

Energy Demand Model and energy efficiency improvements

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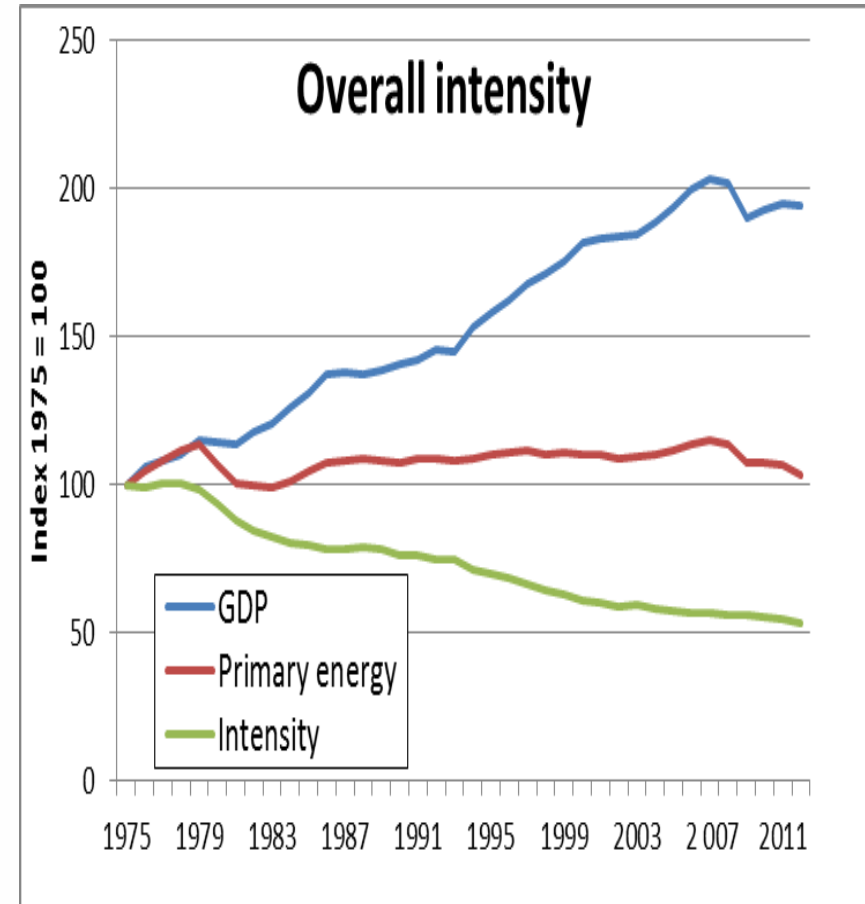
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Outline

1. Energy efficiency improvements in Denmark
 - Very short
2. Energy Demand Model
 - Used for long-term energy system scenarios

EE in Denmark - overview

- Strong EE improvements
- De-coupling energy consumption and economic growth
- Also under the actual economic crises
- Long-term stable policy framework
- Combination of several policies and measure

