Urban Planners with Renewable Energy Skills

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Deliverable
Best practice examples

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Dissemination level		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	

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The UP-RES project provides urban planners with fundamental knowledge about energy efficient planning and integration of renewable energies. In order to encourage them to use their newly acquired knowledge, 24 best practice examples have been collected. These cover a broad range of different measures to enhance sustainability and result in a more environmental friendly energy generation and usage. All examples are listed below:

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Each best practice example is explained in detail on the following pages.

2. Best Practice Examples

The Greenest City in Europe – Växjö, Sweden

Concept

According to the Law on Communal Energy Planning (1977:439) each municipality is responsible for preparing an energy plan that covers production and distribution of energy in the municipality. The Plan shall promote energy economy, sufficiency and reliability of energy supplies, and even be approved by the city council.

Here the example from Växjö is presented, as Växjö is largely consdered as one of the greenest cities in Europe.

The Energy Plan for Växjö municipality has been updated on Sep 11, 2011. The summary action plan of the Energy Plan is as follows:

VKAB – Växjö Municipal Concern Ltd

	Description of task	Responsible
1	When constructing new buildings, 0.5% of the total investment costs shall be earmarked to RES production.	Technical office and VKAB
2	When rehabilitation of the existing hydro power plants is planned, increase of production capacity shall be included in the rehabilitation program.	Technical office
3	The technical office and the housing companies shall become more self sufficient with renewable electrcity, This can be done, for instance, by means of investments in larger wind power plants or power production from local RES sources. During the mandated period of time, the muncipality has to built plus-energy buildings.	Technical office and VKAB
4	Växjö Energy Ltd shall provide incentives for small-scale power production to the grid from urban wind power and solar cells (PV)	VKAB
5	In the dialog with the constructors, the municipality shall encourage investments in small scale power generation	Construction office and municipal council
6	Växjö municipality shall inside its economic rights support and initiate renewable energy production	Municipality council
7	The municipality has to take care that areas as much as possible will be supplied by district heating. Dialog about the DH extension shall materialize with private and DH companies and small-scale heat producers.	VKAB, Municipality council
8	District cooling has to be built to cover more customers.	VKAB

9	Växjö Energy tests bio oil in one small-scale heating plant. Experiences if positive shall be used to extend operation security in the way to use more bio oil in the other heating systems as well as in Sandviksverket.	VKAB
10	Växjö municipality shall lead active dialog with companies and promote relevant opportunities in order to promote large scale wind power according to the wind exploitation plans.	Municipal council
11	Peat use shall be minimized and phased out by year 2020.	VKAB
12	In every building rehabilitation case, the municipal building companies shall prepare calculations in order to meet the below mentioned heat consumption indexes. By the year 2015, at least 50% of the rehabilitated residential Residential buildings: buildings have to meet 75 kWh/m^2 a year, and regarding electricity heated building separately to meet 40 kWh/m^2. Other buildings: 70 kWh/m2 and regarding electricity heated building separately to meet 40 kWh/m^2. In case such inzxes cannot be reached, it shall motivate monitoring of each building object according to the energy plan.	VKAB
13	Växjö municipality shall have actively provide energy efficiency and air conditioning advisory services to residnetials, companies, house owners, organizations and associations in order for them to be able to obtain support and advice to their energy efficiency improvement activities.	Technical office and municipal council
14	Växjö municipality shall study how the renovation/rehabilitation activities in apartments and buildings can be managed when energy use shall be reduced while using the life-cycle analysis as the tool.	VKAB and municipal council
15	The municipal companies shall build only residential buildings that use energy less than 55 kWh/m^2 (and for electricity heating 30 kWh/m^2).	VKAB
16	The municipal companies shall build only buildings other than residential that use energy less than 50 kWh/m^2 (and for electricity heating 30 kWh/m^2).	VKAB
17	Växjö municipality shall study how the new building projects can be designed according to the life-cycle costs minimization, particularly in terms of energy consumption.	VKAB and municipal council
18	Before newbuilding projects, an analysis hasto be carried out about how flexinble solutoins could be used to allow several activies to be used in the buildings in parallel.	VKAB, building office and municipal council

19	Metering and billing of energy consumption shall be organized on apartment level where ever possible.	VKAB
20	a study has to be carried out how the energy consmption of public buildings can be allocated to municipal organizations	VKAB
21	Växjö municipality shall lead new energy saving campaigns that are based on positive experieices from the implemented energy saving projects, for example SAMS. We demand that these campaigns have to have the perspective of children and youngsters.	VKAB and municipal council
22	Växjö Energy Ltd shall use various teknological and economical solutions in order to serve district heating to very energy efficient buildings. This may even include district heating driven household applications.	VKAB
23	We demand that one of the building areas shall be studied from the smart net point of view.	VKAB and municipal council
24	The possibility to complement the Sandviksverket plant with a production unit driven by renewable energy shall be studied.	VKAB
25	Växjö municipality shall work for development of the bio gas markets together with various actors and participate in various bio gas projects.	Technical office
26	The municipality shall work for improving the infrastructure of renewable driving power and charging opportunities for electric vehicles. All larger municipal working places shall offer charging facilities.	VKAB, technical office and municipal council
27	Opportunities will be offered to residentials, companies and the municipal concern to testelectric vehicles with the intension to increase the intrest and the knowledge level of electric vehicles.	VKAB
28	Demonstration projects will be organized in order to study possibilities to use renewable driving power or electricity in the service vehicles and tools of the municipality as well as in public transport.	VKAB, technical office and municipal council
29	Energy efficient and sustainable vehicles shall be prioritized when buying new vehicles to the municipality.	Municipal council
30	A strategy shall be created to ensure sufficient delivery of RES for heating, cooling, electric power and driving power.	Municipal council
31	Another strategy shall be created for Växjö Energy in order to ensure reliable supply of heating, cooling and electricity to its customers	VKAB
32	Measures against risks and vulnerability shall be defined in order to secure the reliable supply of energy to both urban and rural areas.	Relevant offices
33	The municipality shall inform the industry about the energy services of Växjö Energy. This shall be done throught the internet and visits.	VKAB, environmental and health offices and

		municipal council
34	The municipality shall initiate a project that focuses on energy and climate from the point of view of environmentally risky operations. The municipality shall identify in this respect energy intensive industries and strat the dialog in order to reduce energy consumption in such industries.	Environmental and health offices
35	An group ef experts shall be created as an arena on which the representatives of comonaies may discuss the energy and climate issues. For instance, the group can work based on benchmarking or on change of eperience between municipal and private building companies when energ eficient buildings and apartments are concerned. An annual event on energy and air conditioning shall be organized in Växjö as well.	Municipal council
36	Every adminstration unit and company shall prepare a plan to phase out the fossil fuels.	All offices and councils
37	The municipality shall issue instructions about how the energy consumption and impacts on atmosphere of entrepreneurs and services can be reduced over the whole life cycle.	VKAB, technical office and municipal council
38	Växjö municipality shall work actively to to influence both the national and international climate policy	Municipal council

Lesson to learn

The municipality can set an action plan that stimulates the private and binds the municipal stakeholders in the city towards energy efficiency and RES use, as has being done by Växjö in Sweden.

Source: www.vaxjo.se

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RES and EE Penetration in Freiburg, Germany

Freiburg Introduction

Freiburg is situated in South Germany near to the French and Swiss borders with the data as follows:

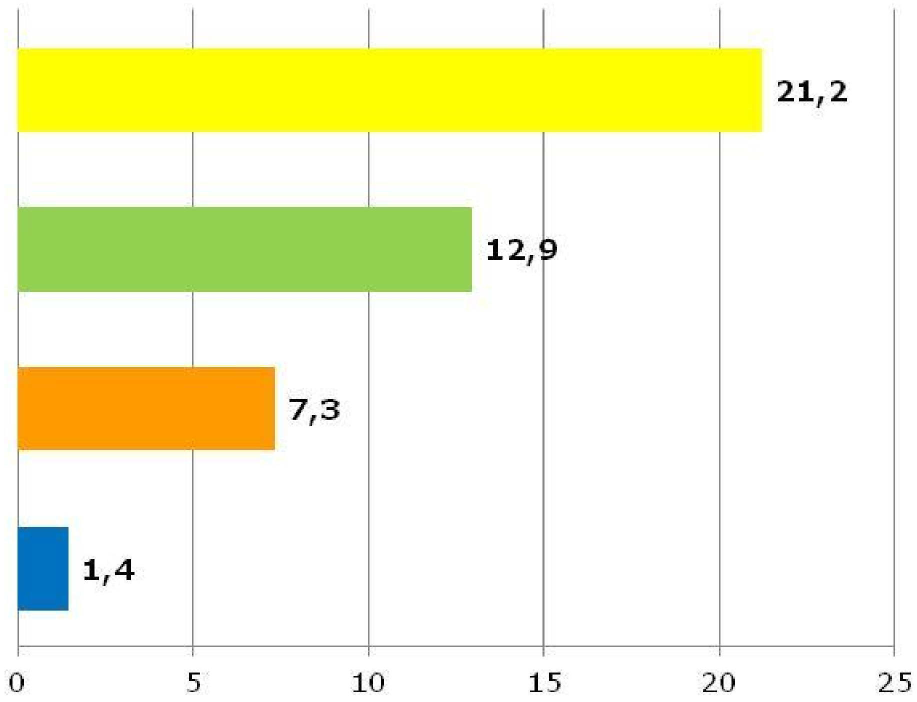
- 220.000 Inhabitants
- 130.000 Jobs
- 54.000 In-commuter
- 16.000 Out-commuter
- 29.000 Students
- 4,2% unemployment rate
- 1,29 Mill. guest nights (!) in 2010

Policy

The CO_2 reduction strategy of the city comprises 63 measures on the following fields:

1. Municipal development planning: solar optimization in development areas while arranging and orienting buildings, avoiding shadows, orienting/inclining roofs as well as introducing new EE standards to buildings
2. Municipal buildings and facilities: pilot EE projects and solar panels on public roofs, building modernization to meet passive house standards
3. Mobility: Extension of public transport network to cover all citizens with not more than 500 m walking distance (presented in another Best Practice case)
4. Internal organisation and communication: Exhibition on low energy building and refurbishment,
5. Supply – disposal: development of district heating and micro-scale CHP

Achievement



Freiburg actively promotes RES expansion. In the above picture, the yellow, green, orange and blue colours represent electric power generation based on solar, biomass, wind, and small hydropower, respectively, in terms of the installed capacity (MW) in year 2010. The power generation of 42,8 MW in total is constantly growing.

Photo: Both the solar panels for electricity and the solar collectors for heat production in the same building in Freiburg (Photo: A. Nuorkivi, AaltoPro).

Conclusion

Systematic work to substitute fossil fuel based heat and power with RES is possible in the city scale.

