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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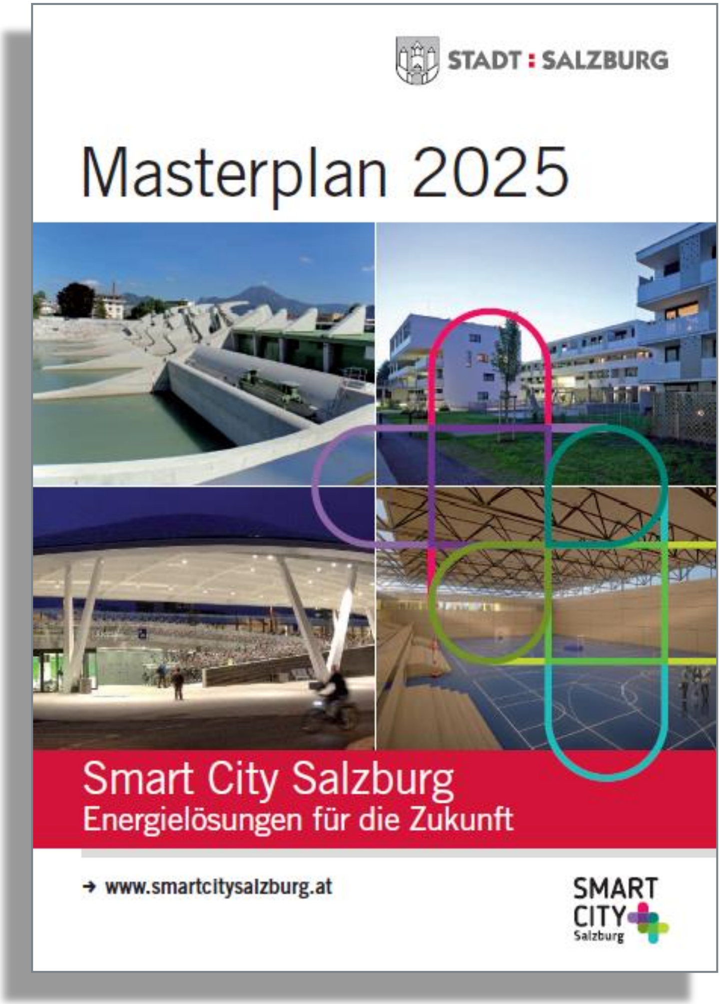
Content

- **Introduction**
  - Motivation
  - Project “Smart District Gnigl”
  - Salzburg-Gnigl
- **Area under investigation**
  - Pre-evaluation of the feasibility of a local DH network
- **Demand situation and supply options**
  - BCG: Scientific planning support
  - Analyses of customer structure
  - Waste heat from production bakery
  - sewage duct as heat source
- **Alternatives**
- **Conclusions and recommendation for actions**

