Energy efficiency inside out

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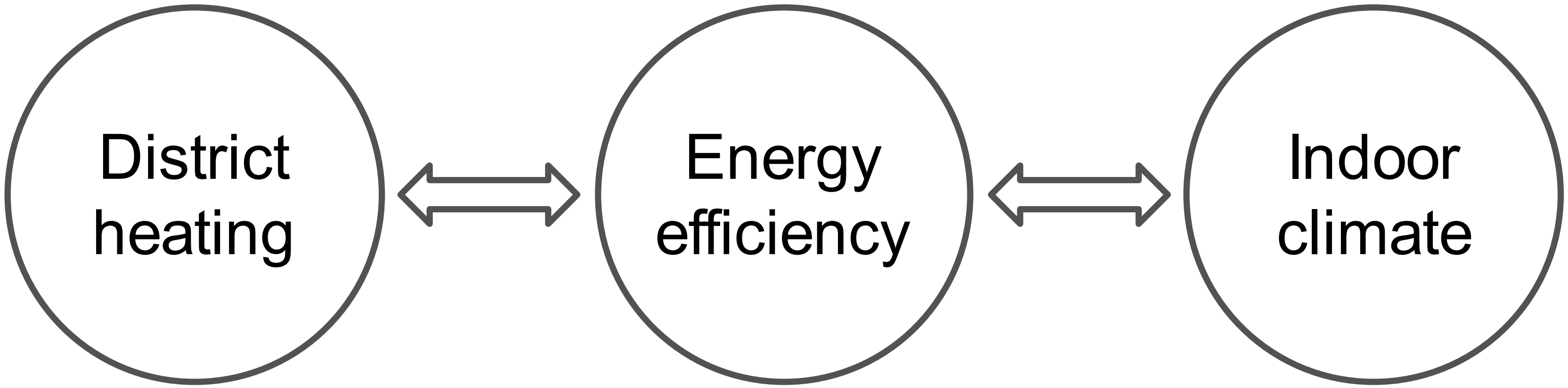
Presentation

- Introduction
- Framework of analysis
- Case studies - three Swedish municipalities
- Linkages between actors
- Conclusions and recommendations

Connections throughout the chain



- What kind of linkages are there within the chain of energy efficiency, district heating and indoor climate?
- Energy efficiency measures affect, in several ways, the indoor climate and the district heating suppliers
- Ambitious goal for buildings 20% until 2020 and 50% until 2050 compared to 1995*
  - Nationally about 9 percentage points remains to reach the goal

*Note:Governmental proposition 2005/06:145. National program for energy efficiency and energy smart construction.