Sources of information:

- Innovation Academy e.V., Freiburg
- City of Freiburg

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Public and Light Transport Prioritized in Freiburg, Germany

Freiburg Introduction

Freiburg is situated in South Germany near to the French and Swiss borders with the data as follows:

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- 130.000 Jobs
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5. Supply – disposal: development of district heating and micro-scale CHP

Local public transport in Freiburg

Tramway

- 36,4 km railroad network
- 83 vehicles
- 7,5 minutes interval during the day
- 70% of all passengers

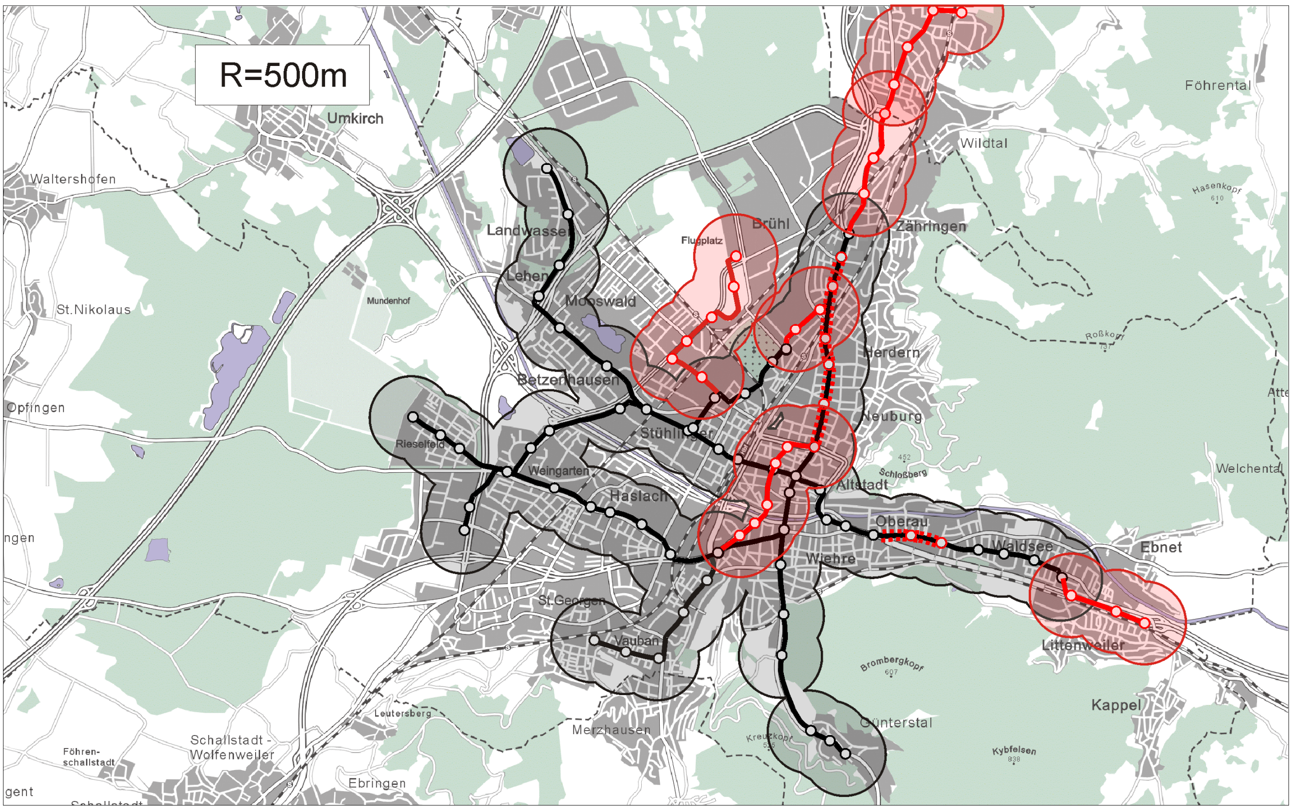
Bus

- 274,3 km bus network
- 73 buses
- 30% of all passengers

Achievement

Achievements of the public transport (VAG Freiburg) are, for instance:

- In 2010 some 74,4 million passengers travelled with the VAG's trams and buses. On average, that meant 200,000 passengers a day who saved the environment from exhaust emissions and traffic noise! This is an astounding number for a city with a population of 220,000.
- The backbone of the network is based on four tram lines providing services every seven and a half minutes. Optimally coordinated with the tram service are 26 bus lines taking passengers from the most important interchange points to surrounding areas
- In a few years to come, thanks to intensive use of public transport and optimized routes, the public transport will not any longer need subsidies but it will cover its costs by means of the ticket sales revenues only.



Extension of public transport network (red) to be reachable by the inhabitants in less than 500 m walking radius.

Other CO2 reduction strategy achievements in Mobility:

- In Rieselfeld of Freiburg, thanks to improved public transport, the car density is as low as 28,5 cars/inhabitant compared to the average of 35 in Freiburg.
- The bicycle parking house for some 1.000 bikes was built near to the main railway station in year 1999 already. It is in constant use to integrate rail transport to biking.
- Additionally, a city biking system and extensive biking routes reduce the need of private cars.

Photo: Cars do not have access to the bridge that is dedicated for bikes in the middle and for pedestrians on the sides (Photo: A. Nuorkivi, AaltoPro).

Conclusion

Systematic work to substitute fossil fuel based heat and power with RES is possible in the city scale.

Sources of information:

- Innovation Academy e.V., Freiburg
- VAG Freiburg 2011
- City of Freiburg

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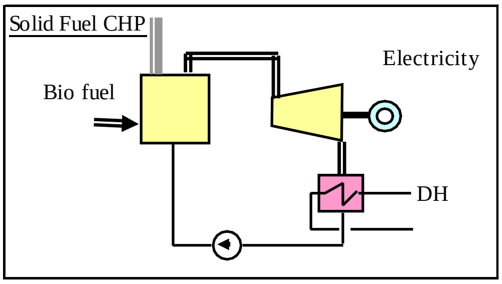
CHP using renewable fuels in Tallinn, Estonia

In Tallinn, the modern CHP plant uses waste wood collected from the radius of 100 km to generate both heat and electric power. First, the waste wood is cut to chips that are taken to the combustion chamber of the steam boiler. The boiler generates superheated steam at high pressure and temperature that runs the steam turbine and the generator to generate electric power. The waste heat is used for district heating in the city of Tallinn.



The electric output of the plant is 25 MW whereas the heat output can change from 70 to 55 MW depending on whether the condensing energy of the flue gases will be recovered or not.

While using the heat recovery, the overall efficiency of the CHP plant can be as high as xx%.

The CHP plant was commissioned in year 2009 with the total investment costs of € XX million.

Two similar plants in Estonia exist in Pärnu and Tarto but run by the Finnish Fortum company. More such plants are operated in Denmark, Sweden and Finland.

Lesson to Learn

Centralized use of biomass together with CHP/DH technology is the only way to generate heat and power at such a high efficiency as xx%. This requires an integrated optimization of approach of fuel supply logistics, land use for the fuel storage, CHP and the heat distribution networks.

Sources: www.dalkia.com, www.fortum.com

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Advanced Planning of Porvoo City Expansion, Finland

Summary

In the city of Porvoo, the entire city planning procedure has been changed. The traditional way was that that municipality created the general location plan in which the buildings could be easily built and connected to rads, and the physical dimensions of the buildings could be set. The actual building codes had ensured that the new buildings met the EE norms. Thereafter, the energy and water utilities connected the buildings to their infrastructure in the best way still possible.

In the new way, the energy experts and the urban planners start working together in the general plan stage already. The impacts of various plans will be quantified in terms of energy consumption, investment and operation costs as well as emissions. The particular plan will be chosen for implementation which offers the lowest lifecycle costs and emissions. In Porvoo case, the new urban plan that was based on maximizing the share biomass fuelled CHP and DH appeared to be the best choise from environmental point of view, and moreover, with the overall life-cycle costs much lower than the traditional plan would have caused. In other words, it was a win win approach from both reduced emission and cost point of view, which was highly appreciated by the local decision makers.

Porvoo case introduction

Porvoo is located just 40 km north-east of Helsinki, the capital of Finland.

During the first stage of the project an outline plan was drawn up for the Skaftkärr area of Porvoo, Finland, on the basis of which a new energy efficient and low-carbon district for 6 000 residents will take shape in the near future in Porvoo. In planning the residential area, information has been produced on what types of methods could be used to improve energy efficiency in the areas, what the effectiveness is of the various methods and how planning practices could or should be developed so that energy efficiency in the areas improves.

Models for assessment

The difference of the old and the advanced approaches can be emphasized with the five planning model examples as follows:

Model 0+: The traditional plan from year 2007 was considered as the reference case: Business as Usual -case. The buildings are scarcely located in places where they look naturally situated, and to which the roads and infrastructure can be easily built. The buildings in the refrence case are assumed to be low-energy houses as in all other cases as well. Therefore, the building energy efficiency did not make any difference between the models.

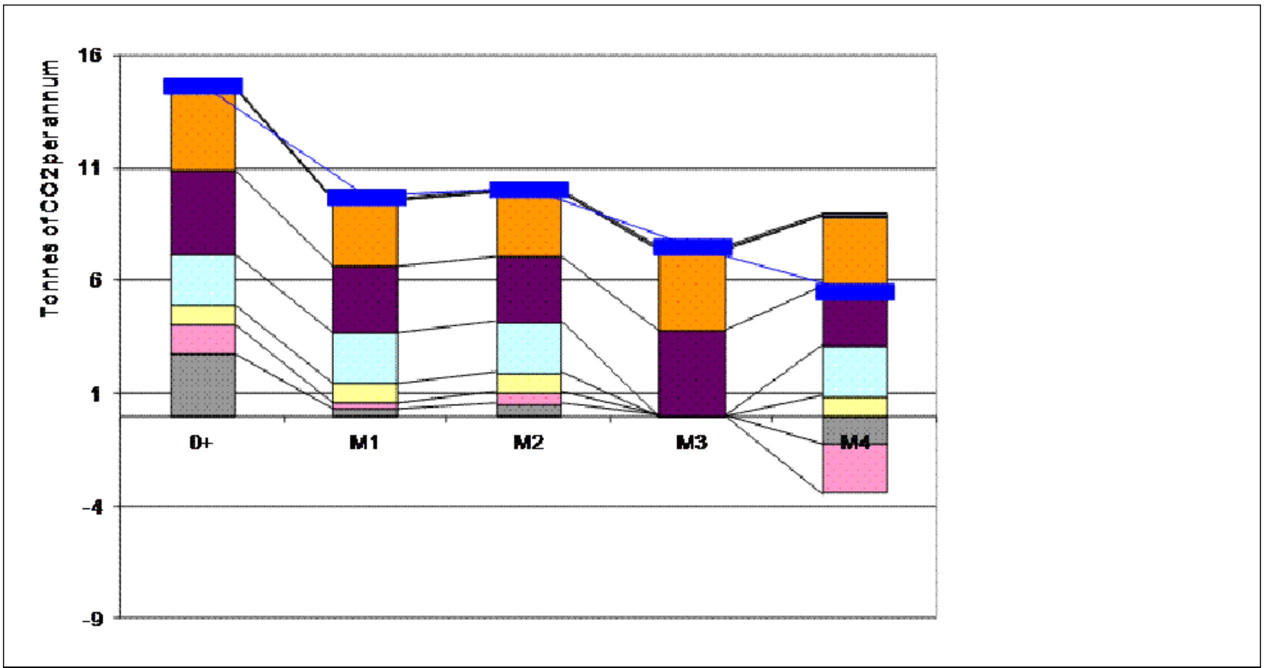
Model 1: A dense model supported by the nearby city centre. The low-energy house are connected to the district heating system, that is 70% based on biomass and the balance of 30% on natural gas. Effective public transportation has been planned as well as advanced light traffic routes from the northern part to the city center have been included in the plan.

Model 2: An effective model dominated by small houses. The energy source of the low-energy small houses would be a micx of 50% DH, 50% grould water heat pump heating. The emission of traffic and public transportation have been minimized by using the dense housing structure and effective routes of public transportation.

