Market uptake of small modular renewable district heating and cooling grids for communities

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CooHeating.eu

Framework conditions and policies on small district heating and cooling grids in Denmark, Austria and Germany

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CoolHeating website: www.coolheating.eu

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1 Introduction – facilitating DHC

The framework conditions are important for the establishment and operation of collective district heating and cooling systems. A characteristic of collective systems compared to individual systems is that a collective system requires organisation – and this requires framework conditions e.g. to facilitate that the investments in hardware can be financed. The costs of financing should be minimized, reflecting the low risk characterizing heat and cooling supply.

A key aspect of collective systems is trust. Trust is crucial for realizing the synergies of a collective system. This implies obligation of the consumers to pay for part of the fixed costs, i.e. to provide security that the investments will be reimbursed.

Subsidies and taxes is an instrument which can influence the behaviour of the consumers. E.g. in Denmark the tax levels are relatively high, providing further incentive for energy efficiency.

This report (deliverable 2.4 in the CoolHeating project) provides information on the experience regarding framework conditions for renewable district heating systems in Denmark, Austria and Germany. The purpose is to provide inspiration for the five target countries to optimize their regulatory framework and implementing measures for small DHC through exchange of information and best practices.

This report is supplemented by a Best Practice report (deliverable 2.1), which contains descriptions of a number of examples of renewable district heating plants in operation. Another supplementing report is on information material for the public (deliverable 3.3), which addresses the aspect of local acceptance.

The Commission has launched its first ever strategy to tackle the massive use of energy, particularly fossil fuels, in the heating and cooling sector. The strategy includes plans to boost the energy efficiency of buildings, improve linkages between electricity systems and district heating systems which will greatly increase the use of renewable energy, and encourage reuse of waste heat and cold generated by industry.[1]

District heating is an energy infrastructure, enabling utilisation of various renewable energy sources and sources of waste heat. In Denmark where district heating is widely applied, the challenge is to switch from CHP-based production to a more diversified production of district heating based on solar, biomass and various heat sources, often in combination with heat pumps driven by electricity, which to an increasing extend is produced by wind power.

Hence, expanding the use of district heating is also a question of seeing district heating as part of the whole energy system, and thus designing the framework conditions accordingly. This process is on-going, also in the more experienced district heating countries of Denmark, Austria and Germany.

The template for the report is provided by PlanEnergi, and the contents for each chapter is provided by the respective partners in each country.

[1] https://ec.europa.eu/energy/sites/ener/files/documents/1_EN_ACT_part1_v14.pdf

2 Framework conditions for DHC in Denmark

Denmark has a relatively large share of district heating, providing cost efficient heat supply to heat consumers in small as well as larger city areas. District heating started without national political objectives, it was based on private initiatives, where consumers organised themselves.

The oil crisis in the 1970s initiated an energy policy, where energy efficiency was a priority. The Heat Supply Act in 1979 facilitated detailed planning, also giving priority to security of energy supply by reducing oil imports. After successful implementation in the 1980s, the objective in the 1990s was to simplify and decentralise the decision process for establishment of new district heating plants. This introduced the "project based" planning scheme, which still applies. Priority was now given to reduce CO_2-emissions and secure investments in natural gas infrastructure.

The successful implementation of district heating until the 1980s was based on a planning hierarchy; the state, the counties, the municipalities. In 1990 the municipalities became solely responsible for the heat planning, supported by some overall regulation by the Minister. The municipalities can have two roles; as authority (approving projects) and in some cases as owner and operator of district heating utilities.

Key positive aspects:

- Vast experience with district heating from large scale implementation of district heating systems providing cost efficient district heating to a large number of consumers
- Widespread and strong local involvement in consumer owned district heating utilities
- Development of district heating systems is ongoing in terms of organisation (mergers) and more diversified production capacity (solar thermal, heat pumps, biomass, etc.)
- High level of trust due to transparent regulation based on non-profit heat pricing

Key negative aspects:

- Regulatory framework is somewhat outdated, e.g. need to change from producing to consuming electricity (from CHP to heat pumps).
- Process of adjusting the regulatory framework is on-going, but characterised by inertia
- Requirements for development of district heating implies need for consolidation and build-up of competences – without compromising the local involvement
- Lack of acknowledgement of key qualities of district heating as energy infrastructure, implying focus on bench-marking and privatisation

The Best Practice report (D2.1) contains examples from Denmark, which demonstrates development of district heating towards a more diversified production of district heating, based on renewable resources and providing competitive heat prices. E.g. the example in Brædstrup was supported by several development projects, demonstrating new storage technology (borehole), solar thermal in combination with heat pump and natural gas fuelled CHP.

Large scale seasonal heat storage is another example illustrated in the cases "Gram" and "Marstal". Besides increasing the share of solar energy in the heat supply, this technology demonstrates the role of district heating as energy infrastructure, providing flexibility also to the electricity system by absorbing surplus electricity based on wind power by applying heat pumps.

The development of solar thermal district heating was to a large extend facilitated by the regulation, which implied that – until 2015 – natural gas was mandatory to apply in small-scale CHP-plants. One exception to this was solar thermal, and this implied that solar

thermal was given focus. Today, most of the plants are allowed to apply biomass, which implies an immediate reduction of the heat price in many cases.

2.1 Energy policy

The Danish energy policy has the objective of 100 % renewable energy in the energy and transport sectors by 2050. The three focus areas are; climate mitigation, security of supply and green growth. In 2012 an agreement was made in the Danish Parliament, and with some adjustments (reducing the ambitions), the targets of a fossil free energy system in 2050 remains in force.

Six analyses are elaborated as part of this political agreement, of which one regards the future role of district heating. Key points from this analysis is that there is a potential for expanding the district heating supply in Denmark, mainly by increasing the density in the areas currently supplied with district heating. This can be done by converting customers currently supplied by e.g. natural gas to district heating supply. Zoning of areas in different types of supply, mainly district heating and natural gas, was made in the 1970's and 1980's in order to facilitate optimal solution for the society by avoiding overlapping investments in energy infrastructure.

