

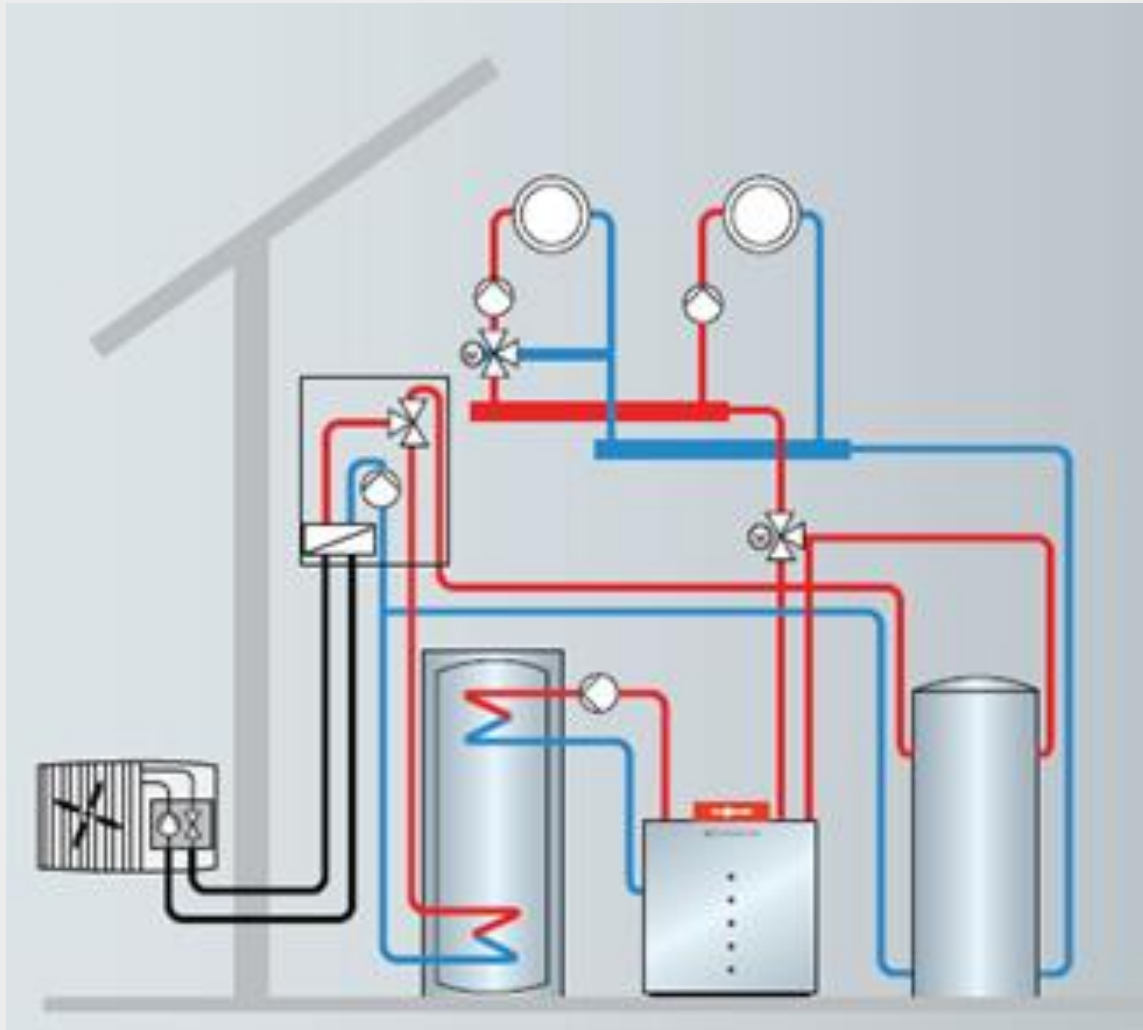
Domestic gas hybrid technologies and their interaction with the Danish energy system

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Hybrid with gas boiler and heat pump



Partners

- TI is a consulting and development organisation within energy and environment focusing on energy.
- TI works with all energy technologies: e.g. heat pumps, combinations of oil, gas and renewable energy.
- DGC is a consulting and development organisation within energy and environment focusing on energy gases.
- DGC works with all energy gasses: natural gas, town gas, LPG, biogas and hydrogen, and also with combinations of gas and renewable energy.
- DGC was established in 1988 by the Danish gas companies.



Danish Energy Policy

- Electricity, wind, biomass and energy savings
- No fossil oil and gas in new private homes from 2013
- Shift from fossil oil and gas to renewables
- Analyses of the future use of the gas infrastructure

Gas is renewables' best friend ...