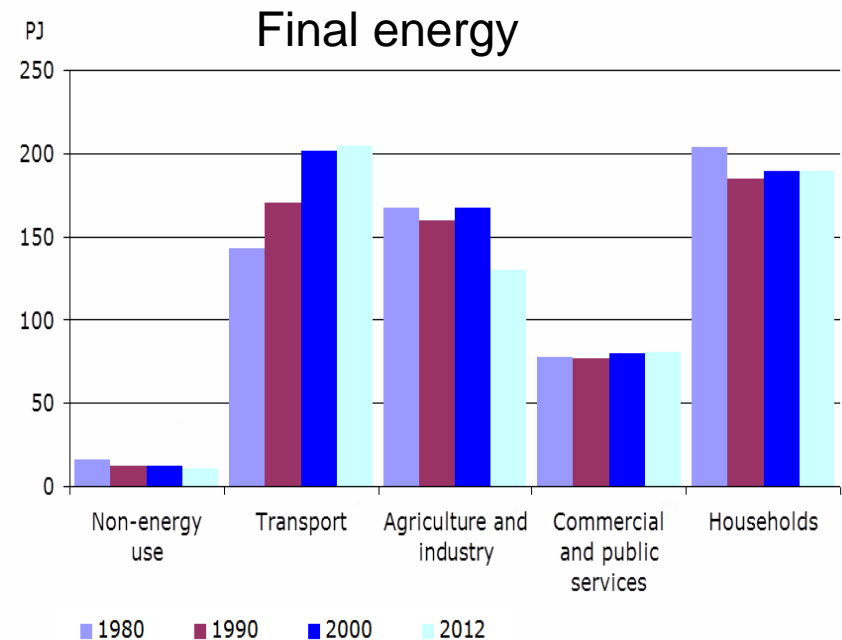


Energy efficiency has delivered

- The de-coupling is linked to increased energy efficiency
- End-use efficiency
 - Better insulation of buildings
 - More efficient appliances etc.
 - Higher efficiency in industries
- Efficiency of energy supply
 - Especially increased use of combined heat and power production – CHP
 - But also more efficient power plants and individual boilers

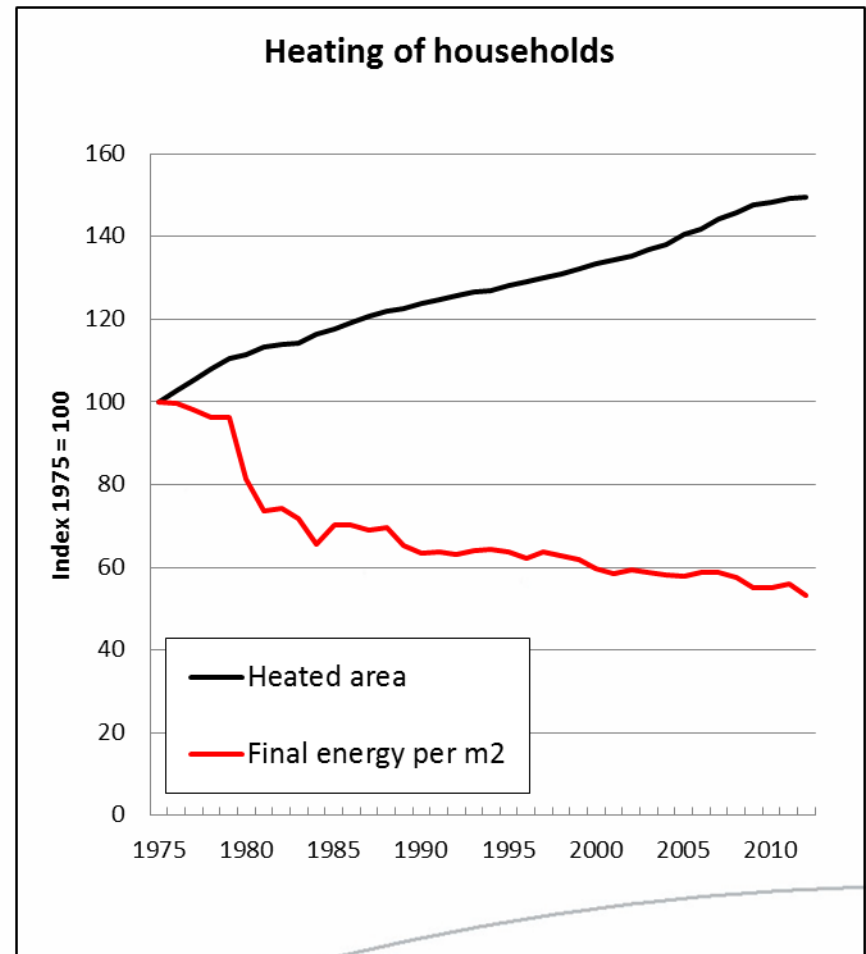
Strong end-use EE improvements

- High economic growth – more energy services
- Stable consumption
 - Not transport
- Combination of measures has delivered
 - Economic incentives- tax on energy, etc.
 - Regulation – building codes etc.
 - Information, awareness, education, etc.