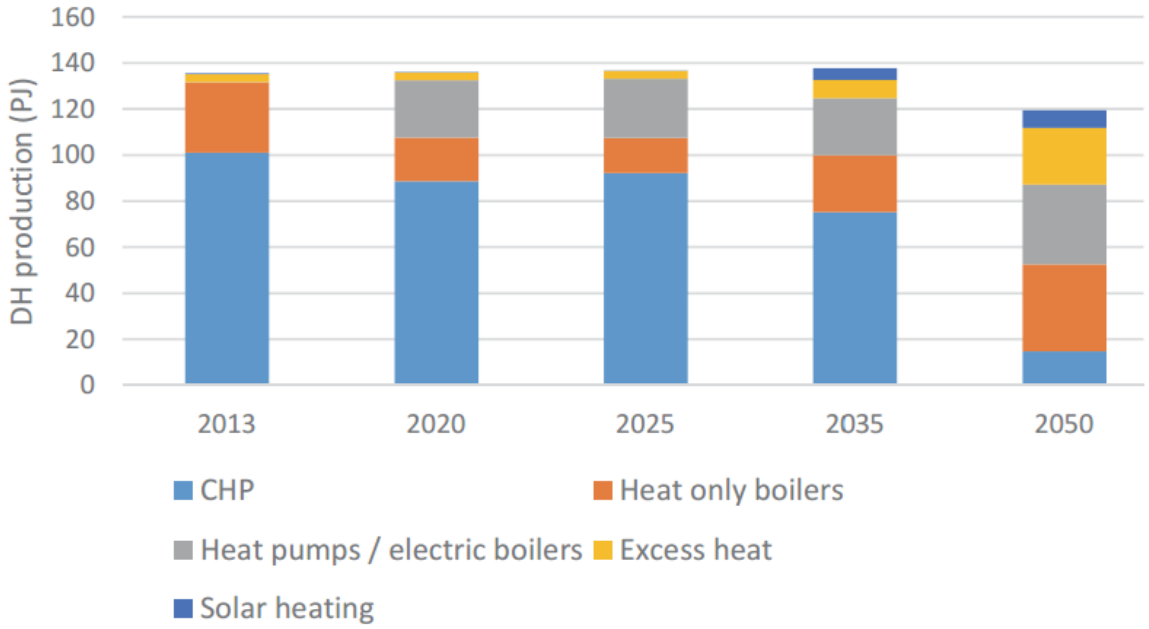

Figure 2.1 District heating production in Denmark as estimated in the district heating analysis (wind scenario).[2]

On the production side of district heating, a significant reduction in the use of natural gas and coal is foreseen, increasing the use of biomass. Waste incineration is more or less unchanged, due to the policy of waste handling, cf. figure 2.1. A brief summary of the heat supply in Denmark is provided by the Danish Energy Agency.[3]

Another key point regarding the production is increased use of electricity (mainly heat pumps), which is a consequence of the increasing share of wind power in the Danish (and other European) electricity systems. This implies that efficient use of electricity is required and the CHP-production will be reduced due to reduced demand for CHP-based electricity production capacity.

[2] http://www.ens.dk/sites/ens.dk/files/climate-co2/Global-Cooperation/Publications/Publications/regulation_and_planning_of_district_heating_in_denmark.pdf
[3] http://www.ens.dk/en/supply/heat-supply-denmark

Denmark has extensive supply of district heating; 63 % of all private Danish houses are connected to district heating. Six large district heating areas supplies approximately 56 % of the district heating supply (67 PJ). The remaining share of the district heating supply is provided by almost 400 small and medium-sized district heating plants.[4]

Besides renewable energy and security of supply, a key priority of the Danish energy policy is competitive prices of district heating. The efficiency of the Danish district heating sector is subject of political discussions. Bench-marking is being considered (it was introduced in the water sector a few years ago) and discussions regarding the basic regulation (non-profit) of the Danish district heating sector are raised, possibly opening the option of privatization of district heating utilities. This is also a political discussion, but should not jeopardize the key qualities of the Danish district heating sector such as the high level of trust, local involvement (consumer-owned) and transparency (non-profit), but also acknowledge the value of district heating as energy infrastructure, enabling efficient utilisation of renewable heating and electricity production.[5, 6]

The Energy Regulatory Authority (DERA) is the first administrative body to interpret the energy legislation. DERA submits National Report Denmark to the Commission regarding the directives of the Energy Market.[7] Regarding district heating, DERA elaborates statistics on the heat price, including prices for consumers in all Danish district heating networks.[8, 9, 10]

The Energy Board of Appeal is the final administrative appeal body for decisions by public authorities under various laws governing the energy sector.[11]

2.2 DHC related legislation

In Denmark, the key legislation related to DHC is:

- Heat Supply Act[12, 13]
  - Regulates the heat planning, pricing, authorities etc.
- Planning Act
  - Heat planning is part of municipal planning process
  - Local plans, defining the detailed use of an area, e.g. containing a district heating plant

The purpose of the Heat Supply Act is to promote the most socio-economic, including environmental friendly, use of energy for heating of buildings and supply of hot tap water and within this framework to reduce the dependency of fossil fuels in the energy supply.

Furthermore, the heat supply should promote the co-production of heat and power. This has served as a key parameter in the roll-out of efficient district heating in Denmark. However, there is currently a fundamental change in the role of district heating – reducing the CHP-based production and increasing the use of electricity for heat production. Unfortunately, the framework conditions are not (yet) updated to facilitate this development.

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[4] http://www.ens.dk/sites/ens.dk/files/dokumenter/nyheder/filer/regulation_and_planning_of_district_heating_in_denmark.pdf
[5] https://ing.dk/artikel/her-rapporten-aabner-ideologisk-front-mod-de-danske-vand-varmeselskaber-186234
[6] http://www.ens.dk/info/tal-kort/fremskrivninger-analyser-modeller/baggrundsrapporter-analyser-forsyningssektorerne
[7] http://energitilsynet.dk/fileadmin/Filer/Information/Diverse_publikationer_og_artikler/National_Report_2015_Denmark.pdf
[8] http://energitilsynet.dk/fileadmin/Filer/0_-_Nyt_site/VARME/Fjernvarmestatistik/2015-12/Fjernvarmestatistik_dec_2015.pdf
[9] http://energitilsynet.dk/varme/statistik/fjernvarmestatistik/december-2015/
[10] http://energitilsynet.dk/varme/statistik/prisstatistik/
[11] http://www.ekn.dk/the-energy-board-of-appeal
[12] Unofficial translation of an old version: http://www.ekn.dk/sites/ekn.dk/files/media/dokumenter/the-energy-board-of-appeal/Danish_Heat_Law_2000EN%5B1%5D.pdf
[13] https://www.retsinformation.dk/Forms/R0710.aspx?id=165652

A change of paradigm in the regulation of district heating is required:

- From electricity production (CHP) to electricity consumption (heat pumps)
- A larger share of DH production based on renewable energy sources
- A more diversified heat production in DH networks; applying different production technologies, requiring more investments, also in heat storages (required e.g. for a higher share of solar thermal by using seasonal heat storage).

Another important trend is reduction of the temperature levels in the district heating systems; reducing the heat losses and facilitating efficient utilisation of renewable energy sources e.g. solar thermal and surplus heat utilised through heat pumps.

2.3 Incentives – taxes and subsidies

In Denmark the tax levels on fossil fuels are relatively high, providing further incentive for energy efficiency, as well as facilitating feasibility and utilisation of renewable energy sources.