- The gas infrastructure has a very large energy storage capacity that can balance the energy system with more wind power and solar
- A gas boiler is flexible and may easily be combined with renewable energy technologies (hybrid systems)

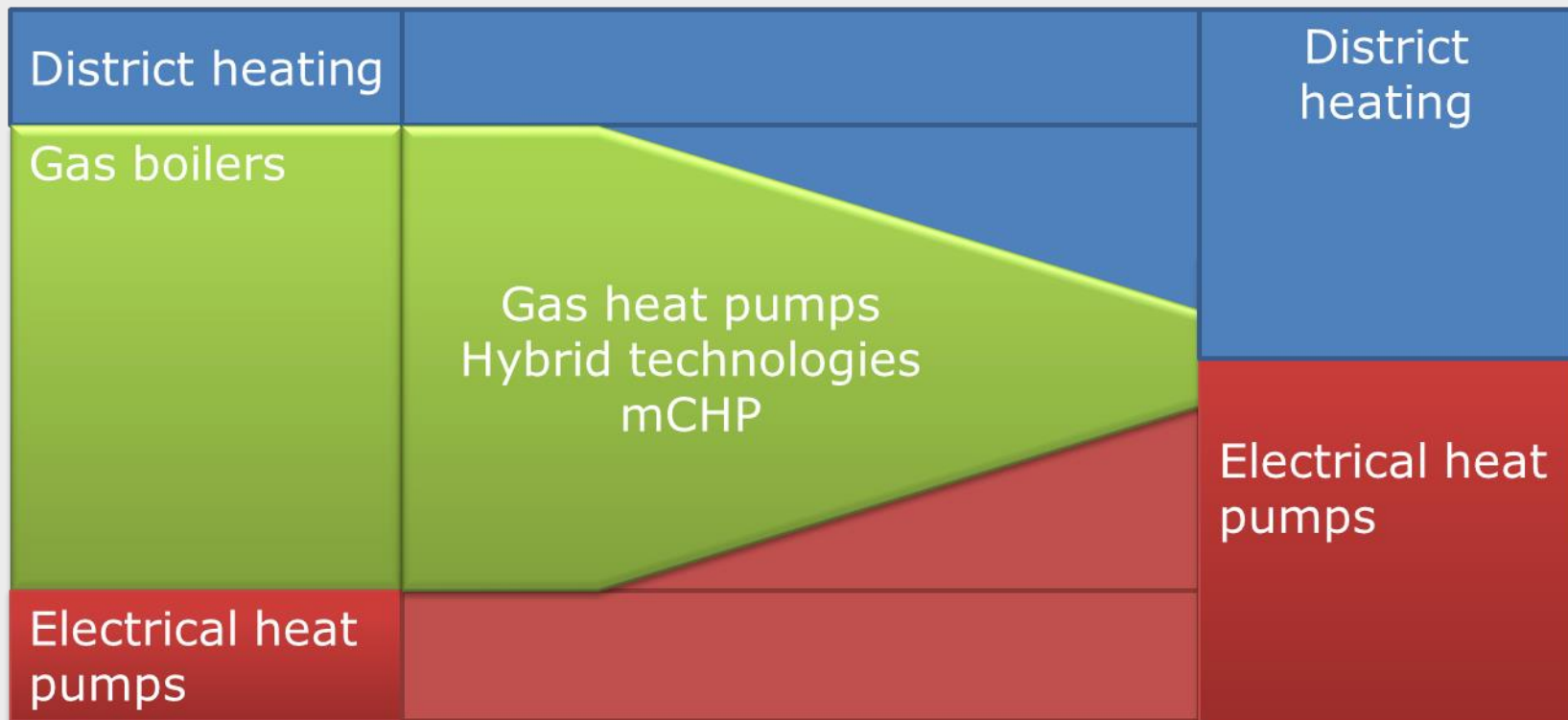
... and Gas is also renewable ...

- Gas can be made greener by mixing with renewable gasses (e.g. biogas)
- Gas can be more energy-efficient (e.g. Gas heat Pumps)

Hybrid the bridge to the future – English analysis ...