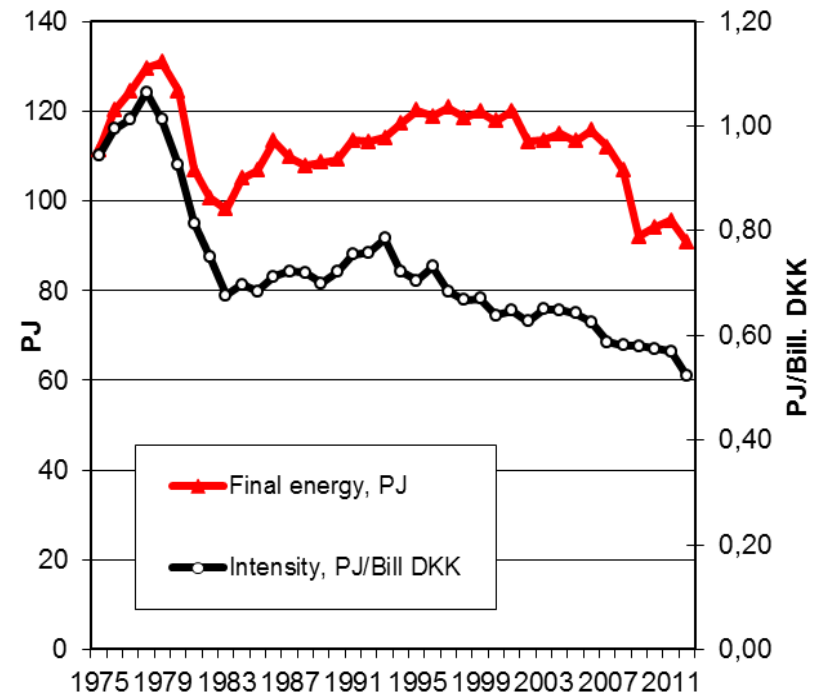
Buildings: Big saving over the last 35 years

- 45 pct. lower consumption per m²
 - Very strong improvement from 1979 to 1984
- But almost 40% of energy consumption still in buildings
 - Still a big potential
 - In Denmark and global
- Measures are needed



High efficiency improvement in industry

- CO2-packages in 1993 and 1996
 - CO2-tax
 - Voluntary agreements scheme
 - Subsidy scheme
- Energy efficiency obligation for energy distributors
 - Strong focus on industry



Decrease in intensity:

1975-2012: 1,5 % p.a.

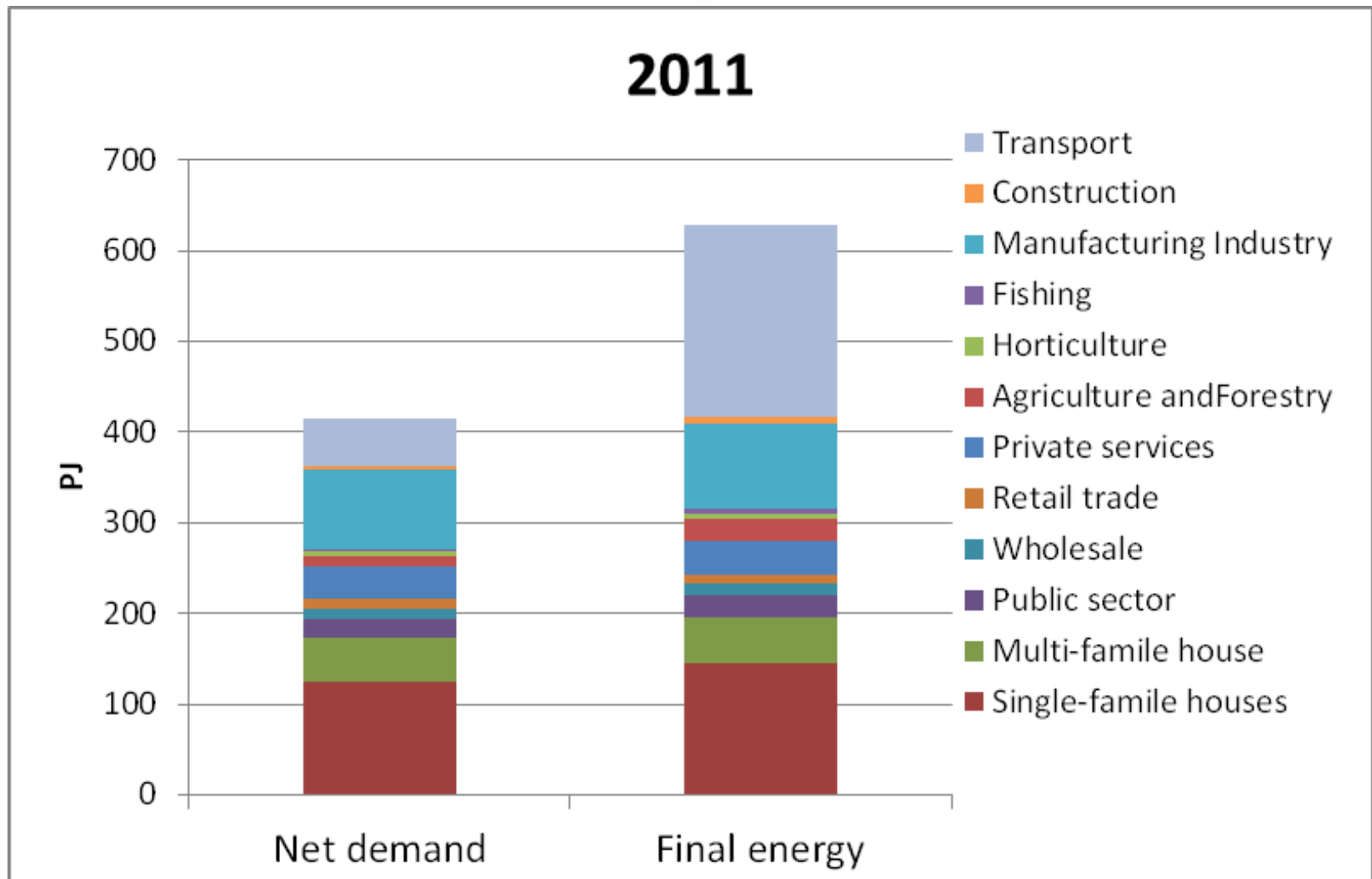
1994-2012: 2,1 % p.a.

