Feasibility of micro-DH networks in scattered urban areas using local sources: analyses of technical and non-technical barriers of a case study

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Motivation

- An ambitious “Masterplan Smart City Salzburg” has been accepted by the municipal council in 2012
  - Municipal buildings should be realized as “plus-energy-building”, exploiting local energy sources as much as possible in order to reach CO2 neutrality for the whole district.
- In this context, the new build “Bildungscampus Gnigl” (BCG) should be a pilot project!
  - an innovative educational concept including a Kindergarten, a primary school and a club house
Project “Smart District Gnígl”

- National funded research project (“feasibility study”), **aim:**
  1. **Scientific planning support for the BCG →** implement plus-energy standard (as far as possible)
  2. **Development of an energy concept for the district →** utilize local resources (incl. surplus energy from BCG) as much as possible

- One possible concept: implementation of a **micro district heating network**

![Diagram of energy concept]
Salzburg

Historic Center

Gnigl

https://en.wikipedia.org/wiki/Salzburg
Salzburg-Gnigl
Area under investigation

Demolition of existing School building + some nearby residential buildings + club house

no district heating network is available in this area

industrial bakery Flöckner
Pre-evaluation of the feasibility of a local micro DH network

**Threshold a)** ÖKL, Bund-Länder-Arbeitsgruppe Ökoenergiefonds, Merkblatt Nr. 67, Technisch-wirtschaftliche Standards für Biomasse-Fernheizwerke, 1. Auflage, 1999

**Threshold b)** Kommunalkredit, Umweltförderung im Inland, Infoblätter zu allen Förderschwerpunkten, Biomasse-Nahwärme, Referenzdokument 10, KPC, Version 1.1, 2009

**Threshold c)** Zinko H. et al., District heating distribution in areas with low heat demand density, IEA IA DHC-CHP, Annex VIII, 2008 AND Fröling, et al., Environmental performance of district heating in suburban areas compared with heat pump and pellets furnace, 10th International Symposium on DHC, September 3-5, 2006

Energy demand of buildings according to the OPTRES database of Salzburg AG
Demand situation and supply options

Possible heat source: surplus heat from BCG?

Some buildings might still have oil boiler?

Possible heat source: sewage duct?

Possible heat source: waste heat from bakery?
BCG: Scientific planning support

- **1. Step:** developments of criteria for the selection of candidates

- **2. Step:** development of requirements for the architectural competition
  - Maximize surfaces for **solar energy production**
  - Minimize energy demand → passive or low energy standard
  - **Low temperature** heat distribution system
  - Heat storage/ **storage capacity** in the building mass

- **3. Step:** quantitative evaluation of 22 design proposals from the architectural competition according to the above requirements
  - Translation into a easy understandable qualitative evaluation for the jury
    - Bad
    - Ok, modifications necessary
    - Good
BCG: winner of the architectural competition

Evaluation result of the project team
BCG: requirements for plus-energy-standard

**Definition:** The primary energy demand is lower than the energy supply from local renewable sources (on a yearly basis). Two cases:

- **a)** PV surplus is supplied to the grid and taken at a later point in time → Primary energy factor = 2.1
- **b)** PV supply is simultaneously to the energy demand of the BCG → Primary energy factor = 1.0

→ Minimum PV area required for plus-energy standard is between 1700 and 2400 m² (depending on energy standard and heating system)

Source: 2. Call of the national research programm „Haus der Zukunft plus“

according to pr EN 15603
BCG: recent technical specifications

- **Heat consumption**
  - no proper energy performance certificate available!
  - Glass surfaces are dominating → high consumption is expected

- **Heating system**
  - Ground water heat pump (3 x 40 kWth) + gas peak load boiler (90 kWth) (Thermal response test has been payed by the city of Salzburg)
  - Heat distribution: concrete core activation and floor heating
  - Room ventilation with heat recovery

- **Local energy production:**
  - 500 m² PV + 40 m² Solar Thermal → no “Plus-Energy Building”!!

