BASREC

Best Practice Sharing

Municipal Energy Integration

Booklet 1 – Integral Urban and Energy Planning

July 2015

Foreword

Integral urban and energy planning has become vital in designing and upgrading communities to meet the constantly strengthening requirements of high energy efficiency, low primary energy factor and minimal emissions. The challenges cannot be met only on the building level, but need to be approached on the community level, both because the needs and ways of transportation and because of the properties of various types of renewable energy sources setting new requirements to the community structure.

One of the challenges faced by the new integral planning has been identified as the different professional background of the planners. According to tradition, the urban planners, usually architects, and the energy planners, dominantly engineers, have had difficulties in professional communication.

Moreover, the urban planning as the main process has had to meet with the various conditions of economy, financing, functionality, visuality, and finally those of energy. Now however, the relative importance of energy has suddenly increased as energy in its various forms is the main reason to green house gas emissions, and thus for global warming.

In Europe, the tightening competition amongst the energy companies has reduced prices to the benefit of the customers. On the other hand, however, the companies have become more closed and do not publish performance indicators as they used to, thus hiding operation information from their competitors. Moreover, private ownership of DH companies has set a new barrier for co-operation with the municipality: often information exchange has been restricted, co-planning has been put aside, energy efficiency is not promoted. The DH company protects and extends heat sales as it is their core business. Who is to pay the bill (if anybody) for sustainability and long term objectives? A new barrier to integral urban and energy planning in communities, which hampers development of DH and CHP, and now in particular introduction of the DC has been created. As a solution, the private DH company and the municipality should recognize the common goal which is economic and integral energy supply in the densely built urban center. The practical approach towards integral energy and urban planning should be built on meeting the common goal.

The booklet has been issued with an objective to:

Provide guidance to cities, regions and energy companies in the Baltic Sea Region (BSR) in their process of accelerating conversion from fossil fuels, improving energy efficiency, and extending the use of renewable energy sources,

BASREC has initiated a project on Best Practice sharing within Municipal Energy Integration. The project scope included the following 3 main topics:

1. Integral Urban and Energy Planning
2. Planning and Integral Operation
3. District Cooling

Relevant stakeholders in a number of selected Cities (Helsinki, Porvoo, Stockholm and Copenhagen) have been interviewed, and based on this three booklets (1,2,3) have been issued, one on each topic. The present booklet presents the main conclusions in respect of "Integral urban and energy planning". It discusses the different opportunities and challenges in the various Cities and extracts experiences and best practices based on the individual City cases and at a common level for the entire BSR. Based on the interviews, an overview of the main features and driving forces drawn from the questions below is included for the individual cities in chapter 5.

- *Is there a national planning framework for energy planning?*

- *How is local energy planning organised and what are the experiences in respect of initiatives towards local energy planning under the national policy framework?*
- *Which sectors are traditionally covered by local energy planning?*
- *What are the experiences from coordination between energy planning and urban planning activities at city level – both in respect of new development areas and in respect of rehabilitation plans for existing City areas?*
- *What are the experiences in respect of coordination between climate policy and initiatives and development plans for different supply companies at local level?*
- *Is there a need for intensified efforts in respect of training to establish common understanding and harmonised approach between municipal planning and energy planning?*

The authors of the booklet truly hope that the approaches and examples presented in the booklet will contribute to a more integral planning of urban structures and renewable energy systems, and DHC/CHP in particular as an integrator of various types of energy sources, in the BSR municipalities and beyond.

Contents

Abbreviations

BASREC	Baltic Sea Region Energy Co-operation
BSR	Baltic Sea Region
CHP	Combined heat and power plant
DC	District cooling
DHC	District heating and cooling
DH	District heating
DHW	Domestic hot water
EE	Energy Efficiency
EU	European Union
HP	Heat pump
RES	Renewable Energy Sources
PEF	Primary Energy Factor

1 Integral Urban and Energy Planning – the concept and main features

Integral urban and energy planning is an important issue while planning urban structures to favour Energy Efficiency (EE) and Renewable Energy Sources (RES) development, and with District Heating and Cooling (DHC) and Combined Heat and Power (CHP) in particular. It has been estimated that even a half of the energy production and demand of an urban community will be decided during the urban planning phase (Mr. H. Lylykangas, a Finnish architect specialised in urban planning research).

Traditionally the urban planner is the first actor to influence the sustainability of the community in terms of land use planning, planning of building structures and physical planning. The early planning influences primary energy consumption and emissions while fixing the transportation routes as well as locations, types and sizes of the buildings. It is therefore important that, the urban planners are aware of the basic features of energy and emissions caused by electrification, heating, cooling and transportation inside the community as well as transportation out and inwards the community. The local needs are to be covered by supply systems of which some are local and some are interconnected citywide, with other cities, at national level and even at international level through cross border electricity connections and imported fuels. Consequences in respect of lifecycle costs – socioeconomic as well as costs for different actors, security of supply, local emissions and climate needs to be understood and assessed in close cooperation with relevant stakeholders.

As an example which often might not be fully understood there is a risk that prioritizing one type of RES may eliminate the economy of the other, and finally, lead to increased PEF and emissions even though the original objective was to reduce primary energy factor (PEF).

Such a risk is when introducing individual heat pumps on a DH/CHP region, as the heat pumps reduce the heat load that could be used for DH and consequently as a heat market for CHP.

CHP, as well known, is the most economic way to generate both electricity and heat from any fuel at such a high efficiency as 90+%. The fuels may range from biofuels to fossil fuels and even to nuclear fuel. Nuclear energy, however, is seldom used in CHP due to long distance from the nuclear plants to large urban communities to be heated. Nevertheless, there cannot be any CHP without the heat load in terms of either DH system or industrial steam needs.

When using individual heat pumps extensively in a DH area, the DH load will decline, and so the CHP power generation. Therefore, the decline in CHP power generation has to be substituted by power-alone generation, which may increase the PEF from about 1 to even 3. Moreover, electricity for the heat pumps is to be produced by power-alone as well. The power-alone as the incremental power generation in the power system is often condensing power based on coal. Therefore, we may end up to increased PEF and emission even though having had the opposite target.