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

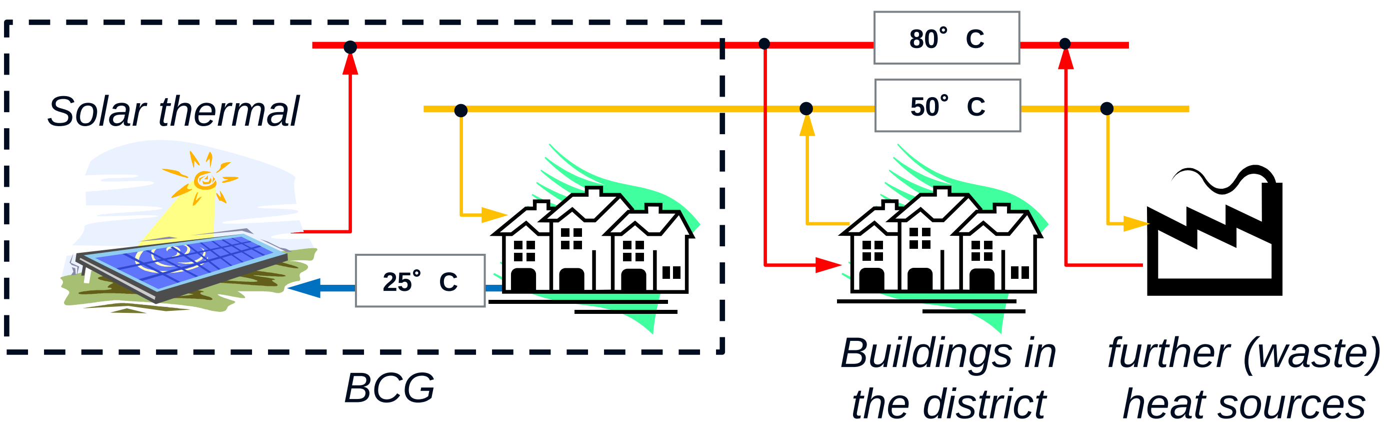


More information: www.smartcitysalzburg.at

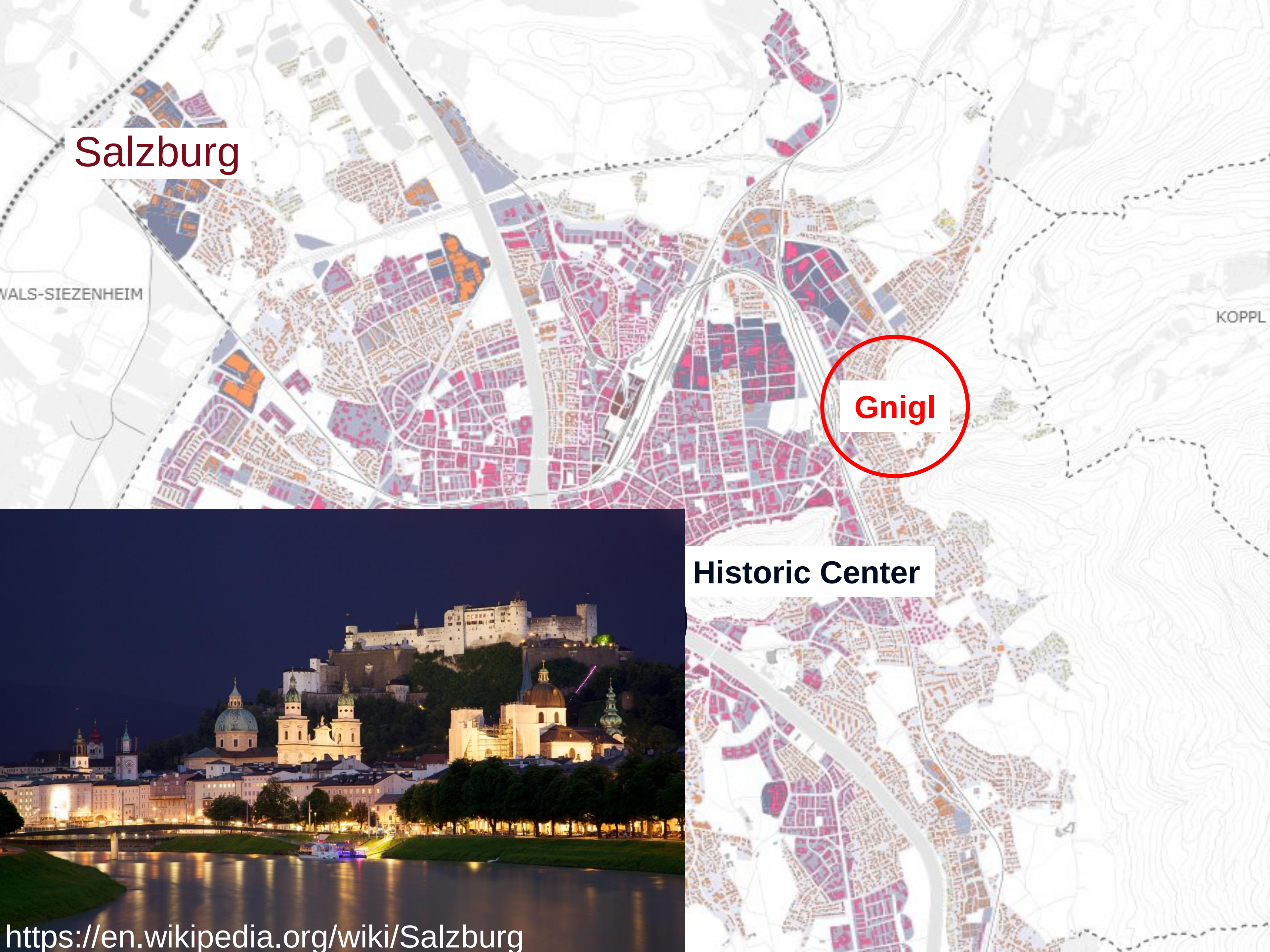
Project “Smart District Gnigl”

- 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**



This project is supported with funds from the Climate and Energy Fund and Implemented in line with the ”Smart City Demo” programme.



