EUROPEAN HEAT PUMP SUMMIT

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SYMPOSIUM + EXPO
NUREMBERG, 20–21.10.2015

Industrial | Commercial | Residential
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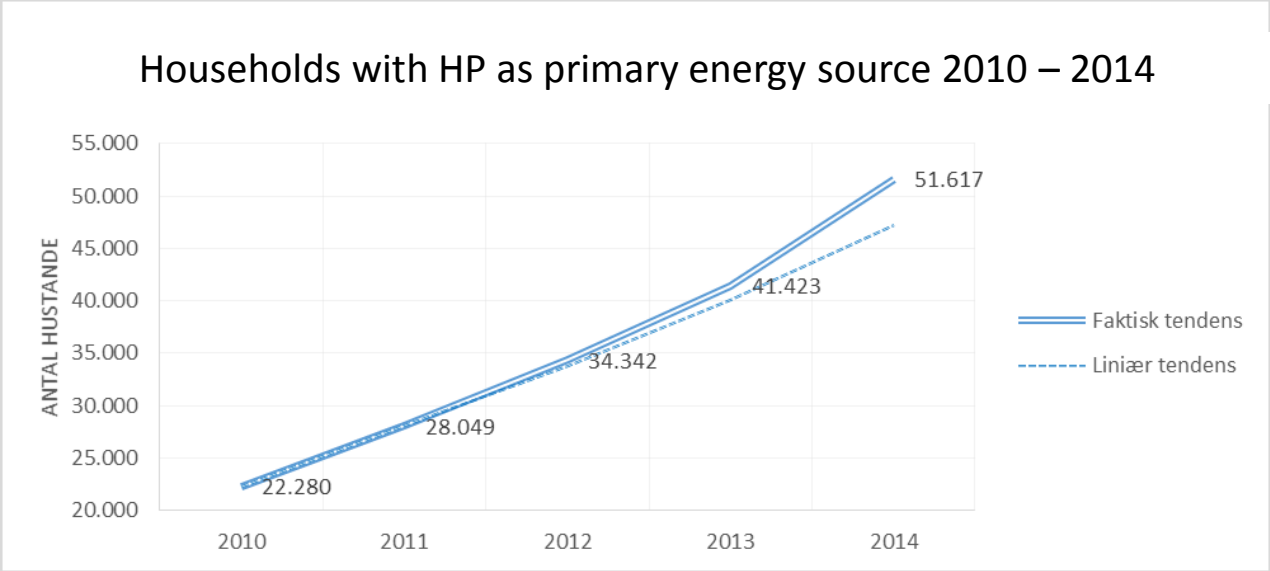
Danish demonstration project with implementation of hybrid heat pump systems

Svend Pedersen
Senior Consultant DTI

The Governments ambition for the Danish energy future

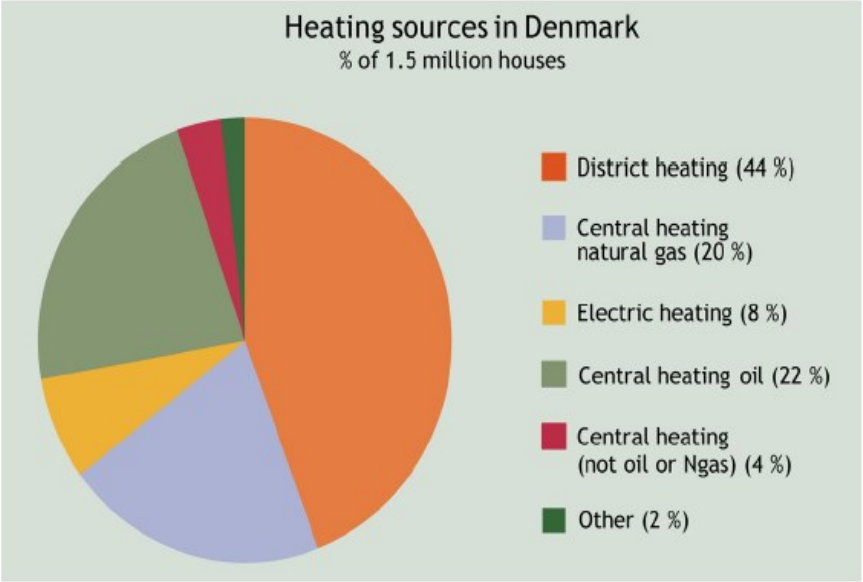
- Denmark fossil free in 2050
- Heating shall be supplied 100% from Renewable Energy in 2035
- No more oil fired boilers in 2030
- 35 pct. Renewable Energy in 2020 energy consumption
- 50 pct. wind in the Danish electrical consumption
- 2013 No installation of oil and gas fired boilers in new buildings
- 2016 No replacement of oil fired boilers in existing buildings in areas with gas or district heating grid.