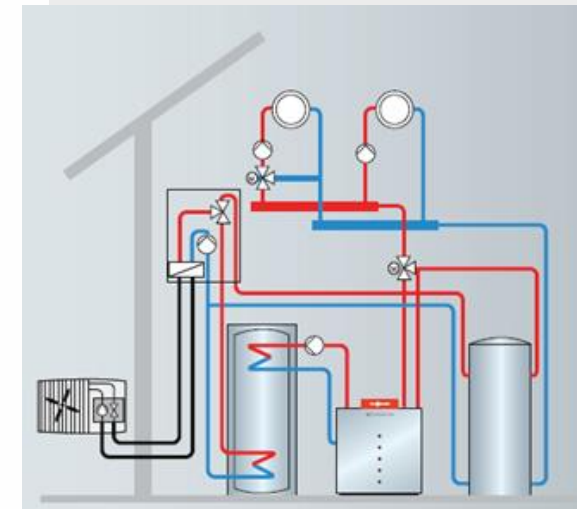
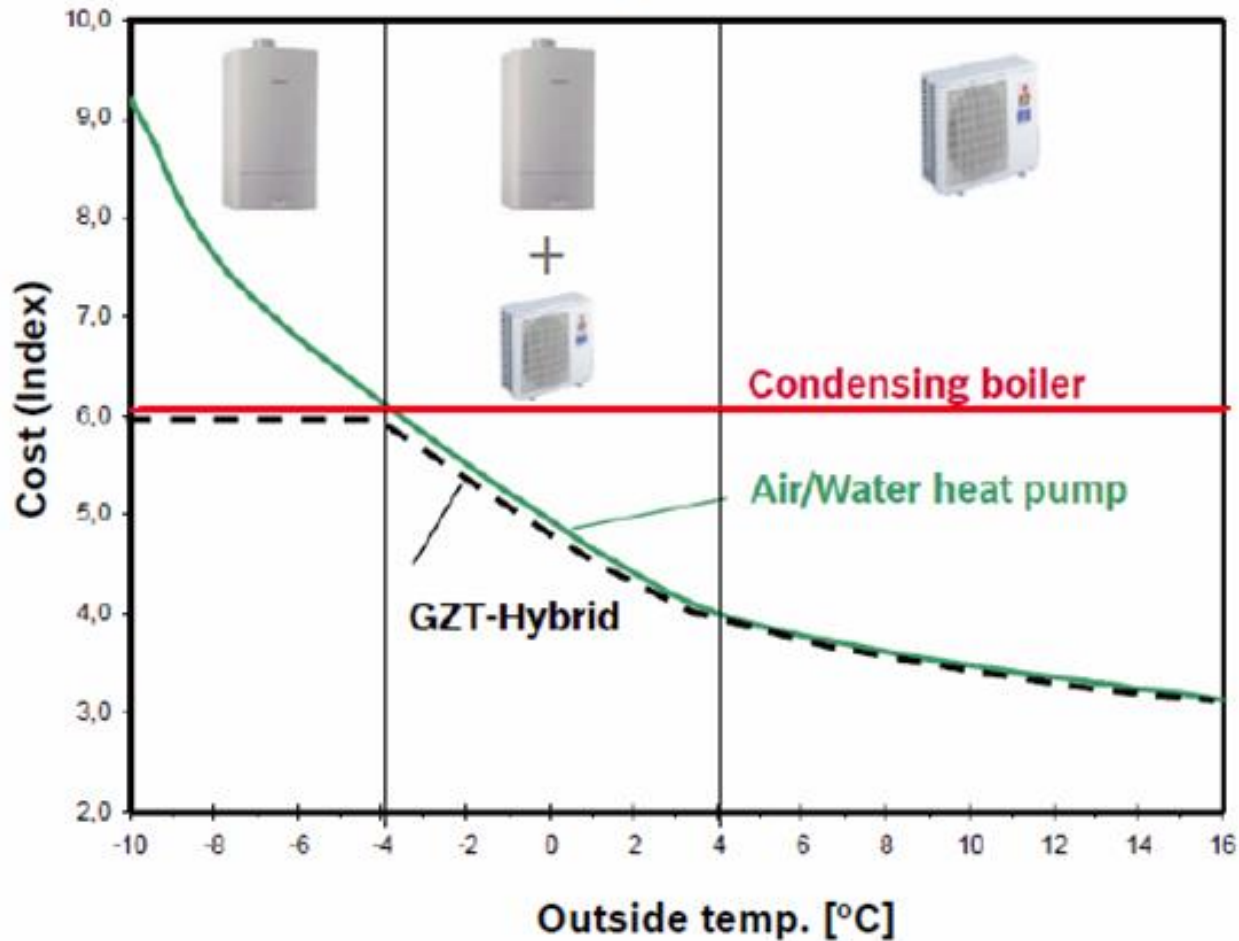
Today

Objective 2050
No CO2 for space heating

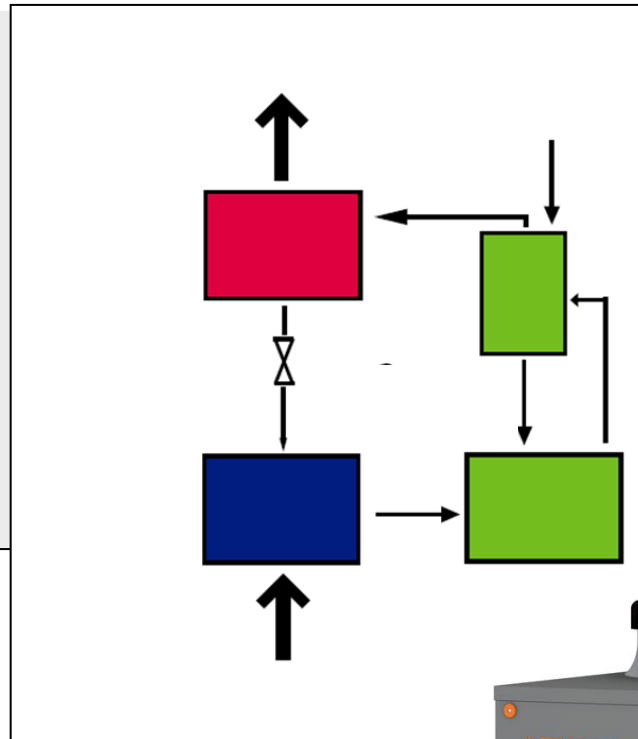
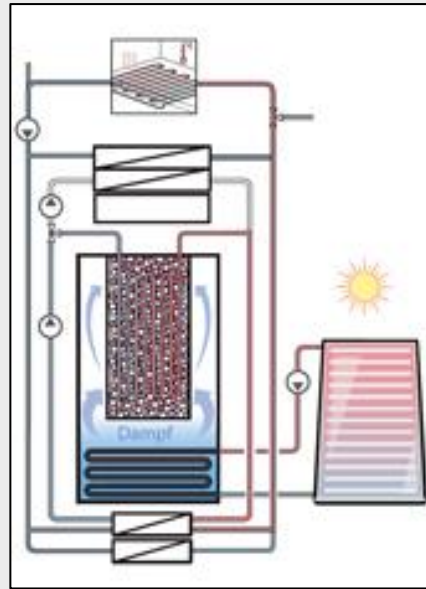


Hybrid (add-on/new)

Operation depending on outside temperature



Other more efficient gas Renewables..