Energy Demand Model

Energy Demand Model

- The demand side of our 2050 energy scenarios
 - Can the Danish energy system be based on 100% renewable?
- Very simple but also robust model
 - Useful for long-term scenarios – calculation for 2035 and 2050
 - Not for short and medium term forecast
- Main principle:
$$\text{EnergyDemand}(2050) = \text{EnergyDemand}(2011) * \text{growth energy services} * \text{energy efficiency}$$

Net energy demand



Energy quality

- Temperature requirements in industrial processes
- Relevant categories for transport

Net demand, 2011 PJ	Cars	Light trucks	Trucks Tractors	Busses	MC/knal Etc	Flights	Rail	Ships	Proces heat						Individual heating	Distric heating	Electricity	Total					
									<50 °C	50-75 °C	75-100 °C	100-150 °C	150-200 °C	>200 °C									
Single-famile houses					0,19									69,09	32,33	22,38	123,99						
Multi-famile house														5,65	33,91	8,92	48,49						
Public sector														2,99	9,87	8,59	21,44						
Wholesale		0,05				0,64	0,13			0,13				1,27	4,12	5,22	11,57						
Retail trade						0,05	0,09			0,09				1,05	2,75	6,23	10,26						
Private services		0,04				0,56	1,14			0,99				8,29	12,27	13,23	36,52						
Agriculture andForestry			2,96											0,15		4,21	10,83						
Horticulture			0,03				3,44	0,38						0,03		0,81	4,70						
Fishing									1,96							0,14	2,11						
Manufacturing Industry			0,10											9,66	4,86	27,86	87,96						
Construction			0,82													1,30	3,57						
Transport	17,84	7,15	7,39	2,16	0,16	13,38	2,32	2,24									52,64						
alt	17,84	7,25	11,30	2,16	0,35	13,38	2,32	4,20						2,49	7,30	8,29	14,92	4,21	20,90	98,17	100,12	98,90	414,09

