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Strategic heat planning in Denmark

- **The role of heat planning in Denmark - historical overview of danish energy policy**
- **Regulation of district heating in Denmark**
- **Heat planning by Fjernvarme Fyn A/S – expansion of DH**
- **An example: establishment of DH in the city of Sønderød**

Peer Andersen, Fjernvarme Fyn A/S

Historical overview of the danish energy policy

- Oil crises in 1973 and 1979 initiated a new energy policy in Denmark
- First law on heat supply from 1979:
- Reduction of dependency of oil import
- Security of supply
- Energy efficiency



Historical overview of the danish energy policy

Means to obtain goals about reduction of dependency of oil import:

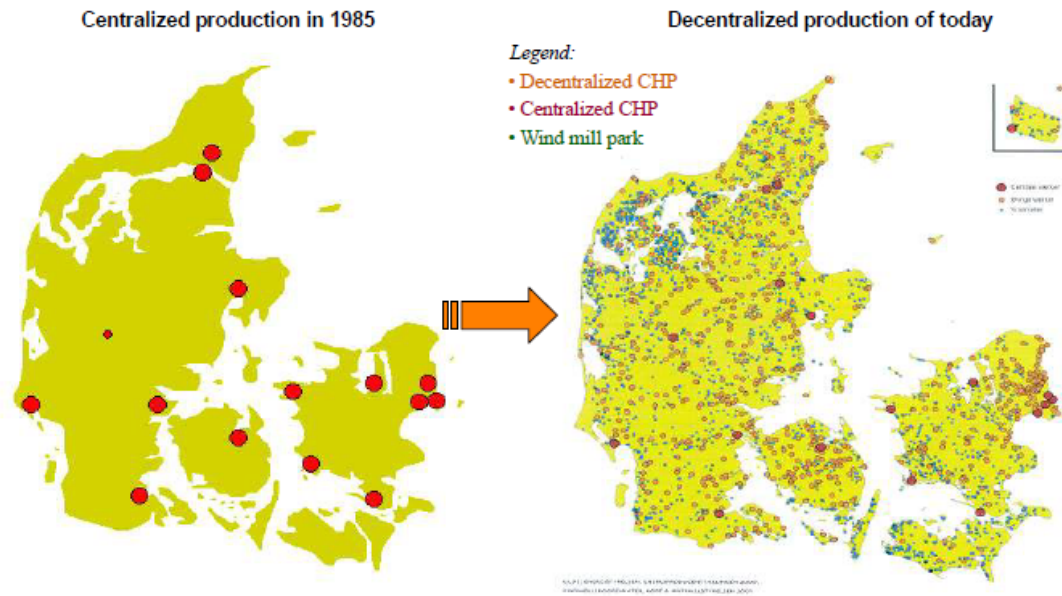
- Heat planning: delineation of areas for natural gas and for district heating
- Municipalities was authorized to require mandatory connection to public heat supply in some areas (natural gas or district heating)
- Taxes on fossil fuels for heat production
- Investments grants for decentralized CHP
- Subsidies for electricity produced by CHP on natural gas and biomass

Historical overview of the danish energy policy

- Heat planning was implemented by the municipalities in the 1980s
- From 1990 heat planning was replaced by project approval by the municipalities:
- All projects for construction or renovation of district heating production facilities and distribution systems for district heating or natural gas must be approved by the municipalities under provisions of the law on heat supply:
- Projects can only be approved if they are socio-economic optimal relative to alternative solutions.
- Heat production facilities (except peak and reserve load) > 1MW must be CHP
- Decentralized CHP can only use natural gas, biomass, waste or biogas as fuel

Historical overview of the danish energy policy

Decentralized CHP production



Historical overview of the danish energy policy

Political initiatives to promote renewables in the energy sector including DH:

- Physical planning of land-based windpower
- Subsidies for windpower
- Subsidies for electricity produced by biomass and biogas
- No tax on renewable energy
- Stop for landfill of waste (1997) suitable for incineration

Regulation of district heating

- **Privatisation / liberalization of the electricity production in 2000**
- **District heating companies are still monopolies regulated as nonprofit business**
- **District heating prices are strictly cost-based**
- **Decentralized CHPs are typically owned by district heating companies**
- **Central CHPs typically owned by private commercial companies.**
- **Distribution of costs of cogeneration. Regulatory praxis is to split the advantage of co-generation when district heating companies buy heat from private electricity companies**
- **The Danish Energy Regulatory Authority monitors prices**

Energy Policy

■ Long term National Goals:

- Denmark free of fossil fuels in 2050.
- No Coal and oil in heating and electricity sectors in 2030.
- Totally free off fossils fuels in heating and electricity in 2035.