https://en.wikipedia.org/wiki/Salzburg


Salzburg-Gnigl
http://www.salzburg.com/wiki/index.php/Gnigl

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Salzburg-Gnigl

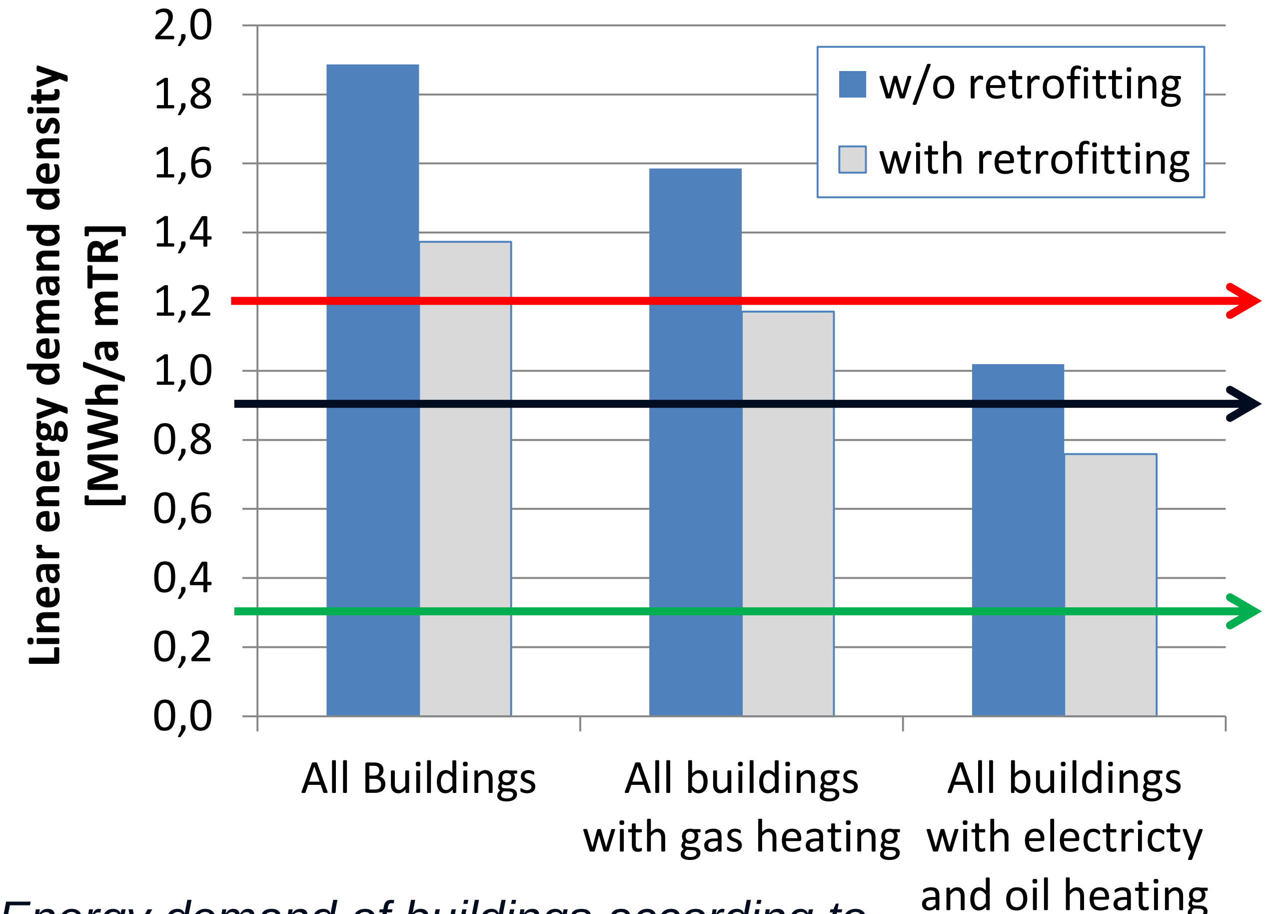
Area under investigation

no district heating network is available in this area

industrial bakery Flöckner

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

Pre-evaluation of the feasibility of a local micro DH network



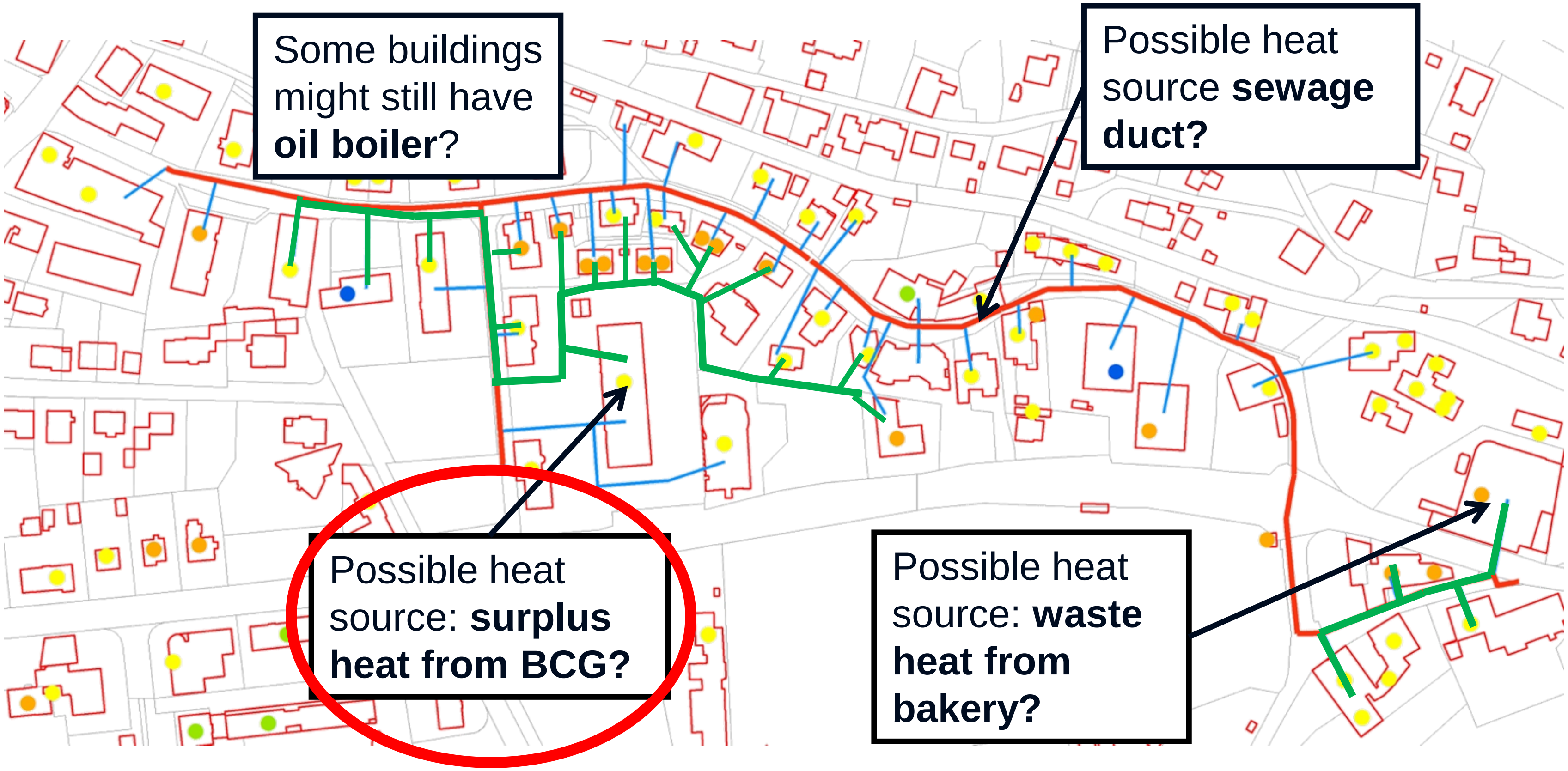
Threshold a) ÖKL, Bund-Länder-Arbeitsgruppe Ökoenergie-fonds, Merkblatt Nr. 67, Technisch-wirtschaftliche Standards für Biomasse-Fernheizwerke, 1. Auflage,1999