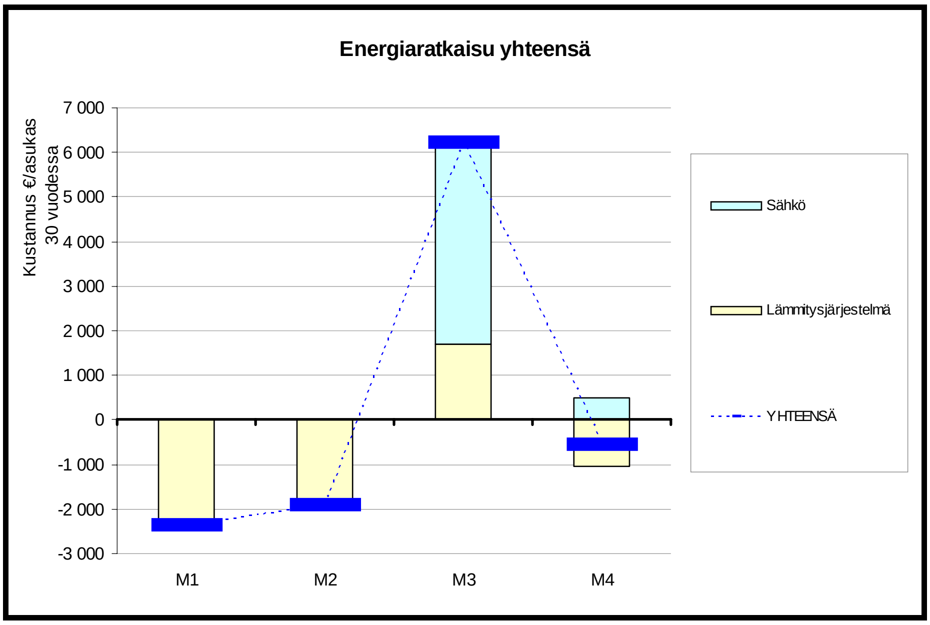
Model 3: A scarsely built model with low-energy houses, in which individual electricity and heat generation based on 100% RES was used. Trafficwas as in Model 0+.

Model 4: A community type land use model, in which the focus is on minimizing the needs of traffic. The working place, distance work location and services asare located in the particular area. Also effective public transport and light traffic systems are included. The heat is produced 100% by solar. In addition, in the project area, solar heat ould be produced thte use of the entire city of Porvoo.

The picture below show the CO_2 emissions of the Models 0+, 1..4.The largest emitters are private cars, the violet representing the work related travel whereas the yellow representing the other, mainly free-time travels. The blue on the top is the public transport a dn the light blue shows the electric appliances. Heating is marked with gray and the domestic hot water with pink color. As conclusion, in all models the CO_2 emissions were lower than in the reference model.



In the below picture the life-cycle costs of the Modules 1..4 are compared to the reference investments of Module 0+ in terms of the units costs per capita. The infrastruture costs comprise the utility networks adjusted to the actual type of soil as well as the customer investments. The light blue and yellow represent the lifec cycle costs of electricity and heating, respectively. A surprise was that the costs of all cases other than Modul 3 were lower than those of Module 0+. In Module 3 in particular, the ultra high investment costs are caused by individual RES systems in buildings.



Conclusion

The Porvoo case emphasized the vital need of educating the urban planners with RES and EE skills in order to introduce the new planning approach elsewhere in Finland. In general, there is little co-operation between the energy and urban planning experts in pratise, and the planning processes of energy and land use are fully separate, no interaction at the moment.

Internationally, the Finnish energy systems have been frequently awarded as the best practise in the world (IEA, UN, Euroheat& Power) and the country is famous for its architectural tradition (Aalto, Saarinen, Rewell, etc.). Therefore, one might think the coordination of energy and urban planning is fairly consistent, but unfortunately this is not the case. The Climate Change has set new requirements that have not been recognized in education programs and in planning processes so far.

We have realized in Finland that modernizing the urban planning process will take time and much effort due to the large insitutional barriers: lack of tradition in co-operation, lack of common understanding among the urban planning and energy experts, consequential processes rather than parallel ones, etc.

As conclusion, in order to achieve the sustainable city plans with maximum energy efficiency and optimal RES applications, the following impacts shall be evaluated and quantified in the spatial planning process:

- Impacts on energy supply in the planning area
- Impacts of various plans to the costs of the city
- Impacts of various plans to the costs of the customer, the resident
- Impacts on the energy company’s business opprtunities in the future
- Impacts on the green house gas emissions and on other environmental issues.

Sources of information:

- www.skaftkarr.fi
- www.porvoo.fi
- www.sitra.fi
- www.porvoonenergia.fi
- www.posintra.fi

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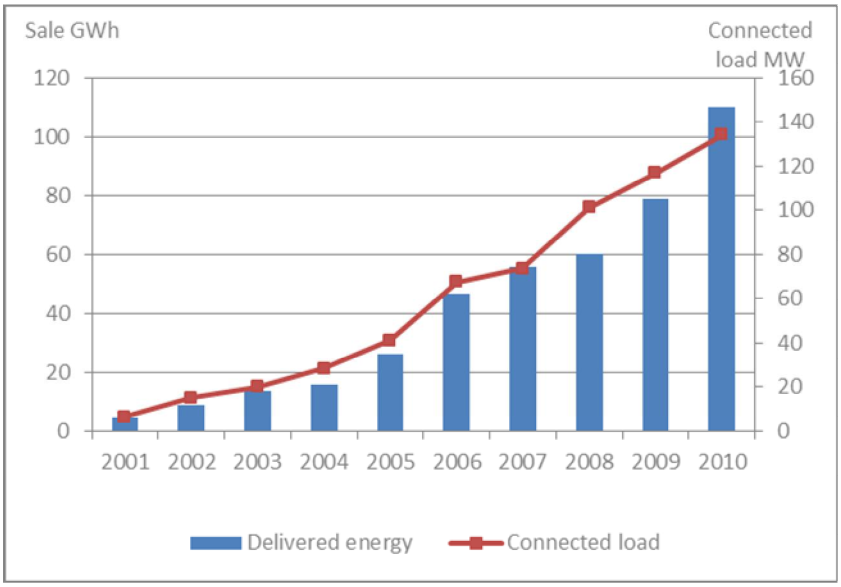
District Cooling in Helsinki

Despite the northern location, there is an extensive and constantly growing district cooling system in the Finnish capital Helsinki. Helsinki Energy utility delivers district cooling to their customers by means of water at +8^{o}C temperature and the customer returns the water back to the utility at +16^{o}C temperature. The temperature difference is used for cooling the customer building.

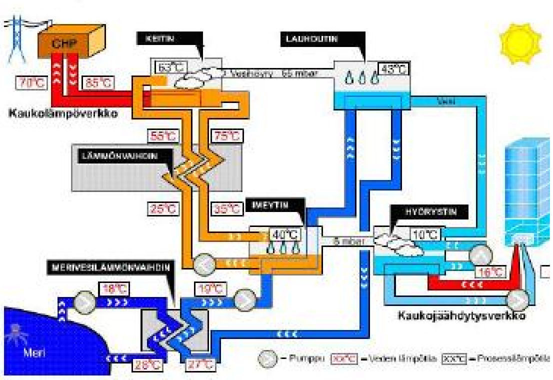
The district cooling development in Helsinki started in 2001 and the DC supply has been constantly growing on fully commercial basis, as presented below.

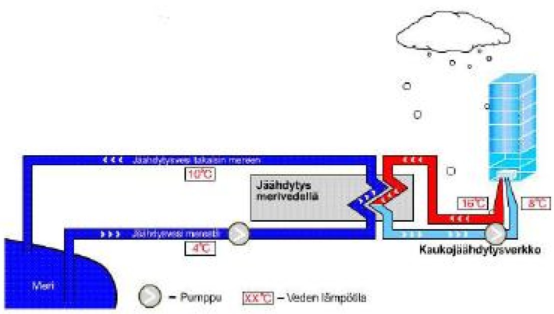


The cooling system consists of three different technologies and locations as follows.

First, sea water is used for cooling when the water temperature is low enough as a means of free cooling. A heat exchanger of platin material is used to transfe the cooling to the DC circulation.

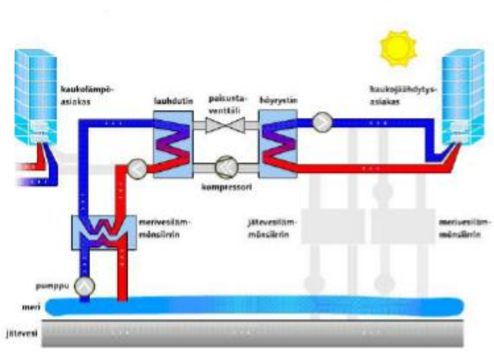
Second, in Ruoholahti suburb, district cooling services are provided by means of absorption chillers of 35 MW in total. The chillers are driven by district heating instead of electric power. The chillers are used in summer time because the sea water temperature is not cold enough to cool down the buildings connected to the chilling system In winter, on the other hand, chillers are not needed but the sea water with low temperature is sufficient to provide natural cooling to the buildings. In order to increase flexibility in district cooling services, there is a storage tank of 1000 m^3 capacity to be charged/discharged according to the actual needs. Typically the tank is charged in the night time, when the cooling demand is low but discharged in day time to reduce the operation of the absorption chillers.

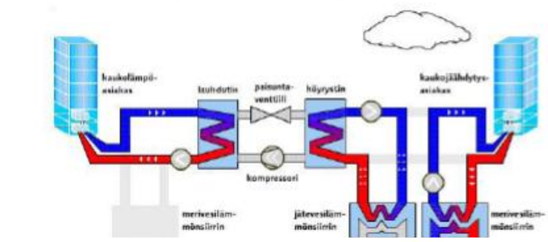


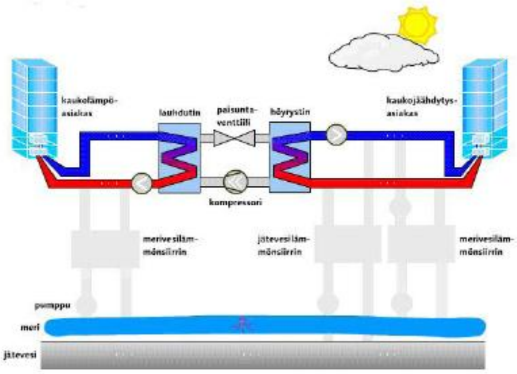


Third, there is a compressor driven heat pump plant under the Katri Vala park that provide district heating in winter and district cooling in summer time.

a) In summer time, the plant provides cooling at 60 MW capacity





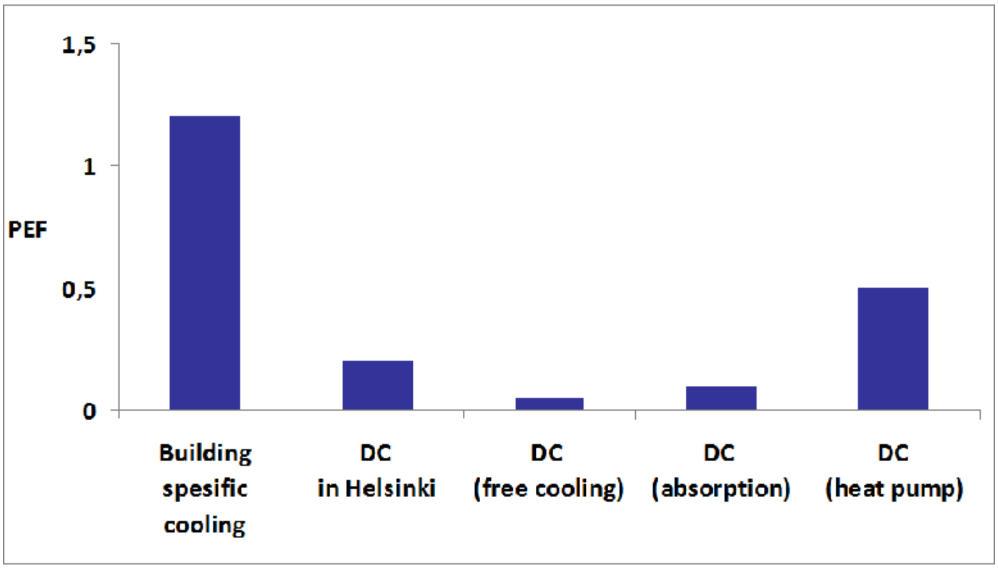


c) Heat pump both in spring and autumn

In summer the source of cooling is the sea water but in winter the source of heating is the waste water tunnel of Helsinki. In spring and autumn the same machinery can be used both for heating and cooling simultaneously. Both the sea water and the waste water are renewable energy sources to be used for cooling and heating, respectively.