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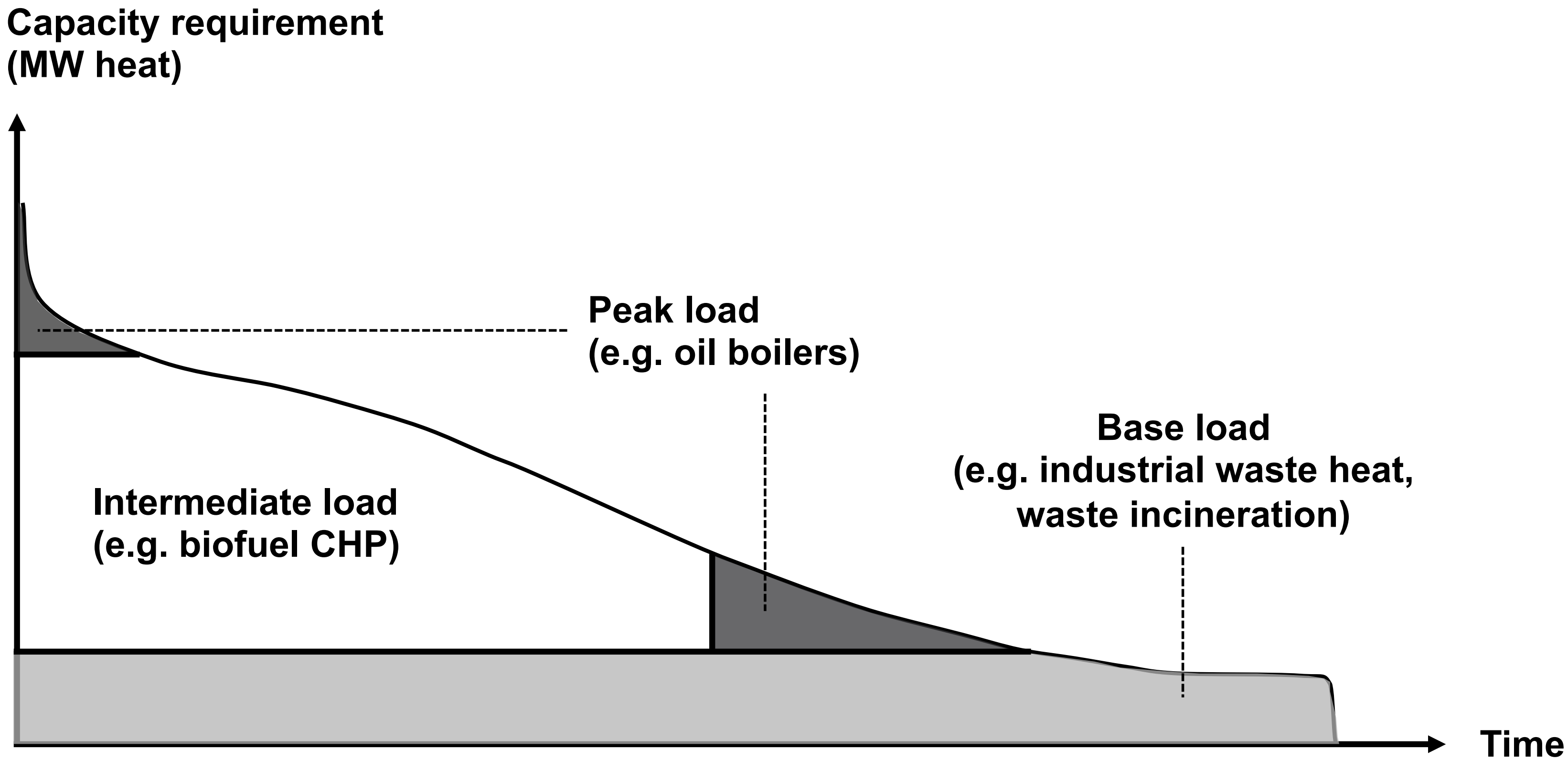
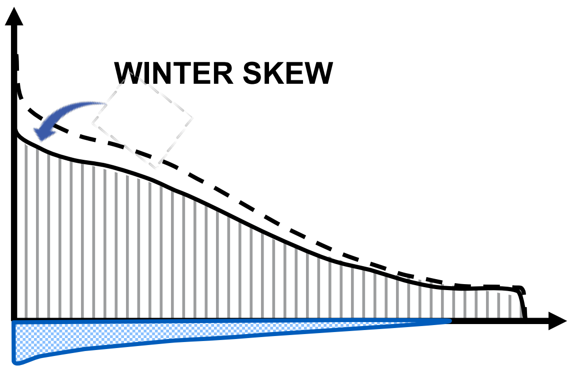
Framework of analysis – district heating

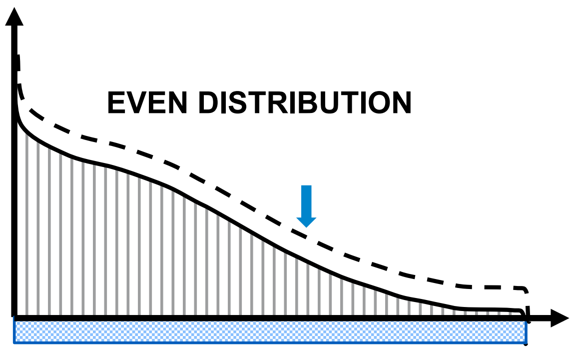
Heat load duration diagram



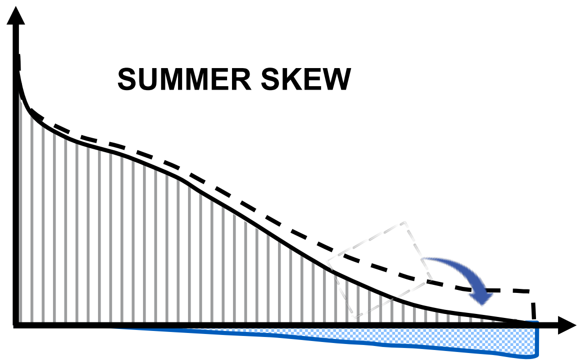
Energy savings profiles from energy efficiency measures illustrated by the heat load duration diagram



Examples
Facade insulation
Energy efficient windows
Ventilation with heat recovery