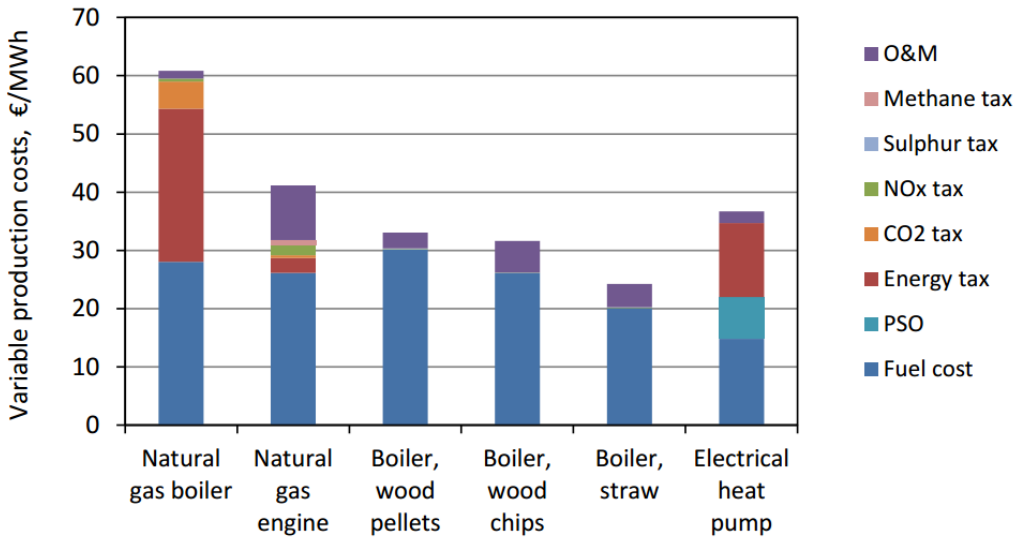

Figure 2.2 Estimated variable costs of heat production.[14]

Energy taxes in Denmark comprise tax on electricity, natural gas, oil products and coal products. Fuels are applicable to energy tax and CO_2-tax. Environmental taxes, NO_x and S, and in some cases methane tax, is applicable on emissions from district heating production.

		Energy tax	CO_2-tax	Sulphur	NOx	Methane
Gas	€/Nm^3	0.4032	0.0520	*	0.0038	0.0087
Oil	€/l	0.4060	0.0611	*	0.0012	-
Coal	€/t	206.7	61.25	*	2.1545	-
Straw	€/t	-	-	3.59	0.9073	-

Table 2.3 *Sulphur tax is € 3.11 pr. kg sulphur based on the sulphur content in the fuel. Electricity tax is € 0.1190 pr. kWh. PSO (public service obligation) is a payment to support renewable electricity production.[15]

[14] http://www.ens.dk/sites/ens.dk/files/climate-co2/Global-Cooperation/Publications/Publications/regulation_and_planning_of_district_heating_in_denmark.pdf

Energy taxes on mineral oil, natural gas, coal and electricity are harmonised in the EU, implying that the products are subject to taxes in all EU countries and regulated by common EU rules.

The total net-income from energy taxes in 2015 was € 6.1 billion, corresponding to 5 % of total taxes. This

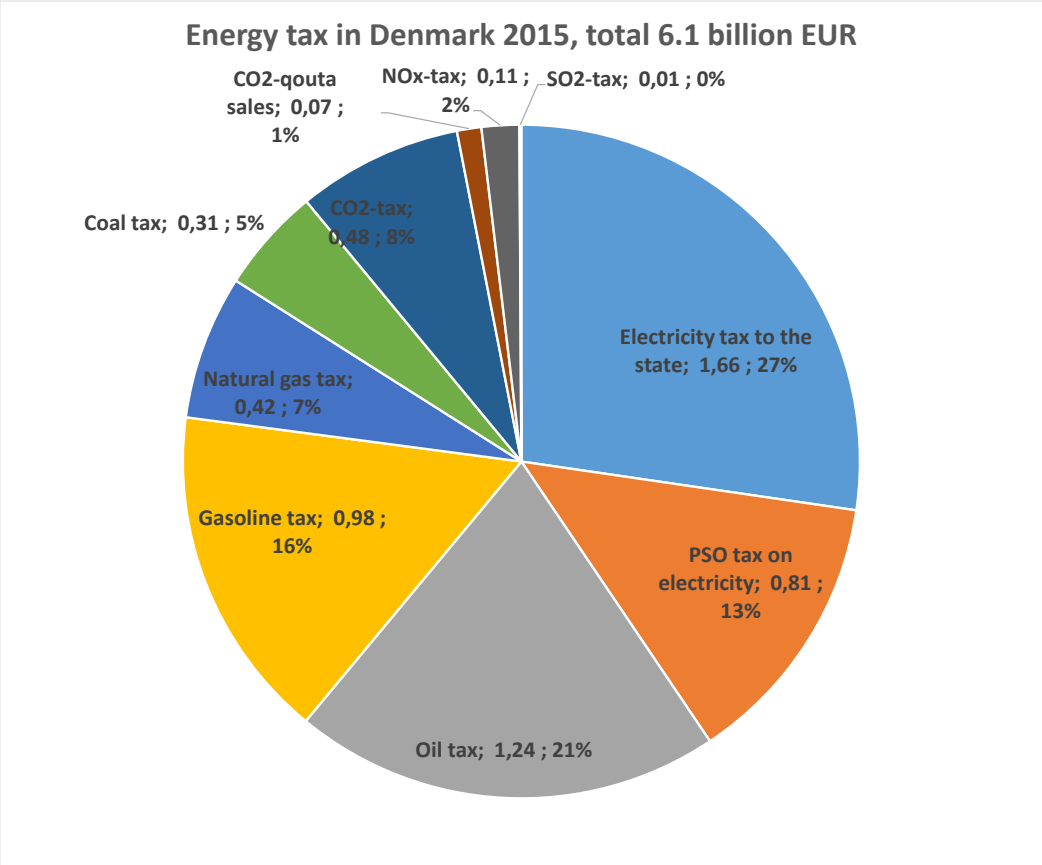

Figure 2.4 Energy tax in Denmark totalled € 6.1 billion, corresponding to 5 % of total taxes. This includes PSO (public service obligation, ear-marked for renewable energy, not to the state budget).

The Danish taxes on electricity are the highest in Europe (electricity 12 %, VAT 20 %, PSO 9 %), underlining the point of need for adjustment e.g. when increasing amount of electricity driven heat pumps are required. Exempt from electricity tax is renewable energy – provided that 1) electricity based on renewable energy 2) Direct own consumption, not supplied to the grid (maybe possible to have hourly readings from Energinet.dk) 3) The electricity must be consumed by the producer – the same legal entity. This e.g. applies for a wind turbine and a heat pump, provided that the conditions are fulfilled.[16]

Tax refund is applicable for companies, including industry, for part of the energy taxes. Some companies can also get a tax refund for CO_2-tax and in some cases sulphur, NO_x- and methane taxes.

