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**


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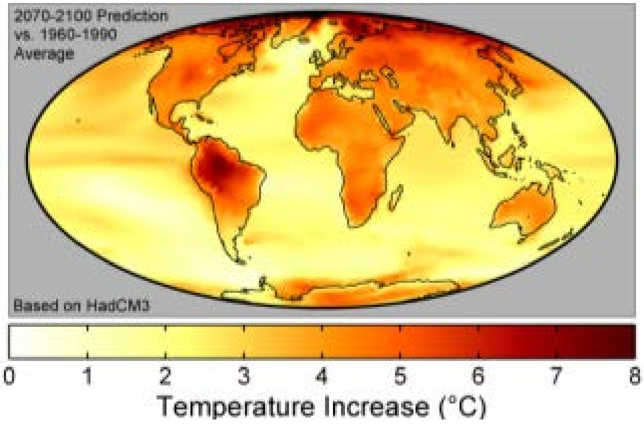
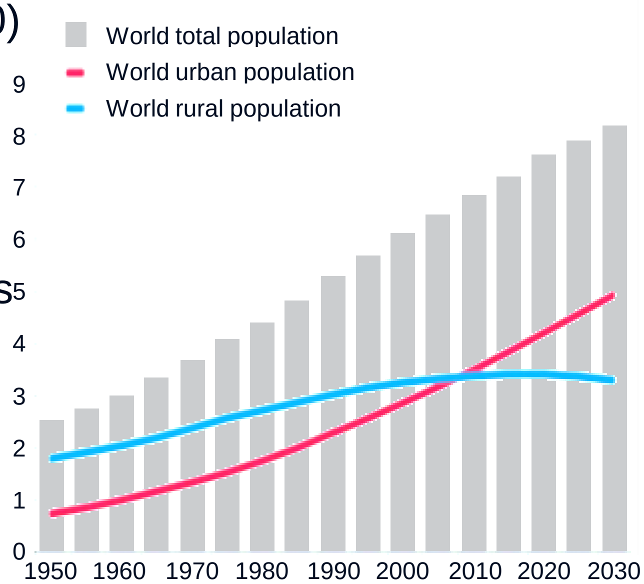
Smart Cities: Drivers and challenges

- **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



http://www.globalwarmingart.com/



Urban & rural population of the world, 1950-2030. Source: UN Population Division.

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”

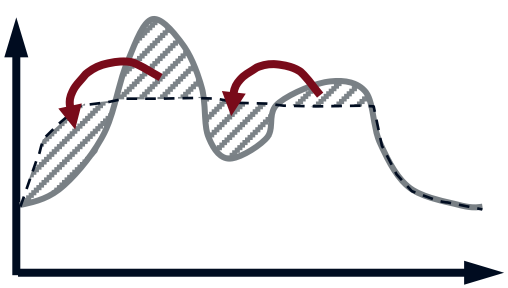
Smart Cities Stakeholder platform

- **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.
    http://ec.europa.eu/eip/smartcities/about-partnership/how-do-i-get-involved/index_en.htm

“smart” thermal grids: Characteristics I/IV

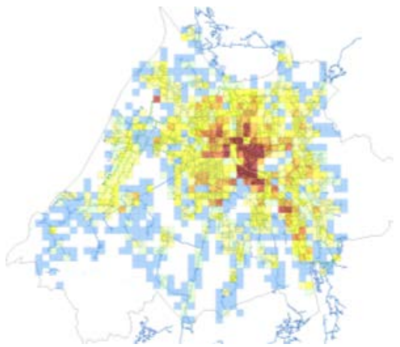
- Innovative solutions can be achieved, if they are **intelligently**
  - *planned* and
  - *operated* as well as if they
  - enable the end-user to *interact* with the heating and cooling system.