The work has not been started, so there is still room for improvement!
BCG: Identification of non-technical barriers

- Although the city of Salzburg was involved in the project, the support of the SD Gnigl project team was a "suggestion" and not mandatory.

- Higher investment costs for a "Plus-Energy-Building" (e.g. higher costs for additional PV area) were not considered in the initial budget for the BCG.
  - However, other design proposals could have reached plus-energy standard within the given budget.

- For the members of the jury of the architectural competition energy supply and demand was not the focus (urban layout, visual appearance …)

→ The City of Salzburg is now adapting the procurement and construction processes for municipal buildings in order to avoid similar problems.
Demand situation and supply options

Possible heat source: surplus heat from BCG?

Possible heat source: sewage duct?

Possible heat source: waste heat from bakery?

Some buildings might still have oil boiler?
Analyses of customer structure

- Questionnaire to the property owners, Feedback: 18 out of 41 buildings
- Side survey of selected buildings

Heating system currently installed

Willingness to connect to a local DH network

Initial assumption: mainly oil boilers

+ Some buildings without central heat distribution system
Demand situation and supply options

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Possible heat source: sewage duct?
Waste heat from production bakery

- **Waste heat potential between 353 and 390 MWh/a** (extraction at 80-90°C supply temp.)
  - → about 10% of the heat demand in the district

- **Payback period:**
  - about 7.5 years (353 MWh/a)
  - about 6.9 years (390 MWh/a)
  - (heat price 4.44 ct/kWh, without any subsidies)

- **Owner of the bakery interested!**
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New majority owner at Flöckner

Die Großbäckerei Resch und Frisch aus Oberösterreich übernimmt drei Viertel der Geschäftsanteile der Salzburger Großbäckerei Flöckner. Der Rest verblieb im Besitz der bisherigen Eigentümerfamilie.


[link](http://salzburg.orf.at/news/stories/2562873/)
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Possible heat source: sewage duct?
sewage duct as heat source

- Usable flow rate: 3.7 l/s,
- temperature: 10 – 12° C
- Cooling down to 4° C
- max. capacity: ca. 92 kW
- **Potential: 230 MWh/a** (average max. usage time 2,500h/year)
- COP of the WP > 4 for $T_{\text{supply}}$<40° C
- **Channel: Ø: 0.3 m, depth: 3.5 m**
  - Costly inlet structure and bypass necessary → **high investment costs**
  - High **effort for maintenance** (cleaning the heat exchanger)

→ The economic feasibility of using the waste water is not given under this conditions.
Demand situation and supply options

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Alternative pathways towards zero-emissions?

- **exchange of heating systems + thermal retrofitting**
  - 100% biomass → ~ 0% CO2
  - 100% heat pumps → 15% CO2 (if supply temp. are low!)
  - in combination with retrofitting, both measures are often profitable (40 years time horizon)

- **Installing PV on the BCG/ on all available roof areas**
  - 2.000 m² PV → 74% CO2
  - 7.387 m² PV → 39% CO2
  - Higher values can be achieved, if the electric loads could be synchronized to the PV supply

→ the results are significantly different when using data from the TABULA project

[http://episcope.eu/](http://episcope.eu/) (TABULA energy demand is ~ factor 2 larger than OPTRES data)
Conclusions and recommendations

- **To reach ambitious goals, “business as usual” is not an option**
  - Planning and development processes of buildings require significant adaptations e.g. mandatory requirements for energy production and demand, a qualified jury, appropriate financing …

- **Not every random district is suitable to become “zero emission” by integrating a new building**
  - The distribution of demand structures and the usable potential of local energy sources is highly individual and needs to be assessed throughout the city in advanced for identifying suitable areas

- **Even small businesses can supply waste heat**
  - Its potential needs to be assessed and the supply needs to be supported (e.g. subsidies) and secured (e.g. drop out insurance)

- **A small number of buildings doesn't allow superficial analyses**
  - Individual assessment of the building stock is required
Thank you for your attention!

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