As mentioned above, a key priority in the Danish heating legislation is combined heat and power production. However, a key measure will stop by the end of 2018, removing the economic incentive to establish CHP. This is in line with the development towards more electricity based on wind power production, but the point of security of supply is not clarified. This can be obtained by CHP-capacity or other measures. Hence, part of the existing CHP-capacity would probably be required, although it is not clear how large a share. The

[15] Danish legislation on energy taxes www.retsinformation.dk "mineralolieafgiftsloven", "kulafgiftsloven", "gasafgiftloven", "elafgiftsloven".
[16] http://www.skat.dk/SKAT.aspx?oID=2061604&chk=211712

consequence of the stop of this subsidy is an increase of the consumer heat price by 25 % in the relevant areas.[17]

The subsidy is a state subsidy, to all decentralised CHP-plants, which delivers electricity to the liberalised electricity market. The subsidy is a payment for capacity, hence it is independent of the actual production. The subsidy paid monthly and depends on the average electricity spot price in the current month. The subsidy ensures the producer a minimum price for an allocated amount of electricity, which depends on the maximum electricity production in the years 2001-2003.

The increased amount of wind power in the Danish electricity system reduces the demand for electricity based on CHP. However, in hours with low production from wind turbines, there is a need for electricity from other sources; CHP or import from other countries.

Currently, it is unclear whether the subsidy for CHP will continue in some form. This implies that new investments in CHP are postponed – or replaced by other investments. The point is that the subsidy is based on the requirements of the electricity system to ensure the electricity supply.

The applicable fuel types are regulated in the legislation. Until 2015, small-scale decentralised CHP-plants were obliged to use natural gas. This regulation stemmed from a priority of establishing a natural gas grid. Now most CHP-plants are allowed to apply biomass instead of natural gas, which has resulted in decreasing heat prices for the consumers. Other restrictions regarding fuel types apply cf. the above-mentioned Project Order under the Heat Supply Act.

The Danish legislative framework is comprehensive and has been successful in creating a framework for development of efficient district heating systems. In particular the high level of taxes has provided incentives for energy efficiency.

However, the comprehensive regulation has to be updated in order to comply with the new energy and climate policy targets. This change of paradigm comprise that district heating goes from production of electricity (CHP) to consumption of electricity (heat pumps) and stressing the – new – inter-action between the electricity system and the district heating system.

The target is a CO_2-neutral energy system, which is characterized by

- Fossil-free energy sources, increased synergies in the energy system
- Not compatible with CHP, requires flexible energy system primarily driven by wind power and secondarily by biomass
- Energy storage in gas and district heating systems

This change in regulation is an on-going process, which includes the following points, which could serve as inspiration also for other countries:

- Remove the requirement for CHP, including requirement for 90 % design supply for CHP, since it does not facilitate the future energy system
- Introduce requirement for energy efficiency (primary energy factor)
- Remove the ban against solar thermal and heat pumps in “central CHP-areas”
- Assumptions for calculation of socio-economic feasibility (assuming that the future energy system is based on wind power and export/import of electricity and short-term and long term storage in the district heating and gas systems
    - Revision of the assumptions applied for the socio-economic calculations, including the electricity prices (should reflect the actual prices) – cf. the report from the Danish Energy Agency from 2015

[17] http://www.danskfjernvarme.dk/groen-energi/analyser/grundbeloeb

- Electricity will be both sold and purchased by the district heating plants – requirement for differentiated electricity prices for gas engines, heat pumps, electric boilers etc.
- Acknowledgement of the value of system services of an electric boiler, and not only the income on the spot market

2.4 Permitting procedures

The permitting procedure follows the procedure outlined in the Project Order of the Heat Supply Act.

The municipalities are responsible for the heat planning. This implies that they should facilitate that projects are elaborated, and that these projects investigates the options for supplying heat energy, fulfilling the defined conditions. These conditions are defined in the Project Order[18] under the Heat Supply Act. This document defines the conditions under which for the municipality can approve a heat supply project, including fuels.

The scope of the project proposal includes the following points (some points may be excluded, and further information can be required):

- The responsible parties for the project
- Relation to the heat planning, including supply conditions and energy sources
- Relation to other legislation, including Electricity Supply Act and Natural Gas Supply Act
- Definition of supply area and heat demand, technical installations to be established or changed – including pipe network, capacity, security of supply and other operation conditions.
- Time schedule for the establishment
- Land disposal, easement imposition, agreements with land owners etc. required for the implementation of the project.
- Statement describing the applicants negotiations with relevant supply companies
- Economic consequences for the consumers
- Energy and environmental assessments and socio- and business-economic assessments
- Socio-economic analyses of relevant scenarios. For projects implying establishment or extension of heating networks or natural gas grids, individual heat supply is a relevant alternative.
    - In the socio-economic assessments, the yearly discount rate from the Ministry of Finance is to be applied, currently 4 %

The local council is responsible for coordination with the physical planning as well as the municipal and local planning.

The approval of the project by the local council is based on an energy, socio-economic and environmental assessment of the project. With a few exceptions, only the most socio-economic project can be approved.

To support this procedure of elaborating descriptions of a project, guidelines from the Danish Energy Agency are available.[19] As well as updated assumptions for the calculations (e.g. price development for fuels).[20]

[18] https://www.retsinformation.dk/Forms/R0710.aspx?id=183229
[19] http://www.ens.dk/info/tal-kort/fremskrivninger-analyser-modeller/samfundsokonomiske-analysemetoder

A building permit must be acquired before construction of the plant. The application may take place in parallel to the Project Proposal, i.e. before the approval of the project proposal is granted.

An Environmental screening procedure is also required.

In relation to implementation of projects the following checklist is relevant in relation to environment and planning:

- Planning
    - Municipal planning, appendix required?
    - Local plan, new local plan required?
    - Environmental assessment – separate procedure may be required
    - Sewage plan, adjustment required?
- Building line, protection lines
    - Neighboring areas
    - Conservation areas
    - Drinking water
    - Natura 2000 areas
    - Etc.
- Other issues
    - Ground water
    - Emissions (air)
    - Noise
    - Waste
    - Etc.

Depending on which aspects is relevant for the concrete project, a typical required time period for project proposal and required applications, hearing period and approval is 8-12 months, but can be significantly longer in some cases.

In case of complaints in the hearing periods, adjustments of the calculations may be required. The process time for the authorities (city council, Danish Energy Regulatory Authority, Energy Board of Appeal, the legal courts) may also prolong the time until implementation can commence.