Danish gas hybrid activities

- Gas companies' strategy process (bridging the gap since 2009), RE demo projects together with the boiler industry
- SmartGrid network in DK (2013-)
- EUDP, FlexGas (2014-2016)
- Danish Energy Agency, national demonstration projects (TI/DGC 2013-2015)

Roadmap of the DK national demonstration project

	2013	2014	2015
Task 1 - Description of gas hybrid systems and their implementation potential	OK!		
Task 2 - Investigation of perspectives of hybrid solutions in connection with Smart Grid	OK!		
Task 3 - Support of the phasing out of fossil fuels	OK!		
Task 4 - Experience from abroad	OK!		
Task 5 - Finding suitable hosts for field tests	(OK!)		
Task 6 - Planning of measurements	OK!		
Task 7 - Installation of hybrid units			
Task 8 - Installation of measurement equipment			
Task 9 - Identification of practical problems during installation			
Task 10 - Measurements			
Task 11 - Identification of operating economy			
Task 12 - Reporting			

Results: Why Gas hybrid?

The best of two worlds

Gas boiler

Advantages: Low cost of installation. Constant output and efficiency at low outdoor temperatures. Can be installed in old, uninsulated houses.

Disadvantages: 100 % fossil today.

Heat pump

Advantages: High efficiency at moderate outdoor temperatures. High share of Renewables.

Disadvantages: High cost of installation, Lower output and efficiency at lower outdoor temperatures and high flow temperature.