Moreover, in case the customers have compressor driven heating, the return water of the district cooling system can be used for cooling of the compressor released condensing water.

In the annual energy balance, the district cooling systems of Helsinki uses 60% of renewable energy in terms of low temperature of the sea water and the waste heat of the power plants. The waste heat cannot be fully sold to the district heating customers in the summer time but can be used as the driving energy of the absorption chillers.



The primary energy factor of the district cooling options of Helsinki is presented in the picture above.

The same phenomenon as is with the PEF applies to CO2 emissions of the cooling methods as well.

In the annual terms, the heat pump plant system in Helsinki

- Replaces heat only production (400 GWh fossil yearly, equal to 30 million liters of oil)
- Remarkable primary energy and CO2 savings (nearly 100 000 tons CO2 yearly, equal to 500 million kilometers by a car)
- Competitive costs compared to alternative solutions
- Could be replicated in most cities in Europe.

Lesson to learn

From the urban planning point of view, centralized cooling (and heating solutions) based on the nearby located renewable energy source yield reduced GHG emissions as well as savings in overall investment and operation costs.

Awards

- Euroheat&Power and the International Energy Agency (IEA) have awarded Helsinki the **Best District Cooling System** in 2011.

Information source: www. helen.fi

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Energy efficiency advisory integrated to building design inspection in Oulu, Finland

Concept

In the city of Oulu, Finland, the construction permission inspectors, instead of only technically inspecting the design documents of new buildings and building retrofits to meet the official construction norms, they started to provide guidance to the constructors about how to improve the energy efficiency of their building design and retrofit. So far, Oulu is the first city in Finland that has started including EE and RES in the building design inspection.

Benefits

As a result, substantial energy savings worth €20 million equivalent have materialized compared to if the alternative of the buildings being built according to the minimum requirements set by the norms. The input costs of the new services in Oulu was €0,1 million, thus yielding high productivity with the output/input ratio of 200!

Lesson to learn

The Oulu has demonstrated the energy saving potential that is caused by integration of energy efficiency advice to normal construction permission inspection. Similarly, taking energy as a paramener in the urban and regional planning stage already will provide energy savings and reduction in GHG emissions in the later and more detailed stages of planning.

Source: www.sitra.fi

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Development

Ground Water Heating and Cooling in Siilinjärvi, Finland

In Siilinjärvi municipality, an office building has been provided with an innovative DHC system that uses the ground water both as a sole cooling and heating source of the building.

The real heat load of the real estate company owned building “Lentokapteeni” amounts to 350 kW and the cooling load to 450 kW.

There are 12 000m of piping in the heat well. The wells are used also for cooling.

One of the tenants has a large server room, which poses a significant need for cooling (continuously 150 kW). The heat recovered from the server cooling is used for heating the other parts of the building as needed.

The headquarters of the regional power and heat company “Savon Voima Ltd” are situated in Lentokapteeni building as well.

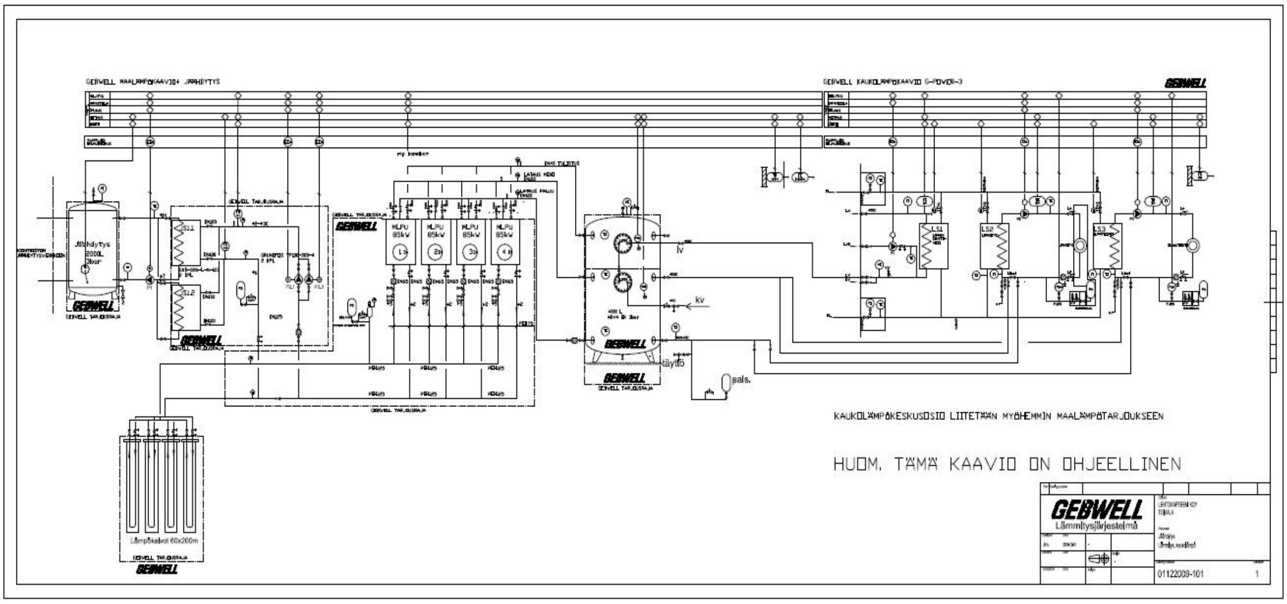
Lesson to learn

Since the ground water is used integrally for heating and cooling, very low primary energy factor values are achieved, and consequently ultimately low specific CO_2 emissions as well.

Information source:

www.gebwell.com

Designed building “Lentokapteeni” in Siilinjärvi, Finland



The scheme of DHC in Lentokapteeni building.

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District Heating and Co-generation of Heat and Power in Helsinki

District Heating in Helsinki

Helsingin Energia is a local municipal energy company owned by the City of Helsinki. It operates as an independent economic unit, in the form of a commercial enterprise. Helsingin Energia covers more than 90 percent of the heat demand of the capital city with district heating. Its net turnover in 2009 was 723 M€ and operating profit 247 M€. Helsingin Energia has more than 13 000 paying customers in Helsinki district. For a comparison, average price for district heating in Finland in 2009 was 5,62 snt / Kwh.

At the moment, district heating (DH) covers 93% of Helsinki's total heating energy demand. This means that there is more than 1230 km of district heating pipelines beneath the Helsinki district. The heat sales in 2010 were 7360 GWh (26469 TJ).

The EU has classified Helsingin Energia's efficient district heating and district cooling (DHC) system as a BAT (Best Available Technology).

District heating production is mainly based on four large CHP plants located in three different areas: Vuosaari,Hanasaari and Salmisaari. Natural gas represents 60 % of

district heat production. The other fuels are coal 35%, heat pumps 3% and oil 2%.

In the city of Helsinki, DHC and electricity are produced in CHP processes on a large scale. The emissions have decreased and the air quality in Helsinki has improved considerably since 1990s – despite the fact that energy production has increased by more than 60%!

The main indicators of DH in Helsinki are:

- **District heating** covers **93%** of the total heating energy demand in Helsinki
- **More than 90% of DH** energy is produced by **CHP**
- The **annual energy efficiency of CHP exceeds 90%,** which is one of highest in the world. If electricity and heat were to be produced separately, the fuel costs and emissions would be at least 40% higher.
- Despite of **low prices of DH**, Helsinki Energy is highly profitable.
- In year 2010, the heat sales specific CO_2 emissions were only 113 g/kWh.
- For example, data server centers are connected to the DHC system to create world's most eco-efficient computer halls.

Today, Helsingin Energia uses the light district heat as a heating solution for low-energy houses built in the outskirts of the DH network. The building automation of these houses supports the concept of lower temperature of the circulating water in the smart DH system.

Green future

The city council has set the goal by year 2020 to have the share of RES in heat and power produciton at least 20% of all heat and power production of Helsingin Energia. Also Helsingin Energia is expecte to reduce green house gases by 20% from the level of year 1990.

On Dec. 8, 2010 the City Council approved the development program of Helsingin Energia towars carbon neutral future by year 2050. The program implementation requires a strong investment program that may temporarily weaken the currently strong financial position of Helsingin Energia.

Awards:

- The EU has ranked DHC and CHP in Helsinki as **Best Available Technology** in 2008, and,
- The International Energy Agency IEA has awarded Helsinki for **superior solutions for climate change mitigation** in 2009.

Sources:

www.helen.fi

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Geothermal heating in Unterhaching

The plant delivers a maximum thermal power of 38 MW. Two holes reach to a depth of more than 3000 metres, where the water has a temperature of about 120 °C. Some of the heat is used to generate electricity with a maximum production capacity of 3 MW.

For heat supply, thermal water from around 3500 metres is pumped up and lead through a heat exchanger, which is connected to the district heating network. Buildings that are connected to the network have another heat exchanger that passes the thermal energy to the building's internal heating system. In order not to exploit the underground water supply, the used geothermal water is pumped back through a second hole to the same depth, but several hundred metres away from the primary well.

For electricity production, a novel process called Kalina cycle is used in Unterhaching. It enables to use a heat source with very low temperatures – even below 100 °C – to generate steam for a steam turbine. The geothermal heat is transferred to a mixture of ammonia and water, whose boiling point is lower than that of pure water. Additionally, the mixture improves the efficiency of the heat transfer.

Geothermal drilling

Geothermal heating is the direct use of geothermal energy for heating applications. As of 2007, 28 GW of geothermal heating capacity is installed around the world, satisfying 0.07% of global primary energy consumption. Efficiency is high since no energy conversion is needed, but capacity factors tend to be low (around 20%) since the heat is mostly needed in the winter. In Unterhaching, the capacity factor is increased, because excess heat is converted to electricity when heat demand is low enough.

Kalina cycle

The Kalina cycle is a thermodynamic process for converting thermal energy into usable mechanical power.

It uses a solution of 2 fluids with different boiling points for its working fluid. The solution boils over a range of temperatures, not only at one temperature like a pure working fluid. This way, more of the heat can be extracted from the source than with a pure working fluid. The same applies on the exhaust (condensing) end. This provides better efficiency, comparable to a combined cycle.

By appropriate choice of the ratio between the components of the solution, the boiling point of the working solution can be adjusted to suit the heat input temperature. In Unterhaching, the most common combination of water and ammonia is used, but other combinations are also feasible. While ammonia is a favourable working fluid due to its low boiling point, it is problematic due to its toxicity. However, safe operation is possible when leakage of working fluid is properly monitored and prevented.

