TRANSFORM

Intensive Lab Session

Vienna

9th – 11th September 2014

Smart Urban Lab aspern Seestadt

Smart Urban Lab Liesing-Groß Erlaa

Conclusions Working Group A

Develop a smart energy supply system

Introduction and Problem Statement

aspern – Vienna's urban lakeside is one of Europe's largest greenfield urban development areas. The southern part is already under construction the first new inhabitants are currently moving in. Currently the focus is on the development of the master plan, the planning of the energy supply system and the preparation of the environmental impact assessment for "aspern Seestadt north" with around 1,6 Million square meter floor space and construction starting in 2018.

Mr. Bernd Vogl, head of the energy planning department of the City of Vienna, briefly described the energy situation in Vienna and formulated the problem statement for aspern Seestadt north and working group A:

How should the energy supply of a smart city or district look like to meet Vienna's climate- & energy-targets for 2050 *(which are 1 ton CO_2 emissions and 2.000 watts (or 17,500 kWh) primary energy consumption per capita)****?***

In his presentation Bernd Vogl showed actual key figures from Vienna:

3,000 watt per capita primary energy consumption
5.5 tons CO_2 emissions per capita (3.1 t without Emission Trading Sector)
11% renewable energy share (final energy)
11% waste heat (final energy),

In Vienna district heating up to now plays an important role. Beside waste incineration natural gas fired CHP plants are the main heat source. But they can no longer be operated economically due to low electricity prizes. Therefore the future development of district heating in Vienna has to be adapted to these new framework conditions.

For urban development integrated energy and urban planning has to be rolled out, local renewable energy potentials shall be considered and possibilities for energy storage in local structure explored.

A major challenge is to generate funds for new long term investments in energy systems. Here change management is needed, and energy companies as well as developers have to rethink existing concepts. We need to get active and think forehand with new awareness in energy planning.

See also the presentation of Bernd Vogl.

Group Work Sessions

Manfred Mühlberger, facilitator for working group A, introduced the role and task of the group, assuming that for the next three days the group is an energy planning team commissioned by Wien 3420 Aspern Development Company to design an energy supply system for aspern Seestadt north, with the focus on the technical aspects.

First the different topics to be discussed were collected and structured under the headings: energy sources, energy distribution, energy storage, energy conversion**.**

With estimated future business as usual demands of 80 GWh for cooling, heating and domestic hot water and another 85 GWh for electricity, it was clear for the group that most of the energy could not be generated on-site (around 60 MW installed power). Talking about an smart efficiency scenario consumption would be reduced to 54 GW for heating and cooling and 47 GWh for electricity. But where this energy will come from?

Current uncertainties, which of course could not be fixed during the ILS Vienna, are:

- ground water energy potential,
- deep geothermal energy potential (the first deep drill was not successful, new exploration is uncertain),
- waste heat potential (waste water, production plants, etc.),
- storage potential.

The discussion evolved around the options for energy distribution at the site:

Option 1: Local hot water energy grid (with central heat generation) and electric grid
Option 2: Electric grid only (with heat generation at the building blocks)

A natural gas supply grid was not considered in the following discussions. A gas supply for building blocks with gas-fired boilers there would not be in line with the 150 g CO_2/kWh target (set as a benchmark from the authority for the environmental impact assessment) and the new Viennese building regulation. However it was stated that a gas-grid could be utilised in the future for biogas or power-to-gas applications.

Potential thermal energy sources and conversion technologies into discussion for both options were:

- waste heat (e.g. from sewer tunnels, a local laundry, supermarkets, local industry plants)
- ground water or 300 m deep soil using heat pumps,
- solar thermal collectors,
- biomass boiler (or CHP),
- natural gas boiler for peak loads.

Some of these sources like waste heat could be better utilised with a local heat grid. Solar thermal installations are more efficient with a storage for overcapacities in summer..

For option 2 the participants agreed on the need for a central room heating system (with storage or boiler). Hot water could be generated per unit or apartment.