One may argue that these considerations are not correct, because it assumes the power-alone will be generated by condensing power plant based on fossil coal. There may be other sources available like wind, solar, and hydro power, for instance, which as alternatives to coal fuelled power plants would not gain additional primary energy need. Yes, maybe so, but:

- Wind power is in full use during the heating season already. The excess wind energy is available outside the heating season, from May to September, when there is little need for heating and heat pumps. Therefore, wind power in the present systems cannot substitute the condensing power in large scale.
- Hydro power resources are almost fully used in the BSR already, and the existing resources are used for balancing the fluctuations in power demand and production. During the heating season, in the months from October to April, there is no excess of hydro power available. Therefore, hydro power cannot substitute the condensing power.
- Solar power is in early development phase, and cannot be yet be used for heat pumps in large extent.

Therefore, most of the heating season, the power-alone alternative is based on fossil fuels, and too often on coal. With electric heating used in the DH/CHP governed urban areas, the problem with higher primary energy consumption and related emissions would be even worse than with individual heat pumps.

Therefore, as a rule of thumb, individual heat pumps should be primarily recommended in the rural areas and suburbs where DH/CHP is not a sustainable alternative. Of course, the calculation whether heat pump or DH should be used as design option of the particular urban community, has to be made case by case.

The background of the urban planners differs. Most but not all of them are architects or civil engineers. The planners work in regional councils, city planning offices, consulting and construction companies, and research institutes. The overall organisation of planning is depending on the country. Neither the urban planner nor the planning process is uniform across the BASREC countries but characterised by significant variations. In Germany, for instance, the term “urban planner” is certified by each federal state (Bundesland) differently, whereas in some BASREC countries “urban planners” are an undetermined group of planning professionals.

Co-planning carried out jointly by urban and energy planners may have a substantial environmental, economic and even financial return, as for instance, experienced in the best practice case of Porvoo (Finland).

By means of co-planning between the two professions, the win-win situation was achieved as the primary energy consumption, flue gas emissions and even the total costs during a 30 year period fell compared to the reference case from year 2007. Learning from each other while initiating the new co-planning approach took some time (about a year), but was vital to the positive outcome both for the actual project and for future activities.

Strengthening Climate Change has set new requirements for urban and regional planning that only can be addressed by co-planning of urban and energy planners together. Co-planning of urban structures and energy systems is a requirement to ensure consistency in local and regional development. To be successful, however, in many cities such co-planning requires new skills and attitudes from both urban and energy planners.

2 Integral Urban and Energy Planning – driving forces and motivation

Plans for urban development provide valuable information about the future development of energy consumption in the given urban community. Conduction of cost-benefit analysis when planning the development of an energy system in parallel with the planning of urban development elucidates the long term effects of given development. The long term profitability of planning and investing in an energy system that can supply an urban community throughout its technical lifetime, in contrast to at all times investing in energy solutions for supplying the short term/ current energy demand, is significant. Short term optimization might turn out to be inadequate and lead to inadequate reinvestment in new energy technologies within the technical lifetime of the existing energy technologies.

EU Member States shall carry out a cost-benefit analysis covering their territory based on climate conditions, economic feasibility and technical suitability. The cost-benefit analysis shall be capable of facilitating the identification of the most resource-and cost-efficient solutions to meet heating and cooling needs.

Having a broad perspective on energy planning also might lead to positive synergies in contrast to local optimization.

Urban planners face a new and comprehensive challenge. Roughly three quarters of the European population live in cities. The building and construction sector represents more than 40% of all energy consumption and related emissions. Transportation is another important source of pollution. But urban areas do not only feature the highest density of energy demands, they also dispose of the highest density of energy resources. Mapping these often hidden treasures such as industries producing waste heat, existing power stations, waste incineration and water treatment plants, solar source, nearby forests and agricultural activities, rivers and lakes provides a good basis for starting a debate, identifying synergies, and establishing partnerships.

Many projects for eco-cities and -districts, zero-energy buildings and new experiments of energy efficiency prove that spatial planning can substantially and positively influence on the uptake of renewable energies and energy efficiency measures. Spatial planning can be the key to a socially, economically and ecologically more sustainable future. Many encouraging examples show that economic benefits can be achieved through urban planning that has incorporated climate change and energy efficiency related aspects.

The “energy transition” requires a change in the way we think our future and behaviour. It will only happen, if and when all actors in the value chain understand the need for changes as well as the possibilities and tools at hand. Expertise in climate and energy is needed on all levels of spatial planning. While traditionally, energy supply and urban planning were perceived as separate domains of expertise, we need to provide new skills and tools to planners today with a view to create smarter and more sustainable communities.

The fundamental idea of DHC is to use heat and other energy sources that otherwise would be wasted (surplus heat from electricity production, from industrial processes or waste incineration) or renewable energy sources (biomass, geothermal, solar) to provide comfort to buildings (space heating and cooling, warm water preparation) and heat to various processes (industrial processes, hospitals). Therefore, DHC and CHP are important infrastructures for any city concerned about energy efficiency and aiming at expanding the use of renewable energy sources. A collective energy solution for the benefit of all requires local government and urban planners to take on a pivotal role. Specifically, upgrading of the public building stock should go hand in hand with the establishment of heating and cooling plans. A comprehensive approach to local energy supply and demand, and the development of eco-districts, will help to keep costs for the citizens at affordable levels.

Integral Urban and Energy Planning simultaneously can contribute to increased property market value and increased security of supply, sustainability and predictability.

3 Integral Urban and Energy Planning – barriers and competitive solutions

There is little tradition in the world to integrate energy and emission policies to urban planning even though energy mainly used in housing and transportation is the main source of Green House Gasses (IEA. 2011).

The barriers for integral urban and energy planning are mainly connected to tradition and organizational structures. Different departments and experts are not used to work together – they do not have the same picture and the same understanding of proportions and relationships between actions and consequences.

Both different education and conceptual thinking of the two professionals, urban versus energy planners, result in basic differences, for instance, like

- Social vs physical sciences,
- Spatial vs mathematical models,
- Multidisciplinary discussions vs detailed technical problem solving,
- Qualitative vs quantitative terminology and measurements

The willingness to see beyond pareto optimality, which is a state of allocation of resources in which it is impossible to make any one individual better off without making at least one individual worse off, could be in conflict with various political agendas. Failure to see the socioeconomic benefits of optimizing the energy system on a larger scale could be expensive.

The increased political focus on climate issues, economic growth and local development however makes it necessary to establish a consistent decision basis at local level under the national framework conditions, policy goals and commitments.

