INFORSE-Europe Sustainable Energy NGO Seminar

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http://www.inforse.org/europe/seminar_2011_Hamburg.htm

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INFORSE Europe

Sustainable Energy Seminar 23.08.2011

Feed-in of solar thermal energy into a district heating network

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1. Overview of the E.ON Hanse Wärme GmbH
2. Renewable energies in the heating market
3. Long-term thermal storage: example Hamburg-Karlshöhe
4. Overcoming of technical obstacles of the solar thermal energy: project ‘multifunctional storage‘
5. Overcoming of economical obstacles of the solar thermal energy (pilot project Hamburg)
6. Prospect

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

PtJ Projektträger Jülich Forschungszentrum Jülich

solites

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Company

E.ON Hanse Wärme GmbH is the major branch company of this nature in the E.ON regional area.
Company data 2010:

Balance-sheet total	211 m €
Net sales	137 m €
Investments	15 m €
Employees	180
Heat production	1.625 GWh
Power generation in CHP	260 GWh
Plants	ca. 900
Heating networks	ca. 120
Cogeneration (CHP) plants	ca. 150

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E.ON Hanse Wärme

Qualifikations and memberships

- Integrated quality-, health- and safety protection management system DIN EN ISO 9001 / 14001 and OHSAS 18001, certified 2003...2012
- Environmental partnership Hamburg since 2003
- Health and safety protection partnership Hamburg since 2005

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E.ON Hanse Wärme

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Chances for renewable energies - the heating market

Heat generation from renewable energies [TWh] BMWi Energiedaten, Tab. 20	**1997**	**2007**	**2009**
Biomass	48.6	84.2	95.7
Biogenic share of domestic waste	2.3	4.8	5.1
Solar thermal energy [13 Mio. m²]	0.7	3.7	4.8
Geothermal energy	1.3	2.3	5.0

- The share of the renewable energies rose in 2009 up to 8.4%, growth rate 1.0% p.a., tendency rising
- The fuel ‚wood‘ dominates the position ‚biomass‘
- Only the biogenic share of domestic waste is important for the public district heating supply.

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Primary energy effort of district heating (Germany)

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The district heating market is (not yet) a market for biomass and renewable energies

Primary energy effort of district heating supply [BMWi Energiedaten Tab. 25]	**2006**	**2009**
Hard coal	21.1%	22.3%
Brown coal	7.1%	7.5%
Mineral oil	1.9%	2.1%
Natural gas	48.8%	47.2%
Waste etc.	21.1%	21.0%

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Heating network feeding 2006…2010

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	2010 [GWh]	2009 [GWh]	2008 [GWh]	2007 [GWh]	2006 [GWh]	Share 2010
Biomass CHP	56,9	39,8	27,4	16,4	3,8	3,5%
Wood	8,1	10,2	12,1	5,8	5,2	0,5%
Landfill gas CHP	1,5	1,3	1,4	0,9	0,3	0,1%
Solar	0,0	0,0	0,2	0,4	0,4	0,0%
Industrial waste heat	1,5	1,9	4,6	6,7	7,9	0,1%
Sum renewables	68,0	53,0	45,6	30,2	17,6	4,2%
Waste combustion CHP	265,5	270,1	257,7	274,9	245,4	16,3%
Natural gas CHP	370,0	373,8	400,2	369,7	355,6	22,8%
Natural gas CHP, partners	12,3	10,5				0,8%
Coal CHP, partners	31,7					1,9%
Natural gas, boiler firing	877,6	889,8	834,2	802,1	1.074,7	54,0%
Heating networks feed-in	1.625,0	1.597,3	1.537,7	1.476,9	1.693,3	100,0%

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Biogas heating in district heating supply of E.ON Hanse Wärme