Threshold b) Kommunalkredit, Umweltförderung im Inland, Infoblätter zu allen Förderschwerpunkten, Biomasse-Nahwärme, Referenz-dokument 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 surburban 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



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

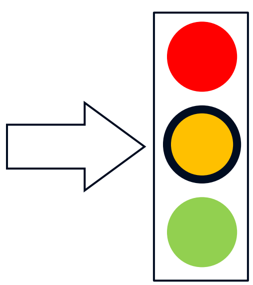
Bad

Ok, modifications necessary

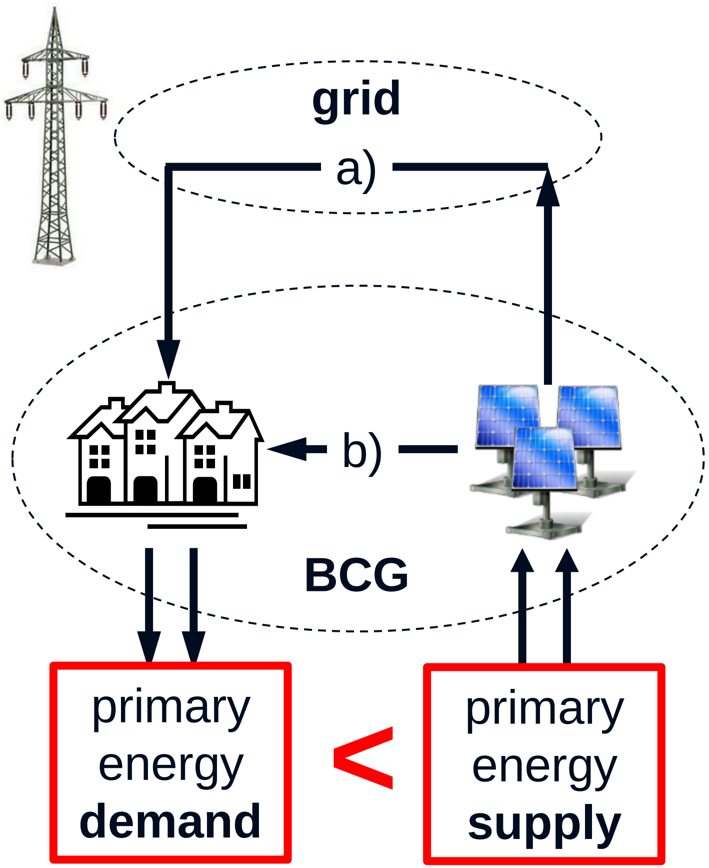
Good

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:

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

a) *PV surplus is supplied to the grid and taken at **a later point in time***
→ Primary energy factor = 2,1

according to pr EN 15603

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)

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: concreate 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

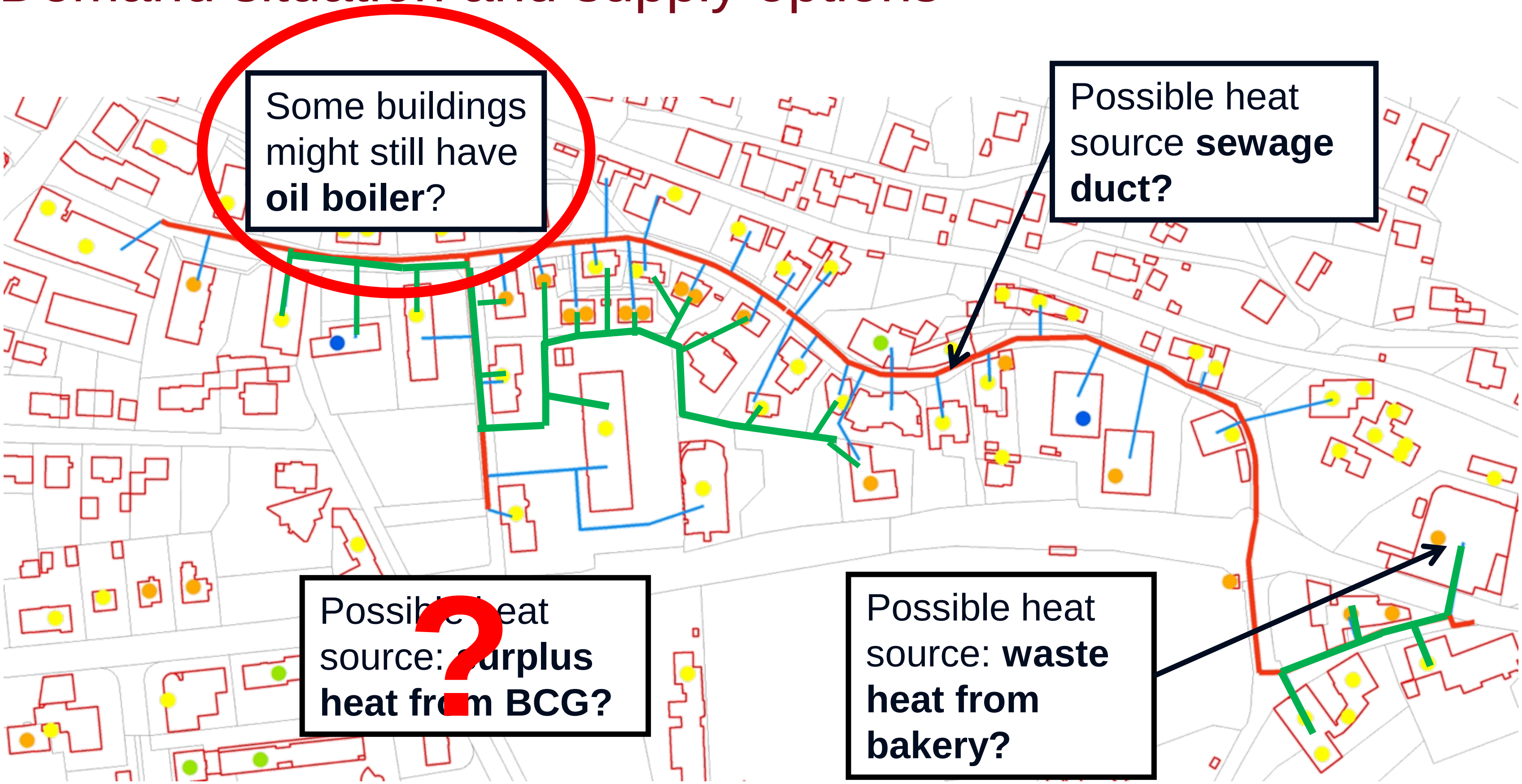
- Although the city of Salzburg was involved in the project, the support of the SD Gnigl project team was a „suggestion“ and not mandatory