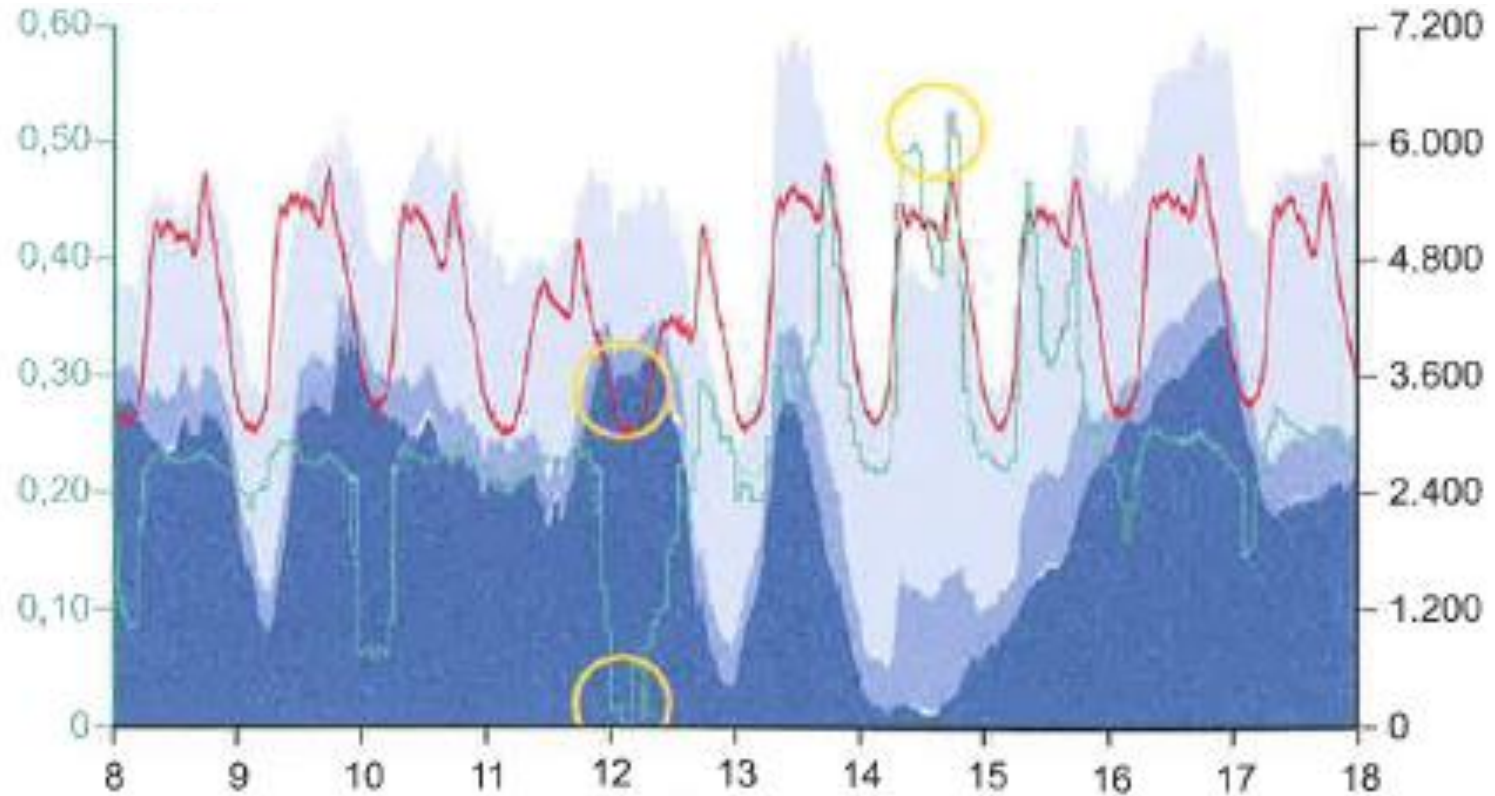
Gas hybrid heat pump

Advantages: Low cost of installation. Constant output and efficiency at low outdoor temperatures. Can be installed in old, uninsulated houses. High efficiency at low and moderate outdoor temperatures. High share of Renewables.

Peak shaping and Smart Grid aspect

- Hybrid help solving "peak wind" electricity production - preventing overload of electricity grid
- Use of the gasboiler, at very low outdoor temperature when the electricity production cannot cover all demand
- The result is no need to oversize the electricity production capacity and residential heat supply is not affected.
- SmartGrid will help in controlling the hybrid appliances according the electricity production (e.g. with tarif control).

DKK/kWh



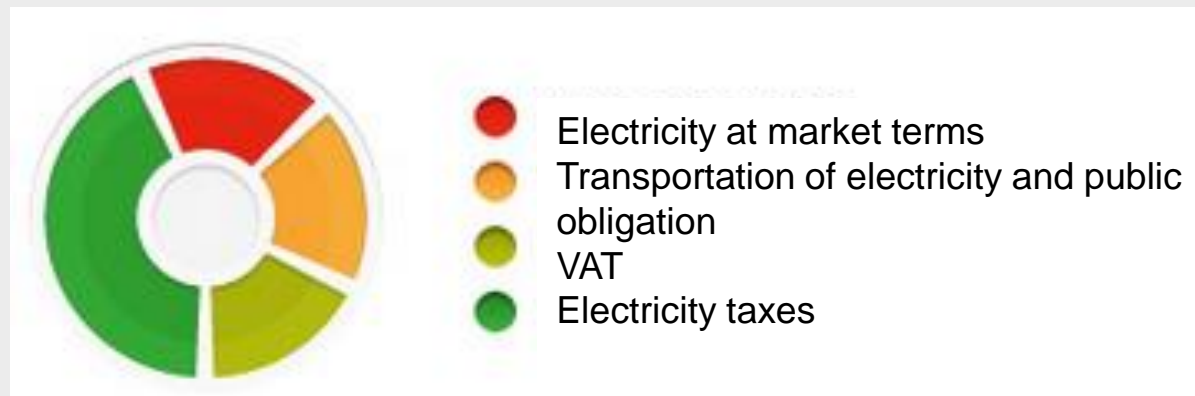
MWh

Dates in January 2014

Wind power - Local power plants - Centralised power plants
Market price of electricity - Electricity consumption

Results: The effect of "Peak shaping"