A huge challenge in connection to sustainable urban development is to address both present and future needs which are dictated by resource scarcity and expected climate changes. An interdisciplinary approach to sustainability is necessary. The main topic of physical regeneration needs to be seen in context alongside social, economic, environmental and cultural aspects of urban life. Sustainable urban development is reached best through integrated urban development plans around long-term visions for cities and neighbourhoods in their regional and national context.

Focus on minimising the energy consumption, integrating renewable energy supply and making the use of fossil fuel more effective is important. Future-proofed, flexible quality solutions pay. But it may be difficult to assess which technologies will be optimal both now and in the future. Sustainable energy development requires an integrated approach to demand and supply options and a full understanding of the total chain from resources to requirements. The interfaces and the balancing over time in all dimensions are important to efficiency in the short, medium and long term.

To intervene in a liberal energy market by introducing a public supply of say DH, which will give some actors on the market a large market share, and in some situations a monopoly, could be troublesome. A monopolized market would in many cases lead to need for regulation and compromise an idea of a free market and further lead to a conflict of interest among decision makers.

Initiatives can be taken from different stakeholders both in the international, national and urban environment e.g. urban development planners, energy suppliers, building owners, technology suppliers and lobby institutions with different interests. Cooperation between all involved public and private stakeholders, however, is important to ensure implementation of development plans in accordance with agreed development goals. Monitoring and evaluation should be an integral part of each development plan. The success stories are found where the process has been planned and implemented in an interactive and not in a counteractive way.

A good and efficient co-operation between involved parties throughout the process is important to ensure implementation in accordance with defined goals and strategies.

A consistent overview and a common understanding of assumptions, system relations and boundary conditions is a necessary communication base for the different stakeholders. A framework makes it possible to develop good local energy plans and to monitor progress. An action programme makes things happen.

Introducing integral urban and energy planning will bring environmental benefits and may also gain a sound financial and economic return as already materialized in some cities. Nevertheless, starting a new way of planning requires measures that cause additional costs in the starting phase:

- Training courses to urban and energy planners to understand the objectives, concepts and working methods of each other, as well as the relations between energy consumption related emissions and urban planning.
- Learning integral planning amongst two different professions mainly architects and engineers takes more time to develop than working in the traditional way. The time delay may cause costs due to postponed implementation.
- Consulting costs as external consultants will be needed to calculate and analyze the impacts of various city and district plans on energy consumption and associated emissions in buildings, transportation, energy production and distribution.

A few years back, training courses were started in Finland to educate urban planners to better understand the relations between energy production and emissions as well as the impact of the city planning to costs and selection of energy production alternatives.

As all partners were experienced in organising training, and as most had already used modular structures to design training, modules were chosen to be the structure for the training contents and objectives. In each module there were more detailed learning contents, but having a modular structure helped form the learning path for the courses. It also enabled the courses to be marketed. The modules were commonly designed by the partners, and the content was selected in order to provide trainees with a general perspective to RES integrated urban planning and at the same time give enough practical understanding.
Mobilising the training in a new environment may face some barriers, for instance:

- Novelty of energy training of urban planners. Care is needed to properly target the material: too much emphasis on energy engineering with data, mathematical formulas, numeric analyses will confound those who are accustomed to the architectural tradition of visual and behavioural features. Therefore, the trainees were a little worried about the content at the beginning of the course;

- Resistance to adopt a new way of approaching urban planning may be faced, as energy strategy analysis can be considered as a disturbance to the traditional urban planning. Therefore, the management does not always support such a new training approach;

- Typically, the urban planning organisations have low budgets to finance the participation of an individual in the new type of training;

- Urban planning organisations have relatively lean organisations with small staff. Therefore, it may be difficult to allow an individual to participate in the long training course. Therefore, it may not be possible to release an individual without compromising the mandatory work.

Denmark's future energy system is to be entirely based on renewable energy sources. Municipalities will play an important role as local energy planning authorities in terms of adopting and refining this vision in different local contexts. There is a willingness among Danish municipalities to actively carry out energy planning, and the plans reveal a large diversity of (new) activities. At the same time, however, there is a strong need for better coordination of municipal energy planning activities at the central level. It was recognised that the role of municipalities as energy planning authorities needed to be outlined more clearly in, e.g., strategic energy planning which integrates savings, efficiency and renewable energy in all (energy) sectors. Therefore "Strategic energy planning" (SEP) has been developed specifically to support municipalities in the planning of the energy system. The purpose of the municipal strategic energy planning (SEP) is to promote the transition to a more flexible energy system with less energy consumption and a higher share of renewable energy. SEP includes all forms of energy and energy within the municipal geographical area. Presently it is voluntary for the municipalities whether to develop strategic energy plans.

SEP is long-term planning and provide a basis for the municipalities to prioritize their efforts in the coming years. SEP focuses on strategic choices and greater efforts and cooperation between authorities and stakeholders is an absolute necessity. It is also important that municipalities collaborate across municipal borders to avoid coming suboptimal energy solutions.

To support municipalities' SEP, the Danish Energy Agency published two guides specific to the SEP process: *Mapping Guidance* and an A*nalysis Guide*. In addition, a number of other guidance and national assumptions that are relevant for local government working with SEP, have been issued.

4 Examples from Integral Urban and Energy Planning

There is evidence from Finland (Skaftkärr, Porvoo) and Denmark, that integrating urban and energy planning can produce city plans that save energy, reduce emissions and are even lower in investment cost than the traditional city plans. Those benefits will be achieved when the city plan allows integration of energy efficiency and renewable energy systems in a sustainable way.

5 Best Practices on Integral Urban and Energy Planning

5.1 Porvoo, Finland

In the new Skaftkärr district of the city of Porvoo, Finland, just 40 km from Helsinki to east, the energy planners and urban planners were set to work together at the master planning stage. The impacts of various plans were quantified in terms of energy consumption, investment and operation costs as well as emissions, which has not been the tradition in urban planning. The particular plan chosen for implementation was the one that offered the lowest lifecycle costs and emissions.

As the Reference Plan for their co-planning, the Skaftkärr plan from year 2007 was adopted, but assuming that passive energy houses would be used apart from those assumed in the plan of 2007. The Reference Plan was a suburban plan traditionally dominated by small houses to be located so that personal cars would need to be used. As heating sources in the Reference Plan, a combination of DH, electricity and heat pumps was assumed.