For the future high efficient buildings (more or less passive house buildings) hot water is becoming as relevant as room heating for the overall heat demand. Hot water could be produced efficiently by electric heat pumps or boilers. However a low temperature grid (with 65°C) could also provide hot water.

For the grid option the temperature, flexibility and size of the grid (e.g. 6 different heat grids for aspern North) is an issue. Energy planning and investments have to be long term. Copenhagen for example is calculating the social, macro-economic costs, the energy company costs and the consumer costs for 25 years. Copenhagen has also flexible tariffs for heat depending on the available heat sources.Will electric power be the mayor and widespread solution for all energy needs ("Tesla scenario")? The answer during the Session was – under the current framework conditions: no ????

Hot Water pipe – yes or no?

In the morning of day 2 the potential and possible utilisation of different energy sources were discussed and evaluated for their pros and cons.

Sun

- Potential of
- 130 GWh generation with thermal collectors or 13 GWh electricity generation using roofs - additionally facades - of the buildings
- Much more detailed investigation of solar potential needed (available space, state-of-the-art yield of different conversion technologies, etc.)
- for better utilization of the limited roof space hybrid collectors with PV should be considered;
- explore possible areas for solar energy production around Seestadt, e.g. walls of U2 underground line, general motors;
- major challenge is the time shift between production and consumption → storage options,

Wind

- Small wind turbines on buildings currently no promising option
- Strong restrictions and concerns for large turbines in Vienna and in Lower Austria

Biomass

- Major issue is the supply (truck traffic, especially for option 2 decentralised block-wise supplies, storage rooms in buildings; regional sourcing of biomass)
- If the Viennese biomass power plant will be shut down after termination of government (20++) subsidy this amount of biomass might be available for other purposes.
- Local (fine) dust emissions
- Central 5 MW boiler (wood chips) or small pellets boiler block-wise

Ground water

- (Very) limited potential
- heat pump per building

Ground soil

- 70 - 300 m deep geothermal probes, centralized heat pumps
- Regeneration of the soil needed, e.g. with solar thermal energy in summer – enough potential?

Biogas

- Hardly local or regional sources for biogas generation in relevant amounts
- Power-to-gas option, but PV generation to low
- small boilers or heating plant?

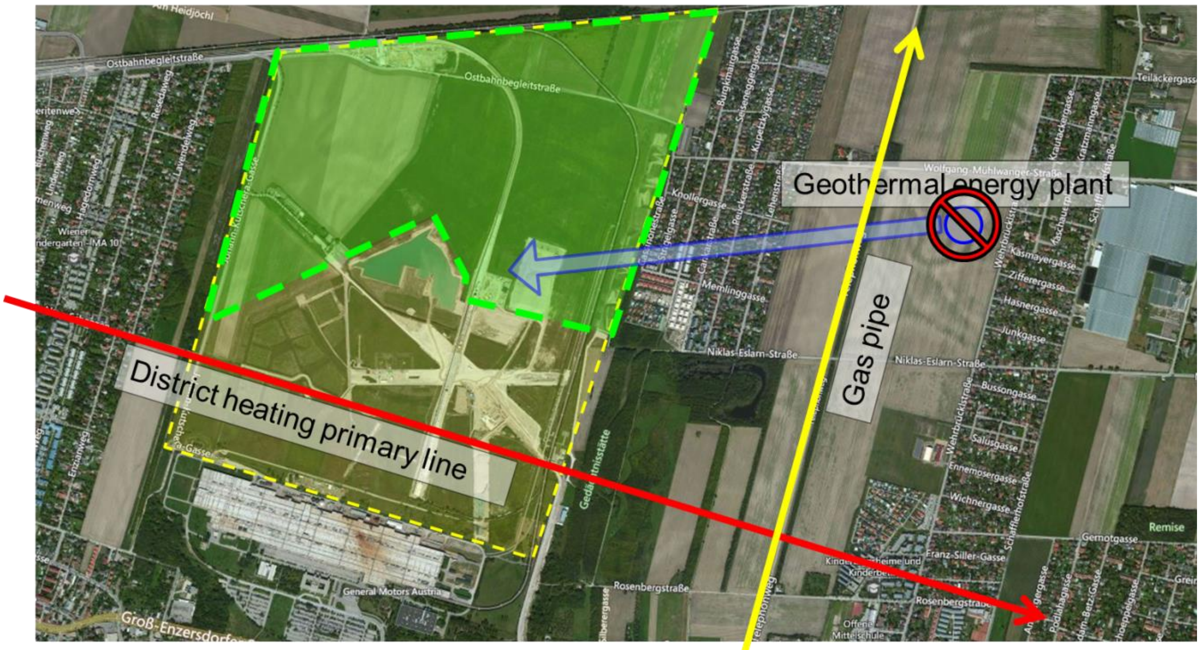
In the afternoon the group was split: one team worked on option 1 (thermal grid) and the other team on option 2 (building block). In the evening the two teams presented their preliminary results in the panel session with all ILS participants.