The boiling working fluid is used like steam in a conventional steam process to propel a turbine that is connected to an electric generator with a maximum power output of 3 MW. During the winter season, all of the thermal energy is used for district heating, while electricity generation is only activated when heat is low enough.

District heating network

Most of the power from the geothermal drilling hole is not converted to electricity, but transported to private and commercial customers for room heating and process heat. For that purpose, over 36 km of pipes have been installed in Unterhaching to form a district heating network.

Map of district heating network in Unterhaching [geothermie-unterhaching.de]

Fact sheet

Project start	08/2002
Project duration	7 years (final approval test 04/2009)
Investment	80 M€ (36.7 M€ public funding or loan)
Revenue	2.8 M€ (2008), 4.7 M€ (2009), 7.9 M€ (2010)
Staff	9 employees
District heating network	36.4 km length, 46.5 MW connection power
Annual heat power output	79 GWh (2010), 126 GWh (planned)
Annual electricity output	11 GWh (2010)
Temperatures	90-110 °C flow, 55-65 °C return

Summary

This project shows that geothermal heating can be realized economically while being environmentally friendly.

Source: geothermie-unterhaching.de

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Energy-saving projects in Munich East

Several energy-saving projects have been realised in Riem, the quarter on the former Munich-Riem Airport by the municipality, the utility company SWM and private initiatives. While being independent measures, they together created a good example of what an energy efficient city district can look like. A rarely seen aspect in this district is the inclusion of mobility in the energy efficiency measures.

Photovoltaic power station

In 1997, a **photovoltaic power station** was installed on the roof of the fair trade centre. With a size of 38,100 m², it was the biggest system of its kind at the time worldwide. It produces over 1 GWh electricity per year and has maximum power rating of 1 MW.

Geothermal plant

In addition to renewable electricity from solar power, in 2004 a **geothermal plant** went operational, which delivers heat for the district heating network. It is hydrothermal, i.e. it operates on natural hot water that occurs in a depth of about 3 km. Through one hole, the water with a temperature of more than 90 °C is pumped up and lead through a heat exchanger that feeds the district heating network. Through a second drill hole, the used water is pumped back underground in order to not to deplete the water reserves.

Geothermal plant in Munich East [GtV-Bundesverband Geothermie]

The heat can satisfy the complete demand during summer and base load during winter. The annual geothermal heat generation is 50 GWh, while the total annual heat demand is 100 GWh. The remaining half during the cold season is delivered through three gas-fired boilers with a total power rating of 34 MW.

The drilling extracts more heat from the borehole than naturally can be restored during the same time. For that reason, a new borehole will have to be drilled after an estimated operating time of about 30 years. In contrast to fossil energy sources, the heat reservoir will replenish quickly once heat extraction is interrupted. In addition to reducing air pollution, about 12,000 tons of CO_2 emissions are omitted per year (compared to purely gas-fired heat generation).

Living without car

Another project endorses living without own car. For this purpose, residential areas are planned in a way that facilitates the use alternative means of transport. Short ways for daily needs make it easy to walk or go by bike. Good transport links enhance the use of public transport for longer distances. For going to the city centre, a good subway connection is available all day.

More than 100 households live car-free or use cars. A survey conducted in 2007 about their living situation had the following results: the first positive indicator is the high response rate of more than 50 %. It suggests that participants identify with the project and want to share their experience. The actual returned answers are positive as well:

More than 90 % of all participants are very satisfied with their housing situation. Good public transport, bicycle and pedestrian paths, green space and good neighbourhood are the major contributors for this result. Only shopping possibilities, especially in the eastern part of Messestadt, are considered suboptimal.

Car use was necessary for about 50 % of all households occasionally, especially for transporting goods, relocation or travelling to remote locations without sufficient public transport connection.

Nearly all survey participants pointed out the positive aspects of car-free living: contributing to environmental protection, easier mobility and cost savings. Several respondents stressed the special advantage of living in Messestadt: as all neighbours live also without own car, cleaner air, less pollution and noise a direct incentive compared to car-free living elsewhere.

Almost 100 % of households were sure to be able to live without a car for a least the following two years. About 90 % of households even declared that for the next 10 years.

Despite their positive self-perception, nearly every second household suppose that the perception by others is worse in society.

Zero-energy houses

In addition to new mobility concepts, energy-efficient housing has been realized in Messestadt as well. One whole apartment complex has been realised in the zero-energy standard. This means that the annual energy demand can be satisfied using only renewable energy collected in the same area.

One long, three storage high building with 90 m length and two smaller row houses comprise in total 34 housing units. The big building is constructed with steel and wood surface; the row houses are made completely from wood. The whole complex is oriented to south in order to capture as much sunlight and heat as possible. Flat roofs provide place for terraces, but also solar thermal and photovoltaic panels.

Wood facades in Messestadt Riem [baunetzwissen.de]

The energy concept envisions that the annual primary energy demand for heating, hot water and electricity is low enough to be able to generate the same amount of heat electricity from their own facilities per year. In order to achieve this goal, all units are constructed in passive house standard. Residual heat load is met by a wood pellet burner; a ventilation system with integrated heat exchanger is also standard for each house.

Sources: PV, Geothermie, Wohnanlage, Wohnen ohne Auto

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Guideline for creating an energy-use plan on municipal level

An *energy-use plan* is the energetic equivalent to the common *land-use plan* in urban and rural planning. It was developed for the Bavarian State Ministry of the Environment and Public Health. The energy-use plan is a process for developing a concept with the aim of realizing a sustainable energy supply on a local level. It consists of the following three steps:

1. Analysis of current energy demand, energy infrastructure and potentials
2. Concept development for energy savings, increased efficiency and use of renewable energy sources
3. Implementation of the concept through actions

The development of this guideline is motivated by the necessity to mitigate climate change and reduce dependency on fossil energy sources. It shows how this high-level goal can partly achieved by measures that can be planned and implemented best on a local level. By integrating many aspects of energy use in municipalities, the resulting concept is more coherent and effective than individual measures.

The following pages briefly summarize the full guideline that is available as 122-page long report in German language (URL below). Its target audience are municipalities and engineering consultants.

Analysis of current situation

The analysis has two goals: the first one is an inventory of current energy demand and infrastructure situation. The second is an assessment of the potential for using local renewable energy sources.

Energy demand is represented by a map with annual electricity (kWh_{el}/a) and heat demand values (kWh_{th}/a) by building or district. Data sources for this map can be real consumption data from the municipal energy supplier, estimation of demand from building databases with metadata on building age, size and usage. Public surveys are an expensive but efficient way of acquiring new data.

The energy infrastructure includes heat and electricity generation units as well as distribution networks. There are basic two types of energy conversion facilities: big centralized power stations or small, decentralized units. The following properties are to be collected for each unit: unit type (combined heat and power, photovoltaic, geothermal, biomass, gas turbine), fuel type (if applicable), unit size (MW), efficiency (thermal/electric), annual electricity and/or heat generation (MWh) and temperature level (°C). Distribution networks include gas pipes, district heating networks. The following properties are to be collected for these grids: pipe capacity (diameter and/or maximum power), connected costumers. The result of these data collection efforts is a comprehensive summary of the current energy situation in a municipality.

The second part of the analysis concerns existing and potential use of renewable energy sources. This includes solar (thermal and/or electric), biomass, geothermal energy, waste heat, wastewater, wind and hydropower.

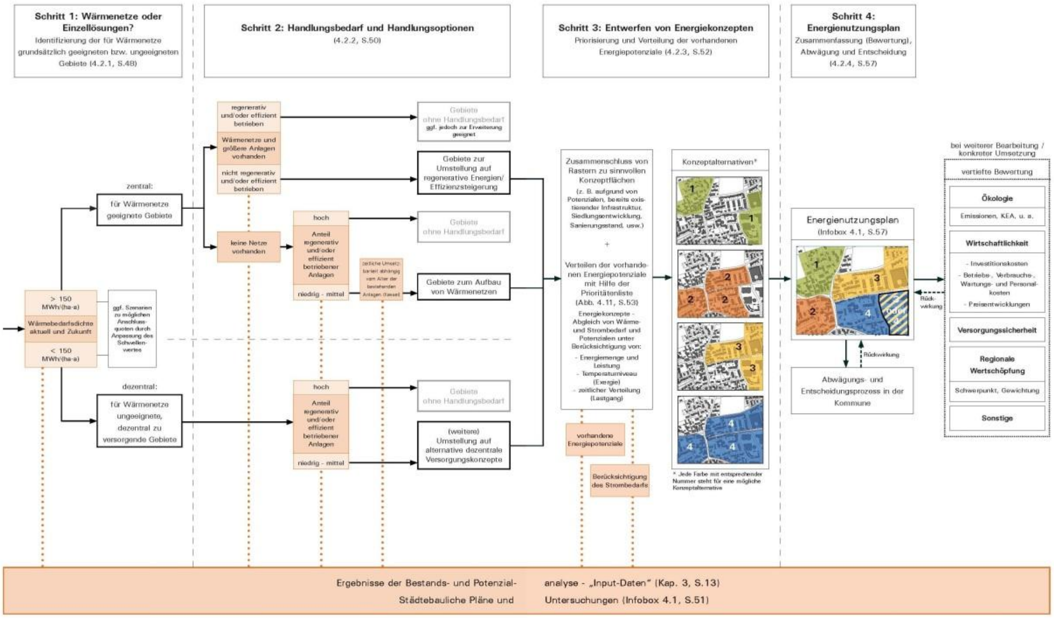
The solar potential on existing roof areas can be roughly derived by using a fixed value for annual solar irradiation per square metre building area. Biomass potential is dependent on local agriculture, vegetation and their current use. The geothermal potential can be assessed using geographic surveys or by using existing maps. Use of waste heat depends on the presence of suitable commercial and industrial facilities and their proximity to heat consumption. Heat from wastewater can be used if central sewage lines are suitable for installing heat exchangers. Wind and hydropower potential can be assessed from geographic maps.

The result of the potential renewable energy usage is a map with potential annual electricity and heat generation figures. The spatial resolution is especially important for heat, as generation and demand should preferably be close to each other.

Concept development

Based on the results of situation and potential analysis in step one, energy potential and energy demand are mapped to each other in a concept development process (figure below). The first decision concerns heat distribution through centralized or local heat generation. In regions with high heat demand, centralized heat generation and heat distribution network are more efficient and economically viable.

The second development step concerns energy sources and technologies for heat generation. Step three then compares demand, potential for demand reduction through efficiency measures (e.g. renovation) and the potential renewable energy sources for both heat and electricity. Priorities are set in cases where potentials overlap depending on economics or technical restrictions. These are for example incompatible temperature levels in waste heat or non-matching times of energy availability and demand.



Flow chart of concept development for an energy-use plan [Leitfaden Energienutzungsplan]

In the final step, all options gathered in step 3 are compared and selected for the final energy concept, the energy-use plan. This comparison includes ecologic factors (pollution, emissions and cumulated energy demand), economics (investment and operating costs, fuel prices), reliability and advantages for local economy.

The resulting concept is a list of measures that are to be implemented.

Implementation

Depending on the measures that are part of the developed concept, different ways of realising them are possible.

Zoning and land-use plans are the most generic instruments of urban planning. Land-use plans allow for dedicating certain areas for renewable energy conversion like wind energy areas and green areas to improve urban climate. Zoning plans on the other hand allow for detailed specification of building outlines, favouring layouts that enable efficient use solar energy on rooftops. While use of certain technologies cannot be enforced, use of fossil fuels can be restricted through their environmental impact, i.e. air pollution.

