Heat conservation incentives and policies for 4th generation district heating systems

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Optimizing the balance between heat supply and heat demand

In a 100% renewable energy based system, we are in a basically new situation, where we are optimizing the balance between investments in renewable energy systems and in heat conservation.

Calculations show that the average optimal heat and hot water consumption level is around 70- 80 kWh/m2 heated area for older houses, and 55 kWh/m2 for new built houses.

From the calculations in it is remarkable that the heat supply costs per kWh are decreasing when reducing the consumption per m2 from 120 kWh to 60- 80 kWh.

Reference: Lund H, Thellufsen J.Z, Aggerholm S, Wichtten K.B, Nielsen S, Mathiesen B.V, et al.

Heat Saving Strategies in Sustainable Smart Energy Systems. International journal of Sustainable Energy Planning and Management 2014;4:3–16. doi:10.5278/ijsepm.2014.4.2.

Requirements to heat conservation

1. **Heat conservation should**	**2. Why these requirements?**
a. Be implemented in **the right/optimal amount.**	a. In order to establish an optimization between investments in supply and demand systems. (This is especially relevant in the present strategical change to 100% RE supply systems).
a. Be implemented **in right time.**	b. In order to avoid investments in oversized supply systems in a situation where heat conservations comes “to late”. (This is especially needed in the present situation with a strategical change of the energy supply system).
a. Supports low temperature systems.	c. To make it possible within the existing district heating pipe capacity to supply the needed heat with low temperature systems - and thus avoid new investments in district heating pipes. d. To support a high efficiency/COP of heat pumps powered with mainly wind power.

The energy system benefits of heat conservation

1. Reduced heat losses in the houses have two effects: Firstly that the spared district heat capacity makes it possible to satisfy the heating needs *with a lower water temperature,* secondly that the existing network has capacity to supply an *increased district heating area.*

2. The lower temperature makes it possible to use heat pumps in district heating systems with a high COP factor and thus a lower consumption of kWh electricity for a given amount of heat .
3. The lower supply temperature also results in *reduced losses* in the district heating network.
4. Integrating heat and power, increases the market for wind power and counterweights the ongoing merit order induced fall of wind power prices.This added value caused by integrating heat and electricity markets can be shared between the heat users and the wind power producers, both making heat cheaper, and wind power more profitable.

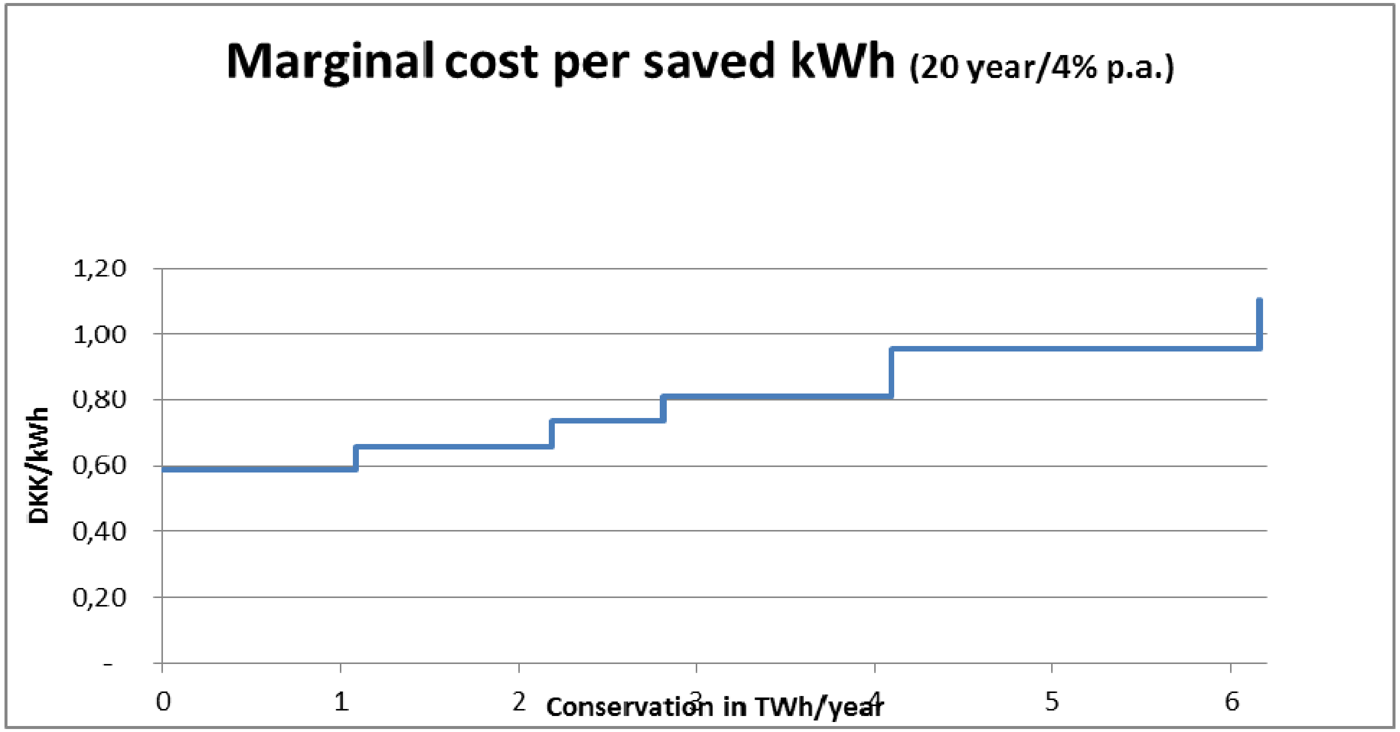
5. More low temperature heat sources can be used,etc.