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Heating supply	**until 2010**	**2011**	**2012**
Number of heating supplies by external biogas-CHP	8	10	12
Electrical power output	5.0 MW	6.2 MW	6.5 MW
Biogas supply (Biogas 52% CH_4)			
Own biogas CHP plants running	9	21	25
Electrical power output	5.4 MW	10.7 MW	13.0 MW
Bio natural gas feed-in to natural gas grid			
Plants		1	2
Capacity (99% CH_4)		350 m^3/h	700 m^3/h
Electrical power output		1.0 MW	2.5 MW

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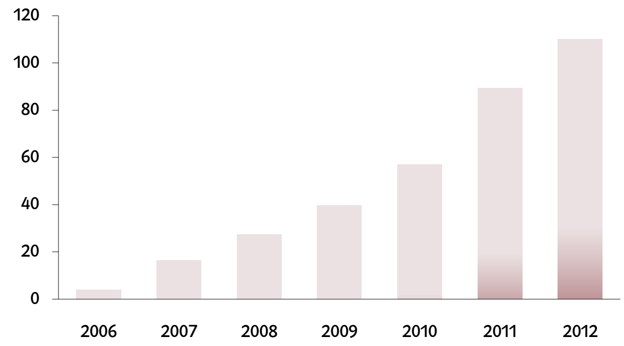
Biogas heating supply [GWh]



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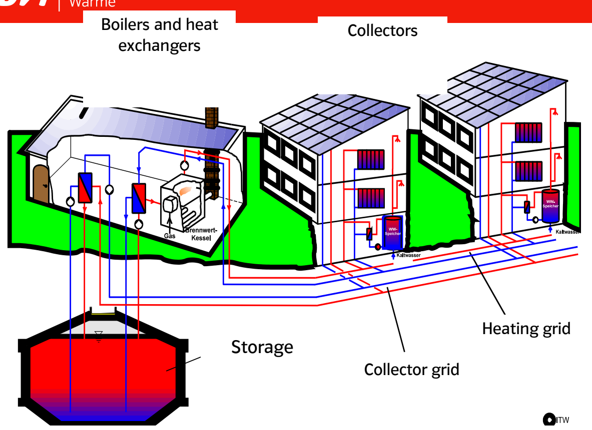
Scheme: concept of the plant



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Flat solar collectors

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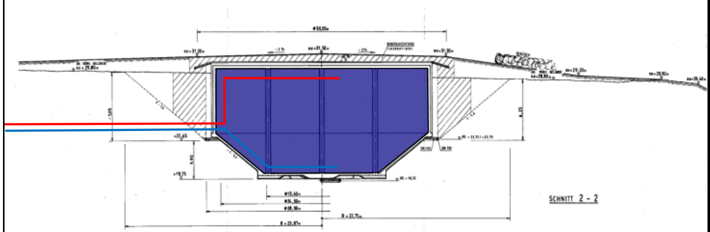
The past: seasonal thermal storage



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Conclusion: solar supported local heating with long-term thermal storage in Hamburg-Bramfeld:

- The solar heat production of 309 kWh / m² in the 5-years-average was within the expected range.
- Solar heat production: 905 MWh in average. Heat losses of the storage system: 400 MWh (!)
- The solar variable gross margin of the heat demand was between 25 and 26%. The heat losses of the storage system were generally too high.
- The combination between 3.000 m² collector surface und 4.500 m³ storage volume proved it‘s value.
- Due to temperature-related stretching and several changes of load (day to night), the collector network is unuseable and has to be replaced.

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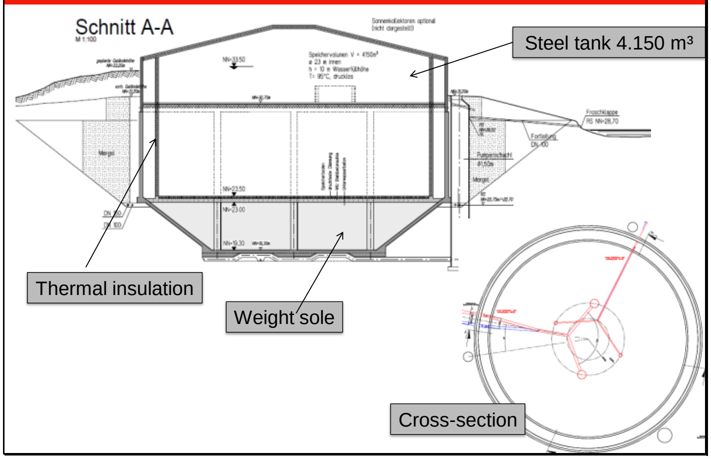
The future: multifunctional storage ± 10 MW



