# Are public grids still relevant in a smart environment? The case of district heating and cooling

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# Flexible infrastructure at the heart of smart cities

**Smarter cities, both inclusive and efficient, will rely on flexible infrastructure**.

This combines a variety of topics related to :

- **Scope: the multiple uses of a given infrastructure** -a car recharge station device can deliver smart charging information, but also provide flexibility and balancing services to the grid, and traffic related information to users

- **Scale: the potential combination of various scales of infrastructure into a globally efficient pattern** -as in waste water treatment devices, where small scale installations and specific treatment of topic effluents boost the overall efficiency of centralised grids

- **Service: the diversity of equipment combined in a given asset base, in order to shape a new, adjusted service** -as in public transportation where fleets combining diverse equipment, related by digital devices, enable different needs to be satisfied, timewise and spacewise

## All public service grid patterns are now challenged by flexible infrastructure

- Trends tend to enhance small scale solutions at building level as a way to improve autonomy, reduce environmental footprint and enhance customer choice
  - The scope for autonomy rises in all main fields of infrastructure: models of autonomous houses with respect to waste recycling, water cycle, energy production and consumption are technically at hand, and question the relevance of large scale grid infrastructure
  - Energy is the field where this evolution produces the most obvious effects: production downscale (PV, solar thermal, micro-CHP, heat pumps…) together with enhanced buildings efficiency, decentralised storage and digital monitoring challenge the relevance of larger scale grid infrastructure
  - Regulatory patterns support the development of those standalone solutions and self consumptions schemes

→ All former large scale grids business models, which structured and shaped cities, are questioned by the rise of scalable, flexible infrastructure

# Have DHC grids become obsolete because of smart buildings?

- In some countries, mainly those with warmer or milder climate, city planners anticipate the heating / cooling question to be solved through increased efficiency in buildings + electricity supply for residual needs

- As a consequence, hesitation prevails in some countries with respect to new District Heating and Cooling (DHC) grids development, and old grids are being shut down in countries where investments required seem to exceed customer affordability

- This question has to be solved on a case by case basis, but empirical feedbacks challenge this one sided view:

  - Though paradoxically, **countries with the highest buildings efficiency are also those where DHC grids are most developed**: this is the case for Sweden, Denmark, Finland, and to a lesser extent Germany and Austria
  - In other “real life” situations, such as social housing in Eastern and Central Europe, **jointly upgrading district heating and buildings also provides better business cases than pure “buildings based” solutions**

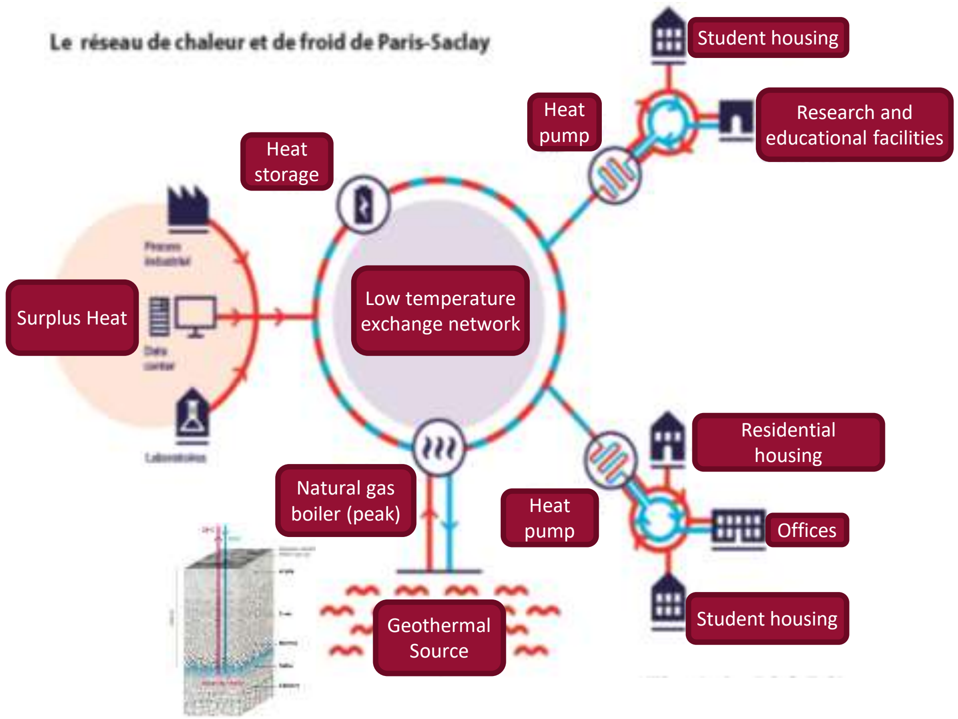
- The development of **integrated long-term approaches for urban planning, including energy supply,** can improve the competitiveness of DHC compared to individual, standalone solutions. This is already successfully implemented by several local authorities in the EU tilia