- 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

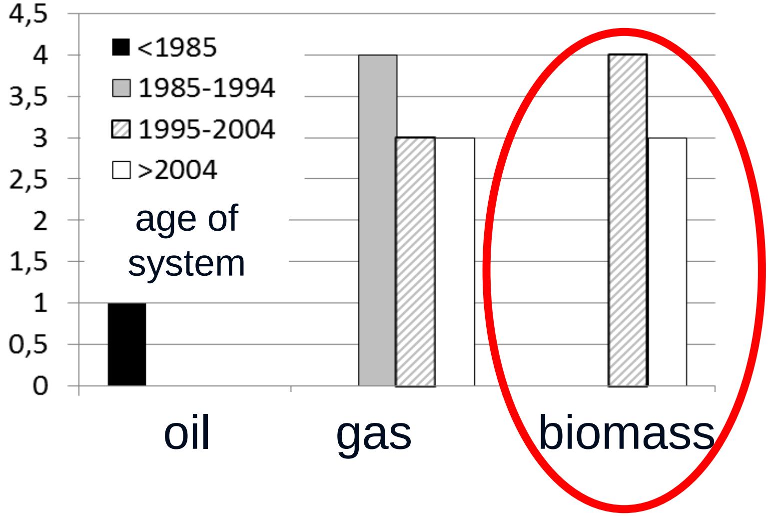
Demand situation and supply options



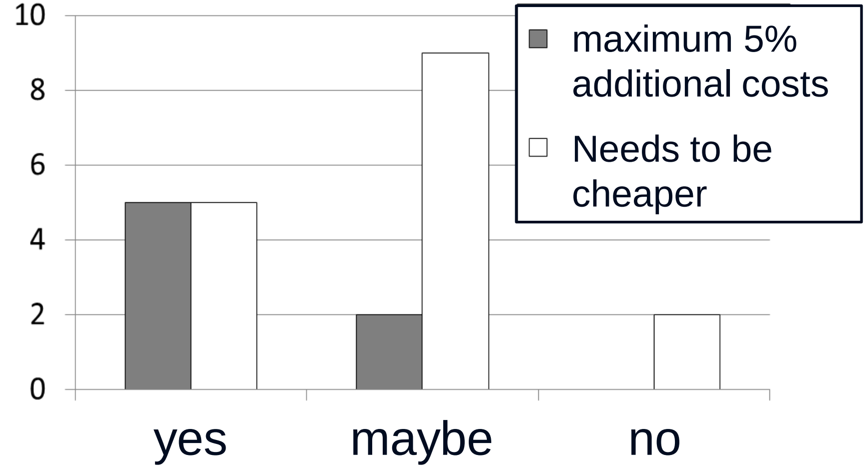
Analyses of customer structure

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

Heating system currently installed



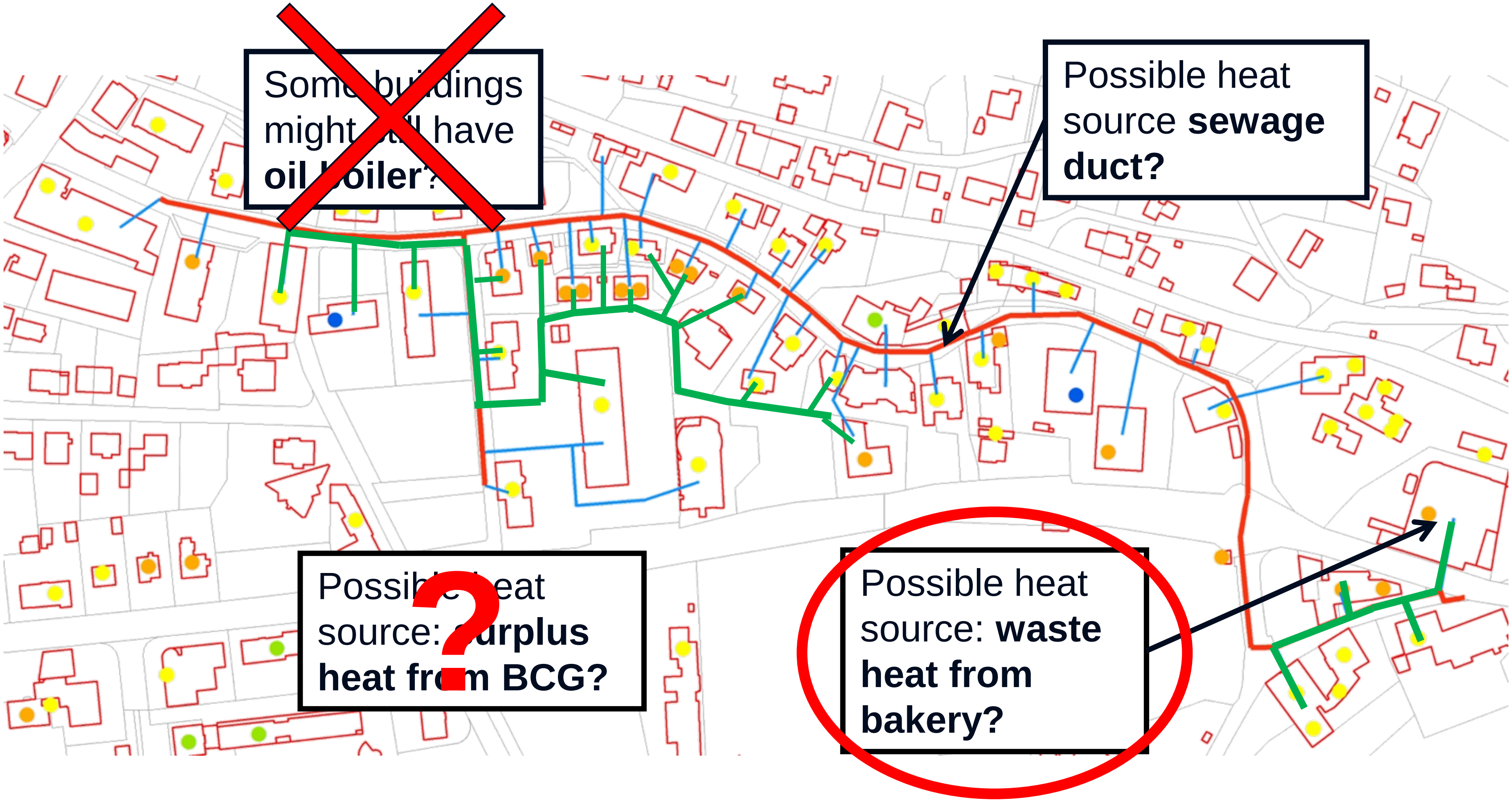
Willingness to connect to a local DH network



Initial assumption: mainly oil boilers

+ some buildings without central heat distribution system

Demand situation and supply options



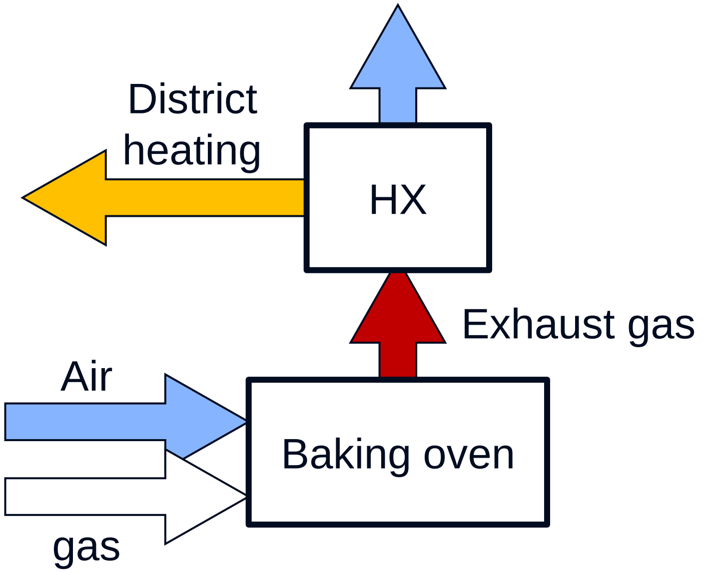
Waste heat from production bakery

- **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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- **Own**

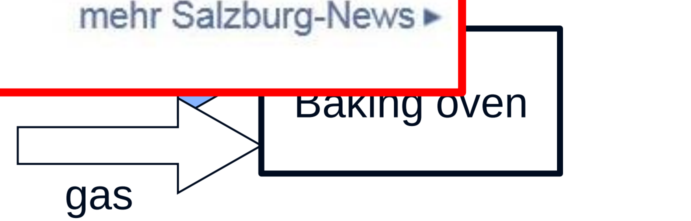
New majority owner at Flöckner

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

Flöckner hat im vergangenen Geschäftsjahr mit 300 Mitarbeitern einen Umsatz von 17 Millionen Euro erwirtschaftet. Die 16 Flöckner-Filialen und die Bäckerei sollen in die Organisation des neuen Hauptgesellschafters Resch und Frisch integriert werden.