Examples
Hot water measures, high performance water mixers



Examples
Solar panels

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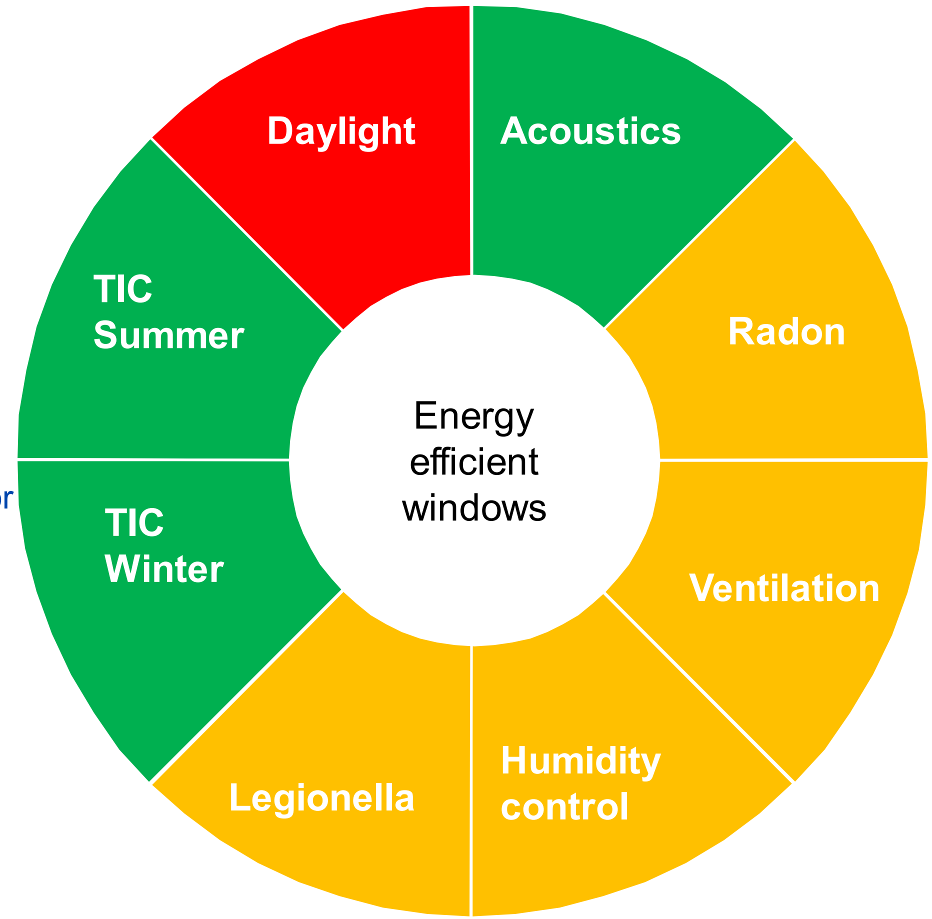
Indoor climate – qualitative assessments based on indicators of from Sweden Green Building Council

Miljöbyggnad 2.2.

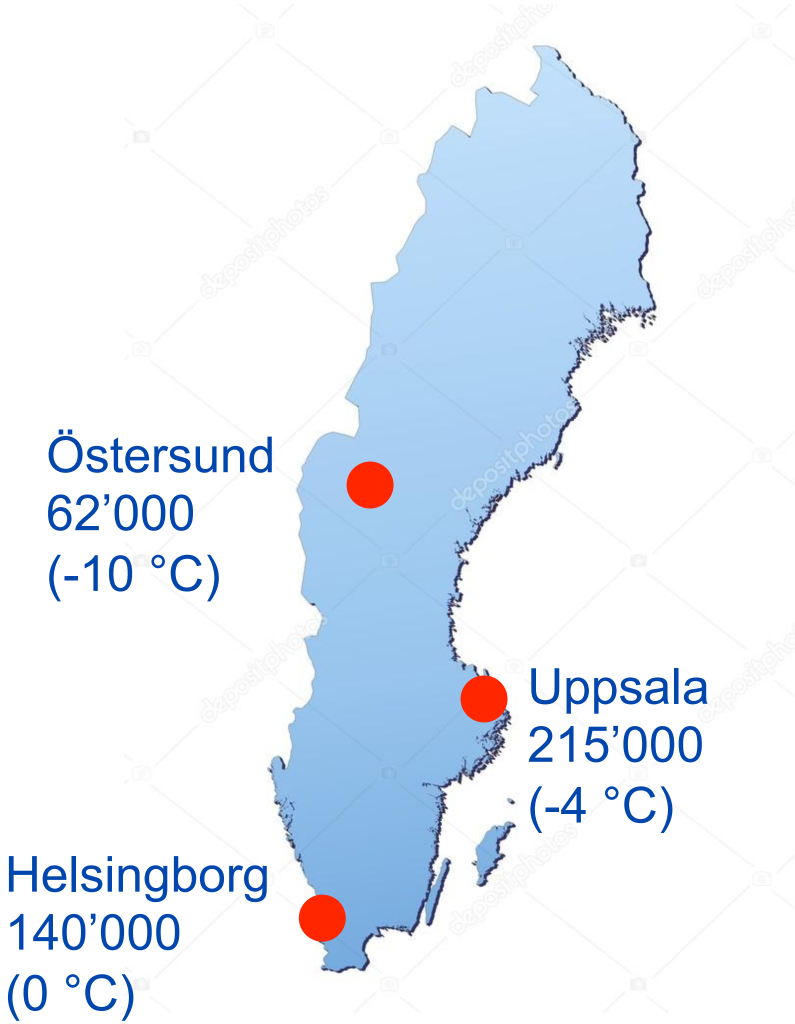
Thermal Indoor Climate (TIC)