- To react on new framework conditions, they have to **adapt** via



supply and demand side management

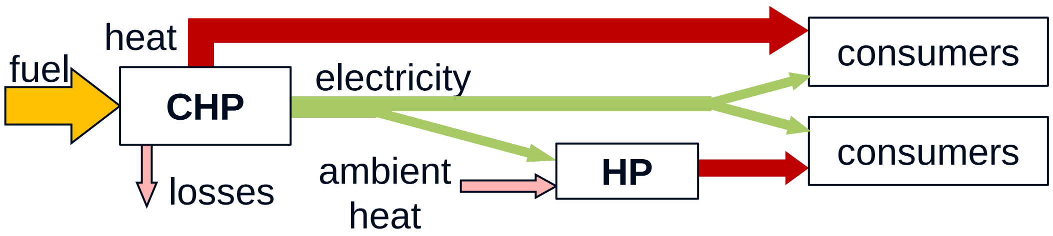
adapting the temperature level in the network



adjusting the network development with urban planning processes

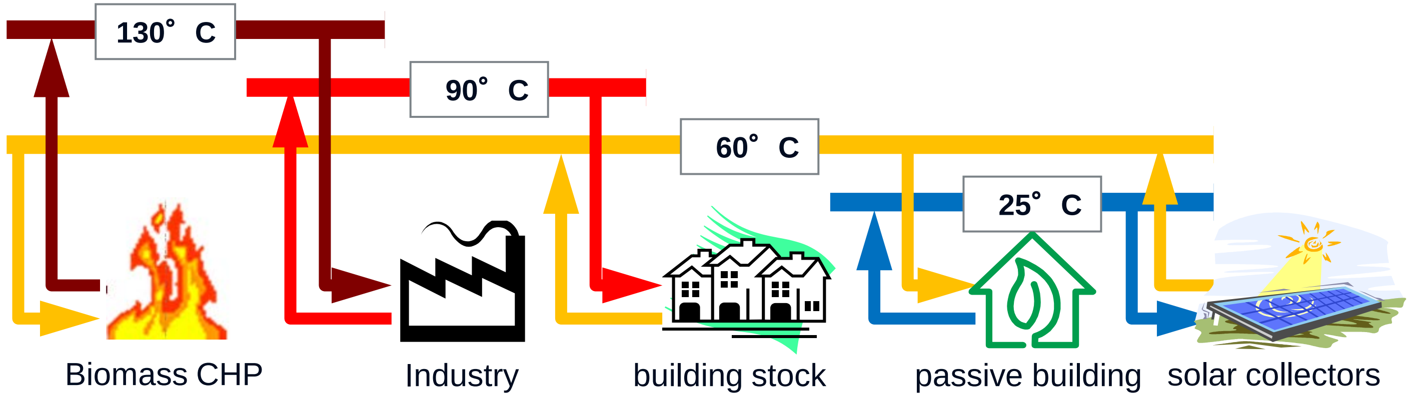
“smart” thermal grids: Characteristics II/IV

- 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



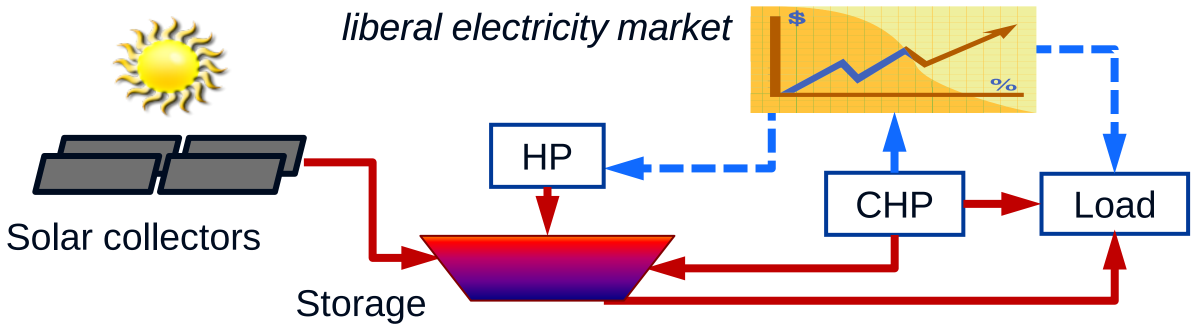
Blackwell, H.: *Looking to the future: CHP, Heat pumps and the best use of natural gas and biomass fuels*, CIBSE Technical Symposium, DeMontfort University, Leicester UK – 6th and 7th September 2011

  - enabling a maximum exploitation of available energy resources by *cascade usage*.



“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.)