A new urban plan based on maximising the share of biomass fuelled CHP and DH appeared to be the best choice from the environmental point of view, and moreover, with the overall life-cycle costs much lower than the traditional plan would have caused. In other words, the new combined energy and urban planning was a win-win approach from both the environmental reduced emissions and the economic lowest cost points of view. This was highly appreciated by the local decision makers.

Co-planning started with a few studies about how people live, move and what their expectations are. Co-operation between the urban and energy planners was not that simple in the beginning. Some time was needed for them to learn and understand each others' way of working and thinking. A year was mentioned as a period of time needed to harmonise the co-operation.

The four options generated by the co-planning were as follows:

Option 1

Features	Compared to reference plan
• A dense new area that is supported by the existing city structure. • The passive energy buildings are connected to the DH. • Effective public and light transport routes are created to the city centre.	• Primary energy consumption 40% lower • CO_2 emissions 34% lower

Option 2

Features	Compared to reference plan
• Effective small-house characterised option, where 50% of heat is based on DH and the balance of other 50% on ground water heat pumps. • Effective public and light transport routes are created to the city centre.	• Primary energy consumption 36% lower • CO_2 emissions 31% lower

Option 3

Features	Compared to reference plan
• A loose land use Option, where heat and power are produced inside the buildings 100% based on RES. • Passive energy houses. • Traffic as in the Reference Plan based on private cars and a little public transport.	• Primary energy consumption 67% lower • CO_2 emissions 48% lower

Option 4

Features	Compared to reference plan
• Community type land use Option, in which the focus was on reducing the need of transport and by locating working places and services in the area. • Effective public and light transport routes are created to the city centre. • Passive energy houses served 100% by solar heating. The area will supply solar heating to all citizens of Porvoo.	• Primary energy consumption 45% lower • CO_2 emissions 62% lower

The life-cycle costs of the four options in terms of Euro per inhabitant during 30 years to come are presented in the next Figure. In three of four options the life cycle costs were lower than in Option 3. In the latter one, the investment costs of RE as well as the individual heat pumps using the electricity produced in the building itself became extremely high.

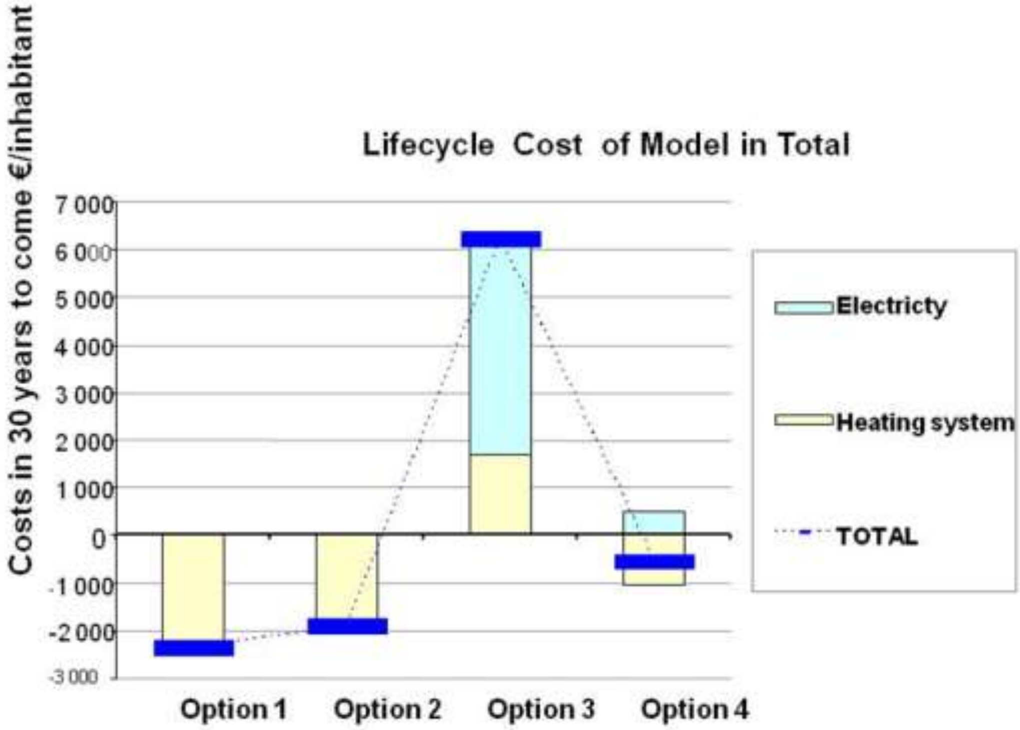


Figure 1: Life-cycle (30 years) costs per inhabitant of four planning options as incremental to the Reference Plan of year 2007 in Porvoo, Finland.

The final option selected for implementation was based on prioritising light and public transport (biking highway, for instance), using DH in most buildings and enabling solar heating to be used later on. DH as the primary source in Porvoo is a special case as 92% of the heat energy in Porvoo is from the co-generation of heat and power (CHP) plant, the fuel of which is 70% from biomass (wood chips).

As DH in Porvoo is almost 90% based on renewable fuel, e.g. waste wood, DH as conclusion was chosen as the heating method for most buildings,

All four options had primary energy consumption and emissions 30-70% lower than the Reference Plan. The infrastructure costs (streets, pipelines, etc.) were substantially reduced as well.

The city management of Porvoo was happy with the results and the new co-planning approach in Porvoo was supported and monitored by the Finnish Ministry of Environment and the Finnish Innovation Fund - Sitra. The co-planning approach is currently expanding to other cities in Finland, for instance to Oulu, Jyväskylä, Tampere. Further expansion, however, will need training and adjustments to local conditions.

In order the new integral urban and energy planning to spread to other cities, training was organized to urban planners all over the country, and some 160 planners participated two wither short courses (140) or the long course of one year (20). The courses were co-funded by the EU with the project name UP-RES, namely Urban Planners with Renewable Energy Skills.

5.2 Copenhagen

After the Oil Crisis in the 1970s the planning of the energy sector in Denmark was focused on CHP. All decisions were to be made based on cost-benefit analyses.