■ Goals for the period 2012-2020:

- Wind shall cover 50 % of total electricity consumption in 2020.
 - Significant challenges in balancing.
- No gas and oilboilers in new buildings from 2013.
- From 2016 no new oilfired boilers in existing buildings.
- Energy savings obligation 2,5 % in 2013-2014 and 3,5 % i 2015-2020 – each year.



Fjernvarme Fyn – Area of Supply



- Max. Demand
780MW
- Yearly production
2.3 Mio MWh
- Pipe length
 - Transmission
60 km tracé
 - Distribution
1985 km tracé

Production 2011.

■ Co - production heat and electricity (CHP).

- 40% from Fynsværket.
- Heatproduction at a efficiency at 330 %.



■ Fynsværket.

- Comm. 1991, 358 (401) MW-e, 450 MJ/s heat.
- Fuel: Coal.
- Staff: 110.
- Owner: Vattenfall.



New Straw Fired Unit

- Unit price 100 mill. Euro
- Separate unit to be commissioned during 2009
- Total fuel consumption: 200,000 tonnes of straw per year

Straw energy content corresponds to 100,000 tonnes of coal

CO₂ reduction: 200,000 tonnes per year

(Typical present local emission: 1.8 mill. tonnes CO₂/year)

- 23 % of heat consumption.



■ Boiler data:

- Temperature: 540 °C
- Pressure: 112 bar
- Flow: 42.0 kg/s (100% rated load)
- Flow: 45,6 kg/s (108% overload)
- Feed water temperature: 245 °

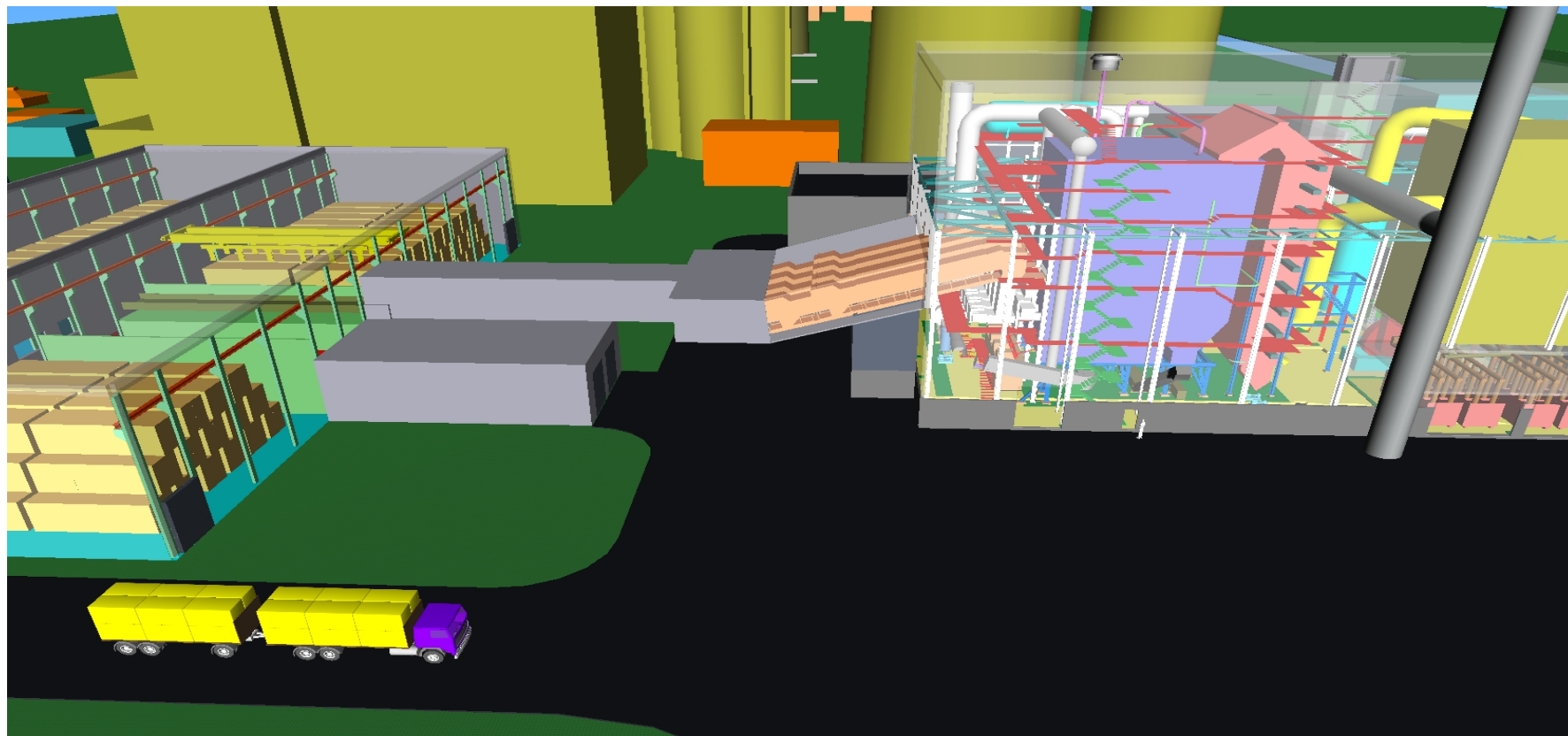
■ Turbine data:

- Temperature: 538 °C
- Pressure: 110 bar
- Flow: 42.0 kg/s (94% of rated load)
- Flow: 45.6 kg/s (100% rated load)

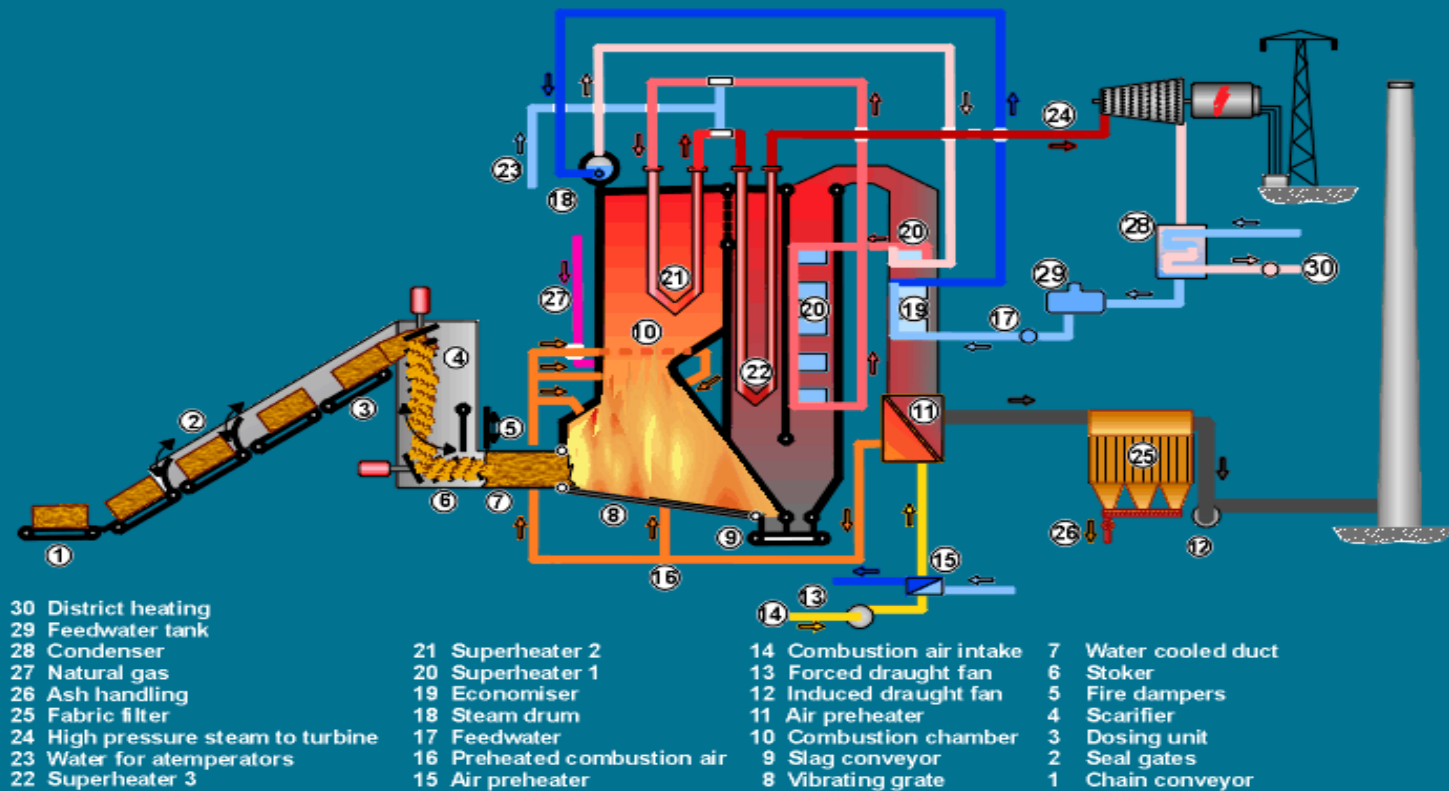
Aerial view of Fynsværket

2006





Straw fired boiler



For guidance only



- **284.000 ton Waste/year ~ 100.000 t coal**
- ODV 11 Comm. 1996, 5 MWe
 14.5 MJ/s
- ODV 12 Comm. 1996, 5 Mwe
 14.5 MJ/s
- ODV 13 Comm. 2000, 29 MWe
 35 MJ/s
- Total 32 t Waste/h.
- 22 % of total heat demand.
- CO₂ reduction: 200,000 t per year.



Production 2013.

- Dalum CHP - Wood chip fired CHP
- 5 MWe , 40 MJ/s



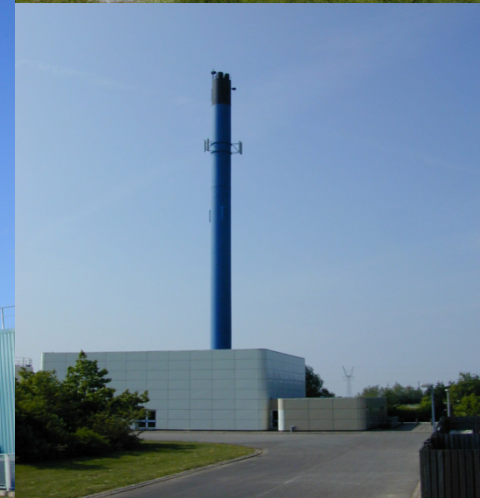
Production

■ Security of supply.

- 2 % backup and peakload production.