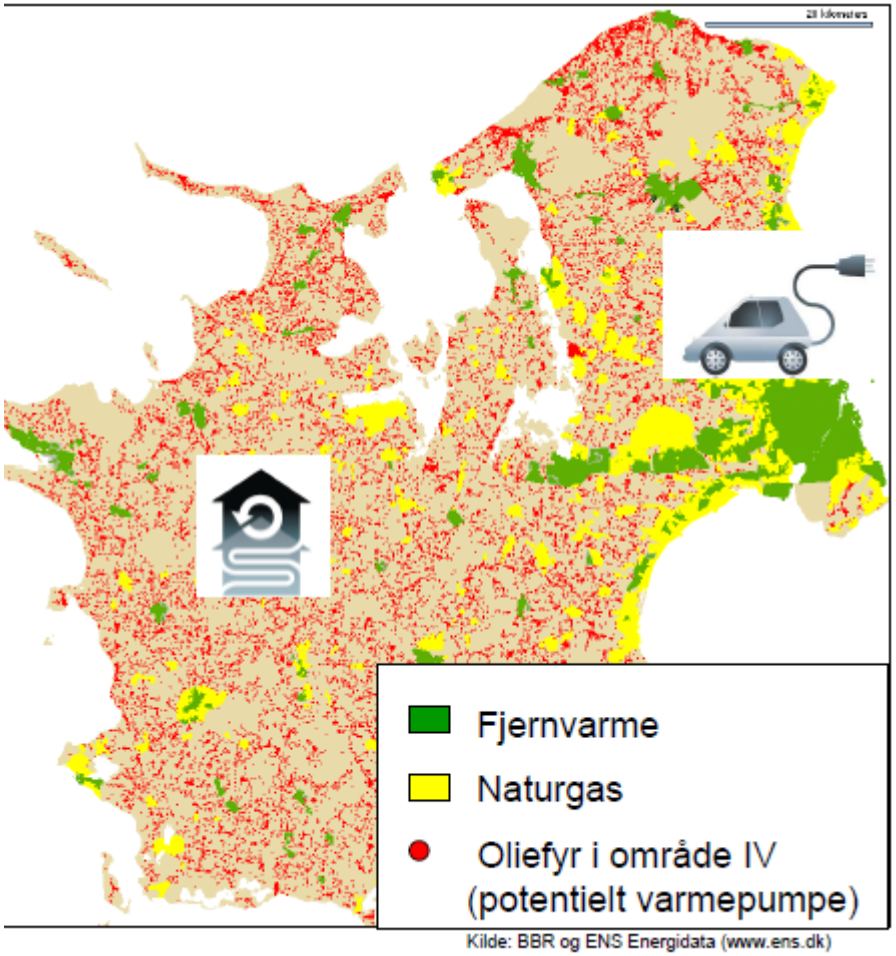
Danish Energy supply

Approximately 2 million households

- District heating app. 1,2 million
- **Gas app. 0,4 million**
- **Oil app. 0,3 million**
- Electricity and heat pumps 0,1 million



Zealand (Sjælland)



Demonstration project regarding Gas Hybrid Heat Pumps

Partners:

- Danish Energy Agency
- Danish Technological Institute
- Danish Gas Technology Centre DGC
- Bosch
- Viessmann
- Weishaupt

