models and a breakdown of silos within the country.

Three aspects will be crucial if a nation is to **succeed** as an international smart city' exporter.

1. We need ambitious municipalities with a willingness to invest
2. New collaboration models need to break down our silos
3. We need great reference projects (Ørka, 2018)

Smart Grids, Energy Efficiency and Environment

The **requirements** for the communications infrastructure in this area of energy efficiency and smart grids are: highly reliable, real-time communication for power quality control in the grid; protocol specifications for smart grid components (several candidates exist), including day ahead planning, exchanging load schedules, schedule load shedding, and dynamic adaptation schemes; standardisation of smart meter communications; application level service definitions for distributed renewable energy sources and for accessing buildings and building automation systems from the grid, focusing on standardization etc. (Luis M. Correia, 2011, p. 30)

Requirements and criteria for **energy solutions** in Smart Cities are described by the Renewable Energies Research Association (FVEE):

- **Intelligent infrastructure** with control of the generation, distribution, storage, conversion and consumption of energy with a systemic approach and optimized, consistent solutions in the community in the implementation of the energy transition
- **Smart consumer-centered offerings** (e.g. multimodal mobility systems with a wide range of possible modes of transport)
- Use of **synergy effects** at the interfaces of the municipal energy system to buildings, water supply, sewage and waste disposal, information technologies, mobility, urban development, etc.
- **A high supply security** and **sustainable energy supply** in the municipality

- The added value and jobs **remain on-site** instead of a purchasing power outflow through energy import. (Kühl, 2019)

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 836819. The sole responsibility for the content of this report lies with the authors.