■ Peak load plants

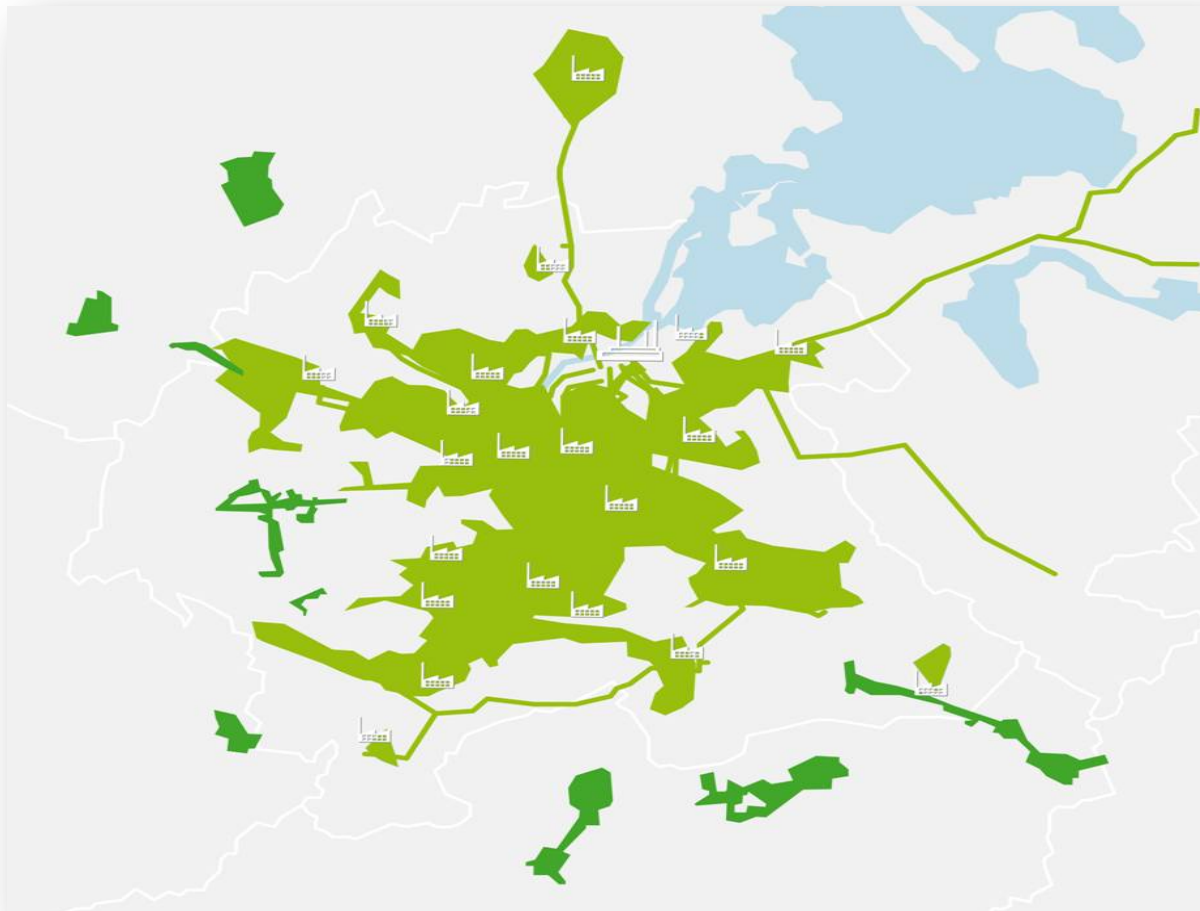
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| ● Number | 22 |
| ● Boilers | 56 |
| ● Capacity | 740 MW |



Storage Tank for District Heating Water



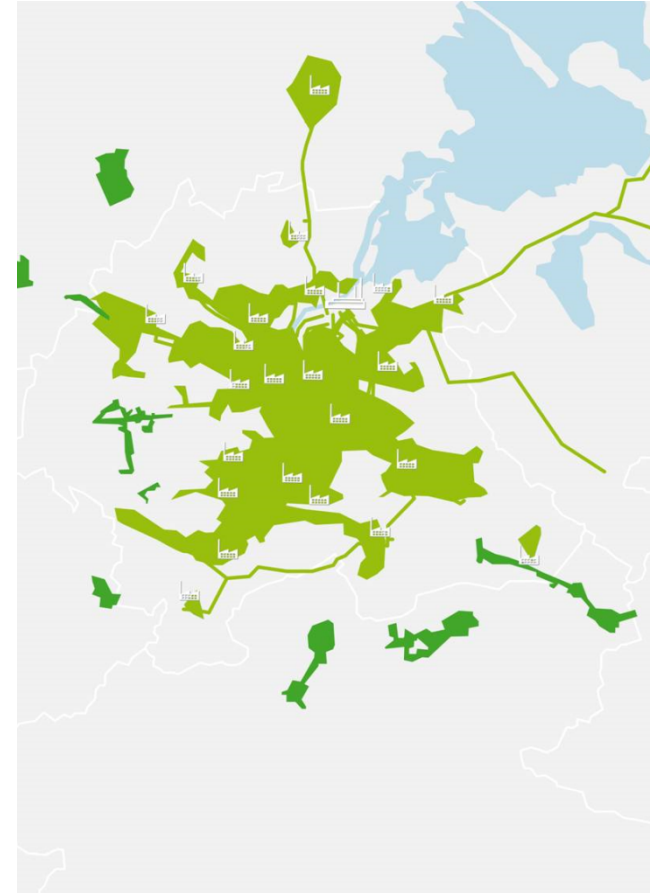
- Gross Volume: 75.000 m³ – among the largest in Europe.
- Net Volume: 66.000 m³.
- Net Energy Content: 4.145 MWh (92°C)
– i.e. 9 hour rated maximum heat production from Unit 7.
- Max discharge: 10.000 m³/h or 627 MJ/s
- i.e. > 100 % of rated maximum heat production from Unit 7.