The above effects are included in the EnergyPlan calculations and are reasons why the cost per supplied kWh may be reduced concurrently with a reduction of the amount of supplied kWh per m2 meter heating area.

Case: Costs of heat conservation in appartment buildings

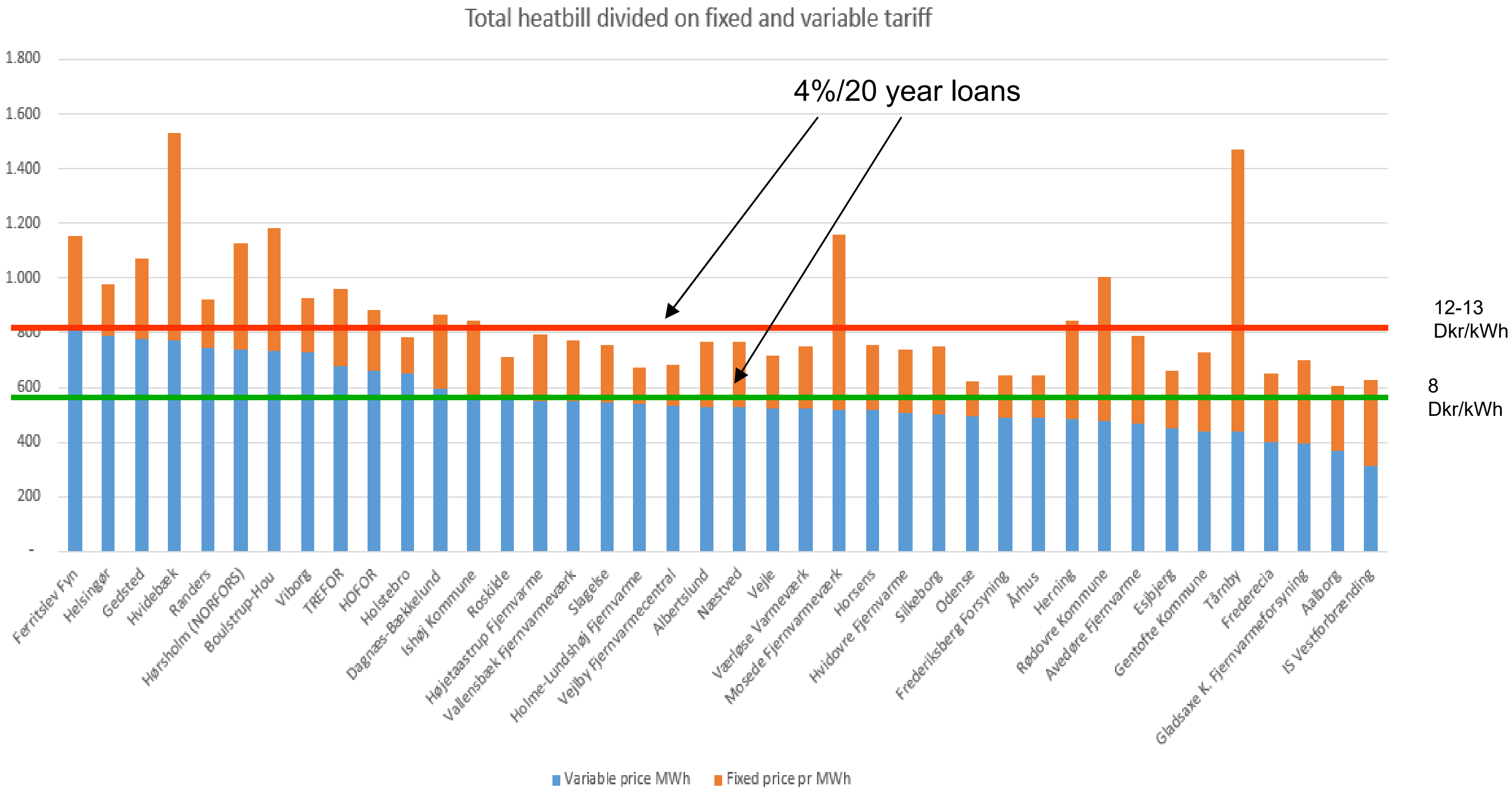
From year	1200	1850	1931	1951	1961	1973	1979	1999	2007	
To year	**1850**	**1930**	**1950**	**1960**	**1972**	**1978**	**1998**	**2006**	**2012**	**Total**
1. Area in 1000 m2	488	22.164	13.557	7.458	14.321	4.624	7.552	3.648	2.807	**76.623**
2. Present consumption in 1000 GWh/year	66.6	3.390	2.135	1.043	1.765	538	856	260	145	**10.199**
3. Consumption Scenario A: 1000 GWh/year	32	1.325	854	409	669	197	330	127	60	**4.003**
4.Total costs of moving to Scenario A Mill. kr.	870	45.410	24.335	10.785	19.726	5.453	8.945	2.850	1.540	**119.914**
5.Marginal costs of moving to scenario A costs Mill. kr.r.	522	26.833	14.088	6.343	9.863	2.726	4.210	1.068	684	**66.339**
6.Total investment costs linked to saving 1kWh/year	25	22	19	17	18	16	17	22	18	
7. Marginal investment cost for saving 1 kWh/year	15	13	11	10	9	8	8	8	8	