- Split between space heating and hot tap water could also be relevant

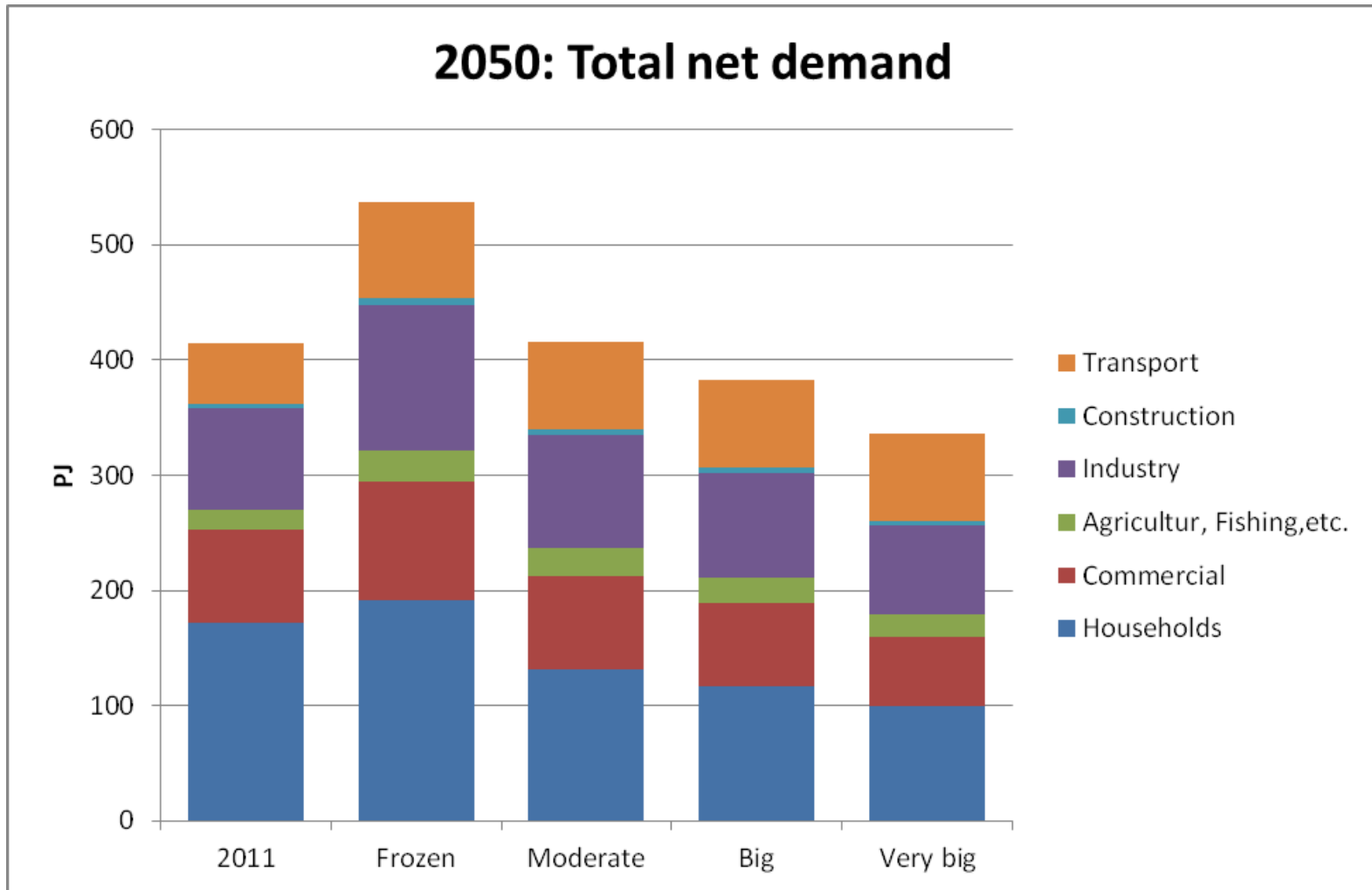
Energy services

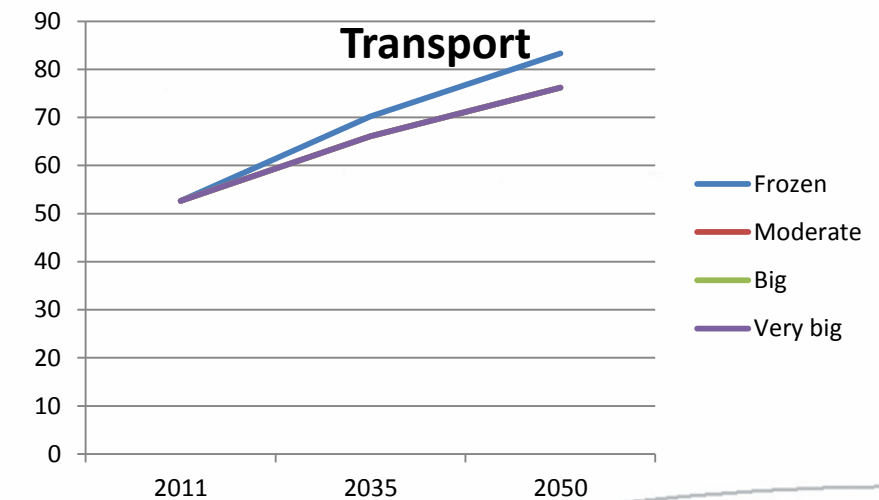
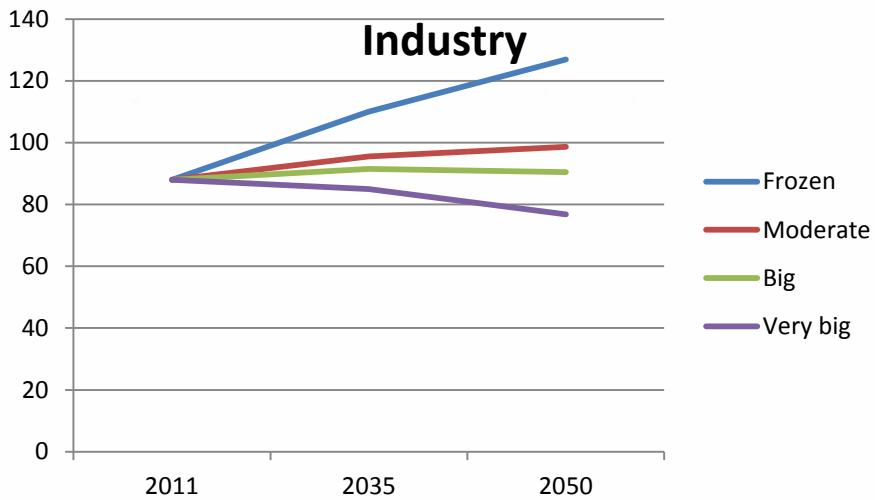
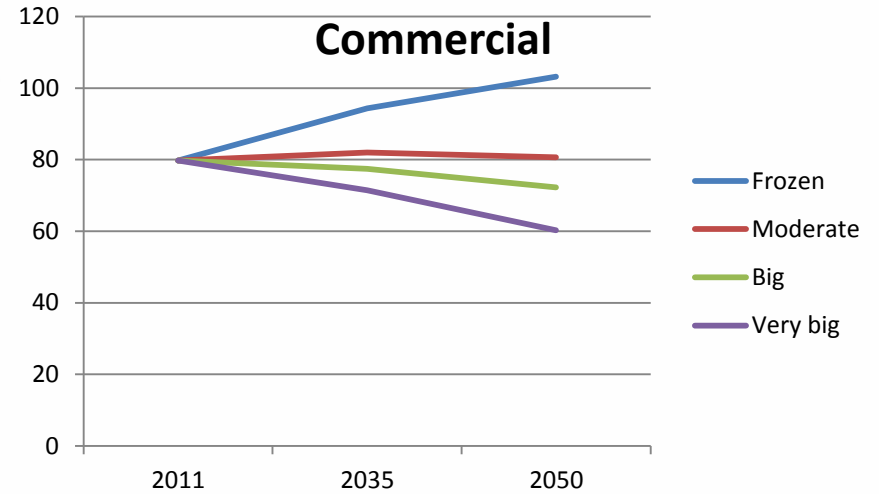
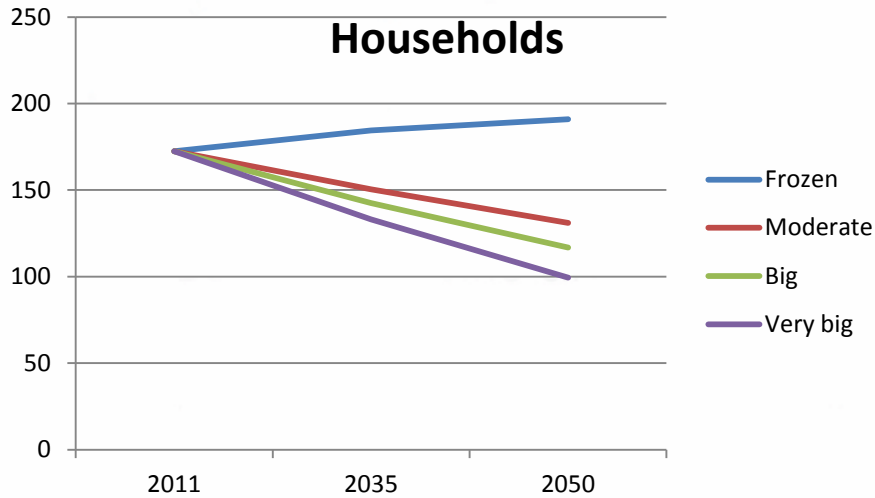
- Buildings:
 - Heated area - For households based on population, average family size, and average size of new homes
 - For commercial sector simple forecast based on historical data
- Appliances, etc.:
 - Split in groups with different drivers (number of m2, population, private consumption)
- Industry, etc:
 - Economic growth – value added
- Same assumptions in all scenarios