Scale

Three case studies

- → **Mid-size municipalities**
- → **District heating dominates supply to multi-family houses (90%)**
- → **Significant part of multi-family housing stock built 1965-1975 – in need of renovation**
- → **Interviews with property owners both rental and co-operative**
- → **District heating utilities participated and provided data for analysis**



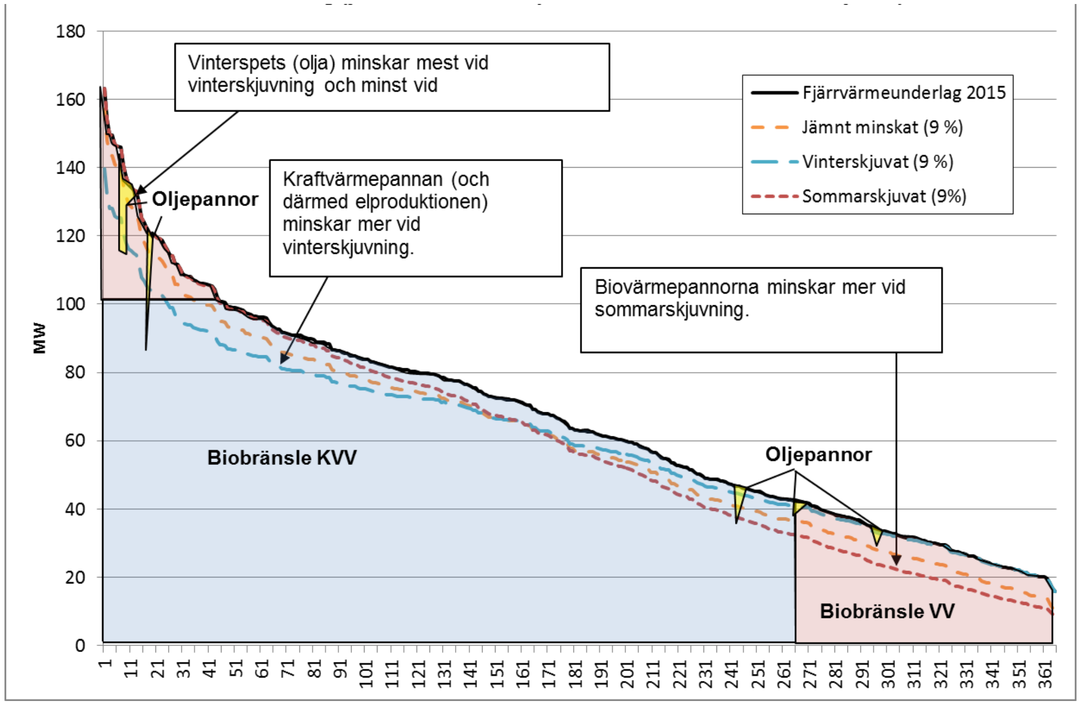
Average temperature in February in brackets

Consequences to Jämtkraft (Östersund) district heating

Assumption: Energy efficiency measures save 9 percent

Decline (GWh)	Even	Winter	Summer
Co-generation (biomass)	43	50	367
Boiler (biomass)	18	13	24
Peak boiler (oil)	1,6	1,9	1,1
District heating (total)	**52**	**52**	**52**
Electricity	11	12	9

Environmental impact	Even	Winter	Summer
Reduction of CO_2 emission (tons CO_2-e) (electricity excluded)	1,440	1,560	1,290
Critical emission factor of CO_2-e (kg/MWh replacement electricity	65<X<89	0<X<65	X>99



Winter savings positive since fossil fuel use goes down. Saves money and the environment. But, negative due to loss in electricity generation.

