Smart Cities and the role of district heating and cooling

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overview

- **Smart Cities**
  - drivers and challenges
  - “preliminary” definition

- **European activities**

- **Smart Cities Stakeholder platform**
  - development of a concept for “smart thermal grids”

- “smart thermal grids” **Challenges and Opportunities**
Smart Cities: Drivers and challenges

- **Climate change** – reduction of CO\(_2\)-emissions
- Dependency on **fossil** energy sources
- Strong coupling of **CO\(_2\)**-emissions to GDP
- Increasing **energy demand**
  - Growth of population (7 bn in 2011, 10 bn in 2050)
  - Industrialisation
  - Increasing wealth + living standards
- Worldwide trend of **urbanisation**
  - EU: 2/3 of final energy use in/ around urban areas
- **Challenge** and chance
  - Urban areas display huge potential for energy efficiency
  - Cities as centres for innovation, policy making, industry and research

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<table>
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<th>Year</th>
<th>World total population</th>
<th>World urban population</th>
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http://www.globalwarmingart.com/

[Image: World total population vs. 1960-1990 Average. Source: HadCM3]

Smart Cities: “preliminary” definition

- Considers the city as a whole in all its complexity (holistic approach)
- **Focus on energy** and resulting carbon emissions
- **considers interactions** to mobility, water, waste, the quality of life of its citizens and socio-economic conditions within the city.
- Requires intelligent **energy management** on regional & city level
  => ICT & Energy Technologies are merging
- Requires multidisciplinary and integrated **energy and city planning**
  => From a single technology approach to a multi technology approach
  => Understanding and optimizing infrastructure on a system level
- Relies on the **integration of processes, concepts and technologies**
  => including the integration of all relevant stakeholders and the implementation of new business models and new innovation processes
European activities (non-exhaustive list)

- **SET plan (Strategic energy technologies)**
  - Smart Cities was the first initiative targeting energy efficiency
  - European Energy research alliance (**EERA**) JP on Smart Cities
    - Sharing of research based on own funding/resources
    - DHC is included in the SP “Urban Energy Networks”
  - Integrated Roadmap: consolidate the individual technology roadmaps

- **European Innovation Partnership (EIP) SCC**
  - Development of Strategic Implementation Plan (SIP)
  - “Invitation for Commitments”: share ideas and plans for actions (no funding available), call was closed on 15th June 2014

- **Horizon 2020**
  - “Smart cities” as a separate call in “secure, clean and efficient energy”
  - Indicative budget (2014/2015) ab. 200 mil. Euro, DHC is a “side issue”
Smart Cities Stakeholder platform

- **Initiative of the EC** (DG ENERGY) and the Covenant of Mayors

- stimulate the **emergence of smart cities** by bringing stakeholders together to exchange ideas, launch projects and improve policy

- **1 phase: 2012 - 2013**
  - Set up of different working groups (including “Energy supply networks”)
  - Development of an “Integrated Solution”: **Smart Thermal Grids** based on previous work and input from WG members

- **2. phase: 2014 – 2016 (new consortium)**
  - First meeting 26th June 2014 (Brussels)
  - Participation in the platform will be based on the participation in the “Invitation for Commitments” that will be re-opened soon.

“smart” thermal grids: Characteristics I/IV

- Innovative solutions can be achieved, if they are **intelligently**
  - *planned* and
  - *operated* as well as if they
  - enable the end-user to *interact* with the heating and cooling system.

- To react on new framework conditions, they have to **adapt** via
  - supply and demand side management
  - adapting the temperature level in the network
  - adjusting the network development with urban planning processes
“smart” thermal grids: Characteristics II/IV

- they need to be designed to achieve the highest overall **efficiency** of the energy system, by
  - choosing the optimal *combination* of technologies (e.g. CHP + HP) and
  - enabling a maximum exploitation of available energy resources by *cascade usage*.

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“smart” thermal grids: Characteristics III/IV

- To generate significant synergies, they need to be integrated in the whole urban energy system from
  - a spatial point of view (related to urban planning parameters and processes) and
  - from an energy system point of view (optimizing the interfaces to other urban networks – electricity, sewage, waste, ICT, etc.)

- **Sizable:** These systems can be both applied for neighbourhood level or city-wide, according to the demand in heat and cold.