Demonstration project regarding Gas Hybrid Heat Pumps

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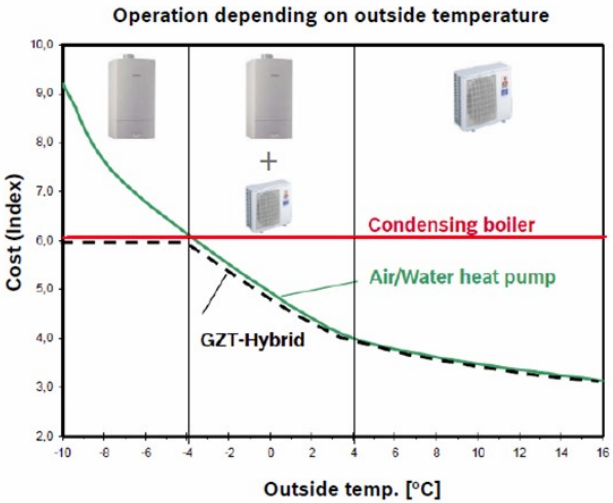
Why Gas hybrid Heat Pumps ?

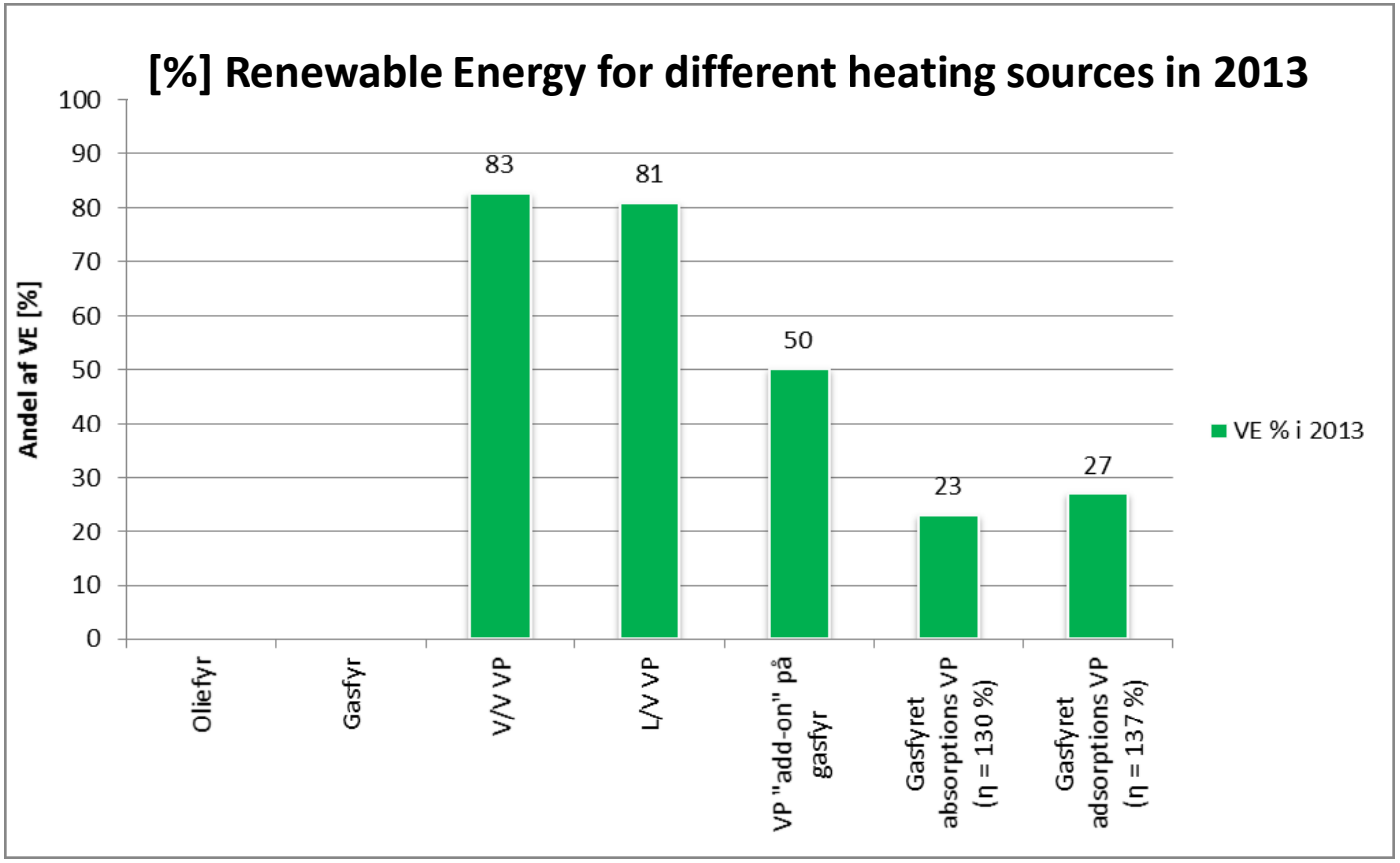
- Danish Gas production will decrease
- Gas Grid Infrastructure from 1980's
- 0.4 Mio Households with gas boiler
- Life time for gas boilers app. 15 years