[20] http://www.ens.dk/info/tal-kort/fremskrivninger-analyser-modeller/samfundsokonomiske-beregnings-forudsaetninger

3 Framework conditions for DHC in Austria

In Austria there are good incentives (law, joint venture, orders, cooperative societies) to stimulate district heating systems.

Key positive aspects:

- Subsidies for investment costs (up to 35-50 %)
- New jobs created
- Keep money in the region
- Standards as an integrative basis for building and operating a DH plant
- Usage of regional resources (biomass)
- Joint ventures for networking and know-how transfer
- Clear forests, less harmful wood
- Competition with other technologies brings new ideas and solutions for DHC networks

Key negative aspects:

- Permitting procedures can be difficult
- Restrictions of the authority might change the economy of the project to a negative level
- Low densed areas could not be connected to the DH or only with high heat losses and investment costs
- Higher competition with other technologies caused by low heat consumption of new buildings

3.1 Energy policy

The objective of the Austrian Energy Strategy is to develop a sustainable energy system which makes energy services available for private consumption as well as for businesses in the future whilst implementing EU rules. Security of supply, environmental compatibility, cost effectiveness, social compatibility and competitiveness have been fixed as core objectives in the Austrian Energy Strategy.

Austria‘s 2020 Targets:

- 34 % share of renewable energy
- 16 % reduction of GHG emissions in non-ETS sectors

There are three main goals in energy policy:

- Energy efficiency: an improvement in energy efficiency at all stages of the provision and use of energy (e.g. new and refurbished buildings, sustainable mobility, implementation of energy management systems, spatial planning, etc.)
- Renewable energy: focus on hydro power (including pump storage), wind power, biomass and photovoltaic
- Security of supply: to be increased and aimed at the highest possible degree of cost effectiveness (e.g. district heating and cooling, new transmission networks, diversification of supply sources and routes, gas storage, smart grids and smart metering)

Based on current studies, research projects and scenario simulations, Austrian specialist institutions the Austrian Energy Agency, the national regulator E-Control and the Federal Environmental Agency have jointly recommended a target for 2020. To achieve the objectives of the Austrian Energy Strategy the specialist institutions regarded a stabilisation

of final energy consumption on the basis of consumption in 2005 to be an indispensable basis.

There are several targets in the energy strategy of Austria, shown in figure 3.1.

Energy Strategy targets by sector

		2005	Targets by sector	2020
		PJ	Percent	PJ
Buildings	space heating & cooling in residential buildings, offices and factories	337	-10%	303
Residential buildings, factories, offices, farms, small users	excluding space heating and off-road mobility	206	+10%	227
Energy-intensive enterprises	comprises iron & steel, chemical, non-ferrous metals, stone & soil, glass, paper and printing, wood industries (excluding space heating)	178	+15%	205
Mobility	including off-road vehicles	385	-5%	366
		1106		**1100**

Source: Austrian Energy Agency, Energie Control GmbH, Environment Agency Austria

Figure 3.1: Energy strategy targets in Austria[21]

The target of the energy strategy in Austria is to reach 38.2 PJ with district heating from renewable energy by 2020. The initial position in 2005 was 14.9 PJ.

3.2 DHC related legislation

There are several laws and standards to meet in Austria to build a DHC plant and grid. The builder and operator of the plant has to meet these regulations. Some of them are shown as examples below.

Laws:

Wärme- und Kälteleitungsausbaugesetz, BGBl. I Nr. 113/2008:

The Austrian law called “Wärme- und Kälteleitungsausbaugesetz, BGBl. I Nr. 113/2008“ supports the development of district heating and cooling. This law includes subsidies for investment with the goal to consider security of energy supplies, a balanced energy mix and a reduction of primary energy needs.

Gewerbeordnung 1994:

If the operator of the DHC plant and grid is a company, this trade law (industrial code) must be followed. A permission for the operational plant is needed and will be provided by the authority.

This permission includes for example emissions, neighbors, water rights, building laws, waste legislation, safety for employees, heating, cooling, fire safety, health protection, operation times, plans, machines and noise protection.

HeizKG 1992:

[21] BMWFJ, 2016, http://www.bmwfj.at/

This law called „Heizkostenabrechnungsgesetz“ regularize the metering of heat consumption. The costs for heat and domestic hot water must be separated. The billing is also regulated in this law.

Heizungsanlagen-Verordnung (of the federal lands):

This heating installation order affects firing systems and combined heat and power (CHP) systems. Limits for emissions and efficiencies are regulated in this order, as well as inspection reports and certificates.

FAV 1997 Feuerungsanlagenverordnung:

The order for firing systems considers emissions (e.g. dust, soot, CO, HC, NO_X, SO_2, HCl), used fuel and inspection of the systems.

Standards:

ÖNORM M 7132 Energiewirtschaftliche Nutzung von Holz und Rinde als Brennstoff:

This standard „Energy-economical utilization of wood and bork as fuel - Definitions and properties” considers different type of fuels, caloric values, economy, forestry, classification of biomass and water content.

ONR FW 110A Fernwärmeversorgung - Stabilisierte Rohrgrabenverfüllmaterialien – SVM für den Einbau von Fernwärme-Kunststoffmantelrohren (KMR):

Stabilized backfilling materials for pipe-tranches and stabilized backfilling material for the installation of district heating plastic sheath pipes are included in this standard.

ÖKL-Merkblatt Nr. 67 - Technisch-wirtschaftliche Standards für Biomasse-Fernheizwerke:

This consultative document considers the technical and economical issues for biomass district heating plants, especially equipment, dimensioning, boilers, heating plant, measuring and controlling devices, optimization, biomass storage, purchasing of biomass, economy and business ratios.

ÖNORM M 7133 Holzhackgut für energetische Zwecke:

Chipped wood for energetic purposes and requirements and test specifications are regulated in this standard, especially dimensions, ash content, fuel, classification, wood, standardization, test specifications, sampling, bulk density, testing, terminology and water content.

ÖNORM M 7135 - 7137 Presslinge aus naturbelassenem Holz:

In these three standards are regulated:

- Compressed wood or compressed bark in natural state, pellets and briquettes, requirements and test specifications
- Compressed wood in natural state, woodpellets, quality assurance in the field of logistics of transport and storage
- Compressed wood in natural state, woodpellets, requirements for storage of pellets at the ultimate consumer

ÖNORM CEN/TS 14588 Feste Biobrennstoffe:

This standard regulates solid biofuels, terminology, definitions and descriptions.

TRVB H118 – automatische Holzfeuerungsanlagen:

This standard regulates the fire safety of automatic biomass plants. It considers fuel, storage of biomass, fire protection of construction and equipment, inspection of facilities, operation and maintenance.

3.3 Incentives – taxes and subsidies

Austria set up some incentives and subsidies to increase the number of district heating systems to meet the energy policy targets. Some of these incentives and taxes are shown below.