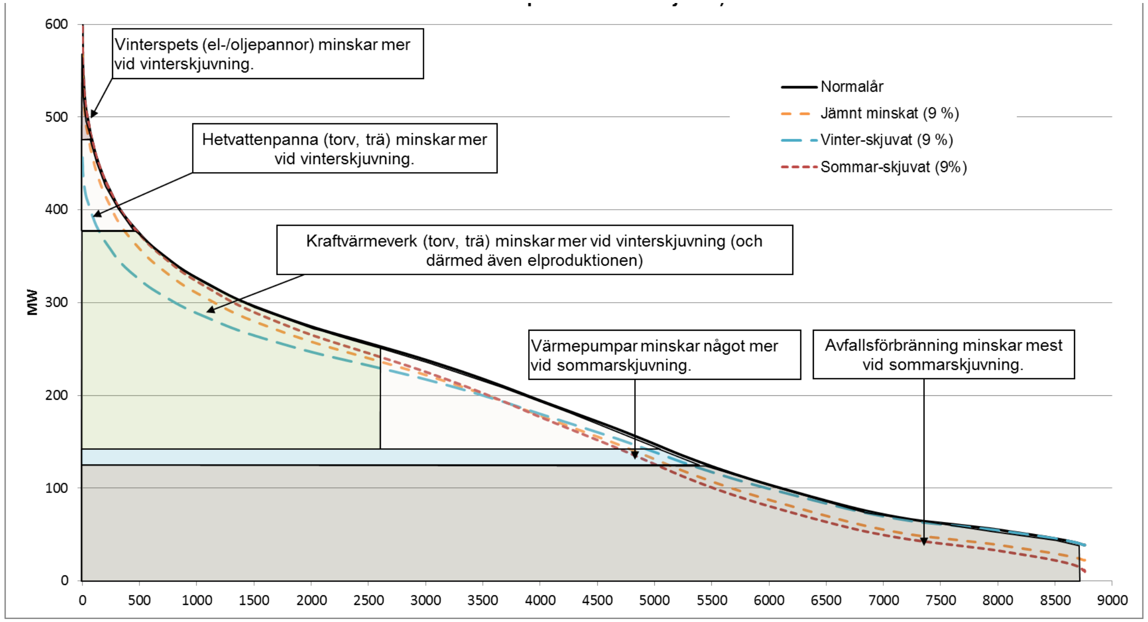
Which savings profile is best in terms of CO_2 depends on how we value climate impact

Consequences to Vattenfall värme (Uppsala) district heating

Assumption: Energy efficiency measures save 9 percent

Decline (GWh)	Even	Winter	Summer
Waste incineration	53	6	74
Heat pumps	9	4	13
Co-generation (peat biomass)	50	97	21
Heat boiler (peat, biomass)	47	66	43
Peak boiler (oil and electricity)	1	3	0
District heating (total)	**143**	**143**	**143**
Electricity	17	33	7

Environmental impact	Even	Winter	Summer
Reduction of CO_2 emission (tons CO_2-e) (electricity excluded)	28,400	38,500	23,200
Critical emission factor of CO_2-e (kg/MWh replacement electricity	-	0<X<594	X>594