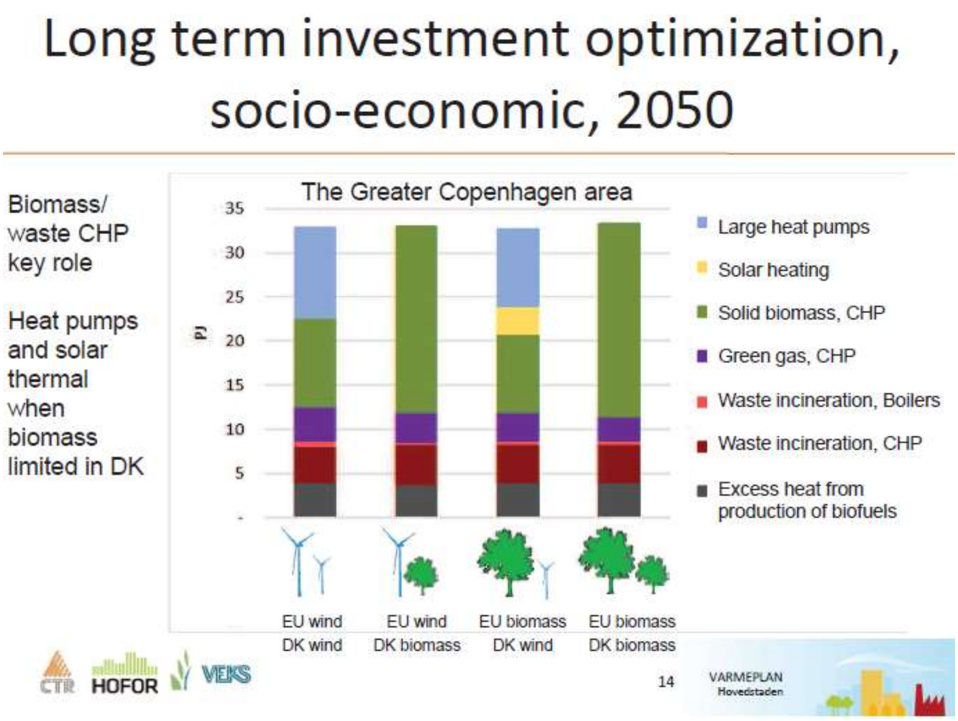
Planning have since been done in close cooperation between government, energy suppliers, private business and consumers; often initiated by municipalities. Without doubt, long term planning have been the main driver for development of DH in Denmark and in Copenhagen.

When the municipality plan for development in a district in Copenhagen all utility parties are normally involved. The supply of heat is planned and ready even before the actual building is initiated. Selling a property and/or a building prospect with a guaranteed DH supply as part of the utility package, is considered an advantage.

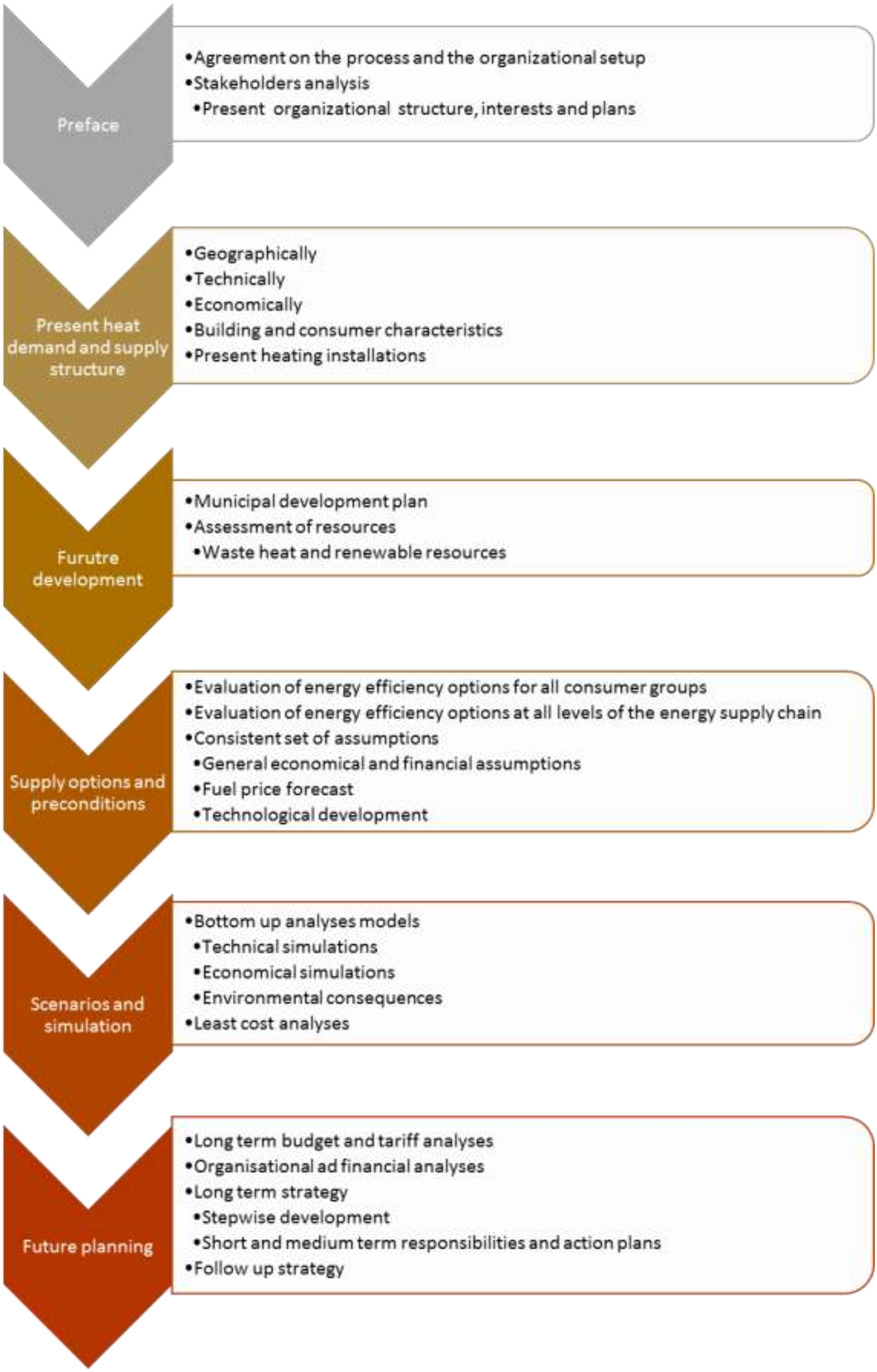
The Heat Plan Copenhagen Phase 3 from 2014 carried out by HOFOR and the heat transmission companies CTR and VEKS, supports the Copenhagen Climate Plan in its quest to become CO_2-neutral. The plan has a long term planning horizon up to 2050 and analyses steps for 10 and 20 years. The project includes the entire metropolitan area and is a further development of the Heat Plan Copenhagen Phase 1 and 2 from 2009 and 2011 respectively. The Heat Plan Copenhagen Phase 3 develops and outlines a scenario for CO_2 neutrality. The scenario sets out how the metropolitan district heating will become CO_2 neutral by 2025. The scenario achieves the CO_2 neutrality using renewables from sustainable biomass and wind power in heat pumps, geothermal heat and waste. The fossil element of the waste has not been further analysed. The work on achieving sustainable biomass is to be continued. Phase 3 has also analysed and reconciled the major investments to be made in the networks and generation over the next 10 to 15 years, including the potential for interconnection with the heating networks in North Zealand.

