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Guidelines for evaluation of energy system in ZEB early design phase system analysis and cost optimality

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- Background
- Structure of guidelines
- Example building with ASHP (Air-Source Heat Pump)
- Different supply systems compared





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Background

- Work developed within research centre on Zero Emissions Buildings (ZEB)
 WP3 "Energy supply systems and services"
- As buildings become more energy efficient, net energy need is reduced and the relative importance of energy system increases
- In line with TEK10 requirements and NS3031 calculation methodology, software tools (TEK-sjekk and Simien *de facto* standard):
 - Cover the building physics part
 - but the system part is oversimplified
- But what about TEK15 and TEK20?





Background

- Develop a tool for analysis, comparison and choice of energy system in ZEB early design phase based on:
 - Technical analysis on hourly data
 - Cost optimality (EPBD methodology)
- "post-processing" analysis:
 - independent from calculation tool
 - Now: Excel. Future: Matlab
- Guidelines based on IDA-ICE as calculation tool:
 - "templates" for different energy systems
 - 1 base heating + 1 top heating; PV and Solar Thermal





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Ancillary tools

□ Heat Pump: COP curve fitting









Heat Pump: COP curve fitting



Heat Pump: COP curve fitting



Ancillary tools

□ Heat Pump: COP curve fitting

□ Solar Thermal: optimal sizing based on *f-chart* method









Solar Thermal: optimal sizing



Ancillary tools

□ Heat Pump: COP curve fitting

□ Solar Thermal: optimal sizing based on *f*-chart method

Global cost: investment, operation, maintenance (EPBD cost optimality)









Global cost



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IDA-ICE: building geometry and envelope



IDA-ICE: technical installations



IDA-ICE: ESBO plant

😳 IDA Indoor Climate and Energy	
File Edit View Insert Tools Options Window Help	
By-Type By-Manufacturer Plant: object in Ådland_HP+ST	
Insert new object Jan General Schematic Outline	Build plant model
In the second	

 Image: Section Section



IDA-ICE: detailed plant







Heating load profile [%]



Heating load profile [kW]







Heat Pump thermal output



Heat Pump electric input



Heat Pump COP and temperatures



Electricity import/export



Electricity monthly



ZEB balance with CO₂ metric



ZEB balance with PE metric (prEN 15603)



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Energy systems compared

Base heating system: (top heater always electric boiler)

- District Heating
- Electric boiler
- Bio-boiler
- CHP (Combined Heat and Power)
- ASHP (Air Source Heat Pump)
- GSHP (Ground Source Heat Pump)
- Three variants for energy supply:
 - PV (Photovoltaic) on all available roof
 - PV on all available roof + ST (Solar Thermal) on South facade
 - PV & ST on roof









Global cost: PV & ST on roof



Cost optimality – Theory



Cost optimality – CO₂ metrics



Summary

Guidelines for evaluation of energy systems in ZEB early design phase:

- Energy systems templates (in IDA-ICE)
- Ancillary tools
- post processing analysis tool

□ Technical analysis of energy system performance on hourly basis

Cost analysis based on input from technical analysis:

- Investment and maintenance costs ~ installed capacities
- Operation cost ~ imported/exported energy

Different level of 'nearly' ZEB

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