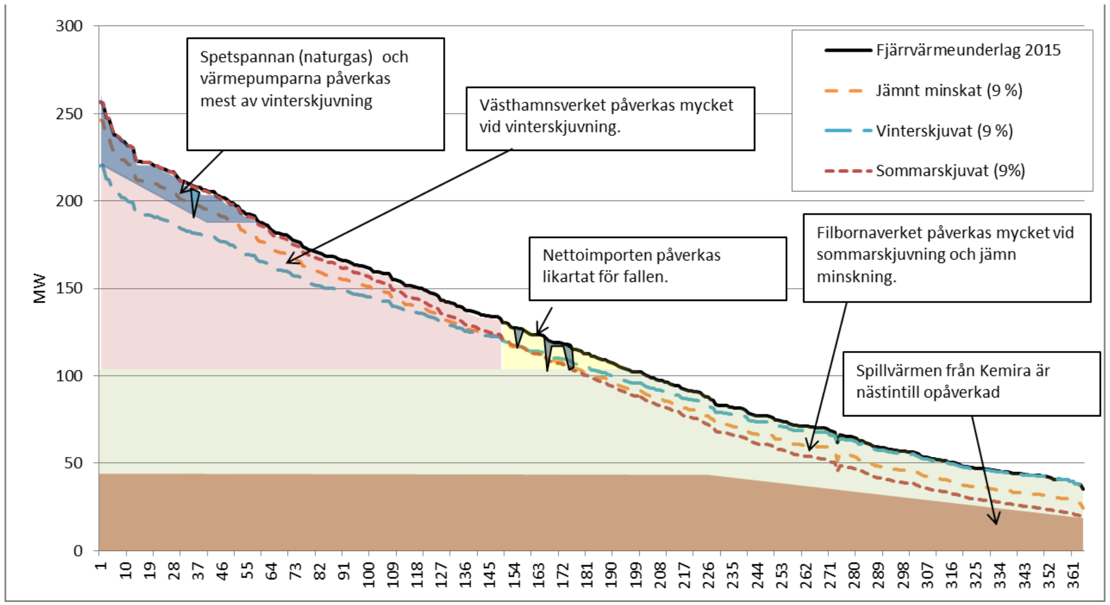
Winter skew performs the best

Consequences to Öresundskraft (Helsingborg) district heating

Assumption: Energy efficiency measures save 9 percent

Decline (GWh)	Even	Winter	Summer
Peak (natural gas)	0,3	0,7	0,1
Heat pumps (el)	17,1	26,2	7,9
Nettoimport (bio+waste)	15,3	11,7	14,3
Co-generation (Biomass)	31,5	66,7	10,4
Co-generation (waste)	51,9	14,2	79,1
Industrial heat Kemira	0,4	0,0	4,0
District heating (total)	**94**	**94**	**94**
Electricity (total)	22	26	22

Environmental impact	Even	Winter	Summer
Reduction of CO_2 emission (tons CO_2-e) (electricity excluded)	28,400	38,500	23,200
Critical emission factor of CO_2-e (kg/MWh replacement electricity	-	-	X>0



No clear results

Different savings profile have similar impact on loss in electricity

For CO_2 summer time savings perform the best

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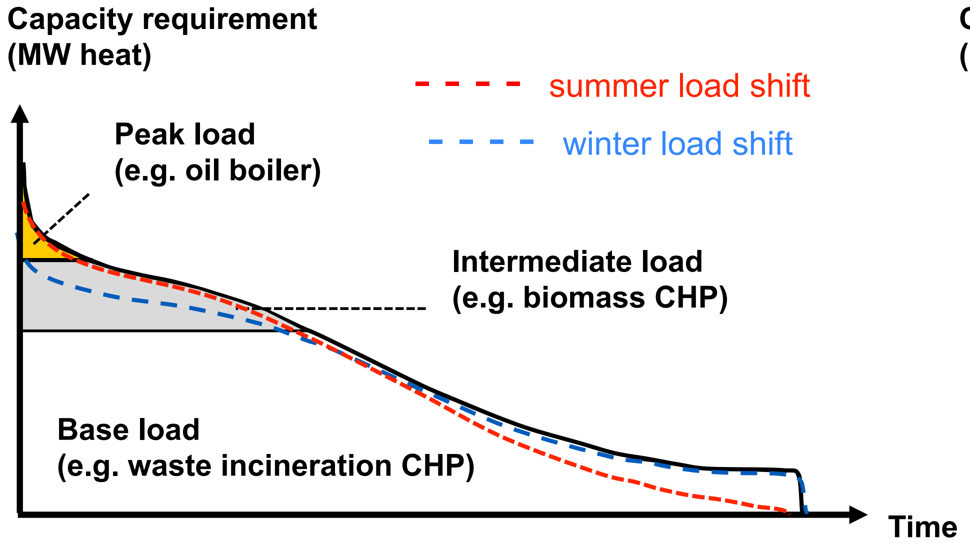
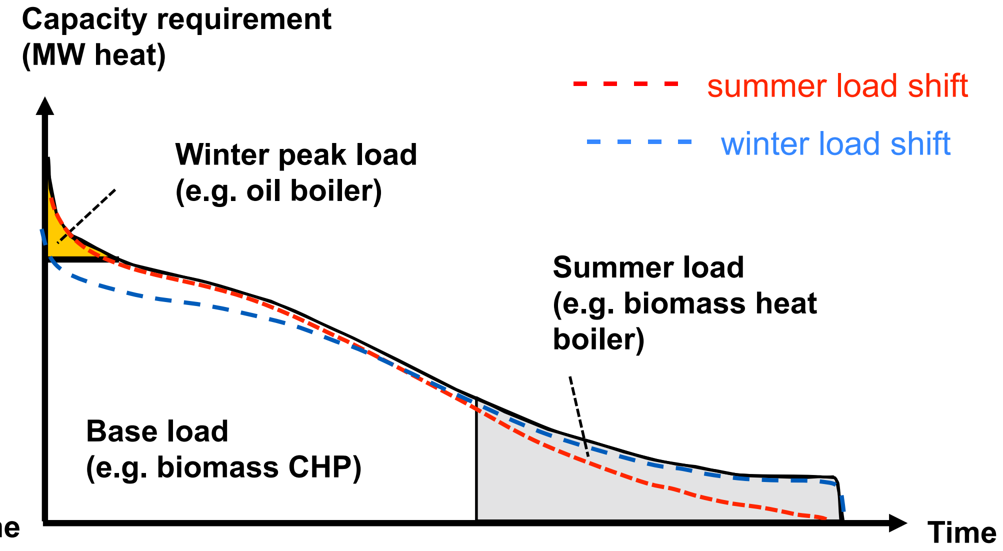
District heating system appropriate to Winter skewed energy savings (left) and Summer skewed (right)