Additionally, a perspective scenario 2050 has been established to assess the role of biomass and wind in the DH supply in the long term – as well as the role of the waste incineration plants. Furthermore, there is focus on the ways in which the district heating system in the metropolitan area can help integrate fluctuating electricity production using flexibility, energy storage and new technologies.

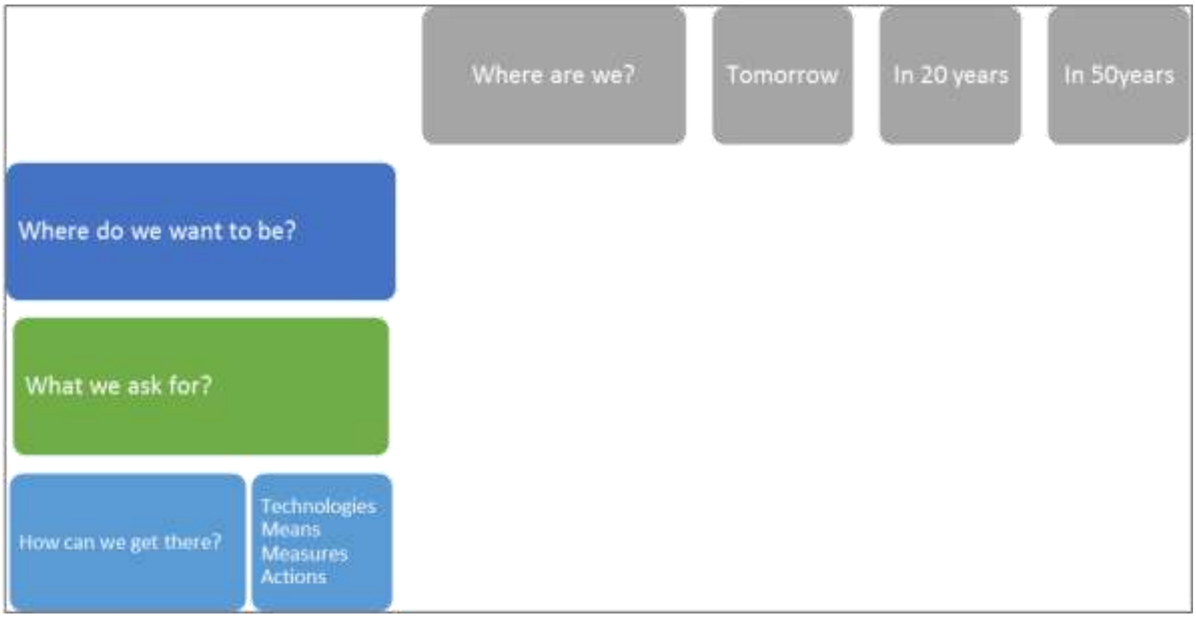
The figure below illustrates some of the scenario analyses from the Heat Plan Phase 3 Copenhagen:



The energy planning process in Denmark typically involves the steps illustrated below:


Preface
•Agreement on the process and the organizational setup
•Stakeholders analysis
•Present organizational structure, interests and plans
Present heat demand and supply structure
•Geographically
•Technically
•Economically
•Building and consumer characteristics
•Present heating installations
Furutre development
•Municipal development plan
•Assessment of resources
•Waste heat and renewable resources
Supply options and preconditions
•Evaluation of energy efficiency options for all consumer groups
•Evaluation of energy efficiency options at all levels of the energy supply chain
•Consistent set of assumptions
•General economical and financial assumptions
•Fuel price forecast
•Technological development
Scenarios and simulation
•Bottom up analyses models
•Technical simulations
•Economical simulations
•Environmental consequences
•Least cost analyses
Future planning
•Long term budget and tariff analyses
•Organisational ad financial analyses
•Long term strategy
•Stepwise development
•Short and medium term responsibilities and action plans
•Follow up strategy

It is an important part of the process to think about requirements and expectations. Different buildings for different people, in different places have different requirements. The following diagram can be filled out to facilitate the dialogue during the planning process:



5.3 Helsinki

In Helsinki city, there prevails close co-operation between the energy planners of Helen, the DH/CHP company owned by the city, and the urban planners of the city planning office. The contacts are on weekly, sometimes even daily basis between the working level experts of the two organizations, without any bureaucracy. The issues under discussion are, for instance, city development as input to DH and DC network expansion, fuel supply logistics, and today the new biomass logistics planning in particular.

At present, the main issue in co-operation is whether to convert two existing CHP plants to switch from coal to use biomass (wood) 40% of fuel input, or to construct a new biomass fuelled CHP plant to the eastern suburb, Vuosaari. As a third option, introduction of decentralized energy systems to come in the future will be studied under the city planning office as well.

In the Uusimaa county region, to which Helsinki belongs, there is coordination of transportation routes, wind power location, biomass logistics, harbours, and other large infrastructure plans having impacts over the city borders.

HSY, the Helsinki Region Environmental Services Authority, is responsible for coordinating transportation and waste management which have impacts over the city borders. Waste to energy is one of the tasks carried out by HSY as the waste is collected from the region to be incinerated in one CHP plant. HSY also provides comments to the individual city development plans.