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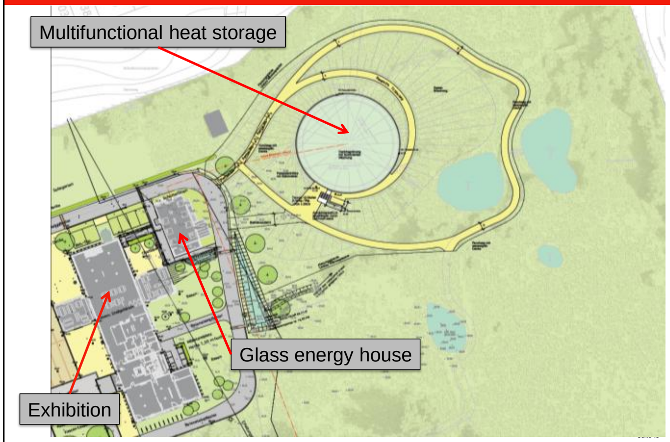
Map of the area: Gut Karlshöhe



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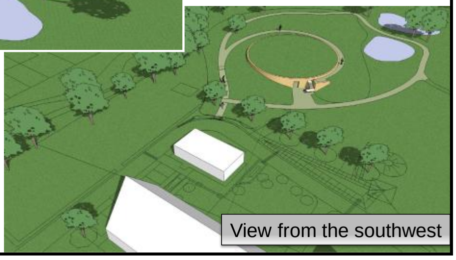
Visualization of the heat storage

View from the east



View from the southwest

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‘Glass energy house‘ (2011)

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Network concept

<u>Solar thermal energy is not predictable</u>

The solar energy feed-in causes rising temperatures of the water flow.
Countermeasures:

- First, the fossil fired production capacities are getting reduced, followed by the cogeneration capacities.
- If the total heat demand is less than 10 MW, e.g. on hot summer days, the storage will be charged with a maximum of 10 MW and discharged after sunset.
- We are striving for a combination between forward and return pipe network feed-in. The lowest rotation water amount in the network is controled via bypass at a suitable point.

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Network concept

Solar thermal energy leads to material stress.

The collector network is stressed by temperatur changes from day to night; the pipe material will be altered.

Countermeasures:

- The temperature in the collector circle gets limited to 100 °C by variable volume flow rates.
- The feed-in into the heating network can occur when the temperature in the collector circle is above the temperature of the network.

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Network concept

Solar thermal energy is expensive
Countermeasures:

- Good locations and roof directions are preferred for the solar collectors. The common building s in the network area are multiple-familiy houses with 4 to 8 floors and a flat roof.
- The collectors and heat exchangers should be standardised.
- In addition to the delivery from the district heating, a second heat exchanger with feed-in heat-measurement will be installed.
- Expensive installations for heat storage within the buildings cease to apply.
- The network-using concept allows to allocate the solar heat of one or several solar collector systems at a withdrawal point.

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Elements of the project

- The long-term thermal storage has been developed into a multifunctional storage capable for temperature up to 100 °C. The new cover of stainless steel and the new thermal insulation are designed for a technical life-cycle of 50 years.
- The storage is connected by a 3 km extension to the district heating system Hamburg-East (120 MWh / 400 MWh). The maximum storage capacity is 240 MWh (10 MW / 24 hrs.)
- The combined network is conneced to several area networks which simplifies the hydraulic integration of the solar collectors.
- Heat from solar collectors, renewable energies and surplus heat from CHP plants can be stored.