A more direct way of realising a centralized heating network is compulsory connection for all building without emission-free heating systems. For areas belonging to the municipality, also direct contracts for renovation measures can be arranged.

Indirect ways for implementing measures are providing information for citizens on advantages of certain options. Also financial incentives can enable the implementation of actions.

The organisational and financial aspects can be either addressed by the municipality itself, through companies as part of contracting or through citizen initiatives.

Benefits

The benefits of creating an energy-use plan are its multiple uses. It offers a comprehensive representation of existing and potential energy supplies. It allows determining an optimal combination of renewable energy sources to meet local energy demand. It gives measures for implementing the planned concept and provides ways to include all stakeholders (citizens, companies, authorities) in the realisation.

Source: Leitfaden Energienutzungsplan (German)

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Local Agenda 21 in Starnberg

Since the year 1997, Starnberg has developed a vision for sustainable development labelled *STAgenda21*. Being focused on environmental issues, several measures have been derived that concern energy supply, traffic and environment.

In eight working groups, social, economic and ecologic issues are addressed. Realised actions include:

- a cycling routes concept as well as the steady construction of cycle tracks
- improvement and expansion of the public transport system
- implementation of combined heat and power (CHP) in public buildings

The following sections shortly describe tasks and results achieved so far by group.

Schools and social issues

Schools are an important hub for spreading new ideas. Creating awareness for environmental issues early has large benefits later on. Hence, this working group's aim is to collect and distribute teaching material and spawn initiatives that change behaviour in an environmentally friendly way.

Climate protection and energy

This working group aims for a sustainable energy supply from renewable sources in order to minimize greenhouse gas emissions. In the year 2005, Starnberg county council declared the goal to satisfy the county's energy demand from renewable sources in 2035.

Implemented projects are energy contracting in the local indoor swimming pool, photovoltaic panels on the roof of a school and service for infrared imaging to identify thermal losses in private households.

Art and culture

The aim of this working group is creation of publication materials on the one hand and inducing public discussion through expositions and presentations.

The working group created flyers and homepages for many projects implemented by the other working groups.

Nature and landscape

Protecting landscapes with flora and fauna from human intervention ist he main goal of this working group.

It developed concepts for preserving several natural habitats like Leutstettner Moos, Würmtal, Meisinger Bachtal, Wildmoos and Michelmoos.

Natural resources

This working group is about preserving quality of the finite resources ground water and earth. This is achieved by rising awareness of the topic water by improving access to natural surface water (lakes, rivers). Another way involves better waste management and wastewater treatment.

Environment and construction

Creating a local identity by preserving building heritage in Starnberg is the first goal of this working group. The other goal is to increase population density in built areas instead of converting green space into new residential areas.

At the same time, sealing of natural ground is to be limited even in the city centre. New buildings are to be constructed near frequently used infrastructure like convenience stores and public transport hubs.

Mobility

This working group focuses on including interests of all road users, not only cars. Public space should be available for everyone. This is why accessibility of transport shall be improved. Air and noise pollution are to be reduced in the city centre.

Economy

This group is about integrating sustainability and economic interests. Group members are involved planning areas for local businesses with the goal of preserving a mixture of usage (living/commerce) in buildings.

Local agriculture is to be supported in order to establish regional business cycle.

Sources: starnberg.de, stagenda.de

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Biomass use in Greußenheim

Greußenheim is a village with 1700 inhabitants near Würzburg. Initiated by active citizens and with the mayor's support, several projects for energy supply from renewable sources have been realised.

Measures include a cogeneration plant that operates on vegetable oil from locally grown rapeseed oil. 21 one- and two-family houses are supplied with base load heat (90 kW_{th}) by a 725 m long local heating network. For peak load, a conventional boiler running on fuel oil is used. The generated electricity is fully feed into the regional electricity grid. The cogeneration unit consumes about 90,000 l rapeseed oil per year, which corresponds to 85 ha area of crop land. As the waste heat of the diesel engine is converted into electricity, total useable energy splits up to 61 % heat and 39 % electricity.


Source: Bayern Innovativ

Another measure is a heat plant that drives a small heating network of public buildings (town hall, church, vicarage, kindergarten, school, building yard, multipurpose hall etc.). It has been in operation since December 1999 and has a thermal power of 650 kW_{th}. It is fuelled by wood chips from local forests. The focus of this promising project was to enable residents to profit from an integration of renewable energies and allow a sustainable energy supply. By this CO_2-emissions are reduced by 350 tons per year compared to conventional heating technologies.


Source: Greußenheim

Sources: Greußenheim, Energieforum, Bayern Innovativ

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Heat demand analysis in Greifswald

An analysis of the heat demand of Greifswald was performed using a geographic information system (GIS) with the following goals:

1. Regional allocation of energy demand for room heating across Greifswald
2. Quantify potential energy savings from renovations of existing buildings
3. Assess the economic and ecological feasibility of district heating now and in the future

The following results were obtained:

1. Creation of a GIS-based visualisation of local heat energy demand, based on available databases
2. Reproduction of past and prediction of future heat demand for renovation scenarios
3. Localisation of feasible regions for existing and future district heating network

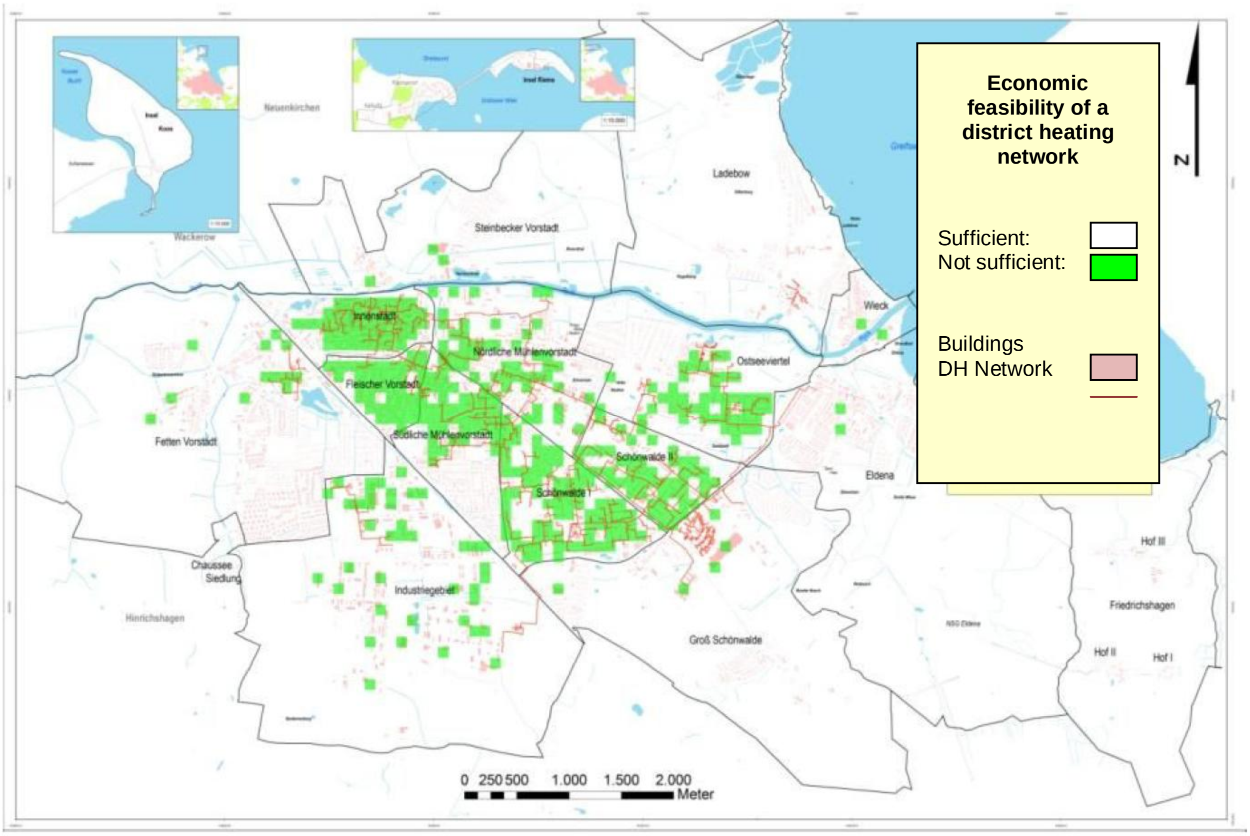

Figure 1: Identification of areas for an economic use of district heating in Greifswald (Source: M. Busch)

The following strengths of a district heating network are identified:

4. Efficiency gains on the side of heat supply can be realised quickly on a large scale, while improvements in local heat supply need many years to spread.

5. The existing network has a high isolation standard, minimizing transport loss of heat from plant to demand.

Source: Diploma thesis Analyse des Wärmebedarfs der Universitäts- und Hansestadt Greifswald mit Hilfe Geographischer Informationssysteme by Michael Busch

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District Heating in Molins de Rey

Molins de Rey is a 24.000 inhabitant's town 20 km east of Barcelona, on the Llobregat River. A District Heating network of 4.7 km provides 695 social housing dwellings in the La Granja neighborhood with hot water at 90º for heating and/or hot water consumption.

The heating station has two biomass boilers of 2MW each and 6 back up gas boilers (1.6 MW). The system was installed and is managed by a private company (Biomassa Aprofitament Energetic SL) that was chosen on public competition. Actually the first year (2000) the DH worked exclusively on gas energy, until the biomass central was achieved (January 2001). The biomass (chopped almond nuts, pine tree nuts and forest wood), is brought by trucks in a 180m3 reserve that has 55 hours of autonomy. The station is working 16 hours/day, and during the night hours hot water is provided by two 100m3 hot water deposits filled on daytime.

The 4.7km network is made of stainless steel tubes with polyurethane coating

Each dwelling has heating exchange equipment in the kitchen or laundry room to transfer the heat of the red to the flat's heating and/or hot water system.

Conclusion:

The station is completely automatic, and thus it is possible to visualize and change all its parameters from a central computer. Each dwelling has a calorie counter connected to the central system for consumption information and control. Now after 10 years the consumption data can be used for statistic and comparative studies, and to backup new initiatives.

This project is successful because it applies to public housing, and thus it was possible to realize with to the investment and cooperation of public institutions: it is promoted by Molins de Rey township and ICAEN (Catalan institute of energy).These institutions have worked together to create Molins energies SL to design and manage the project, have found extra financial support (Catalan ministry of energy and mines, European commission Thermie program).

The results and success can be shown as an example for further projects.

Another issue that makes this project successful is the special attention put on the participation of the users in the process, through the design and installation of easy-to-use heat-control disposals in each dwelling, and on the complete public information of DH system given them. These two measures provide the implication of the inhabitants, and arise their environmental consciousness in general

Sources of information:

- www.gencat.cat/icaen ICAEN (Institut Català d'Energia) *Guia bàsica de xarxes de districte de calor i fred (Basic guide of DH and DC)*. October 2010.

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-

SaaS

Use of biogas from the Garraf waste landfill deposit

Since its commissioning in 1974, the waste landfill of the Vall d'en Joan, in the massif of Garraf 30km south of Barcelona, has received more than 25 million tons of waste from the metropolitan area of Barcelona. In 2001, the Environmental Agency approved the project to restore a portion of the deposit and the grant for the collection and use of biogas generated. This biogas is captured through an airtight enclosed system of degasification wells connected to the suction station where three 3,000 m^3 / h blowers are installed. Through a network of pipes and manifolds, vacuum gas is piped to the energy recovery plant where the biogas is used as fuel for 12 motor turbines installed to generate electric power. (Generating capacity of 100,000 MWh / year)

The treatment of 50 million cubic meters of methanol per year equates to a reduction of about 600,000 tons of CO_2. In addition the captured biogas is treated through controlled high temperature engines combustion to minimize odors.