-  current supply area
-  a possible extension of supply area

Expansions of supply area

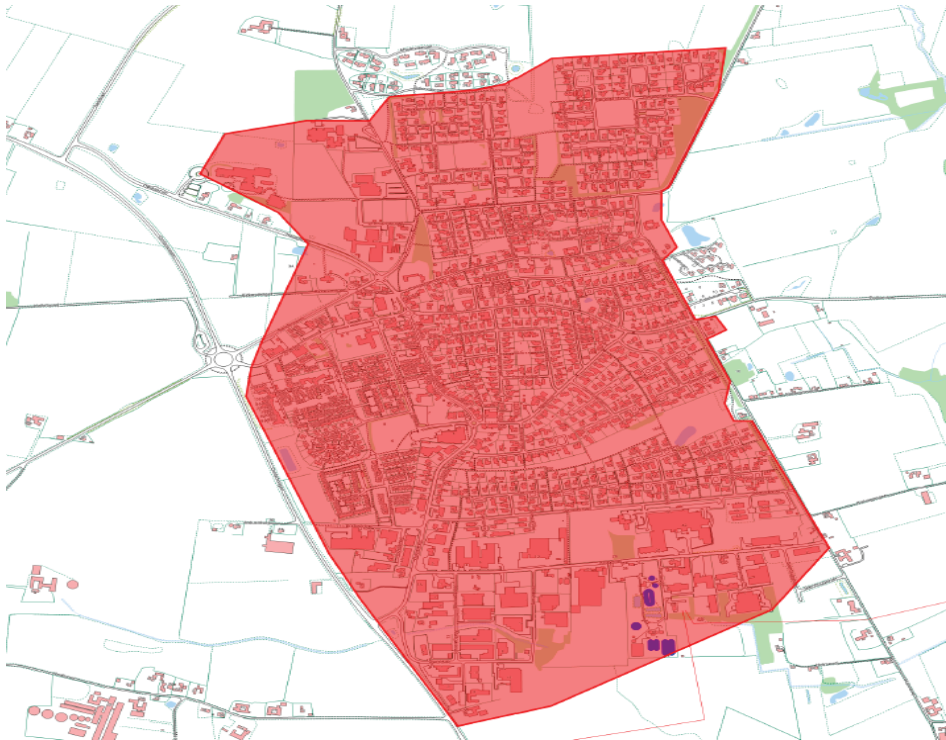
- Distance up to ca. 10 km from existing net.
 - Socio- and user economically profitable projects
 - Reduction of CO₂ emissions: 40 – 50 %.
 - Existing heating, approximately :
 - 70 % natural gas
 - 20 % oil
 - 10 % other
 - Total investment appr. : 70 mio. Euro
 - Total number of potential costumers: 6.000
 - Municipalities applied for approval of projects