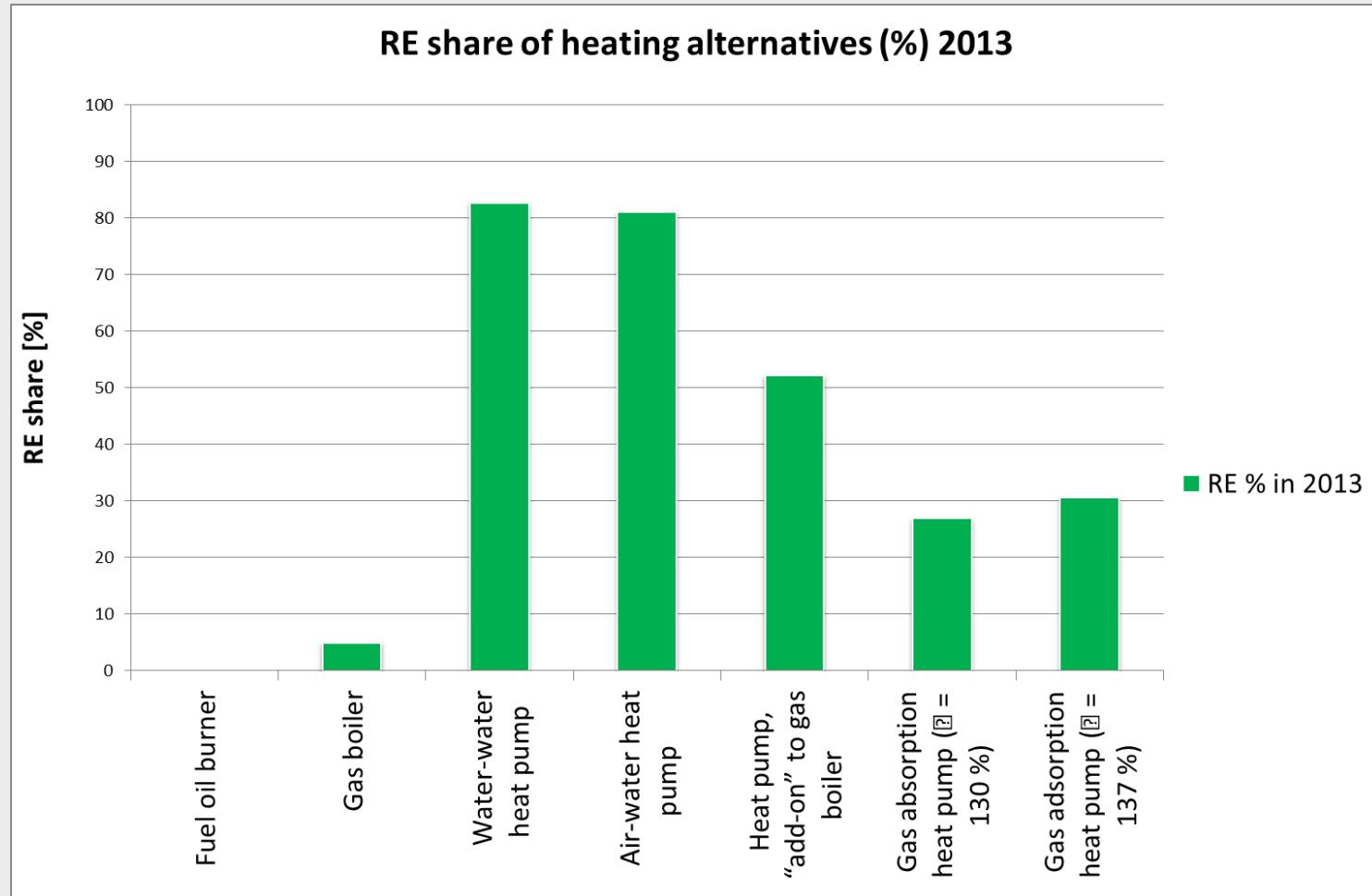
- Danish electricity capacity and consumption in 2012 was 14,166 MW and 112,119 PJ
- To connect/disconnect 400000 heat pumps in DK will average give approx. 3.11 %, or at peak load 6.59 %, of the total capacity during the heating season.
- Based on the actual average consumption in 2012 the gas-hybrid heat pumps would add an average flexibility of 12.38 %, or at peak load 26.25 %, during the heating season.
- The electricity price accounts for a relatively small share of the total expenses/costs including distribution costs, electricity taxes etc.



Results: Economy (heat demand 16.800 kWh/year)

Parameter	Alt. 1	Alternative 2	Alt. 3	Alternative 4	Alternative 5
Heating system	Gas boiler	Water-water heat pump	Air-water heat pump	Gas hybrid heat pump (new installation)	Heat pump as “add on” to existing gas boiler
Energy input	Natural gas	Electricity	Electricity	Gas (40 %) Electricity (60 %)	Gas (40 %) Electricity (60 %)
Total installation costs [DKK]	30.300	118.200	95.200	69.900	35.700
Expected lifetime [Year]	22	20	20	20	20
Plant efficiency [%]	102	330	300	102/350	102/350
Service & maintenance [DKK/year]	2.200	1.900	1.400	2.200	2.200
Total annual costs [DKK/year]	17.328	18.150	16.973	16.813	14.636
Index [-]	1,00	1,05	0,98	0,97	0,84