As a demonstration of the seamless co-operation, the modern waste incinerating CHP plant common to the Helsinki region was commissioned in the neighbour city of Vantaa in 2014 as a result of the regional co-operation of urban and energy planners. The mixed waste used as fuel at the waste-to-energy plant replaces a corresponding volume of imported fossil fuels, such as coal and natural gas, thus contributing to Finnish security of supply. Collected mainly from households, the mixed waste is delivered to the plant from the Helsinki area by the HSY and from the Uusimaa region by a private company, *Rosk'n Roll Oy*.

5.4 Stockholm

In Sweden the municipality plans and approves the heating supply for all building applications, and often requires DH for approval. The municipality in Stockholm has a distinct climate agenda.

There is a culture, in Sweden, for long and thorough planning, which also applies to city development planning. District heating is included in the planning from the start of the planning period, including in the building design. New buildings may have as big capacity demand as 60 MW, which will have a substantial impact on the DH and/or DC system.

Sweden has never had a national district heating policy. District heating has instead been the result of a consistent energy and climate policy, where fossil fuels have been punished and sought new, and smart solutions in order to continue to deliver heat. All major cities have a district heating system. Of Sweden's 290 municipalities, 270 have district heating. For a long time the district heating plants were owned by municipal and produced both heat and electricity. Partly as a result of liberation in the nineties, many of these companies bought by large power companies like Vattenfall, E.ON and Fortum.

In the mid-sixties, several CHP plants were established and sales doubled in five years, from 5 to 10 TWh. The real breakthrough came after the first major oil crisis in 1973. There were years when the so-called “a million program” of new dwellings were completed and could be directly adapted and connected to district heating.

Stockholm has since 1995 worked strategically to reduce greenhouse gas emissions. Greenhouse gas emissions have decreased by 25 percent since 1990. From 5.4 tons to 3.2 tonnes per capita in 2011. Stockholm is now on track to achieve the climate target for 2015 of 3 tons of greenhouse gases per capita. DH with extensive grid networks and increased biofuel share is the action that have meant the most to reducing greenhouse gas emissions.

The city's long-term climate objective is to Stockholm shall be become fossil fuel free by 2040. Among other things, Stockholm invest in renewable energy, energy efficiency measures and sustainable transport without requiring fossil fuels. The report “Roadmap to a Fossil Fuel Free Stockholm in 2050” outlines the objectives and road maps to reach the fossil free future.

The congestion tax and more environmentally friendly cars are other examples of the city's efforts to both reduce car transport and make it more environmentally friendly. Developed public transport and investing in more and better bike paths invites locals to choose climate-friendly itineraries.

Fortum Värme is the first company in the world to offer a marketplace for surplus heat. *Open District Heating* is a concept, which among other things allows data centres to sell their surplus heat at the market price, makes Stockholm a unique place to base a business. The company is now aiming to attract more data centres to set up shop in Stockholm so that the surplus heat they generate can actually be used by people rather than simply being extracted by fans.

6 Conclusions

Due to climate change, the importance of the energy component in urban planning has strengthened as energy in various forms (heating, cooling, transportation, electrification, manufacturing) is the main reason to the green house gas emissions. Nevertheless, inclusion of energy and the related emissions to become an essential part of the already sophisticated and demanding urban planning process faces challenges. Such challenges are:

- Lack of tradition in integral energy and urban planning prevails in general.
- Different professional background and environmental of urban and energy planners with different way of thinking creates a barrier for integral planning.

- Little training tradition exists to educate urban planners to understand the energy and emissions related to the urban plans, or the other way, the energy planners to understand the concepts and processes of urban planning.
- Privatization of DH companies in some cases has worsened the co-operation of urban and energy planners as the DH company prefers to keep their business secret towards competitors and the public audience.

Despite the challenges, integral urban and energy planning has success stories in many individual cities and regions in the BSR already. The success stories have required strong guidance from the city and DH company management, training approaches and opening the planning processes to public participation.

More effort is needed to make urban and energy experts to really co-plan, not only co-operate in traditional way, in developing sustainable urban communities in the BSR and beyond. Neither profession can do that alone, but the integral planning is necessary.

7 Examples to Improve Integral Planning

7.1 Training Approach - Finland

A few years back, training courses were started in Finland to educate urban planners to better understand the relations between energy production and emissions as well as the impact of the city planning to costs and selection of energy production alternatives.

The design modules were designed, and the content was selected in order to provide trainees with a general perspective to RES integrated urban planning and at the same time give enough practical understanding. The ten modules that were developed are described below in Table 2.

Table 2: Energy in urban and regional planning training modules

M1	SUSTAINABILITY CONCEPTS IN REGIONAL AND URBAN PLANNING: A HOLISTIC VISION The share of urbanisation is expected to rise to 70% by year 2050 from the current level of about 50%. Use of fossil fuels to cover the growing energy needs is still growing. Countries have set targets to reduce primary energy consumption and to increase the share of RES. Urban planning has a key role in achieving this.
M2	ENERGY. FORMS - TRANSFORMATION - MARKET OUTLOOK Energy is available in various forms such as fuels, electricity, heat, cooling, mechanical energy. Some energies are “good” due to low emissions and low primary energy factor but some others are “bad” for opposite reasons. This module covers how to assess various types of energy and how to convert from one to another. Calculation examples are given as well as simple tools are offered for public use.
M3	ENERGY DEMAND REDUCTION STRATEGIES: POTENTIAL IN URBAN PLANNING Strategies for reduction of energy consumption are presented from various cases, such as Freiburg and Porvoo. In both cities, urban planning including energy and emission issues has provided sustainable results in terms of reduced primary energy consumption, reduced emissions and even an improved overall economy.
M4	ENERGY DEMAND REDUCTION STRATEGIES: POTENTIAL IN NEW BUILDINGS AND REFURBISHMENT Building as the major consumer of heating, cooling and electricity is a vital point to focus on.