At day 3 the results of the group work were wrapped up and presented to the stakeholders (see chapter results at the end).

National and International Inputs for Group A

In two sessions national and international inputs were supplementing the group work.

Thomas Kreitmayer from the energy planning department explained the allowed limit of 150 g CO_2 per kWh for the heat supply of the area (set for the environmental impact statement). Because of this limit natural gas alone combined with electricity from the grid cannot be utilized because of their higher CO_2 factors. The first search for geothermal energy 4-5 km deep failed in 2013. New dwellings are very efficient and fulfil nearly a zero energy standard due to strong building regulations in Vienna.



Energy infrastructure in aspern Seestadt; *(see Presentation Kreitmayer 07)*

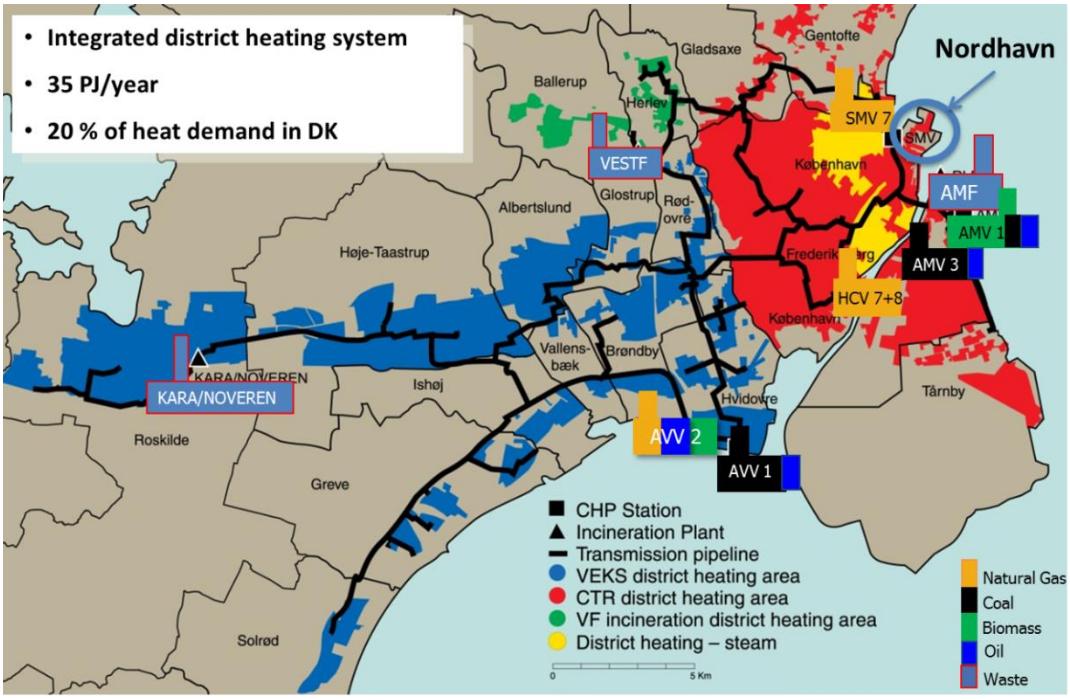
Jan Peter-Anders and Stephan Vielguth (AIT) presented the energy scenario proposed from Wien Energie for aspern Seestadt North, which is based on the minimum standards. In this scenario the western part would be supplied with district heating (green), the northern part with mainly office buildings with ground water heat pumps (blue), the eastern part through a local heat grid with a (bio-)gas plant and with waste heat (orange) and the industrial area in the far east with natural gas (see illustration below).