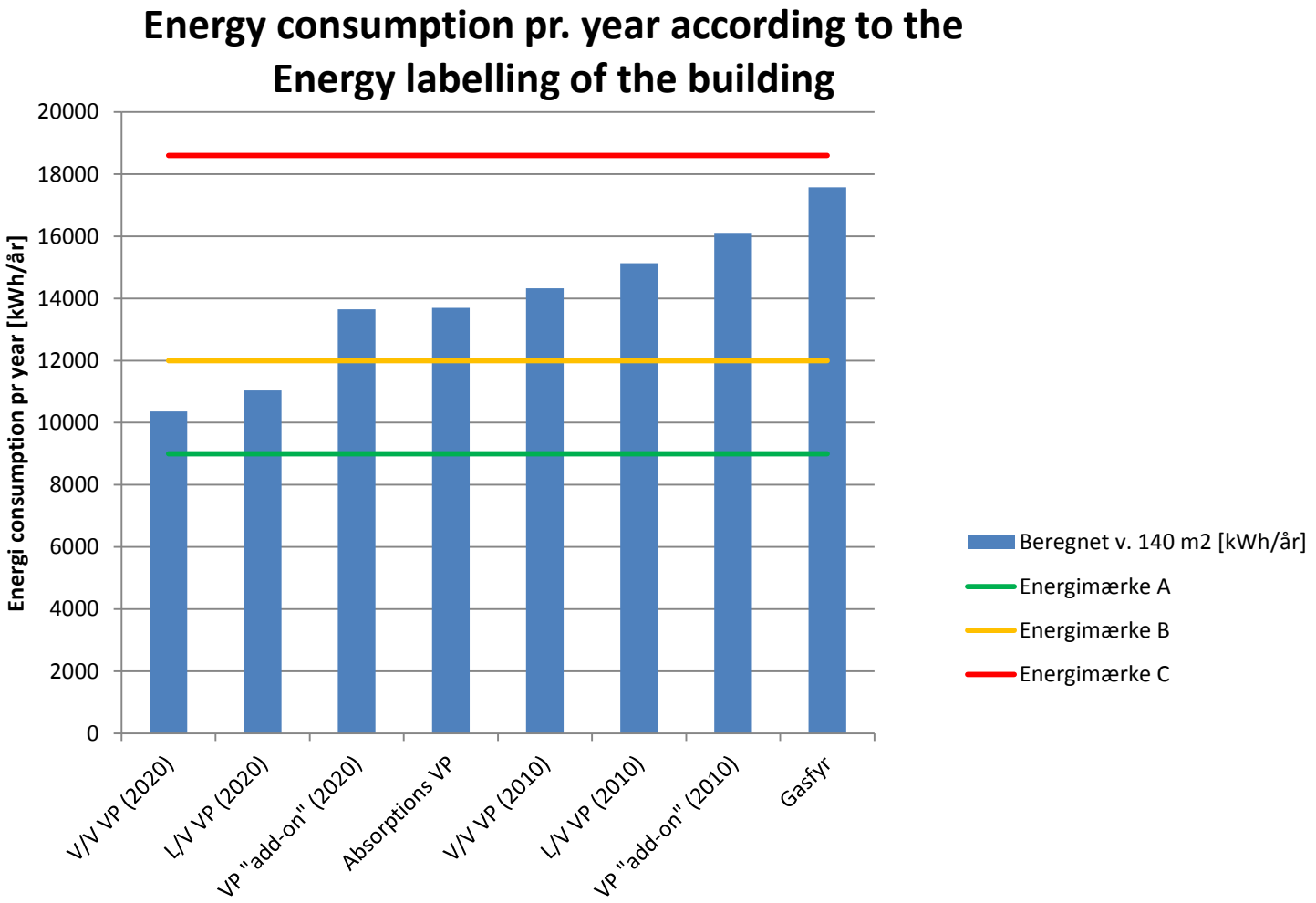
- The heat pumps will in Grid perspective have a capacity of 315 MW elec. overall which is 2,2 % of the overall grid capacity