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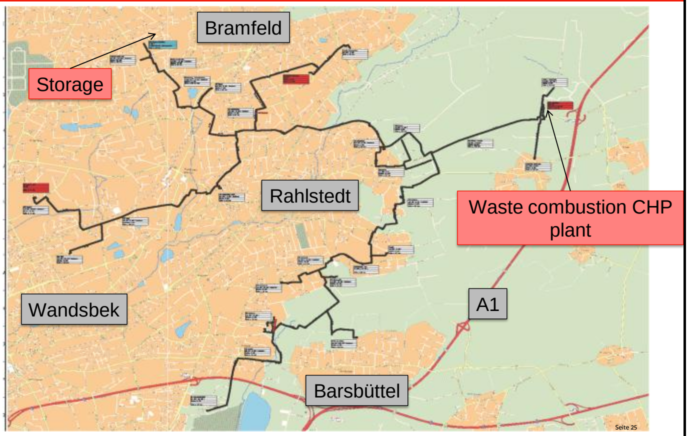
Combined heating network Hamburg-East



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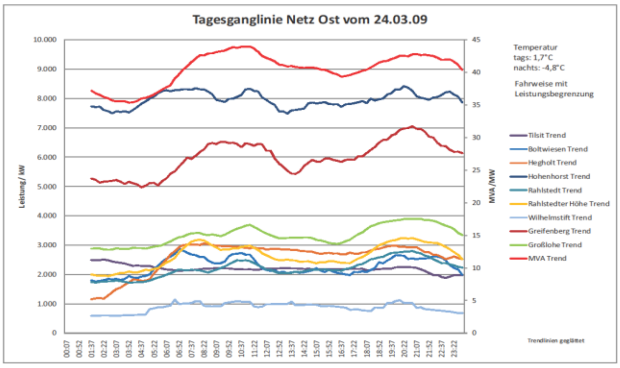
Heat demand at 0 °C in average



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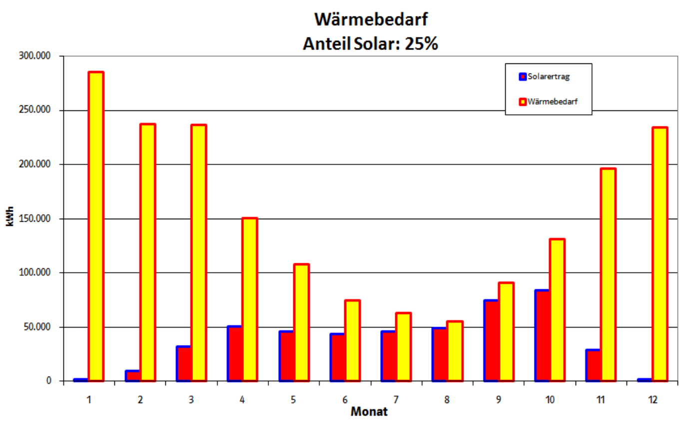
Solar yield of the plant 'Karlshöhe'



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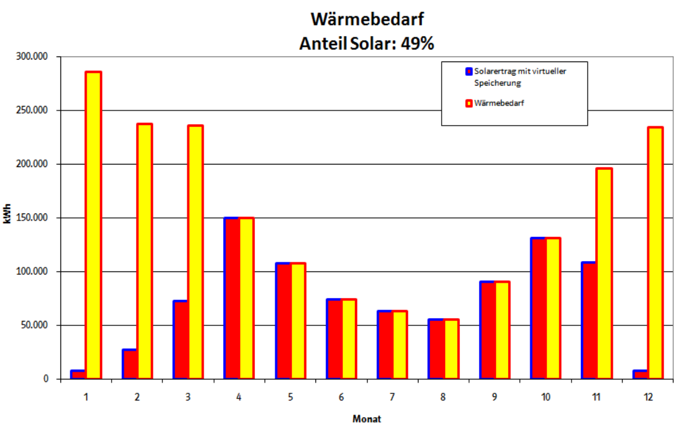
Solar yield of the plant; storage without thermal losses