The station produces enough energy to meet electricity demand of a population of 12,000 inhabitants, and preventing the emission into the atmosphere of between 50,000 and 110,000 tons of CO_2 that would have been produced by fossil-fuel power plants.

The entire site has been transformed by landscape architects in a slow recovery process over the years 2002-2010, and restored to the Garraf National Park that surrounds it. As the biogas exploitation ends, the park will be opened for public use and leisure.

Conclusion:

This power station is a provisional structure functioning for 10 years to use waste biogas reserves: 550 million cubic meters of methane have been used until the end of 2010. This minimizes the emission of greenhouse gases generated by the anaerobic degradation of organic matter from domestic waste that have been deposited for more than thirty years. The environmental impact reduction of previous unsustainable waste management can become an important (although limited in time) issue.

Sources of information:

- www.barcelonaenergia.cat
  Developer: Entidad del Medio Ambiente Área Metropolitana de Barcelona

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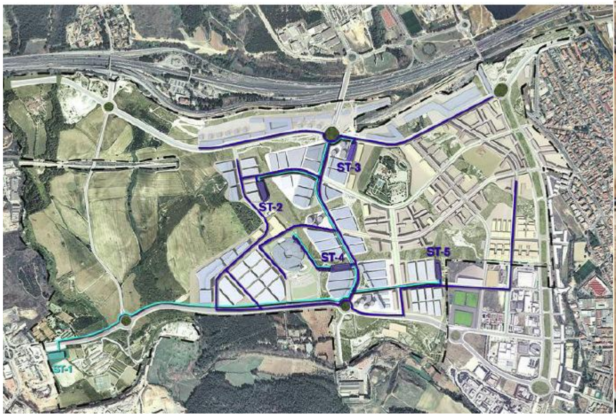
SaAS

District Heating and Cooling in Cerdanyola del Vallès – Parc de l'Alba

The Barcelona General Metropolitan Plan, approved in 1976, created 5 strategic areas for economic and social development in the metropolitan area, which were given the name of Directional Centers. The Directional Centre of Cerdanyola was the most important in size and most ambitious in its aims. It comprised 675 hectares of land located in the geographic centre of the metropolitan area –between Cerdanyola city centre and the cities of Barcelona, Badia, Sabadell and Sant Cugat– and was set aside to house a high concentration of strategic activities for economic and social development of the region as a whole. The Consortium for the Directional Center of Cerdanyola del Vallès was created in May 2001 as a local public entity with two equal partners: the Institut Català del Sòl and the Cerdanyola del Vallès City Council.

The third development stage of 340 ha includes one of Europe's best scientific facilities, the Alba Synchrotron, and a balanced mix of areas for research, production, housing, and services as well as green open spaces. In 2004 the project of a DHC network was approved, stimulated by the high demands of the Alba Synchrotron. The works started in 2007 and the first station ST4 is operational since 2010 (for the moment it is only connected to the Synchrotron, because of the investment crisis other building projects are stopped, except a small investigation center that will be achieved in 2011). Nevertheless as funds permit the construction of the vial network the 4 canons DHC network is being implemented in parallel in prevision for future use. 16,8 km of the 30 km of planned network have been build.



The first Station ST4 near the synchrotron is a gas trigeneration and is connected to the public electricity network (to evacuate power and use as support for cooling production). The particular double-effect absorption unit is powered directly with gauze engine exhaust, and is very efficient

There is an inertia tank of 3750m3 of cold water at 6 º C.

Energy savings of ST4 as compared to a conventional station:

November 2010: cooling 28.000 MWh/year, heating 3.000 MWh/year

Previsions for optimal use: cooling 71000 MWh/year, heating 28.000 MWh/year

Two objectives for future expansion: to optimize the existing system and to implement renewable (400m2 of solar thermal power and another cogeneration Station ST2 using biomass gasification of waste wood are planned.)

Conclusion:

The planning and management is an example of co-responsibility between public administration and private concessionary:

- Obligation to connect the buildings on public –owned land (75% of total land) to the network

- Station construction assumed 100% by the concessionary, and network construction assumed 100% by the administration (DHC, but also electricity, telecommunications, water, etc.)
- The return of administration investment will be provided as new clients connect to the network and the concessionary pays a fee

Sources of information:

- www.gencat.cat/icaen ICAEN (Institut Català d'Energia) *Guia bàsica de xarxes de districte de calor i fred (Basic guide of DH and DC)*. October 2010.
- www.parcdelalba.com

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Spanish solar regulations

The Spanish government adopted a new Technical Building Code (CTE, Codigo Tecnico de la Edificacion) in March 2006 which includes an obligation (since September 2006) to cover part of the domestic hot water (DHW) demand with solar thermal energy. This obligation applies to all new buildings and to those undergoing major refurbishments. Exceptions are foreseen in the case of buildings that satisfy their DHW demand by other renewables or by renewable heat obligation. Other exceptions are buildings with insufficient access to the sun, or under specific historic-artistic protection. In these cases, the reduced or absent solar contribution must be compensated by other measures leading to the same result, like energy efficiency or other renewables.

The required solar contribution varies between 30 and 70 % depending on three main factors:

- Domestic hot water demand of the building (liters/day) the larger the consumption, the higher the required solar fraction. This is due to the fact that solar systems are more effective if the heat load (i.e. the consumption) is higher
- Climate zone and the level of solar radiation available. The CTE divides Spain in five climatic zones and allocates each province, or in some cases smaller territorial units, to one of these zones
- The kind of back-up energy: in case of electricity, the required solar fraction is higher than in case of gas or oil back up. Conventional fuel to be replaced (only for refurbishments)

Having determined the required solar contribution, the CTE contains prescriptions on the method to calculate the system performance and on the required maintenance procedures

The CTE defines a number of technical requirements on the components, design and installation of the solar thermal system, including sections on the solar collector and its components, the working fluid, the storage systems, the hydraulic circuit, the controllers and the conventional auxiliary system

The CTE also contains detailed prescriptions on the regular inspection and maintenance operations to be carried out by trained personnel.

It is important to point out that the municipal solar obligations, approved in the last few years in more than 50 Spanish municipalities (involving more than 20% of the population), including Barcelona in 2000 and Madrid in 2003, remain in force as long as they are stronger than the national obligation included in the CTE. In some ordinances the aesthetic and technical conditions of the facilities are incorporated.

Conclusion:

The effects on the market have been partially offset by the unexpected slowdown in the Spanish construction market in 2008 and 2009. However, solar obligations became a driver in the Spanish solar thermal market since estimates show that over 80 % of installations were motivated by CTE or municipal ordinances.

Looking at the CTE, several experts from the solar thermal sector expressed doubts whether this approach based on detailed prescriptions is suitable. It is argued that a result-oriented approach would be more desirable: instead of prescribing a number of technical solutions, it might be more useful to foresee checks on the effective performance of the solar thermal systems and foresee sanctions, like an obligation to improve them, if the significant under-performance is ascertained.

Sources of information:

- http://www.estif.org/policies/solar_ordinances/ In English: ESTIF European Solar thermal Industy Federation

Barcelona Solar Thermal Ordinance

The City of Barcelona has been the pioneer for Solar Regulations in Europe. The first Solar Ordinance came into force in 2000 and required that a certain share of the domestic hot water demand be supplied by solar thermal, in new buildings and those undergoing major refurbishment.

The implementation led to a significant increase in the use of solar thermal, thereby even stimulating the market for buildings not covered by the ordinance. The regulation was popular with decision makers and received widespread public support. Therefore, the number of buildings targeted increased and procedures, architectural integration as well as quality requirements improved thanks to the revision approved in 2006.

The second Ordinance and its revision were approved after an extensive consultation process, including the professional associations of the affected sectors, including constructors, building administrators, architects, engineers, installers, consumers and tenants, solar and renewable energies and others, as well as the local, regional and national energy agency and the public bodies responsible for housing, urban planning, protection of architectonic heritage and environment.

The terms of this ordinance, revised and approved in 2006, are applicable to the cases in which both following circumstances occur:

1. In the case of:

- new buildings or constructions,
- complete rehabilitation of buildings or constructions,
- change in the use of the whole building or construction.

2. When the use of the building implies the use of domestic hot water, heating of water to condition swimming pools, or use of hot water for industrial purposes.

The buildings covered by the regulation are those intended for the following uses: residential, health, sports, commercial (in special cases), industrial (if hot water is needed for the industrial process or if showers are to be installed for the staff), and in general any other use that entails the presence of dining rooms, kitchens or collective laundries. In order to determine the scope of the application, it is considered that a building project to promote several buildings with the same or different use is a single project.

The design and execution of a system to produce hot water with thermal energy must take the following minimum solar contribution into account:

- To heat domestic water: the values specified by the Ordinance, according to the various demand levels (from a minimum of 60%), for a reference temperature of 60°C: general if the auxiliary source of energy is heating oil, propane, natural gas or other gas (general gas), or the Joule effective electricity is the auxiliary source.
- To heat water of covered swimming pools: 30%
- To heat water for industrial processes, from the temperature of the water network to 60°C: 20%.The heating of uncovered swimming pools will only be allowed with a system of solar energy collection.

Inspired by the positive experience of Barcelona, dozens of municipalities under administration of different political colors have approved solar obligations all over Spain before the 2006 obligation.

The Barcelona Solar Thermal Ordinance, the first regulation of this type to be adopted in a large European city, has been presented to autonomous bodies, local administrations, networks of cities, institutions and various. It has been used by other municipalities as a basis to draft their own regulations. At present 39 municipalities in Catalonia and 26 in the rest of Spain have followed Barcelona’s example and have now adopted solar ordinances.

The Barcelona Energy Improvement Plan (PMEB) sets the objective of attaining, by the year 2010,some 96,300 m2of solar collectors installed in the city, for an estimated thermal generation of some778 GWh/year (280,000 GJ/year).

Conclusion:

The main lessons learned by the administration in Barcelona have materialized in the revision of the Ordinance that started in 2004 and was adopted in 2006. The main changes reflect the general positive experience with the solar obligation: the number of buildings subject to the obligation increased, as well as the required solar fraction. At the same time, the revision corrected some of the weaknesses identified during the first period of implementation. In particular, the quality of the installation works has to be certified and a maintenance contract must be provided, thus increasing the quality assurance measures as suggested by the experience mentioned above.

Sources of information:

- http://www.estif.org/policies/solar_ordinances/ ESTIF European Solar thermal Industy Federation
- www.barcelonaenergia.com Barcelona Energy Agency

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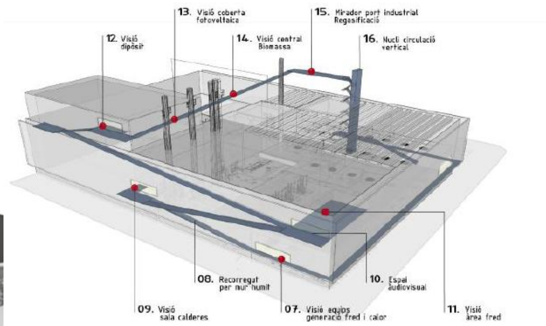
Zona Franca Centralized Heat and Cold Generation Plant for District Heating and Cooling in La Marina – Barcelona

A new DCH generation plant is in construction in the port of Barcelona, south of Montjuic Mountain.