- High temperature for radiators
- Gas boiler back up
- "Known technology" for Installer/consumer

Gas hybrids can phase out fossil fuels, but are the consumers motivated ?



Energy use pr. Year due to the energy labelling of a 140 m2 single family house (2010/2020) (2,5/1,8)



Parameter	Unit	Alternative 1	Alternative 2	Alternative 3	Alternative 4		Alternative 5	
Heating system		Gasboiler	B/W HP	A/W HP	Gashybrid HP (Complete new instal.)		HP add-on on existing gasboiler	
Energi input		Naturgas	Elec	Elec	Gas (40 %)	Elec (60 %)	Gas (40 %)	Elec (60 %)
Netto heating demand	[kWh/year]	16.800	16.800	16.800	16.800		16.800	
Installation costs m. m.								
Unit and installation incl. VAT	[€]	5.000	18.000	14.000	10.724		5.362	
- labour costs	[€]	2.750	5.400	2.100	3.351		1.005	
Labour cost deduction	[€]	900	1.300	700	1.100		300	
Energy saving incentive (0,25 kr/kWh)	[€]	-	400	400	200		200	
Total instal. cost	[€]	4.100	16.300	12.900	9.424		4.862	
Depreciation	[€/year]	186	815	645	471		243	
Interest rate	[%]	3,5%	3,5%	3,5%	3,5%		3,5%	
Interest avg. Gross	[€/year]	83	366	285	192		99	
Interest avg. Net	[€/year]	55	246	191	129		66	
Life time, efficiency, energyprice etc.								
Expected	[year]	22	20	20	20		20	
Efficiency of system	[%]	102	330	300	102	350	102	350
Fuel cost	[€/l], [€/m^3]	1,2			1,2		1,2	
Lower calorific value	[kWh/l], [kWh/m^3]	11			11		11	
Energy price	[€/kWh]	0,11	0,23	0,23	0,11	0,23	0,11	0,23
Electricity price (Auxilary energy)	[€/kWh]	0,29	-	-	0,29	-	0,29	-
Operation Costs								
Gross Heating demand	[kWh/år]	16.471	5.091	5.600	6.588	2.880	6.588	2.880
Auxilary energy	[kWh/år]	75	-	-	25	-	25	-
Fees (District heating)	[€/år]	-	-	-		-		-
Energy Costs	[€/år]	1.788	1.146	1.261	714	649	714	649
Maintenance costs								
Service and maintenance	[€/år]	300	300	200	300		300	
Total annual costs	[€/år]	2.330	2.507	2.297	2.262		1.972	
Index	[-]	**1,00**	**1,08**	**0,99**	**0,97**		**0,85**	

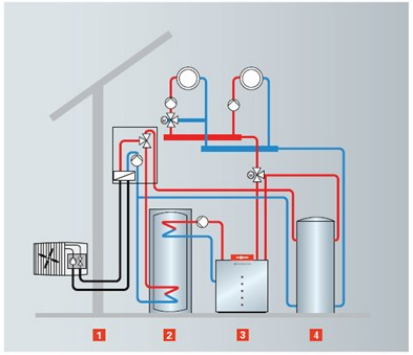
Types of gas hybrid heat pumps

1: Electrical HP and gas boiler sold as a package solution

2: Electrical HP sold as a add-on to an existing gas boiler

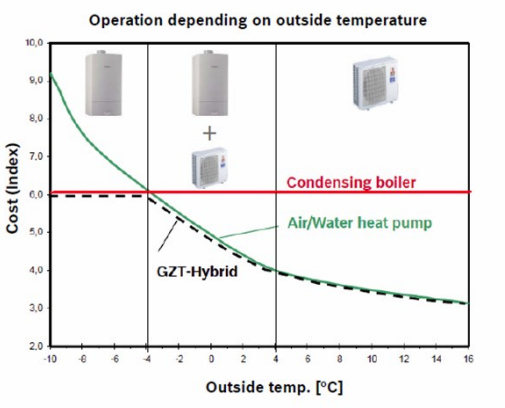
3: Gas fired adsorption HP (Zeolite)