Energy efficiency improvements

	Moderate		Big		Very big	
	2035	2050	2035	2050	2035	2050
Households:						
Single-family house	15%	26%	20%	34%	25%	45%
Multi-family house	15%	26%	20%	34%	25%	45%
Lighting	20%	34%	24%	42%	30%	53%
Appliances (ex)	21%	36%	30%	53%	35%	62%
Commercial						
Buildings	13%	21%	18%	31%	24%	42%
Lighting	20%	34%	24%	42%	30%	53%
Appliances (ex)	13%	21%	17%	29%	25%	45%
Industry etc.						
Process heat	13%	21%	17%	29%	23%	39%
Space heating	13%	21%	17%	29%	24%	42%
Electricity	14%	24%	17%	29%	23%	39%

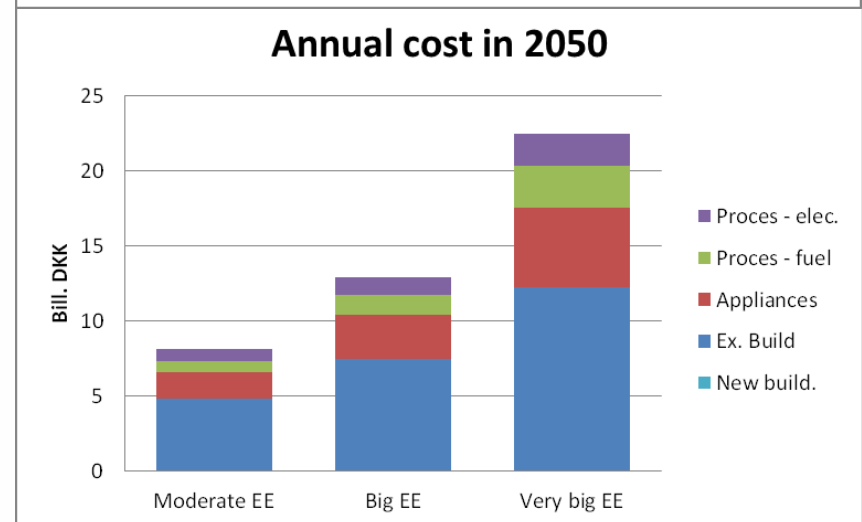
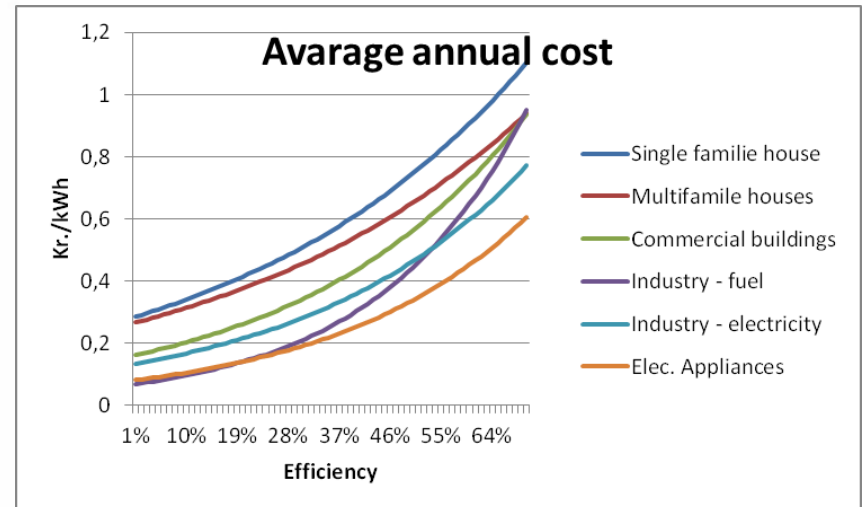
Energy demand 2050





Cost related to EE improvements

- Investments calculated as an annual cost
 - Lifetime
 - 5% discount rate
- Data from reports and studies on saving potentials and cost
- Extra investments compared to normal replacement, etc.



Suggestion for improvements

- Alternatives for the development of energy services
 - Economic growth can be a bad indicator in the long-term
 - Split of industries in sub-groups
 - Better data for the investment cost
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- Thank you for your attention
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