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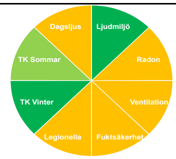
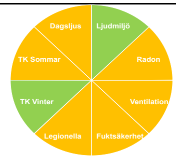
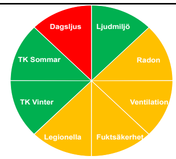
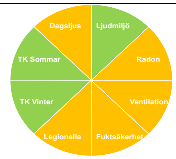
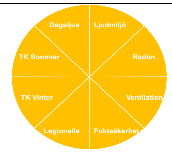
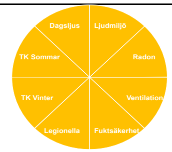
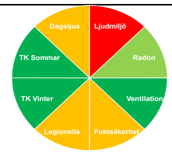
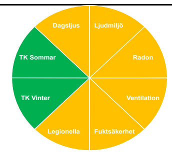
Impact on indoor climate and seasonal distribution

- → **Typically positive impact on indoor climate**
- → **Energy savings mostly captured during winter season**
- → **Package of measures needs to be implemented in order to reach 2020 goal of savings**

<table>
<tr><th>Indoor environment</th><th>Seasonal distribution of savings</th></tr>
<tr><td>
</td><td>Facade insulation
Winter skewed</td></tr>
<tr><td>
</td><td>Attic insulation
Winter skewed</td></tr>
<tr><td>
</td><td>Window replacement
Winter skewed</td></tr>
<tr><td>
</td><td>New front doors
Winter skewed</td></tr>
<tr><td>
</td><td>Individual metering and billing of hot water
Even distribution</td></tr>
<tr><td>
</td><td>High performance tap water mixers
Even distribution</td></tr>
<tr><td>
</td><td>Improved ventilation with heat recovery
Winter skewed</td></tr>
<tr><td>
</td><td>Heat load control
Winter skewed</td></tr>
</table>

Goal to 2020 multifamily apartments

	Östersund/ Krokom	**Uppsala/ Knivsta**	**Helsingborg /Ängelholm**
District heat to multifamily housing (share of supply)	49%	47%	55%
Savings 2020 goal Gwh/year	52	143	94
Savings multifamily housing GWh/ year	**25**	**67**	**52**
Apartments in need of renovation	7,200	16,900	15,300
Total energy demand	72	169	153
Energy savings 25%, GWh/year	18	42	38
Energy savings 40%, GWh/year	**29**	**68**	**61**