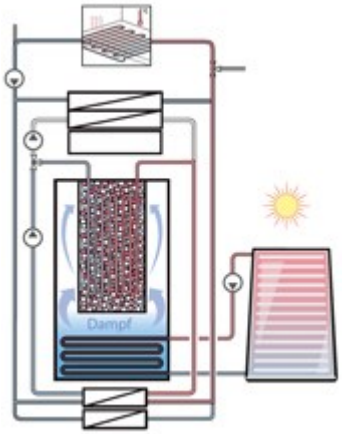
4: Gas fired absorption HP



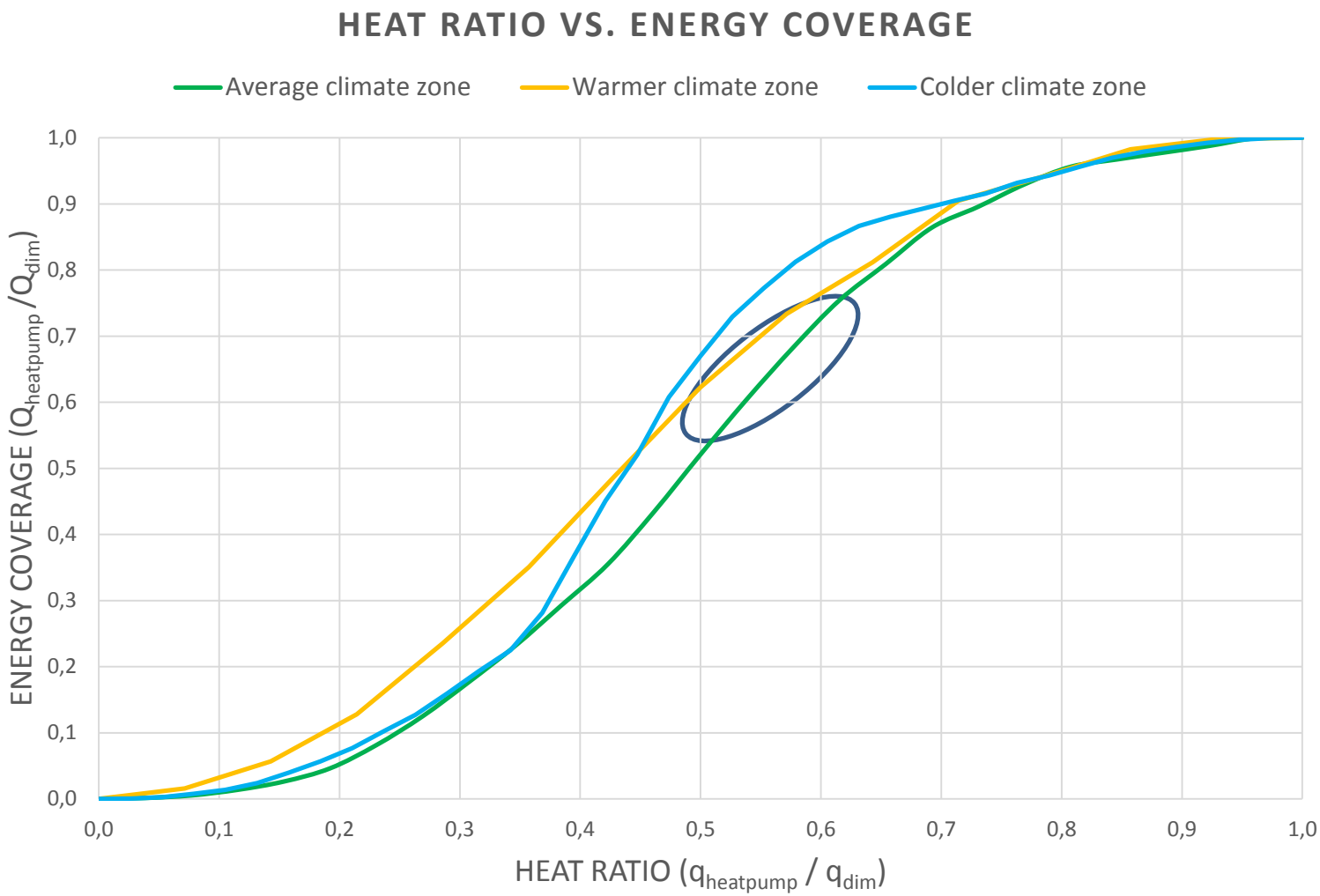
Vitocal 200-S und Öl-/Gas-Heizkessel für den bivalenten Betrieb bei der Modernisierung (1 = Vitocal 200-S Außen- und Inneneinheit | 2 = Warmwasserspeicher | 3 = Heizkessel | 4 = Heizwasser-Pufferspeicher)