# A radical change in district heating and cooling models, makes them a backbone to local energy transitions and a key enabler in smart cities programs

| Traditional DHC unique model (60s-80s) | New models and their key patterns |
| --- | --- |
| **Long term concessions** linking large scale production, supply and grid management within a unique contract | **Mid term concessions + service contracts**, often separating production contracts and supply from grid operation |
| Vertical integration, **no transparency on embedded costs** | Full **transparency on the value chain** at various levels |
| **Centralised production**, often coal or gas based, with or without CHP, unchallenged during the contract | **Decentralised production**, constantly reshaped with respect to environmental targets and cost effectiveness |
| Grid as a closed, **"one way" system** | Grid as enabler to **energy exchanges** |
| **Mandatory connection**, regardless of efficiency of alternative supply proposals | Conditional connection, can be challenged by efficient standalone solutions |
| **Supply driven** development | **Demand driven** development |
| **Low consumer information**, no cooperative dialogue to stakeholders | **Customer/stakeholder information as enabler to the model** |

# The Smart Heating and Cooling network of Paris Saclay (1/2)

## General principle, key figures and advantages




### Grid key figures

- Investment : 50 millions €uros
- 10 km network
- Two geothermal drills 700 m depth
- 1 200 000 m² connected to the network within 2021

### Main advantages

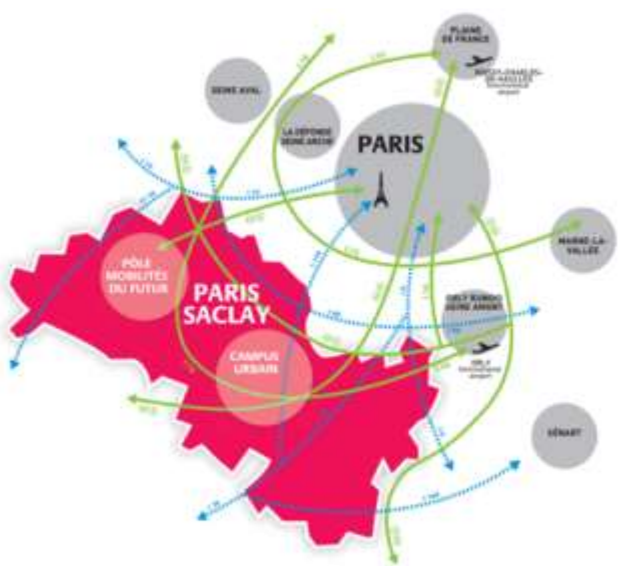
- **Low carbon** emission (< 100g $CO_2$ / kWh) and **> 60% renewable** energy based on **local resource** (geothermal)
- Possible **energy exchange** at low temperature (30°C)
  - Industrial or research center processes (Synchrotron, CEA)
  - Data centers
- Possible **balance** of heating needs and cooling needs between buildings (residential <-> offices <-> educational facilities)
- **Competitive** price compared with natural gas price
- Possible **electrical and heat demand response and real time optimization**

•Paris Saclay is a major scientific, economic and academic cluster, and urban development project
 -**1 740 000 m²** to be build between **2015 and 2028** with associated infrastructure
•Total investment
 -**1,5 billions €** for real estate projects
 -**1 billion €** devoted to laboratories, scientific facilities and collaborative institutes

## The Smart Heating and Cooling network of Paris Saclay (1/2)

Methodology / implementation challenges

How does a mutualised, district scale heating and cooling grid improve the overall long term community value in a highly efficient new buildings environment?
And how is it evidenced?




- Measuring value full scope, long term
  - **Pricing externalities, if a relevant carbon price is missing**
  - **Comparing comparables** (difficult with standalone solutions: performance gap; systemic hidden costs)
  - **Pricing stability and instability (scenarios)**
- **Working harder on needs opens new optimisation fields**
- Managing uncertainty over time matters in new projects : **finding fair risk sharing agreements with cities and developers** when the break-even point of a project depends on city development, and unclear building patterns
- Having the right tools to push a solution, once it is thoroughly justified: **community value for money comes first**
- Finding pragmatic, smart **compromises and combinations between autonomous solutions and collective ones.**

# Reviving an ageing, partly obsolete DH infrastructure though a total new holistic concept : working deep on public infrastructure revives its model