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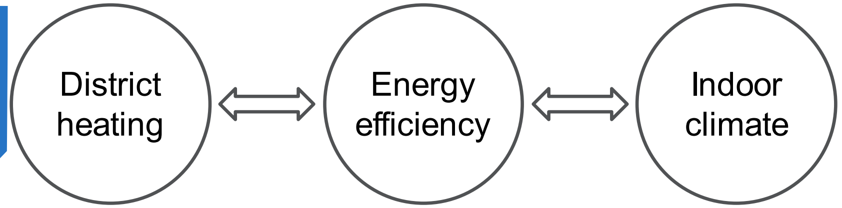
Linkages between actors



→ **Municipal housing company representatives**

- No contacts with energy utility prior to investment.
  - “The choice of measures is decided on by the engineering department”
- Savings calculations are based on simplified assumptions. Only one interviewee reports use of heating tariff information as decision support.
- Generally little tenant involvement, but there are exceptions.

→ **Housing co-operatives**

- Low level of interest in energy efficiency measures (about 10-15 percent)
- ”Tenants” hesitant to accept additional investment costs because there is a direct link between monthly fee to the co-operative and selling price of apartment

→ **Energy utilities**

- There is little or no incentive to help customers to carry out energy efficiency measures
- Revenue comes from selling kWh

Linkages in terms of costs and benefits

	Energy utilities	Property owners	Tenants
Monetary costs	Lower revenues Heat generation cost?	Investment costs Capital costs Higher electricity bills	Adjustment of fee Adjustment of rent?
Monetary benefits	Heat generation cost?	Lower heat/hot water bills Property value? Adjustment of fee Adjustment of rent?	
Non-monetary costs	Potential decease in customer loyalty for slow adjustment of heat tariffs	(Lack of knowledge; housing co-operatives)	
Non-monetary benefits	Customer satisfaction Environmental performance	Environmental performance Less complaints	Indoor environment quality

Conclusions and recommendations

- → Energy efficiency measures most often lead to winter time savings and the implications on indoor environments typically are positive.
- → Generally energy savings captured during the winter are more attractive, but not always.

- → Lack of communication – generally no involvement of the energy utility. Tariffs provide incentives, but are too complex for property owners.

- → **Stakeholder participation can create synergies.**
  - energy utilities can work with their customers to avoid the burden of measures that will have a significant negative impact on district heating system efficiency
  - restructuring company operations to include the implementation of energy-efficiency measures

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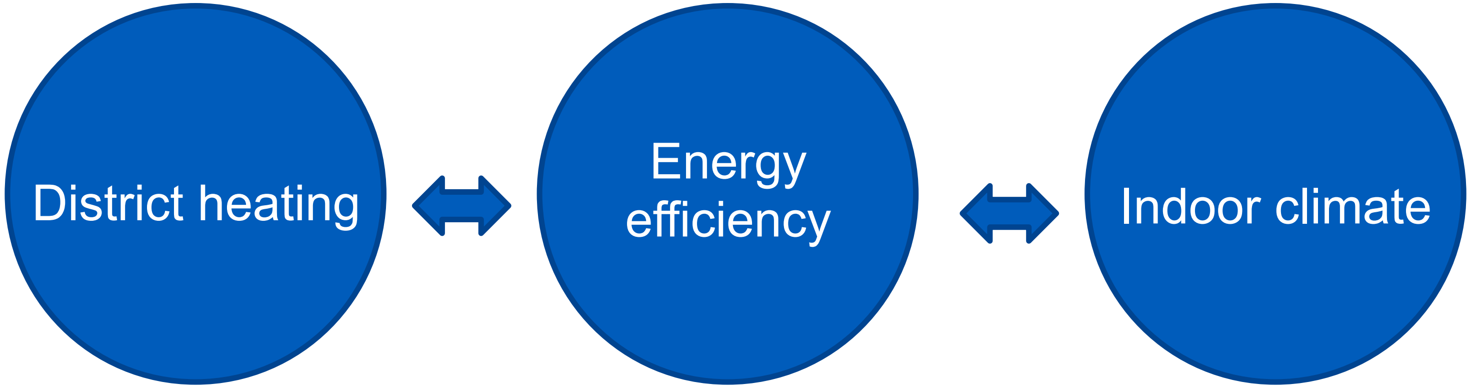
Thank you for your attention!

Questions?



See paper 2-036-17
Or report in Swedish

Sirje Pädam Agneta Persson Ola Larsson Oskar Kvarnström

Report in Swedish available at: https://energiforskmedia.blob.core.windows.net/media/21253/samband-mellan-innemiljo-energieffektivisering-och-fjarrvarmeproduktion-energiforskrapport-2016-305.pdf