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Solar network usage – concept description -

- The solar collectors in a standardised performance are connected to the network by heat exchangers. The feed-in is normally connected to the flow. The average temperature of the return water is 55 to 60 °C.
- Internal heat storage in the building and the required control systems are not necessary. Compared to conventional solarthermal systems, this technique reduces the investment.
- The amount of heat fed into the network can be released from strorage when- or wherever it is required via a supplier's service installation.
- Feed-in and withdrawal will be credited within one balance sheet (8 months from April to November).

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Solar network usage – concept description -

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Examples:

1. A building, equipped with a solar collector, is connected to the network. The solar heating yield is fed into the network and will be credited in the balance sheet.

2. A building, equipped with a solar collector, is connected to the network. Another connected building is supplied virtually by the solarthermal energy. This building can have a different owner. The heat yields and demands are credited in the balance sheet within the balance period.

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Solar network usage - balance sheet -

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Example for particular case	feed-in	delivery
Solar collector surface	150 m²	
Peak power	75 kW	
Heat yield	60 MWh	
Electricity consumption feed-in	300 kWh	
Balance period (months)	8	
Share of heat yield	89 %	
Heat network feed-in	53 MWh	
Thermal power (-12 °C)		100 kW
Heat demand of the building		180 MWh
Within the balance period		90 MWh
Share of solar energy		29,7%
Primary energy factor		
Network	70,3%	0,70
Solar	29,7%	0,00
In total		0,49

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Balance sheet circle

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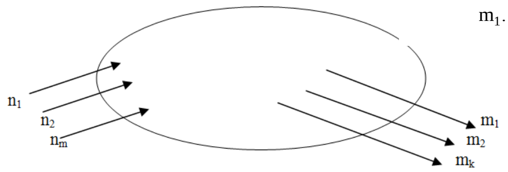
Feed-in points $n_1 \ldots n_m$

Withdrawal points $m_1 \ldots m_k$



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Solar network usage - payment -

- The connection of a solar thermal collector to the network is usually covered by the fixed price [€ p.a.] for the supplied buildings.
- Access to the system, consisting of network, pumps, heat losses, virtual storage, balance sheet etc., is offered for 5,- € / MWh.
- The metering-point of the feed-in is charged with 60 € p.a. (until 100 kW)
- The heat amount fed into the network will be completely credited.

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Advantages of the solar network usage concept

- In a customer-to-customer relation, the price for internal heating storage is covered by the system payment of 5,- € / MWh, which is less expensive than the internal storage.
- The variable gross margin of solar thermal energy for heating requirement is maximized up to 50%.
- The primary energy factor of a residential building can be improved in addition to the key figure [$f_{PE,DH} = 0{,}60$] of the network.
- Efficient roof orientations and building situations can be used. The solar collectors are getting independent of the building which has to be redeveloped.

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Advantages of the solar network usage concept

- Apart from the fact that there is a low heat loss in the collector circle all the solar heat can be used. The losses of the storage are marginal while those of the network are constant.
- The solar heat is covering the network heat losses in summer, will be stored virtually or will be delivered directly to the customer.
- In the balance sheet network heat losses will be ignored.
- Due to the new double insulation, the heat loss in the 4.000 m³-storage is practically zero.

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Prospect

- The projects ´multifunctional storage system‘ and ´glass energy house‘ are a contribution to ´Green Capital‘ Hamburg 2011.
- Other models for network usage of heat from renewable energies are in development.
- E.ON Hanse Wärme plans to reduce ist CO_2-emissions for heat supply from 120 g / kWh to less than 100 g / kWh in 2015. Back in 1990, the emissions were > 260 g CO_2 / kWh.

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Thank you for your attention!