Wärme- und Kälteleitungsausbaugesetz, BGBl. I Nr. 113/2008:

The Austrian law called "Wärme- und Kälteleitungsausbaugesetz, BGBl. I Nr. 113/2008" supports the development of district heating and cooling. This law includes subsidies for investment with the goal to consider security of energy supplies, a balanced energy mix and a reduction of primary energy needs.

The aim is to get a balanced energy mix, a reduction of primary energy usage, cheap CO_2 reduction, higher energy efficiency, lower emissions in the air, usage of waste heat and increase regional heat supply.

The subsidy is paid for investment with maximum of 35 % (based on total investment costs) and maximum 50 % (of environmentally relevant additional costs). These costs can also be costs for property, buildings, facilities, adaption of existing system and planning.

Oö. Wohnhaussanierungs-Verordnung II 2012, LGBl.Nr. 17/2012:
There are also some orders of federal lands in Austria, for example in upper Austria. The loan for connection to the district heating for apartment buildings is € 2,000 maximum per flat.

Agricultural cooperative societies:
In Austria it is common to found (agricultural) cooperative societies for the operational management of the district heating. Usually some farmers or customers found that cooperative society. Farmers can sell the wood from their forests to use in the heating plant.

Joint venture:
The "ARGE Biomasse-Nahwärme" is a joint venture from most of the federal lands in Austria. This joint venture represents more than 600 district heating systems with a total capacity of 800 MW installed boiler load. With this heat more than 80,000 households are supplied and 580,000 ts of CO_2 are saved. Three million stacked cubic meter of wood chips are used. More than 1,300 jobs are saved.
The joint venture takes care about:

- Exchange of experiences between operators of district heating plants
- Representation of interests on state level
- Master policy for insurance
- Training programs for operation of the district heating plants
- Standardize accounting of wood chips
- Solutions for using wood ash

- Marketing
- Publications

3.4 Permitting procedures

To build a small district heating plant and grid in Austria, an official permission is required by the responsible authority. The permission of the building itself is usually done at the municipality (building authority at first instance). To operate the system as a company, there is the need for a permission according to the trade law. This is usually done at the authority on the district (regional) level.

The tender for permission at the authority is formless. The tender should include all technical data, plans and affected land parcels. The authority will place restrictions in an official notification with points that should be followed. These points are for example:

- Water rights to meet, e.g. water proofing
- Environmental issues, e.g. limits for dust and noise
- Fire safety, e.g. fire-proof walls, prevent backfire of the boiler to biomass storage
- Industrial safety for employees

When the system is built, the authority will check the restrictions and give a permission for operating the district heating plant and grid. Tenders for permission for agricultural cooperative societies are usually less complex.

4 Framework conditions for DHC in Germany

Germany has extensive experience with district heating, although the share of district heating is not very high compared to the potential. Currently, there is great focus on transition of the energy sector, facilitating a change to an energy system based on renewable energy.

Key positive aspects:

- Experience with implementation and operation of district heating
- Support programs BAFA and KfW facilitating implementation of renewable district heating
- For small renewable DH the main focus is on biomass fuelled systems: biogas and woodchips
- Many small DH projects are community initiative driven: many heating grids are public owned or owned by the citizens.
- A key reason for the implementation of small DH grids is the initiative and motivation of a single person or a small group of persons in the community.

Key negative aspects:

- The main focus of policies is on the power sector and not the heating sector. Thus there is a lack of political support for reducing greenhouse gases in the building sector.
- New small DH grids can usually only be politically justified in settlements where no natural gas grid exists.
- The financial support for small heating grids is only accessible for settlements with medium-high heat demand. For new settlements with high efficiency building standards, it may not be possible to get support.
- A strong lobby still promotes the use of natural gas and oil heating systems. On top, in some federal states these are even incentivized. Fossil fuel boilers should be forbidden, as it is the case e.g. in Denmark.

The following descriptions are based on the information of several online sources such as the Ministry of Economic Affairs and Energy (BMWI)[22], Federal Office for Economic Affairs and Export Control (BAFA)[23], Kreditanstalt für Wiederaufbau (kfW)[24] and RES LEGAL Europe[25] database. Some text blocks are directly taken from the mentioned websites, some are summarized and some were translated into English as sometimes information was only provided in German[26].

4.1 Energy policy

Since more than 15 years, the German energy sector undergoes a radical change which is influenced by a multitude of strategies, acts and ordinances. Some of these legislations are amended frequently, in 2 years cycles or even faster. During this period, also the responsibilities within the ministries have changed. Today, the Ministry of Economic Affairs and Energy (BMWI, http://www.bmwi.de) is in charge of all energy aspects. The BMWI promotes the "**energy transition**" (In German "Energiewende") as the avenue into a secure, environmentally friendly, and economically successful future. The term energy transition became widely used after the nuclear catastrophe in 2011 of Fukushima, Japan.

[22] http://www.bmwi.de
[23] http://www.bafa.de
[24] http://www.kfw.de
[25] http://www.res-legal.eu
[26] The authors do not guarantee for correctness, for details please see the relevant official websites.