In Vienna tariffs for district heating are regulated and uniform throughout the city. Unlike for gas and electricity district heating is still a monopole market for Wien Energie - the municipal public owned utility.

aspern Seestadt North mimimum scenario, proposed by Wien Energie to the local energy working group before the ILS Workshop. *(See Presentation AIT 06)*

Niels Hendriksen explained the situation in Copenhagen regarding district heating networks. When planning a new district heating supply area a social economics, company and consumer orientated cost calculation is mandatory.

For the next phases in the Nordhavn area, after the first connection to district heating, other systems like ground water or sea water heat pumps are considered in combination with heat storages.



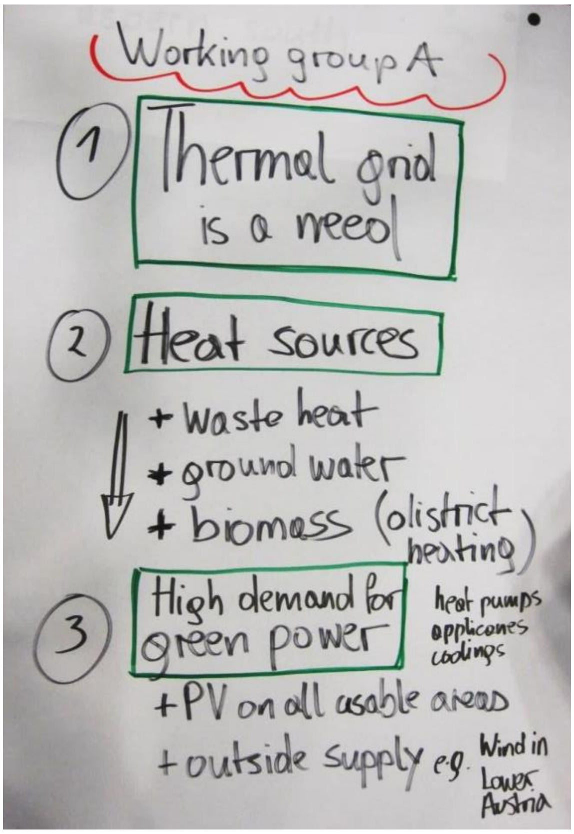
District heating network Copenhagen © Presentation HOFOR @ ILS *(see presentation 09)*

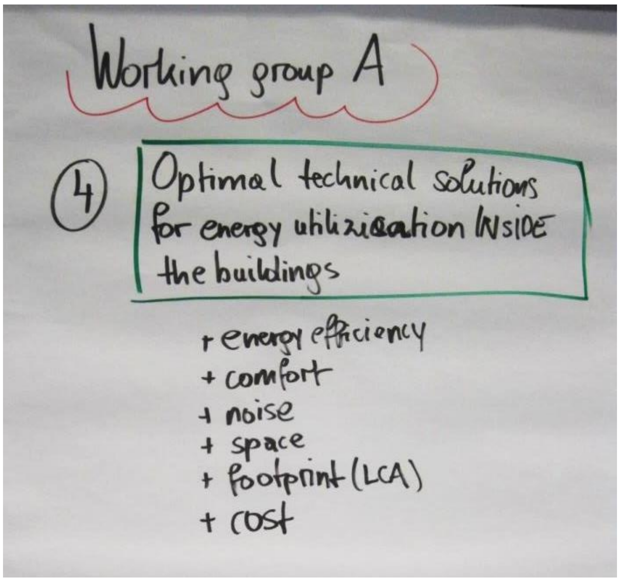
Other international inputs were coming from Hamburg and Amsterdam. Jan Gerbitz from IBA Hamburg presented the energy planning situation at the districts of Wilhelmsburg and Hafen City in Hamburg.