print close





Dimensioning of the heat pump



Field Measurements

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- 6 pcs. Bosch Compress Hybrid 5000 AWS and 30 kW Condens 5000 WT (Type 1)
- 1 pcs. Bosch Compress Hybrid 5000 AWS and 14 kW Europur gas boiler (Type 1)
- 1 pcs. Reb2B Atlantic Alfea Hybrid Duo Gas 14 kW (Type 1)
- 1 pcs. Viessmann Vitocaldens 222-F (Type 1)
- 3 pcs. Weishaupt 25 kW A/W HP and 40 kW gas boiler(Type 2)
- 1 pcs. MHG Thermiair 16 kW and older oil boiler 20 kW (Type 2)
- 1 pcs. Bosch 17 kW Compress 6000 AW and older oil boiler (Type 2)

Field Measurement results

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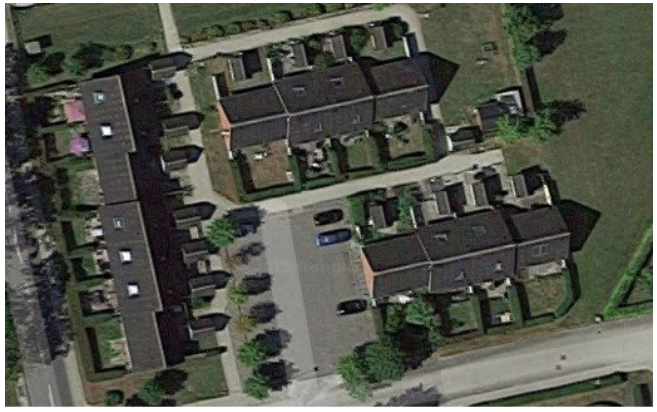
	Elec. Consumption	Heat production	Gas Consumption	Tap water Production	Overall Efficiency	SPF HP	Gas Saving	HP Share of heating
	[kWh]	[kWh]	[kWh]	[kWh]	[-]	[-]	[kWh]	%
Unit 1	5.066,66	17.716,00	7.695,91	3.818,96	106%	2,73	64%	78%
Unit 2	3.203,23	10.502,00	4.322,36	3.194,40	107%	2,93	66%	79%
Unit 3	2.877,83	12.062,00	8.112,86	3.818,96	104%	2,70	49%	65%
Unit 4	3.449,14	15.206,00	8.611,47	2.050,95	115%	2,51	55%	69%
Unit 5	2.477,89	15.687,00	9.566,68	1.253,10	126%	2,98	46%	53%
Unit 6	2.547,74	15.823,00	10.037,57	3.085,50	126%	3,48	49%	61%
Unit 7	6.107,97	22.773,00	3.782,05	1.306,80	111%	3,32	84%	89%
Period 1. oct.2014 to 30. sept 2015					114%	2,95	59%	70%

- **6 stk. Bosch Compress Hybrid 5000 AWS and 30 kW Condens 5000 WT (Type 1)**
- **1 pcs. Bosch Compress Hybrid 5000 AWS and 14 kW Europur gas boiler (Type 1)**
- **Heat Pump SPF 2.95**
- **Overall heat pump production 59 % (Heat+Tapwater)**
- **Heat pump share of heating production 70%**