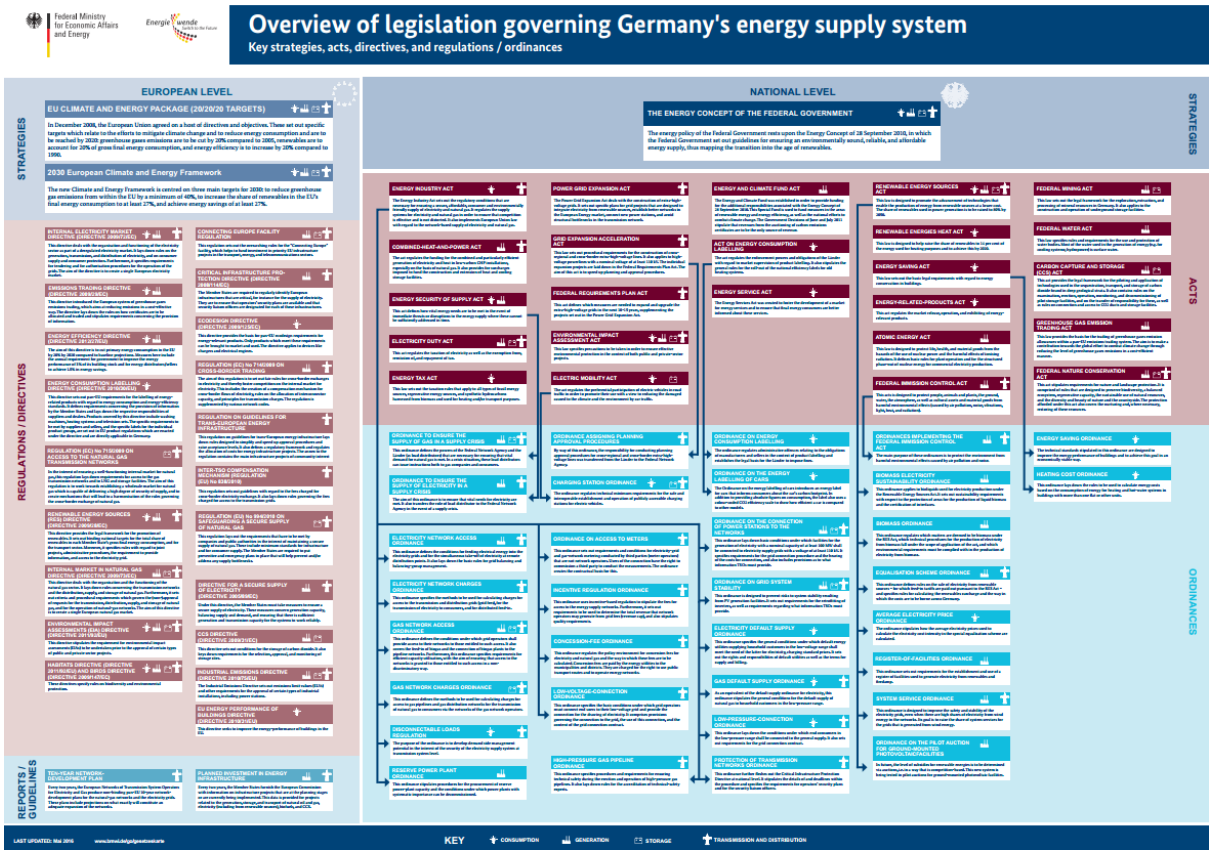

Figure 4.2: An overview on legislation governing Germany's energy supply system is shown in a very good graph of the BMWI on its website[27]

The growing significance of renewable energy sources in the power sector is largely due to the **Renewable Energy Sources Act** (EEG, in German), in force since 1 April 2000, and its revision in 2014. About 33 % of electricity now derives from wind, solar, biomass and other regenerative sources of energy. The EEG is the act that is most famous in the world and which was "exported" to many other countries. However, the EEG is currently under review and amendment and it seems that the government aims to considerably slow down the development of renewable energies in the power sector.

4.2 DHC related legislation

In contrast to the promotion of renewable energies in the power sector, the **heating and cooling sectors** are far less supported and far less debated in the public, although it is responsible for the highest energy consumption of private consumers in Germany. The share of renewable energies in the heating sector is about 13 %. Cooling is, due to its climate, a minor issue in Germany.

The core legislation on renewables in the heating sector is the **Renewable Energies Heat Act** (EEWärmeG), released in 2009. The goal of this act is to support renewables in the heating and cooling sector and to increase its share up to 14 % until 2020. Under this law, constructers of new buildings are required to generate a percentage of their heating requirements from renewable sources of energy, to undertake certain compensatory measures such as installing additional insulation, or to use combined heat and power systems or district heating. This act received considerable less visibility than the EEG. A main criticism of this act is that it only addresses new buildings, but the largest negative impacts on climate change is influenced by the existing building stock.

[27] http://www.bmwi.de/English/Redaktion/Pdf/gesetzeskarte,property=pdf,bereich=bmwi2012,sprache=en,rwb=true.pdf)

Since 2002 the principal basis for promoting power plants using heat-and-power co-generation technology has been the **Combined Heat and Power Act** (KWKG). This provides levy-funded incentives for the highly efficient co-generation of electricity and heat (not limited to renewable energies). According to the KWKG, the operators of eligible combined heat-and-power plants are entitled to bonus payments on their output for a certain period of time. Operators of fuel cell installations and new small co-generation units with an electrical rating of up to 50 kW enjoy particularly favourable terms. With these incentives, the Federal Ministry for Economic Affairs and Energy is promoting investment in high-efficiency combined heat-and-power plants to increase the share of electricity from co-generation. This has been around 17 % up to now and is intended to increase to 25 % by 2020. An amendment to the KWKG in 2012 raised the supplements on electricity from CHP, broadened assistance for the modernisation of installations and heat networks, and for the first time provides funding for heat storage systems.

The **Renewable Energy Sources Act** (EEG) was described in the previous chapter already as the main legislation for power production due to its feed-in tariff system. However, the EEG has also some impacts on the heating grids as the feed-in tariff system included also incentives for combined heat and power production as a so called “CHP bonus”. Many biomass plant operators operating biogas plants, woodchip gasifiers, and woodchip ORC installations used this bonus as an additional income to the basic feed-in tariff. For example, the CHP bonus was paid per kWh heat which is distributed through a small district heating network. However, each version of the EEG had its own pre-conditions to get the bonus. The EEG 2012 finally cancelled the CHP bonus. For more information, see the relevant official version of the EEG available in English[28] or German[29].

4.3 Incentives – taxes and subsidies

In addition to the Renewable Energies Heat Act, the Federal Government uses the **Market Incentive Programme** (MAP) to increase the proportion of heat generated from renewable sources. The annual budget of the MAP is €300 million. Under this programme, assistance is provided primarily for existing buildings to promote the use of renewable energy technology in the heat market, such as solar thermal installations, wood pellet heating systems and efficient heat pumps. Details on the MAP can be found on http://www.res-legal.eu/search-by-country/germany/. There are two types of funding available:

- Firstly: Grants from the Federal Office for Economic Affairs and Export Control (**BAFA**) for smaller installations in private households and companies. These include roof-top solar thermal collectors, pellet heating systems in the cellar, and efficient geothermal probes in the garden for the heat pump in the house.
- Secondly: low-interest loans and repayment grants from the **KfW** for larger systems, particularly those used in a commercial setting; these might be used, for instance, by laundries, hotels or municipal companies which are investing in process heat from renewables or building biomass cogeneration power plants and heating networks designed to run on renewables.

The program mainly aims to modernise existing buildings and commercial/industrial processes. In the case of new buildings, in contrast, funding is only available for certain innovative types of installations. This is because new buildings are already required to use renewable energy under the Renewable Energies Heat Act.

Both support programs, BAFA and kfW, are generally widely used for the installation of small district heating networks, especially for distributing the heat from a biogas plant to households, but also for heat from woodchips or solar thermal energy. Thereby, the two

[28] http://www.bmwi.de/EN/Topics/Energy/Renewable-Energy/2014-renewable-energy-sources-act.html
[29] https://www.erneuerbare-energien.de/EE/Redaktion/DE/Dossier/eeg.html?cms_docId=73930

programs cannot be combined. Both programs have dedicated conditions which have to be fulfilled in order to receive the support.