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

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

“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

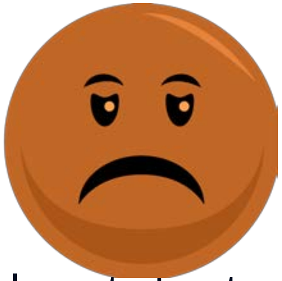
“smart” thermal grids: Challenges and Opportunities

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

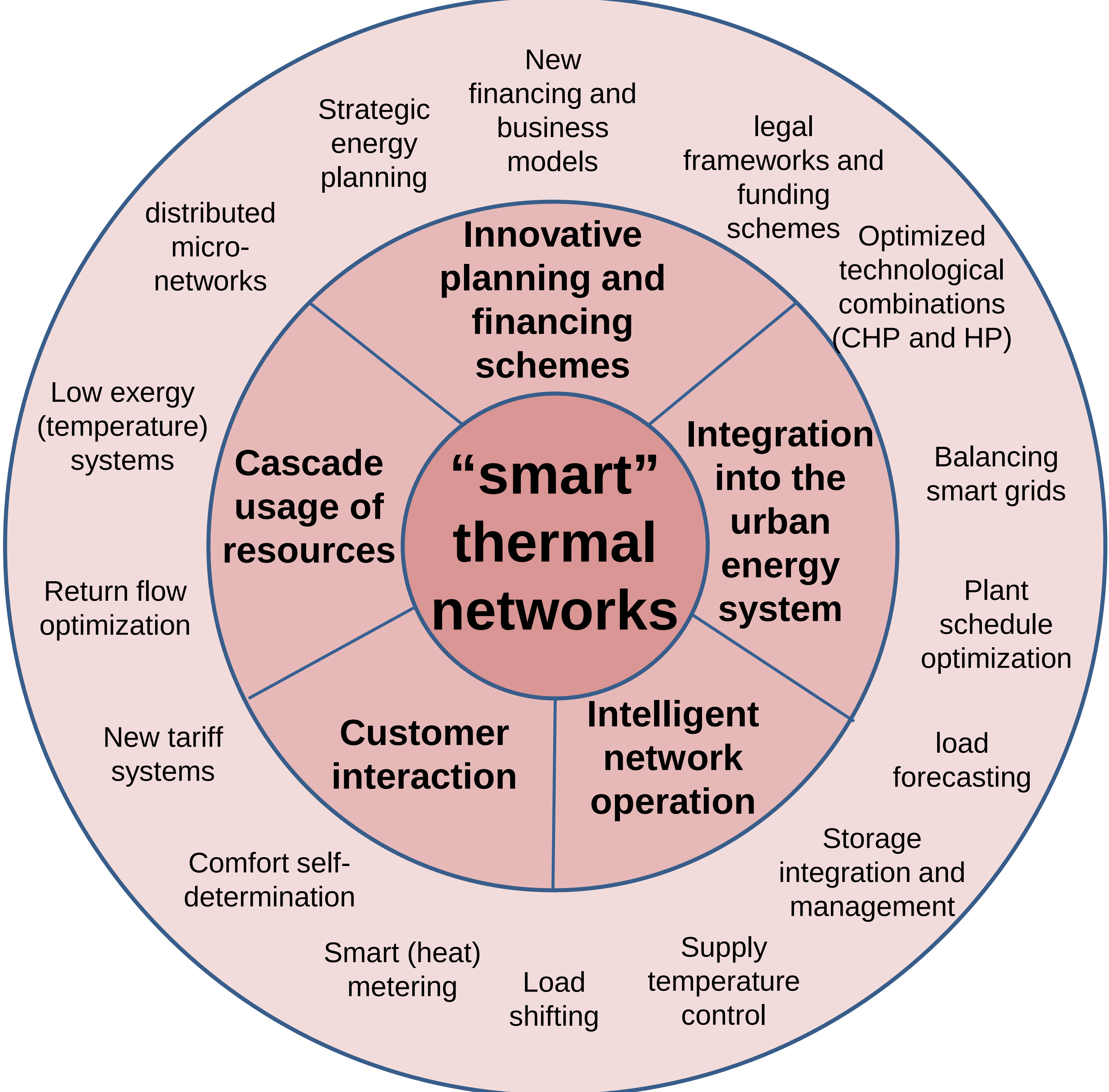
- **Increasing the flexibility in the network**
  - **energy management** strategies (e.g. storage integration, load shifting) will increase the capacities for hosting fluctuating thermal energy resources
  - Systems coupled to CHP processes and heat pumps will help balancing the fluctuating renewable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