12.12.2012

mehr Salzburg-News ▸



http://salzburg.orf.at/news/stories/2562873/

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New majority owner at Flöckner

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12.12.2012

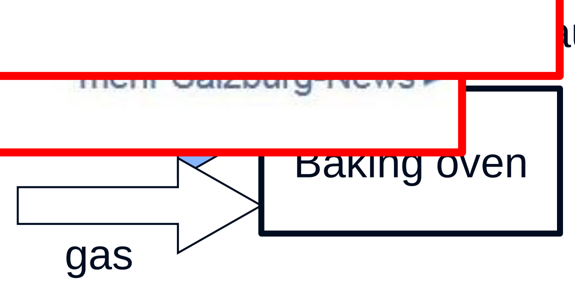
mehr Salzburg-News ›

SALZBURG | WIRTSCHAFT

Bakery Flöckner shuts down production in Gnigl

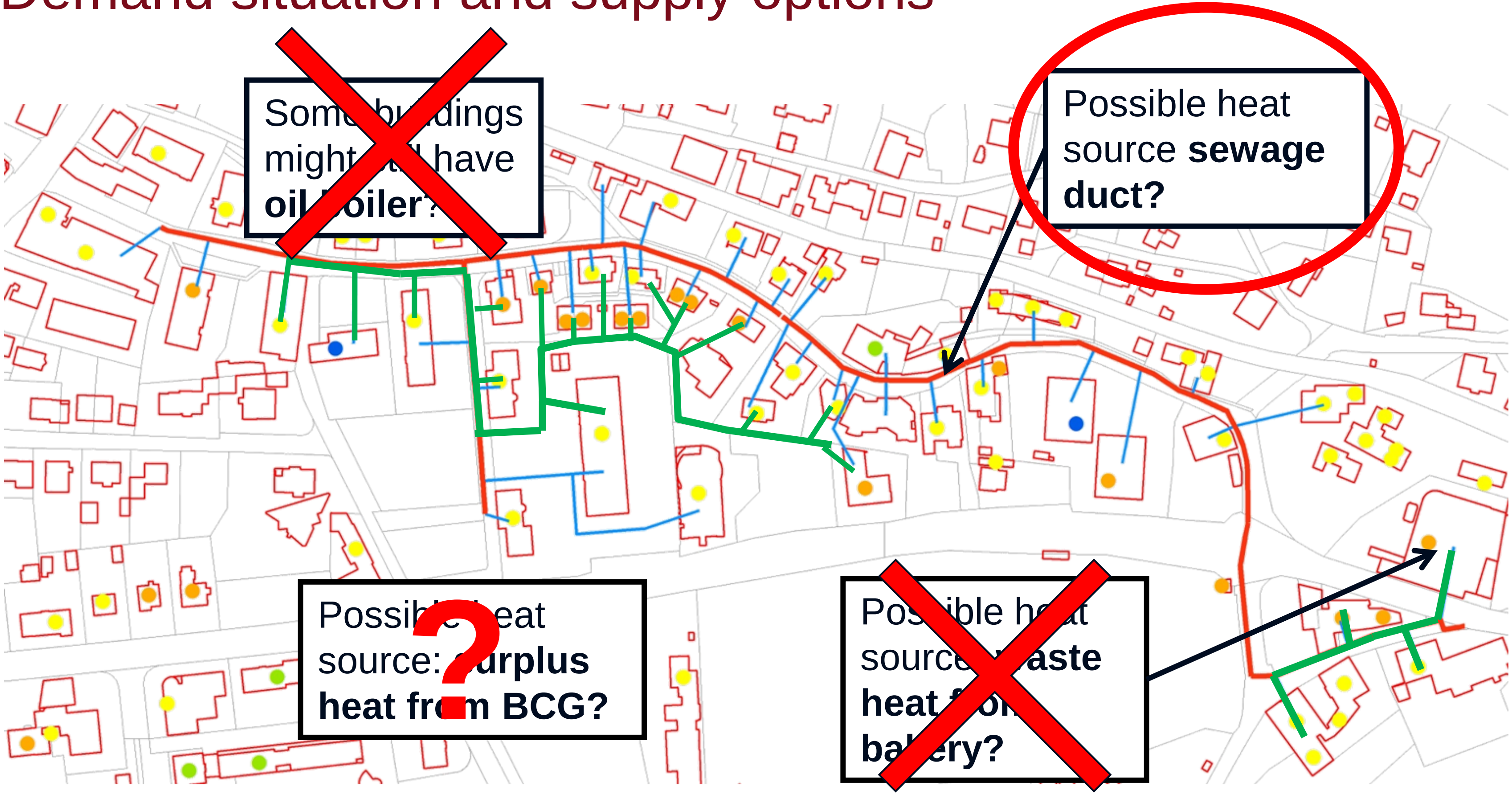
Von (sn-gs). | 15.03.2013 - 07:20 | Kommentieren

Veraltete Maschinen und keine Ausbaumöglichkeit - deshalb läuft die Produktion der Bäckerei Flöckner in Salzburg-Gnigl aus, die Filialen bleiben.



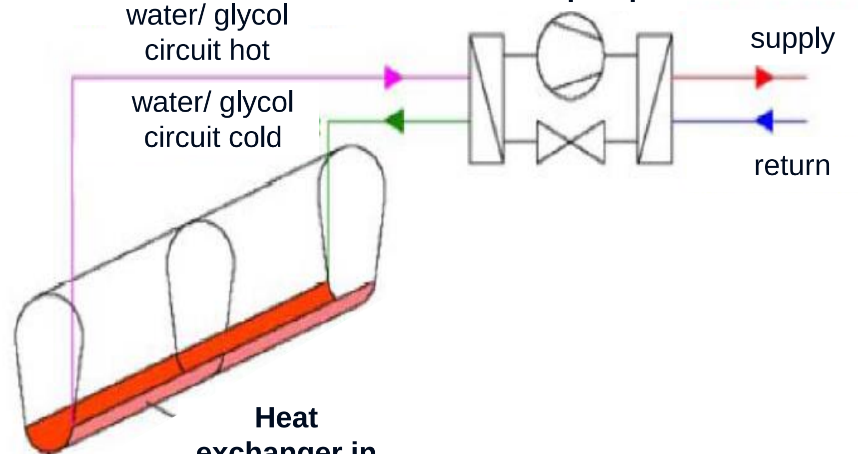
http://www.salzburg.com/nachrichten/salzburg/wirtschaft/sn/artikel/baeckerei-floeckner-schliesstproduktion-in-gnigl-51343/