Marginal costs per kWh of heat conservation



Heat supply cost in some district heating areas distributed on fixed and variable tariff shares in DKr/ MWh.

(75m2 apartment with an annual heat and hot water consumption of 10 MWh)



Heat conservation incentives in different district heating companies

(Cost of heat conservation 10 Dkr for investment saving 1kWh/year in technical lifetime)

City	Present tariff incentives		100% variable tariff incentives		
	Business economy		Business economy		Socio economy
Loan period	20	20	20	20	40
Discount rate	4%	6%	4%	6%	2%
Tårnby	0,44	0,44	1,47	1,47	1,47
Rødovre	0,48	0,48	1,01	1,01	1,01
Hørsholm	0,74	0,74	1,13	1,13	1,13
Herning	0,49	0,49	0,85	0,85	0,85
Kolding	0,68	0,68	0,96	0,96	0,96
Frederecia	0,40	0,40	0,65	0,65	0,65
Silkeborg	0,50	0,50	0,75	0,75	0,75
Høje-Taastrup	0,55	0,55	0,80	0,80	0,80
Aalborg	0,37	0,37	0,61	0,61	0,61
Albertslund	0,53	0,53	0,77	0,77	0,77
Næstved	0,53	0,53	0,77	0,77	0,77
Horsens	0,52	0,52	0,75	0,75	0,75
Vallensbæk	0,55	0,55	0,77	0,77	0,77
København	0,66	0,66	0,88	0,88	0,88
Gladsaxe	0,40	0,40	0,70	0,70	0,70
Slagelse	0,54	0,54	0,76	0,76	0,76
Gentofte	0,44	0,44	0,73	0,73	0,73
Esjbjerg	0,45	0,45	0,66	0,66	0,66
Viborg	0,73	0,73	0,93	0,93	0,93
Vejle	0,53	0,53	0,72	0,72	0,72
Helsingør	0,79	0,79	0,98	0,98	0,98
Ishøj	0,57	0,57	0,85	0,85	0,85
Randers	0,75	0,75	0,92	0,92	0,92
Hvidovre	0,51	0,51	0,74	0,74	0,74
Århus	0,49	0,49	0,65	0,65	0,65
Frederiksberg	0,49	0,49	0,64	0,64	0,64
Roskilde	0,56	0,56	0,71	0,71	0,71
Holstebro	0,65	0,65	0,78	0,78	0,78
Odense	0,50	0,50	0,62	0,62	0,62
Køge	0,87	0,87	0,87	0,87	0,87