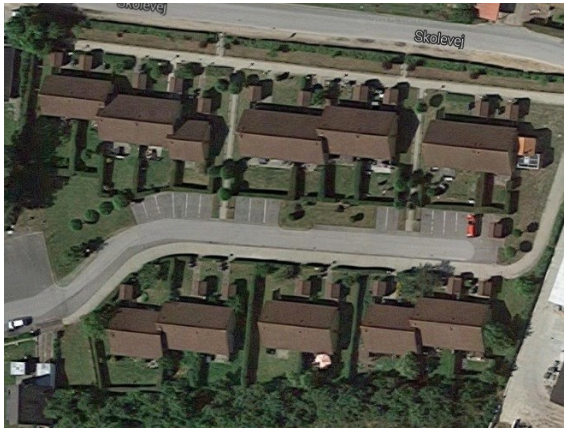
Field measurements
Multifamily houses (Cluster)

VAB 63 , 15 apartments,
51-75 m3 /pcs , from 1984
936 m2 total heated



VAB 73 , 18 apartments,
50-70 m3 /pcs , from 1985
1099 m2 total heated

VAB 74 , 19 apartments,
44-87 m3 /pcs , from 1985
1151 m2 total heated



Field Measurement results

	Elec. Consump.	Heat produc. HP	Gas Consump.	Heat produc. Gasboiler	Eff. Gasboiler	SPF HP	Eff. System	HP Share of heating
	[kWh]	[kWh]	[kWh]	[kWh]	[-]	[-]	%	%
VAB 63	7.209,05	23.820,00	56.793,11	54.610,00	96%	3,30	105	30%
VAB 73	27.938,00	87.850,00	3.750,72	3.500,00	93%	3,14	124	96%
VAB 74	28.972,41	84.670,00	3.984,59	3.740,00	94%	2,92	116	96%
Period 11. oct.2014 to 29. sept 2015						3,12	115	74%

- 3 pcs. Weishaupt 25 kW A/W HP and
  40 kW gas boiler(Type 2)
- Heat Pump share of heating up to 94%
- SPF Heat pump 3,12

Parameter	Unit	Alternative 1	Alternative 2	Alternative 3	Alternative 4		Alternative 5	
Heating system		Gasboiler	B/W HP	A/W HP	Gashybrid HP (Complete new instal.)		HP add-on on existing gasboiler	
Energi input		Naturgas	Elec	Elec	Gas (40 %)	Elec (60 %)	Gas (40 %)	Elec (60 %)
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Life time, efficiency, energyprice etc.								
Expected	[year]	22	20	20	20		20	
Efficiency of system	[%]	100	330	300	100	295	100	295
Fuel cost	[€/l], [€/m^3]	**0,9**			**0,9**		**0,9**	
Lower calorific value	[kWh/l], [kWh/m^3]	11			11		11	
Energy price	[€/kWh]	0,09	0,23	0,23	0,09	0,23	0,09	0,23
Electricity price (Auxilary energy)	[€/kWh]	0,29	-	-	0,29	-	0,29	-
Operation Costs								
Gross Heating demand	[kWh/år]	16.800	5.091	5.600	6.720	3.417	6.720	3.417
Auxilary energy	[kWh/år]	75	-	-	25	-	25	-
Fees (District heating)	[€/år]	-	-	-	-		-	
Energy Costs	[€/år]	1.455	1.146	1.261	581	770	581	770
Maintenance costs								
Service and maintenance	[€/år]	300	300	200	300		300	
Total annual costs	[€/år]	1.997	2.507	2.297	2.250		1.960	
Index	[-]	**1,00**	**1,26**	**1,15**	**1,13**		**0,98**	

Challenges

- Slow start of the sale of hybrid heat pumps
- Few products on the Danish market
- Expensive products
- The technology is hard to explain for installers
- Needs expert knowledge and backup of installers
- Compability problems between products
- Decreasing oil and gas prices

Conclusions

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- **Correct installation and dimensioning** and start up is essential.
- Incorrect installation and start up can cause increased costs
- Compability between products is problem

- Hybrid heat pumps is a easy solution to phase out a large share of gas. Above 70 % is easy.
- The economy is very dependent on investment costs and fuel prices
- The Heat Pumps covers the largest part of the heating production

Thank you for your attention

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