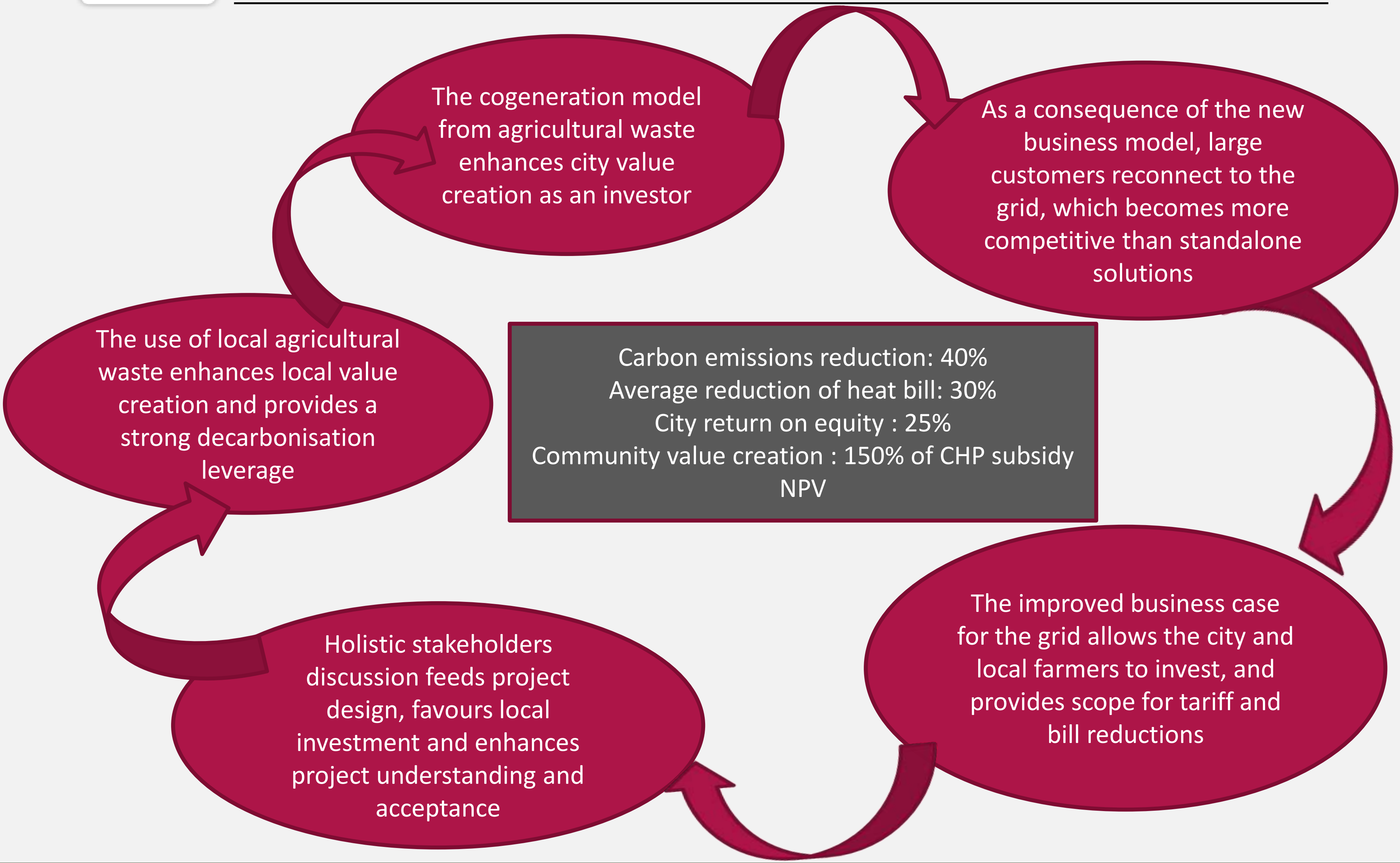
## The example of Querfurt (Sachsen-Anhalt, Germany)

- **Starting point**
  - An ageing, gas fuelled, inherited DH grid
  - Gradual disconnection of large customers moving to standalone solutions leaves increasing capital costs on social housing customers
  - Affordability constraints (heat potentially rising to 130 euros / MWh) make system upgrade impossible
  - Development of greenfield electricity renewables (large scale wind energy) does not significantly leverage the local CO2 balance

- **Project methodology and development (conception and construction 2011-2015, operation since 2015)**
  - Holistic assessment of all energy scenarios and potential projects, based on the city's fundamental scenarios (demographics, city development, economic development)
  - Design of new projects in close connection with local stakeholders
  - Complete benchmarking of those projects and solutions based on economic/environmental/social welfare criteria established with the municipality

- **Project outcome and results**
  - Complete reengineering of the DHC concept
  - New methanisation plant from local agricultural waste + cogeneration provides most of the heat
  - Work is done simultaneously on grid efficiency and heat demand at new prices
  - 40% CO2 reduction in DH system, 30% heating bill average reduction compared to BAU scenario
  - 25% return on equity for city investment

# Querfurt : the virtuous circle of local revival and community wealth



# Lessons learnt and replicability

- Both cases evidence the relevance of a mutualised district grid infrastructure against standalone solutions at building / site level
- In both cases, a **holistic assessment of local challenges**, encompassing demographics and urban dynamics were critical to design solutions
- In both cases, solutions have been **thoroughly benchmarked** against a broad range of alternatives
- This benchmarking, relies on **long term, life cycle criteria including market forecast and pricing of environmental externalities**
- Both solutions and criteria have been extensively discussed with a **broad range of local stakeholders, many of which became active project partners** as a consequence
- **Cooperative maturity** appears as a key factor of success for developing flexible grid infrastructure, open to new energy supply and third party access
- **In a digitalised environment, smart buildings become smarter if they are not insulated, but connected into a much larger system enabling further optimisation and exchanges to occur**