Read color means negative present value of investment.

Green color means positive present value of investment.

Does it pay for a owner of apartment buildings to invest in heat conservation?

a. The **"Total economy neutrality"** situation. First of all any landlord has the right increase the rent in any rented house equivalent to the reduction in the energy bill caused by a given investment in energy conservation. As shown before, at the present incentive structure it does not pay to invest in energy conservation.

b. The **free rent** situation: In houses build after 1991 the rent is set in a free process between landlord and the tenant. Here the landlord is free to set the rent, but may lose competitiveness due to the present bad energy conservation incentive structure.

Conclusion: it does not pay for the landlord to invest in heat conservation.

Does subsidies change the incentive situation?

As we have seen in former slides, the investment costs are between 8 Dkr and 15 Dkr for an investment that annually saves 1 kWh in the technical lifetime of the investment. It is possible to sell the energy conservation right of this investment to the large energy companies for a price of 0,3-0,6 Dkr/kWh

0,3-0,6 Dkr/kWh is a subsidy of between 2% and 5% of these investment costs, from which furthermore should be subtracted the consultancy or transaction costs of getting the subsidy. In subsidy per kWh it amounts to between 1 and 2 øre/kWh.

This subsidy element is insignificant and does not change the incentive situation.

Does technical building renovation codes influence the heat conservation incentive?

It can be claimed that the economic incentives at the house owner and tenant level are not that important, as ambitious building renovation codes could assure that over time all parts in the house will be replaced with parts of a high energy quality.

But it is possible to repair instead of renovate buildings. And if a landowner repairs a roof, windows etc., the repair does not have to live up to building codes. And if a landowner make a renovation that does not pay, he/she will have to pay the present value deficit. So it may pay to repair instead of renovate and thus prolong the lifetime of an investment considerable. This may mean too late and too low reduction in energy consumption.

The conclusion on our preliminary analysis is that the building code implementation linked to renovation, due to lack of economic incentives, will have low impact, as renovation may be replaced by repair. The effects on energy conservation of the building code requirements therefore may come too late and be far below 20-30% of heat and hot water conservation. (This has to be analysed and discussed in dept!)

Conclusion regarding present heat conservation incentives.

Will the energy conservation measures be *implemented* *in right time, in the right way and in the right amount?*

The answers to these 3 questions are from the preceeding analysis:

no, no and no, unless new policy measures are implemented.

In the following we will just mention three policy reforms that could improve the incentive situation, and start turning the answers on the above 3 questions to a yes, yes and yes.

Three policy suggestions

a. Establish a situation with 100% variable tariffs, and

b. Give public guarantee making 30 year 2% loans possible for renovation purposes.

c. Combine this with a certified energy consultancy program as the basis for public guaranty and long time low interest loans (b)