	Construction of new EE buildings is often less challenging than retrofitting existing ones, but the latter is dominant while influencing the energy consumption at the building level. What is the meaning of 'zero-energy building' and how can they be built, and how can existing buildings be refurbished to become as efficient as possible?
M5	ENERGY RESOURCES AND RENEWABLE ENERGY TECHNOLOGIES Solar panels (electricity) and collectors (heat) require solar radiation to function. Heat pumps can convert waste heat to useful energy (heating, cooling), biomass can be used to produce heat and power. The main applications are presented to give an idea of the opportunities offered and requirements set to urban planning.
M6	ENERGY DISTRIBUTION: DISTRICT HEATING AND COOLING DHC as a means to distribute heating and cooling and CHP and heat pumps to produce such products at high efficiency are presented here. Thanks to CHP and DH substantial savings in primary energy consumption can be achieved. An existing DHC network is a precondition for successful application of CHP, and that is the most efficient way to produce electricity and heat - efficiency can be as high as 95%. The DHC system, in order to economically viable, requires compact urban structures.
M7	THE RIGHT SCALE FOR EVERY ENERGY CONCEPT: HEAT AND COOL DENSITY (DEMAND SIDE), POTENTIAL ON SUPPLY SIDE Some types of energy are variable, whereas some are steady. Some energy conversions require large scale to be economic, whereas some others can be economic even at the small scale. In urban planning, one has to be aware of the main features of the types of energy in order to improve sustainability of communities.
M8	NEW MANAGEMENT CONCEPTS IN THE ENERGY MARKET In order for RES concepts to materialise, certain financing/organising methods exist such as delivery and performance contracting, for instance. For the dissemination of RES and EE information, energy agencies have been established.
M9	ENERGY PLANNING Energy planning starts from the demand analysis and forecast. Various concepts can be considered to meet the demand at lowest cost, primary energy consumption and emissions. Urban structure, however, will determine the case with which concepts can be adopted.
M10	NEW TRANSPORT MODELS AND URBAN AND INTERURBAN MOBILITY Transportation covers about a quarter (27% in 2010) of primary energy consumption. Ways to reduce the transportation need through urban regional planning, comparison of various transportation media in terms of energy consumption and emissions, availability and future of renewable fuels for transportation have been discussed. Many cities such as Freiburg, Germany, have already been successful in developing public transportation and biking in a sustainable way.

7.2 Development based on Materialized Training – City of Oulu

The training introduced above has lead to new integral planning approaches in other Finnish cities, for instance, in Jyväskylä, Kuopio, Sipoo, and Oulu.

In Oulu, for instance, the training of urban planners changed the planning concept of the new district Hiukkavaara. An urban planner from Oulu participated in training at Aalto university, Helsinki, to understand the connections between energy, emissions and urban structures. After having returned back to her office in Oulu, she shared the lessons learned in the university with her team mates.

Initially, there was the structural plan from year 2008 to rebuilt and complement the previous military district of Hiukkavaara to become a modern residential district of 1500 ha and 20 000 inhabitants. In 2015, the population of Hiukkavaara amounts to only 2500, basically the old military buildings being there.

Traditionally, urban planning and energy planning were carried out rather separately, but the urban planners having had asked for comments from the local energy company. In 2011, INURDECO (Integral Urban Development Concept) project was launched to change integrate the urban and energy planning processes.

In the course of INURDECO implementation, the traditional urban planning was converted to the integral city planning process which is characterized by intensive communication with various stakeholders and initiating research and study work that was carried out by third parties such as universities and consultants.
Intensive co-operation with other stakeholders, including the local DH/CHP company, Oulu Energy Ltd, was initiated in particular with the Corporate Development and DH Management branches.
Several brainstorming sessions were organized with various stakeholders, 20-30 per session with various combinations of participants, locations and scopes.

As an incentive to the real estate developers to actively participate the INURDECO project with their plans and ideas, they were granted the privilege to start their construction one year prior to the others to start selling apartments and room space one year earlier than the others.

As the energy efficiency of the buildings gradually improves, DH becomes less economic as the heat load density declines. Therefore, more effort shall be given by the urban planning to make the districts more compact as way to compensate the reduced energy consumption.

Additional costs were caused by the new integral city planning process. About €300 000 more was used for integrating the urban plans of Hiukkavaara to plans of the other institutions, requirements of the commercial interest and potential inhabitants. Also politicians were included in the preparation work. Some planning work was done by the real estate developers by themselves and at their own costs. Some 50% of the total costs of €300 000 were sponsored by the national TEKES (Finnish Funding Agency for Innovation). Moreover, an expert was hired to coordinate and manage the planning process with 3 man years of working input.

Financial benefits compared to the traditional planning are likely much more than the additional investments, as the utilities could be better optimized. Shorter roads, water, sewage and DH piping but lower emission levels and higher overall energy efficiency are expected. The benefits, however, have not been quantified yet.

Thinking back in time, the research should have been done in an earlier stage as a stimulator to brainstorming.

Traffic needs were reduced by introducing room space for remote working in Hiukkavaara center instead of people travelling back and forth to their offices being elsewhere. Therefore, car parking space could be reduced substantially, and the district could be designed in a compact way, thus favouring DH.

As a result of the new integral policy, usage of bio based fuels and waste heat will be developed in CHP and DC. In the districts outside the DH supply, various individual solutions will be prioritized to extend the use of RES.

The customer, if wishing to be connected to DH, has to receive an approval from the DH company, Oulu Energia, for connection. The new buildings will be different in size, location and energy efficiency, so the economy of DH connection has to be checked. The document of Oulu Energia whether agreeing or denying DH connection is a requirement to get the construction permit.

Oulun Energia Ltd is the local city owned DH/CHP company. The DH production is based on local peat (57%) and wood chips (35%) and the balance of 8% of coal, oil and others. The capacities of the two existing CHP units are 185 MW and 320 MW for electricity and heat, respectively. The third large CHP plant to be commissioned by year 2019 will be completely running on wood. The new CHP plant will be combined with a new bio development plant that will produce and sell bio based energy products to the market, either the products based on pyrolysis or coking of biomass. The DH system of Oulu is characterized by the DH network of 774 km length, the number of customers (buildings) 8 800, and the heat sales and production being 1 480 and 1 570 GWh, respectively.

Oulu is one of the few DH systems in Finland in which DH has been extended to cover all city districts, including small-house areas.

Today, a **mini CHP** using biomass is in operation in the middle of the existing DH network, but not connected to the main network as the connection pipelines would be long. The CHP supplies heat to two blocks of buildings of 3000 m2 of heated area. The heat costs of the mini CHP, even though being based on wood as fuel, is substantially more expensive than the DH tariff of Oulu Energia Ltd.