Results and final presentation

The main results of the discussion in the working group are:

1. A local thermal grid is strongly recommended as basic infrastructure for aspern Seestadt North. However in the upcoming first construction phase starting 2016, individual energy supply solutions for building blocks could be adequate.
2. Mainly preferred heat sources for the thermal grid are waste heat (wherever extractable), ground water and biomass
3. Electricity will be a (the) major form of energy used in aspern, for electric appliances but also for heat pumps, air conditioning etc. Therefore there is a high demand of green power. PV installations on all usable areas (roofs, facades, etc.) should be considered as early as possible. Options for supply from nearby regions should be explored.
4. Different opportunities for energy supply, distribution and utilization inside the buildings should be explored under a comprehensive set of criteria like energy efficiency, comfort aspects for the users, noise emissions from systems, space requirement in buildings and apartments, the total environmental footprint and resource input and – of course - costs. All these aspects are highly relevant for acceptance and success of a technical solution.



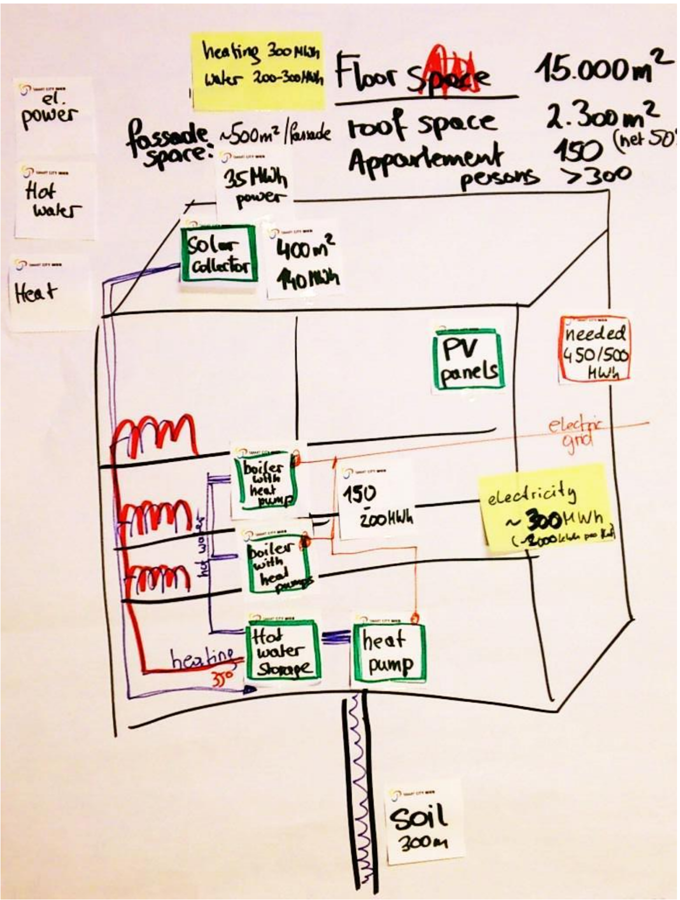


The results of the group work were presented on day 3

Building block solution

Although there is a clear recommendation towards a local thermal grid solution, the discussed “only electric grid and individual block solution” might be an option for the first phase of aspern Seestadt North. As a model case for the discussion served a building block with 15.000m^2 floor space, mainly residential use, with 150 apartments and around 300 inhabitants. The energy demand was estimated with 300 MWh for space heating, 200-300 MWh for hot water and 300 MWh for all electric devices.

A ground source heat pump with a hot water tank storage using heat from 300 m deep boreholes was proposed as heating system with space heating and no radiators at the flats. Using ground heat makes it necessary to recover the soil otherwise the heat reservoir will decline rapidly. For that purpose solar energy might be used. 400 m² of the total roof space of 2.300m^2 are estimated to be usable for solar thermal installations (other area is used for terraces). The energy output was estimated to be 140 MWh per year, so only a rough third of the extracted energy could be returned using this energy source.