A guideline[30] (in German only) from BAFA explains the conditions to receive BAFA support. The following list presents the most important conditions for small heating grids:

- Grants are allowed for heating grids that go beyond the borders of the operator: it must be a "public" grid.
- Investment costs for the heating grid up to the connection point (excluding the connection point) at the heat consumers are eligible. Investments costs of the connection and beyond the connection point are not eligible.
- The grant is calculated by the length of the length of the heating pipes (only flow) and by the pipe diameter.
- Medium diameter <= DN 100: 100 €/m of the flow pipeline up to a maximum of 40 % of the investment costs. Maximum: 10 M€ per project.
- Medium diameter >= DN 100: 30 % of the investment costs. Maximum: 10 M€ per project.

The support of KfW includes several sub-programs in the heating sector. For heating grids, the sub-program "Erneuerbare Energien – Premium"[31] (only in German) is applicable. The following list presents the most important conditions for small heating grids:

- Supported are the extension and the new installation of heating grids in which the heat is generated at minimum 50 % by renewable energies.
- The average heat transported through the heat grid must be minimum 500 kWh/a*m and per meter flow pipe length.
- Heat grids are only supported if the majority of the supplied building stock is existing building with high heat demand and not new buildings. This is not relevant if the heating grid is mainly supplied with process heat.
- The heat grid must consist (with some exemptions) of main pipelines, consumer connection pipelines and heat transfer stations.
- The repayment grant is 60 €/m of the new/extended flow pipeline up to a total amount of 1 M€. In addition, repayment grants of up to 1,800 € per transfer station (connection to the heat consumers) are allowed.

In summary, it can be concluded that both programs contributed to the installation of various small renewable heating grids which would not have been realized without the support.

4.4 Permitting procedures

For the **installation of a small district heating grid** in Germany, no unified permitting procedures apply. The permits needed depend very much on local regulations[32]. It furthermore depends on the design and ownership of the affected land parcels through which the pipelines are installed.

However, usually a building application is needed. Depending on the above mentioned local factors, permits according to the Federal Immission Control Act (Bundesimmisionsschutz-gesetz, BImSchG), Water Resources Act (Wasserhaushaltsgesetz, WHG), Federal Nature Conservation Act (Bundesnaturschutzgesetz, BNatSchG), or according to other acts.

[30] http://www.bafa.de/bafa/de/energie/kraft_waerme_kopplung/publikationen/merkblatt_waermenetze.pdf

[31] https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/Finanzierungsangebote/Erneuerbare-Energien-Premium-%28271-281%29/

[32] See: http://www.kreis-sim.de/media/custom/2052_962_1.PDF?1429086118

For the **installation of the heat generation technology** it depends very much on the type of the technology and the location of the installation if a permit is needed. For instance, for the installation of solar collectors on the rooftop of a private house, no permits are needed. For installations on the green field, usually building applications and building permits are needed. They are influenced by the applicable local legislation as well as by the type and size of the installation. For example, due to its potential high impact of biomass installations (emissions), they either need a permit according to the Federal Immission Control Act (BimSchG), or to the Federal Building Act (BauGB). Again the type of permit depends on the size of the plant, but also on its input material. Larger plants or plants that use certain types of waste need a more sophisticated permit according to BimSchG, whereas for smaller plants with less risky feedstock a permit according to BauGB is sufficient.

These factors influence the needed duration until permits can be obtained. Some permits require public consultation, some not. Timeframes of up to one year must be considered.

5 Conclusions – key points from Denmark, Austria and Germany

The three countries Denmark, Austria and Germany have different framework conditions for DHC. Denmark has for many years applied a high tax level on fossil fuels and in combination with a strong national planning for roll-out of district heating, this has facilitated the high share of district heating. Germany and Austria has not as extensive application of DHC as Denmark, but have also applied framework conditions supporting application of DHC, in particular subsidies.

Whether taxes or subsidies are applied, the impact is the same on e.g. renewable DHC. However, a key point is continuity and time horizon; schemes for subsidies is limited and requires active decision (and agreement), whereas taxes are often more stable. A long time horizon is important for DHC due to the relatively high investment costs in the infrastructure.

Facilitation of internalisation of aggregate advantages of DHC is important for the application of DHC. This implies that society provides framework conditions, which the individual consumer would otherwise not be able to obtain – e.g. fuel flexibility, energy efficiency, low and stable heat prices.

The key points are summarised in the tables below:

Key positive aspects:

Denmark	Austria	Germany
• Vast experience with district heating from large scale implementation of district heating systems providing cost efficient district heating to a large number of consumers • Widespread and strong local involvement in consumer owned district heating utilities • Development of district heating systems is ongoing in terms of organisation (mergers) and more diversified production capacity (solar thermal, heat pumps, biomass, etc.) • High level of trust due to transparent regulation based on non-profit heat pricing	• Subsidies for investment costs (up to 35-50 %) • New jobs created • Keep money in the region • Standards as an integrative basis for building and operating a DH plant • Usage of regional resources (biomass) • Joint ventures for networking and know-how transfer • Clear forests, less harmful wood • Competition with other technologies brings new ideas and solutions for DHC networks	• Experience with implementation and operation of district heating • Support programs BAFA and KfW facilitating implementation of renewable district heating • For small renewable DH the main focus is on biomass fuelled systems: biogas and woodchips • Many small DH projects are community initiative driven: many heating grids are public owned or owned by the citizens. • A key reason for the implementation of small DH grids is the initiative and motivation of a single person or a small group of persons in the community.

Table 5.1: Key positive aspects for DHC in Denmark, Austria and Germany

Key negative aspects:

Denmark	Austria	Germany
• Regulatory framework is somewhat outdated, e.g. need to change from producing to consuming electricity (from CHP to heat pumps). • Process of adjusting the regulatory framework is on-going, but characterised by inertia • Requirements for development of district heating implies need for consolidation and build-up of competences – without compromising the local involvement • Lack of acknowledgement of key qualities of district heating as energy infrastructure, implying focus on bench-marking and privatisation	• Permitting procedures can be difficult • Restrictions of the authority might change the economy of the project to a negative level • Low densed areas could not be connected to the DH or only with high heat losses and investment costs • Higher competition with other technologies caused by low heat consumption of new buildings	• The main focus of policies is on the power sector and not the heating sector. Thus there is a lack of political support for reducing greenhouse gases in the building sector. • New small DH grids can usually only be politically justified in settlements where no natural gas grid exists. • The financial support for small heating grids is only accessible for settlements with medium-high heat demand. For new settlements with high efficiency building standards, it may not be possible to get support. • A strong lobby still promotes the use of natural gas and oil heating systems. On top, in some federal states these are even incentivized. Fossil fuel boilers should be forbidden, as it is the case e.g. in Denmark.

Table 5.2: Key negative aspects for DHC in Denmark, Austria and Germany