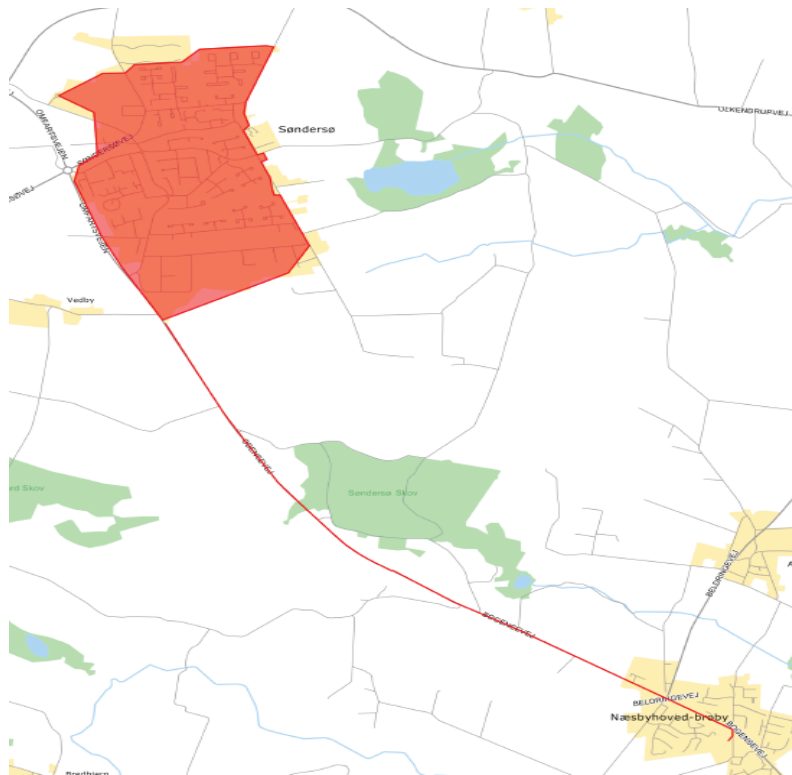
District Heating in Søndersø – an example

- Delineation of project area
- District heating network
- Heat demand
- Heat production
- Socio economic analysis
- Emissions
- User economy

Project area Søndersø



Transmission line



New network

- 7.500 m transmission line
- 25.900 m main lines
- 26.000 m service lines
- Investment: 13 mio. Euro

Heating of buildings

- 1.158 properties (BBR)
- Heated area: 299.000 m² (BBR)
- Individual heating:
 - 84 % natural gas
 - 9 % oil
 - 3 % electricity
 - 4 % others

Specific heat demand in buildings (SBI 2010)

	-1930	1931-1950	1951-1960	1961-1972	1973-1978	1979-1998	1999-
	kWh/m ² /år						
Stuehus til landbrugsejendom	153	164	164	126	97	72	65
Fritliggende enfamilieshus (parcelhus)	155	182	185	136	111	86	68
Række-, kæde- eller dobbelthus	165	185	178	128	100	76	61
Etageboligbebyggelse (flerfamiliehus, herunder 2-familiehus)	153	157	140	123	116	113	76
Kollegium	188	184	164	145	122	100	84
Døgninstitution (pleje-, alders-, børne-, eller ungdomshjem)	268	270	268	196	196	163	161
Anden bygning til helårsbeboelse	228	239	223	158	132	105	86
Avls- og driftsbygning (til landbrug, skovbrug, gartneri m.v.)	45	45	45	33	33	22	22
Fabrik, værksted (til industri, håndværk m.v.)	120	120	120	97	97	66	66
El-, gas-, vand -, varmeværk, forbrændingsanstalt eller lignende	120	120	120	97	97	66	66
Anden bygning til landbrug, industri eller lign.	120	120	120	97	97	66	66
Transport- eller garageanlæg (fragtmandshal, lufthavnsbygning o.l.)	124	124	124	100	100	68	68
Kontor, handel, lager, offentlig administration	103	159	135	123	110	93	70
Hotel, restaurant, vaskeri, frisør eller anden servicevirksomhed	226	226	226	195	195	123	123
Anden bygning til handel, transport eller lignende	112	112	112	90	90	63	63
Biograf, teater, bibliotek, kirke, museum eller lign.	140	140	140	98	98	78	78
Undervisning og forskning (skole, gymnasium eller lignende)	162	162	162	134	134	98	98
Hospital, sygehjem, fødeklinik eller lignende	215	215	215	152	152	120	120
Daginstitution (børnehave, vuggestue eller lignende)	236	236	236	186	186	129	129
Bygning til anden institution, herunder kaserne, fængsel og lign.	215	215	215	152	152	120	120
Sommerhus	74	76	74	58	58	42	40
Bygning til feriemål (feriekoloni, vandrehjem)	55	55	55	44	44	27	27