This system uses cold input from the ENAGAS central that transforms liquid gas arriving in boat from Algeria at -160º temperature into standard – distribution gas though a heating vaporization process. The cool water will circulate at 5º and return at 14º from the 7km red.

District Heating is produced by the biomass central using municipal trees pruning material, and gardening products waste (14.000 tons per year). The hot water will circulate at 90º and return at 60º to the central.

Both centrals are grouped in a single building whose design was selected through an architecture competition, to provide the urban integration of the plant, as well as social awareness and information: the central has a double skin with an educational promenade for visitors, to promote the initiative. The building facades evoke the raw materials used in power generation.



The production central is designed under the principle of modularity and security of supply, equipment consists of:

- Cooling: conventional generation of cold, cold recovered from regasification of frozen gas that come in boats from Algeria, and ice accumulation,
- Heat generation: conventional gas and biomass boilers.
- The equipment will be installed in accordance with the increased demand.

Maximum power installed in the conventional Central

- Conventional generation of cold: 10 MW
- Cold recovered from regasification : 30 MW
- Ice accumulation: 320 MW
- Heat conventional 30 MW
- Heat from Biomass: 10 MW

• Fuel: Biomass, gas and electricity.
• Cooling: Cooling towers.
• Generation: a steam turbine will generate 2 MW.

Conclusion:

A good example of energy transformation (gas) recuperation (cold temperature), and overlapping technologies (adding biomass heat production) in urban context. As the building + network are actually under construction, it is too soon to have results.

Sources of information:

- www.gencat.cat/icaen ICAEN (Institut Català d’Energia) *Guia bàsica de xarxes de districte de calor i fred (Basic guide of DH and DC)*. October 2010.
- www.dalkia.es

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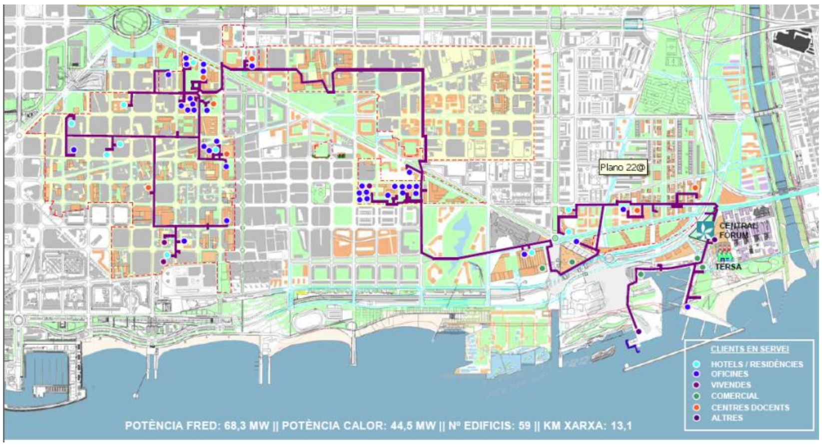
District Heating and Cooling in 22@ district – Barcelona

The 22@ DHC network was approved within the Barcelona Plan for energetic improvements, on January 30th 2002, as part of the concept of re-centralizing energy generation within the municipality introducing energetic efficiency and renewable energies along with a better management and control, especially concerning cooling demand. The urban process transformation of the Forum and 22@ areas (previously heavy industrial districts) has given opportunities to install a new central integrated in the 2004 Forum operation, and the network construction within the Idelfons Cerda urban grid is still being built under minimal impact prescriptions.

The complex consists of a central plant providing a district heating and cooling network that connects to exchange points o substations. The central produces hot water using the proximity and residual heat of the central urban solid waste incineration plant, with a mass exchanger. Absorption machines use this same residual heat to produce cold water, supported by electric machines when the demand exceeds the absorption machines' capacities. Cold water is stocked in a 5000 m3 underground deposit. Nearby sea water is used for cooling the plant, without any additional refrigeration tower.

The 4 parallel tubs network (2 for DH - forward 90ºC return 60ºC, and 2 for DC – forward 5ºC, return 14ºC) is under streets or in underground service galleries and works with variable flow (water is pumped from the central according to demand) and constant volume (closed circuit). The system has several technical elements such as fixed points, discharge points, vents, dilators, and selection valves to guarantee safe supply. Furthermore, the network has a system of leakage detection based on the variation detection of a conductor electrical inserted inside the polyurethane layer of the pipe, which prevents the moist at all times be transported head in or out of the pipes. The network water is treated drinkable water, with a permanent PH and conductivity control, and corrosion inhibitors in the heating network and biocide in the cooling network.



Process:

- 2002- Project start
- 2003- Building of central and first 3.3km of networks
- 2004- Exploitation use with 4.4km of networks and 10 connected buildings in the Forum area
- 2006- Prolongation of network in the 22@ area with a total of 21 connected buildings
- 2008- 10.8 km of networks and 37 connected buildings

2010- 13.1km of networks and 59 connected buildings. Construction of the Tanger plant. This second plant aims to ensure supply in periods of higher demand and will be put into service in case of any eventuality. High energy efficiency and low emissions Hot and cold water production using gas energy, advanced system of ice accumulation which allows the production of cooling energy during low demand periods.

Conclusion:

- Use of residual energy (vapor from the incineration plant)
- Refrigeration with nearby sea water
- Optimized selection of use temperature
- Professional and highly specialized technical team
- Predictive and proactive Maintenance
- Correct demand planning
- CDH network implementation in existing city can be successful if well planned
- Flexible solutions in urban planning to promote private initiative and investment: Previous public investment in infrastructures and investment return through connection rights.

Sources of information:

- http://www.22barcelona.com/index.php?lang=en 22@ Barcelona
- http://www.redesurbanascaloryfrio.com/index.php?option=com_content&view=article&id=12&Itemid=30&lang=en DISTRICLIMA

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Infrastructures in 22@ district – Barcelona

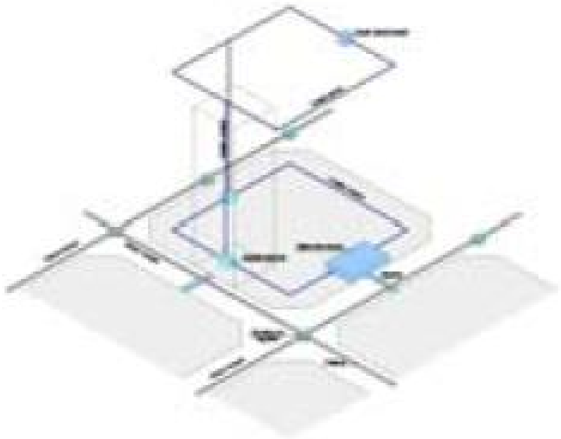
The 22@ Barcelona project transforms two hundred hectares of industrial land of Poblenou into an innovative district. It is the most important project of urban transformation of Barcelona city of the last years and one of the most ambitious of Europe of these characteristics, with a high real state potential and a 180 million Euros public investment of infrastructure plan. Prior to the 2002 Barcelona Plan for energetic improvements, the 2000 Special Infrastructure Plans (PEI) allows for urban improvements on 37 kilometers of streets in the 22@Barcelona area with highly competitive utilities and networks.

The complete development and redesign of existing streets, along with the creation of new ones and public spaces on the land rehabilitated from the transformation of the industrial areas, permits the installation of various sustainable networks besides DHC.

A network of underground galleries is being installed in parallel with the street refurbishing, providing optimal network maintenance and reserve space for future networks. These galleries mostly financed by municipal 22@ and Districlima contain all services: water, electricity, gas, communications, and pneumatic waste system. For electricity and communications, the network is constructed and financed by the 22@ Barcelona project. Operators are charged rent of medium voltage channels (electricity) and neutral optic fiber (communication) which are an important source of income for 22@.

A red of substations is planned, with provisional space and prescriptions for all services. The planned average for one block of the Cerda grid is: 1 underground substation of 30m2, various facility exchange station facilities on the ground floor, deployment of mobile telephony in the upper terraces (planned for volume control and visual impacts).

6 main issues are being resolved: energy (electricity, gas, DHC), water, communications, waste and cleaning, mobility and public transport, treatment of public spaces,



Energy - Electricity

- New substation
- Transport network (medium voltage): channeling through public domain
- Processing and distribution network: private domain

Energy - DHC

- Definition of potential sub-sectors
- Definition of exchange points or substations
- Provision of network implementation

Energy - Gas

- Distribution network being completed (public domain)
- Points of cogeneration

Water

- Drinking water network
- Distribution network being completed (public domain)
- Groundwater potential of Poblenou
- Groundwater Red

- Municipal red (irrigation and cleaning)
- Water Management criteria
- Sewerage

Waste and cleaning

- New Construction junkyard
- Train cleaning machinery
- Street cleaning systems
- Pneumatic waste collection system

Communications

- Core Network of existing operators and reserves for future channeled by the public domain
- Planned telecommunications facilities and distribution network with easement for private domain
- Provision of antenna sites and radio transmission systems in each Cerda grid block

Mobility and public transport

- Hierarchical organization of street network
- Reorganization of the bus network
- Bicycle lanes network
- Metro and rail lines integration
- Intelligent traffic management systems
- Parking

Public spaces:

- Accessibility
- Green spaces – 6500 planted trees
- Public furniture design
- Prescriptions for public spaces design

Conclusion: The optimization of infrastructures refurbishing, including all current sustainable town planning issues and prevision for future developments.

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Bus-HOV lane C-58

Exclusive lanes for high occupancy vehicles and buses (bus-HOV) in the Barcelona Metropolitan area are helping to cut transport times and alleviate congestion problems.

The City of Barcelona has a population of 1.5 million, and an area of 99km², while the metropolitan area has a population of about 4 228 000, over an area of 3 240km², and with an average density of 1 307 persons/km². Car ownership is estimated at about 410 cars/1 000 inhabitants. While Barcelona is a highly centralized city, recent years have seen a marked depopulation from the centre, with the growth of a secondary ring of satellite centers extending beyond the urban area.

One of the most important access routes into the city is the C-58 motorway that connects some of the main satellites to the City Center of Barcelona, used by an average of 154.000 vehicles per day, with important transit problems especially at rush hours.

In summer 2012, two additional lanes of 6.8 kilometers length along the inner part of the motorway, between the Ripollet junction and the Meridiana Avenue in the centre of Barcelona, have been opened to public transport, high occupancy vehicles (HOV - three or more occupants) and electric and environmental friendly cars. The principal objective is to reduce the daily traffic congestion on the C-58 motorway, which is particularly detrimental to public transport, to increase public transport reliability, car sharing, the use of low-polluting vehicles, and therefore reduce CO_2 emissions to the atmosphere.

The new infrastructure does not share the space with the remaining traffic and thus enables a quick access where conventional routes register reiterated congestion problems. It is estimated that the lane will be used by about 300 buses and 7,500 high occupancy or environmental friendly vehicles per day. The lanes are separated and reversible and a traffic management system adapts the lanes to current mobility needs, so that on weekdays lanes will be open from 06.30 a.m. to 01.00 pm to enter Barcelona, and from 04.00 p.m. to 10.00 p.m. to leave the city centre.

Conclusion:

Promotion of public transport, high occupancy and environment friendly vehicles by a fast access lane is supposed to reduce traffic congestion and reduce CO_2 emissions to the atmosphere **significantly.**

Sources of information:

- www.pemb.cat Plà estratègic metropolità de Barcelona
- www.ec.europa.eu/regional_policy/index_en.htm European Commission

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