Modified from: Jan Erik Nielsen (PlanEnergi), Smart District Heating, “The Contribution of Renewable Heating and Cooling technologies to the “Smart Cities initiatives” - Workshop February 9th 2011, Brussels
“smart” thermal grids: Characteristics IV/IV

- To be **competitive**, they need to be cost effective in a way, that operation is affordable, either from
  - an *individual* user perspective, or from
  - a *business* perspective, or at least from
  - a *general* welfare perspective (hence e.g. regulated).
- This can be done by increasing the cost *efficiency* and creating possibilities for *customers to participate*

- They allow to **increase the security of supply** at a local level using local sources of energy for heating & cooling
“smart” thermal grids: Challenges and Opportunities
Challenges I/III

- **Cost effective operation of DHC networks**
  - Increasing costs of fossil fuels
  - Increasing share of **fluctuating renewables** in the electricity network + low electricity prices effect operation of CHP plants
  - Increasing **distribution losses** due to retrofitting of building stoke and high energy standards of new build

- **Supply of industrial waste heat to DHC networks**
  - Low temperatures of the available waste heat
  - Waste heat **availability** doesn’t necessarily match with the demand profiles
  - High **investment costs** for heat recovery (equipment, back-up systems …)
  - Industrial sides often **outside** dense populated areas
  - Missing **business models** and **regulatory framework**
Challenges II/III

- Supply of renewables to DHC networks
  - Competition between solar energy, geothermal energy, industrial waste heat and waste incineration (especially in the summer)
  - Seasonal storing of surplus energy (e.g. from solar) has cost, space and temperature limitations
  - Difficult to attain the networks temperatures (especially in winter) and hydraulic conditions
  - limited potential for renewable heat in urban areas
  - Missing business models and regulatory framework

- Demand side management
  - hydraulic/ ICT limitations
  - possible impact on customer comfort
  - no legal basis (security and privacy)
  - minor motivation of customers (fixed heat prices) and network operators (cheap peak load coverage)
Challenges III/III

- Planning of innovative networks
  - no standard planning procedures available,
  - high complexity of systems (e.g. cascade usage, distributed energy supply)
  - Many stakeholder to be involved
  - Missing awareness of urban planners for DHC
  - Financing of long term infrastructure
  - Competition for space use (e.g. active/passive solar use and green spaces)
  - High temperature heating (and low temperature cooling) systems are often chosen by planners to reduce investment costs on the building side

- Implementation of innovative networks
  - Often out-dated & not easy replaceable infrastructure
  - disruptive construction/ maintenance works
  - handicraft production of DHC components
  - long term contractual conditions for existing equipment (e.g. CHP plants)
Opportunities I/III

- **Changing energy situation**
  - A carbon neutral heating and cooling supply in urban areas requires a **maximum exploitation of all available** low carbon energy sources, many of them will require a **transport infrastructure**
  - **Cooling demand** in urban areas is expected to rise in the future, opening opportunities for district cooling e.g. using surplus energy in summer times via absorption chillers

- **Industrial waste heat utilization**
  - Building that are equipped with **suitable heating systems** can handle very low supply temperatures
  - **Heat pumps** will enable one to utilize very low temperature level
  - Advanced **energy management** and storages will help to match supply/demand
  - **Transport pipelines** allow to bridge higher distances from the source to the costumer
Opportunities II/III

- Transition to low-temperature networks and cascade usage
  - increase the potential of renewables
  - Increasing network transport capacity (decreasing return temperature)
  - Reduce distribution losses and investment costs
  - enable heat pumps to be used as centralized heating sources

- Increasing the flexibility in the network
  - energy management strategies (e.g. storage integration, load shifting) will increase the capacities for hosting fluctuating thermal energy resources
  - Systems coupled to CHP processes and heat pumps will help balancing the fluctuating renewable electricity sources
Opportunities III/III

- **Energy management**
  - Wide spread of **ICT** (e.g. wireless), customers are used to ICT, many experience from smart grids, also: integration into smart grids
  - application of demand side management to **larger loads** (e.g. industries) is promising (including cooling)
  - Many DHC systems have already **short term** storages implemented
  - Many demo sides for **seasonal storages** operating
  - simple **control strategies** available

- **cross cutting: processes**
  - Many activities fostering the integration of energy aspects in **urban planning** (e.g. priority areas for retrofitting, industrial waste heat utilization)
  - **Implementation process** can be supported by developing small-scale networks
  - Many **business models** (e.g. ESCO, PPP) are existing/ can be derived from experience in electrical networks
Suggestion for a definition of "smart thermal networks"
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