Sketch of a building block with a local, individual heating solution and only electric grid connection

The average coefficient of performance of the heat pump is 3, which means for 3 kWh of heat 1 kWh electricity is needed. To provide the heat and hot water energy demand (500-600 MWh) 170-200 MWh electricity is needed. This results in a total electricity demand of about 450 – 500 MWh. At the building only 10% might be generated with 500 m^2 PV panels at the façade. Thus around 400 MWh of green electricity needs to supplied from sources outside the building block area.

Local thermal grid solution

For the local thermal grid two options were presented:

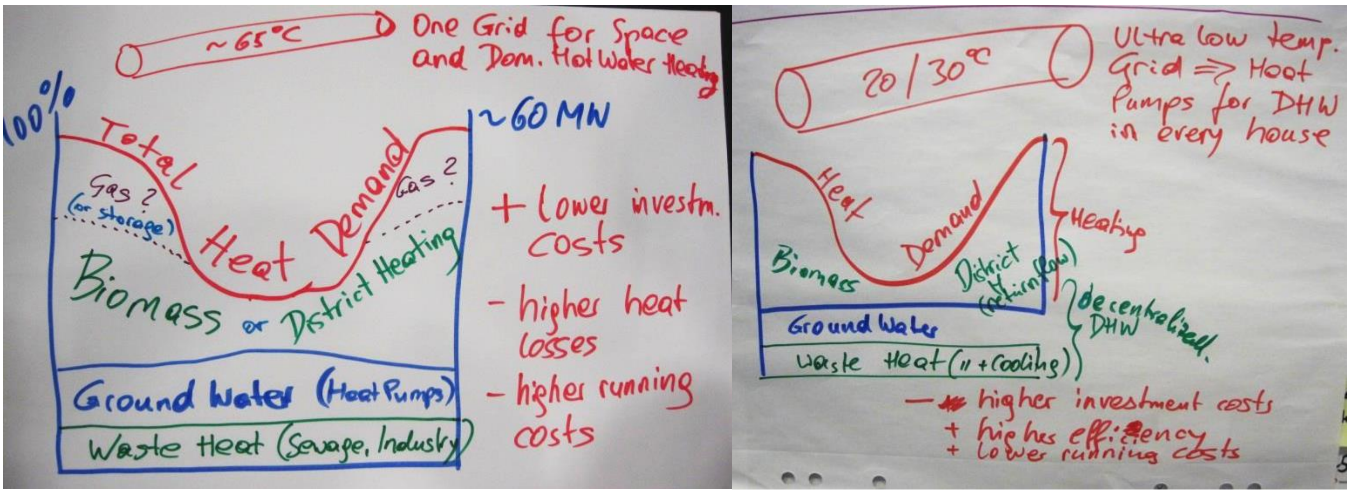
A. Low temperature grid (65°C)
B. Ultra-low temperature grid (20-30°C)

For both options heat sources have the same priority: first using all possible waste heat, then ground water, and the biomass or district heating for the peak periods (district heating just for peak load might not be feasible for Wien Energie).

For option A space heating and hot water could be delivered with the same grid. A biomass boiler would be installed to cover the remaining heat demand (base load supplied by waste heat and ground water). Alternatively district heating was discusses for covering this remaining heat demand. For the few really high demand loads on certain days of the year a gas boiler might be considered as a cost-effective solution.

Option B would be more energy efficient due to the low operating temperature and could possibly also be used for cooling in summer. However for hot water supply decentralised solutions have to be implemented (e.g. heat pumps or boiler in the apartments or building blocks). In case of a connection to the district heating grid for covering the remaining heat demand, the return flow could be used as a source.

In terms of advantages and disadvantages, option A causes lower investment costs (no decentral installations needed for domestic hot water demand) but higher running costs and heat losses than option B. Option B provides with better opportunities to use waste heat (of various temperature levels).



Two proposals for a future thermal grid – low and ultra-low grid with different heat sources

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