Results: The gap from fossil fuels to renewables



Status: DK marked and Field test

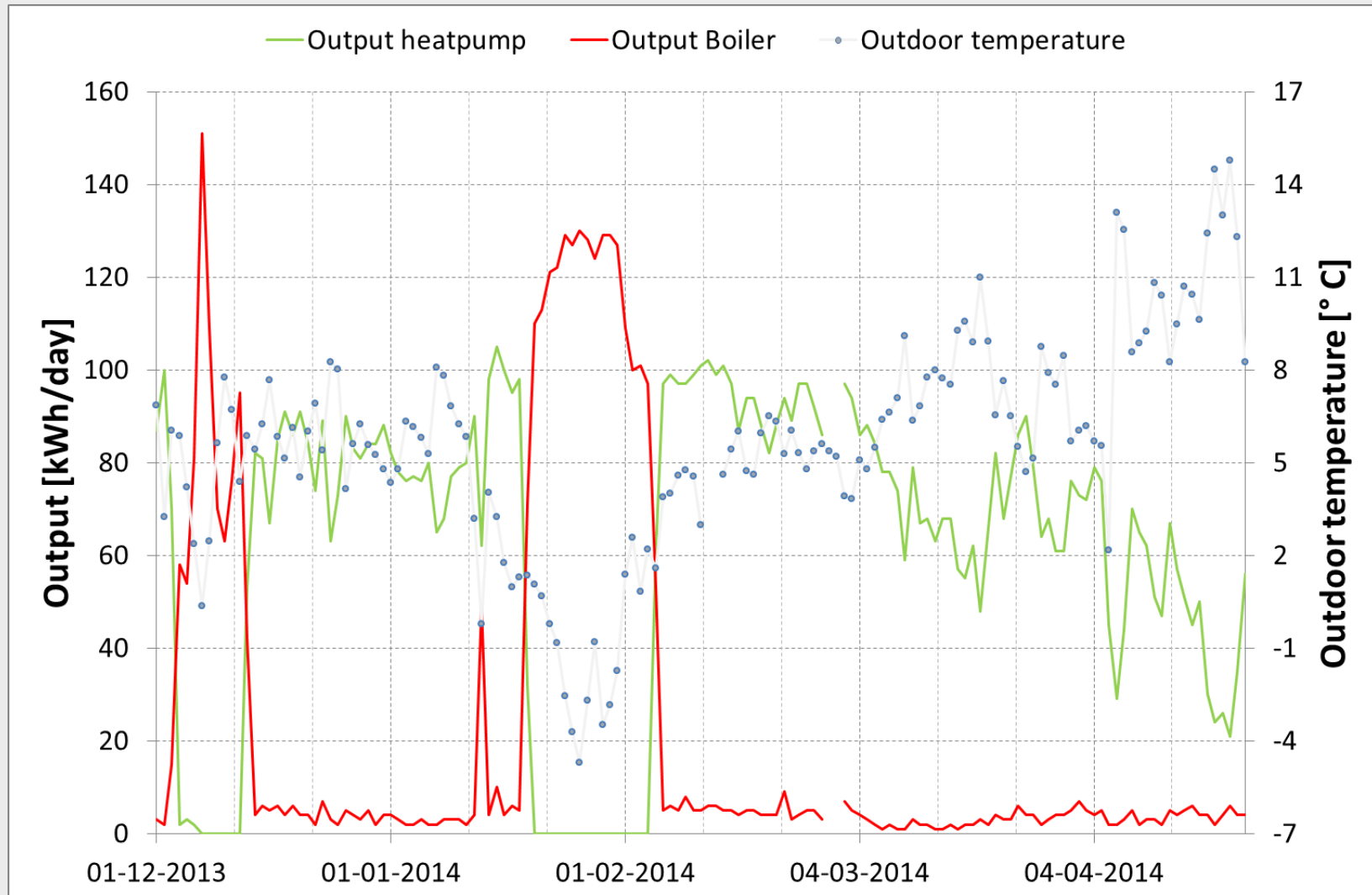
- Number sold in Denmark (interview dec. 2013): 86 units
- 1-2 "add-on" solutions (part of DGC measurement program)
- 15 "add-ons" (part of a Insero project)
- 3 gas absorption heat pumps
- 1-2 gas adsorption heat pumps



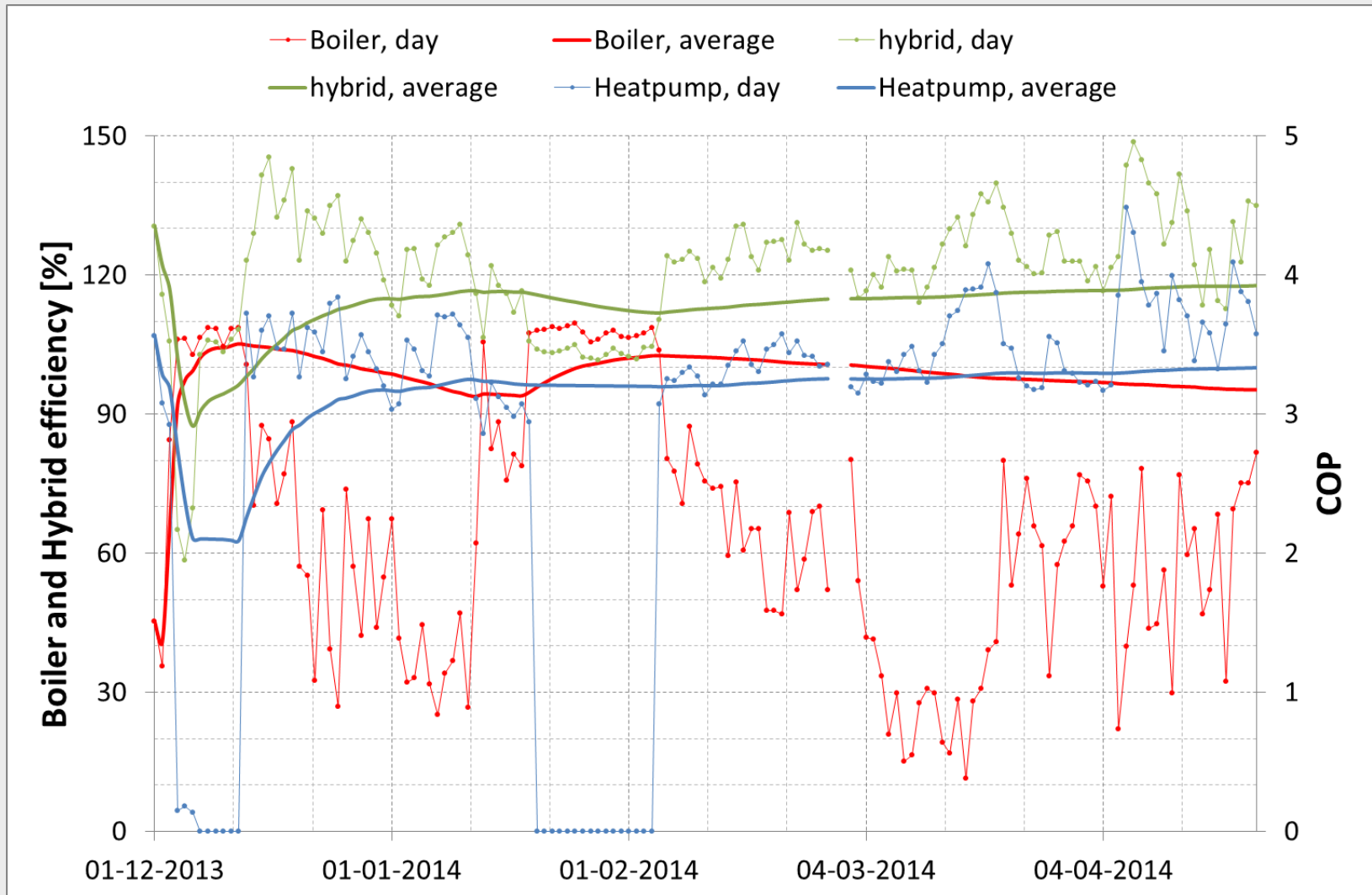
First ad-on field test installation (MHG-unit)