Heat demand

Calculated heat demand, BBR and SBI
2010

- **Heat demand: 30.800 MWh**
- **Heated area pr. property: 258 m²**
- **Heat demand pr. property: 26,6 MWh (år 1)**
- **Heat demand pr. m² : 103 kWh (år 1)**
- **Yearly reduction rate: 1 %**

Number of connected buildings

- **50 % in year 1**
- **90 % after 10 years**
- **No expansion of city area**
- **City areas constructed after year 2000 not included in the project**

Heat production in the project

	Marginal production	Marginal efficiency
Fynsværket, CHP Coal	85 %	338 %
Fynsværket, CHP Straw	10 %	215 %
Varmecentral, gasolie	5 %	90 %

Industrial surplus heat not included

NPV (1.000 DKK)	Projekt	Reference	Projektfordel	Forskel i pct.
Brændselskøb netto	22.132	118.243	96.111	81%
Forbrugerinvestering	23.926	10.027	-13.899	-139%
Selskabsinvestering	75.347		-75.347	-
Driftsomkostninger	26.308	25.453	-854	-3%
CO2/CH4/N2O-omkostninger	6.151	10.864	4.714	43%
SO ₂ -omkostninger	620	414	-206	-50%
NO _x -omkostninger	1.013	1.992	978	49%
PM _{2,5}	104	518	414	80%
Afgiftsforvriddningseffekt	-16.883	-17.176	-293	2%
I alt	138.718	150.334	11.617	8%

Totale emissioner over 20 år.	Projekt	Reference	Projektfordel	Forskel i pct.
CO ₂ -ækvivalenter (tons)	54.581	99.212	44.631	45%
SO ₂ (kg)	11.946	7.880	-4.066	-52%
NO _x (kg)	33.388	65.918	32.530	49%
PM _{2,5} (kg)	1.687	8.333	6.645	80%

Connection costs- 150 m2 residential house – natural gas/oil to district heating

■ Transmissionsbidrag:	11.250 kr.
■ Byggemodningsbidrag:	28.125 kr.
■ Standard tilslutningsbidrag:	9.356 kr.
■ Stikledning: 20 m a´ 830 kr.	16.600 kr.
■ Afslutning af stik:	1.994 kr.
■ Sløjfning af gasstik/olietank:	5.000 kr.
■ Tilskud fra Fjernvarme Fyn:	- 1.900 kr.
■ Rabat ved tilslutning år 1:	- 4.678 kr.
■ Eget VVS arbejde	<u>25.000 kr.</u>
■ Total DKK	90.747 kr.

Current heat costs

Køb af brændsel, 1.888 m3 a' 8,89 kr.	16.784
Årligt abonnement/målergebyr	650
Service af kedel/fyr/skorsten	1.875
Køb af el til fyr/cirkulationspumpe	878
Afskrivning af fyr	2.000
Total DKK	22.187

Heat costs district heating

Energibidrag	6.723
Transportbidrag	2.255
Rumbidrag	1.913
Service af fjernvarmeinstallation	300
Målerbidrag	325
Total DKK	11.516

Yearly savings	10.671
Pay back time (years)	8,5

Current heating costs

Køb af brændsel, 1.995 liter a' 11,50 kr.	22.943
Årligt abonnement/målergebyr	0
Service af kedel/fyr/skorsten	1.875
Køb af el til fyr/cirkulationspumpe	1.049
Afskrivning af fyr	2.000
Total DKK	27.867

Heating costs district heating

Energibidrag	6.723
Transportbidrag	2.255
Rumbidrag	1.913
Service af fjernvarmeinstallation	300
Målerbidrag	325
Total DKK	11.516

Yearly savings DKK	16.351
Pay back time (years)	5,5

The role of heat planning - conclusions

- Heat planning can support the development of district heating by delineation of areas where district heating is economically feasible and where it is not.
- Heat planning is needed for design of networks and heat production facilities
- Heat planning must be combined with means to ensure the competitiveness of district heating relative to individual heating, eg. energy taxation, regulation of prices
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