Demand situation and supply options



sewage duct as heat source

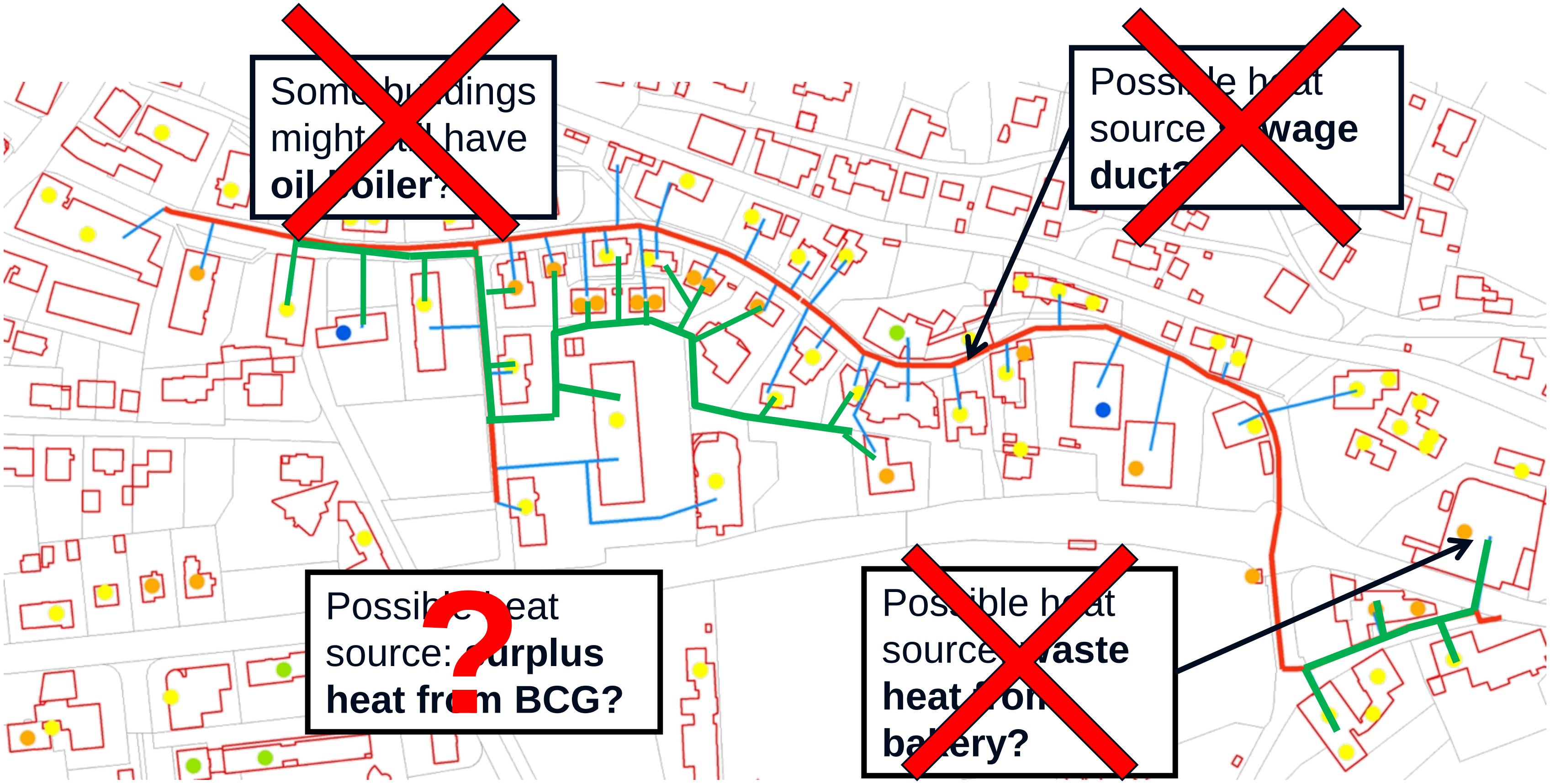
- Usable flow rate: 3,7 l/s,
- temperature: 10 – 12° C
- Cooling down to 4° C
- max. capacity: ca. 92 kW
- **Potential: 230 MWh/a** (average max. usage time 2.500h/year)
- COP of the WP > 4 for T_{supply}<40° C
- **Channel: Ø: 0.3 m, depth: 3,5 m**



  - 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



Alternative pathways towards zero-emissions?

exchange of heating systems + thermal retrofitting

- 100% biomass → ~ 0% CO_2
- 100% heat pumps → 15% CO_2 (if supply temp. are low!)
- in combination with retrofitting, both measures are often profitable (40 years time horizon)

→ the results are significantly different when using data from the **TABULA** project
http://episcope.eu/ (TABULA energy demand is ~ factor 2 larger than OPTRES data)

Installing PV on the BCG/ on all available roof areas

- 2.000 m^2 PV → 74% CO_2
- 7.387 m^2 PV → 39% CO_2
- Higher values can be achieved, if the electric loads could be synchronized to the PV supply

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 <u>usable</u> potential of local energy sources is highly individual and needs to be assessed throughout the city <u>in advanced</u> 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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