Results: Output vs Outdoor temperature

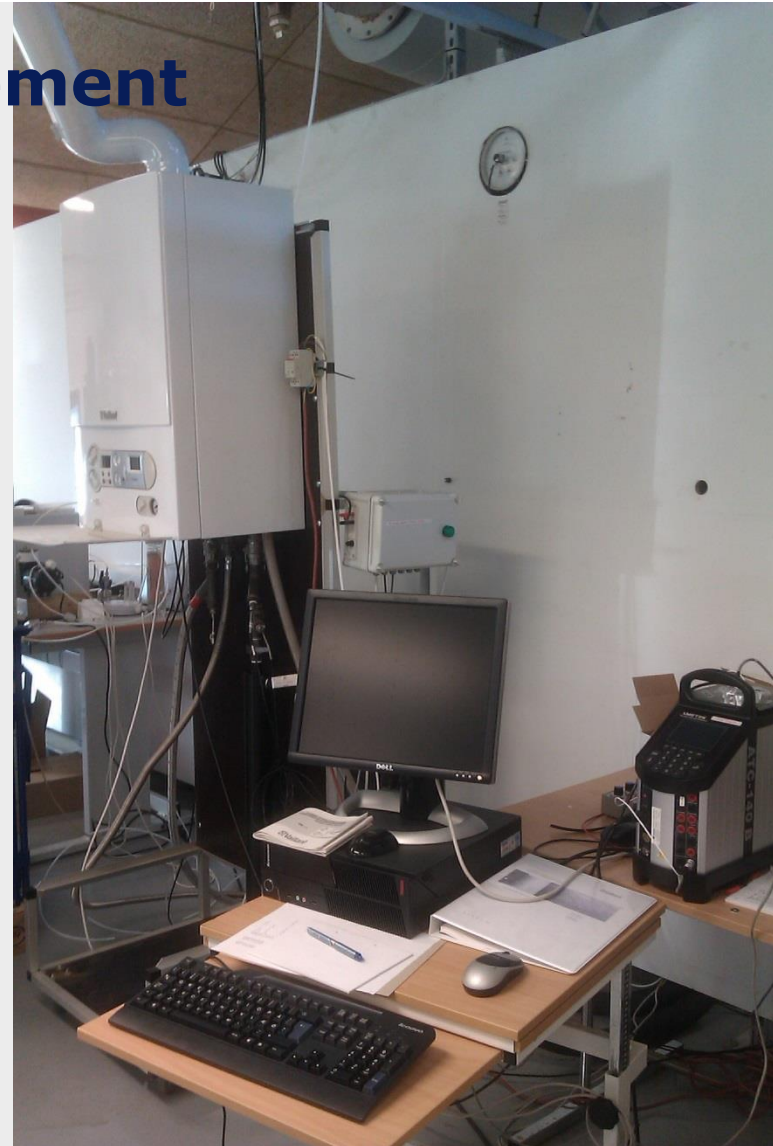


Results: Boiler efficiency vs Heat pump COP



Hybrid with a new electric element

- Preliminary testing with good results!
- New national demonstration project with good collaborators (2014-2016)




Conclusion

- Gashybrid can make efficiency optimization (End User economy, CO₂).
- Gashybrid is a realistic way of bridging the gap to more RE in existing residences.
- Gashybrid can make comfort and safety in new business concept (leasing).
- Green wind and solar power consumption in Danish residential Gas Hybrid installations is possible in periods with high power production but...

Next steps

- Focus on weak points and recommendations to the industry. E.g. installer education.
- Development is needed - It would be reasonable to consider regulation of taxes according to the electricity production.
- Test facilities / Standardisation / ECO design



**Thank you for your
attention!**