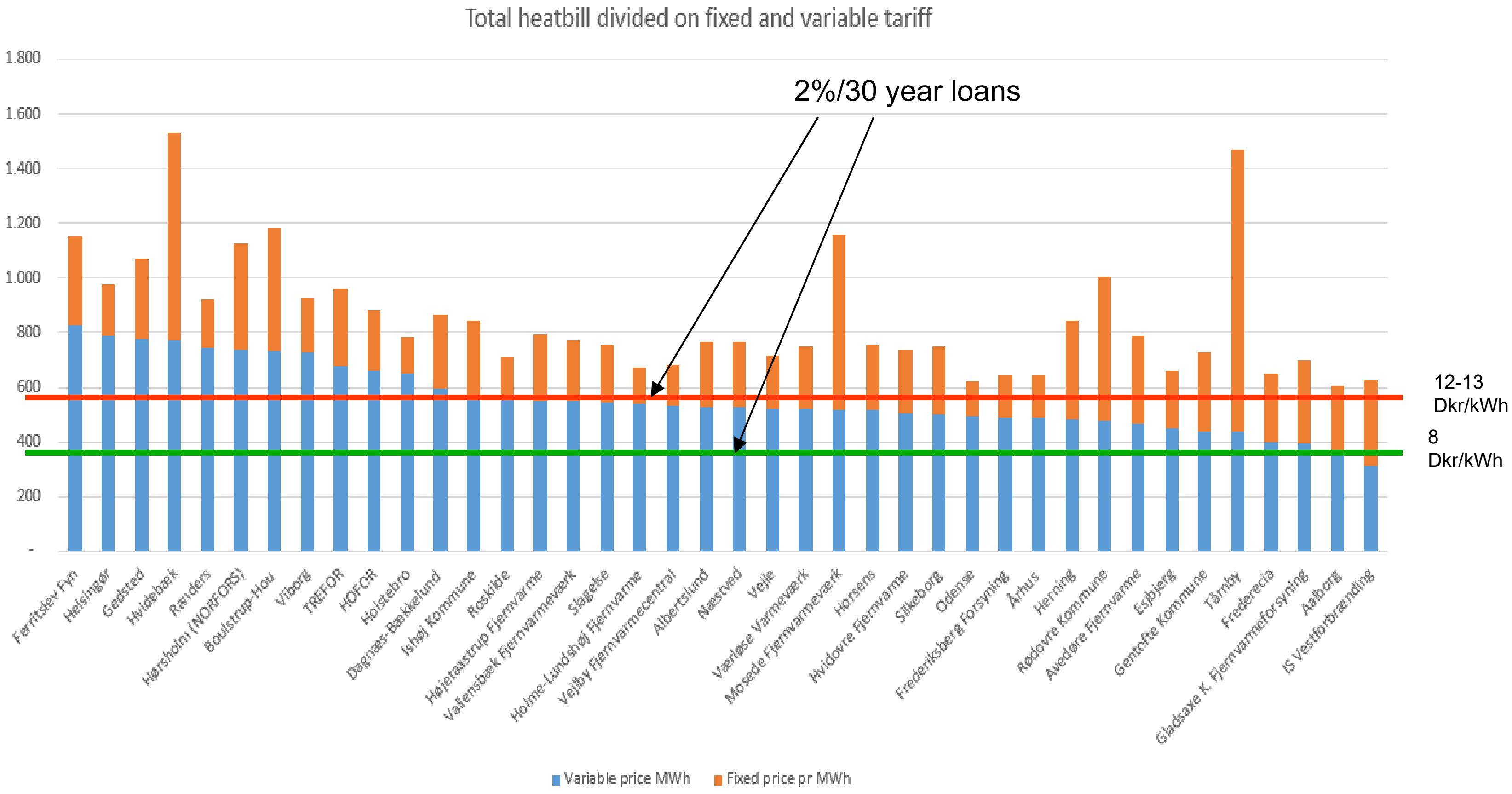
From sector based to energy system based heat tariffs

Range of investment horizon	3rd generation district heating	4rd generation district heating
Time range: Time horizon and supply system change	Fossil fuel sector based	Strategic change to renewable energy based supply system
Space range of investment	Sector based heat supply	Integrated smart energy system
Resulting tariff system	3rd generation tariff system based on the short run marginal cost structure in existing supply systems	4rd generation tariff system based on long run marginal costs in a smart energy system structure

From tariffs based on present heat sector cost structure to tariffs based on future system cost structure and the long term marginal costs.

Heat supply cost in some district heating areas distributed on fixed and variable tariff shares in DKr/ MWh.

(75m2 apartment with an annual heat and hot water consumption of 10 MWh)



Heat conservation incentives after policy reforms

City	Present tariff incentives		100% variable tariff incentives		
	Business economy		Business economy		Socio economy
Loan period	20	20	30	30	40
Discount rate	4%	6%	2%	4%	2%
Tårnby	0,44	0,44	1,47	1,47	1,47
Rødovre	0,48	0,48	1,01	1,01	1,01
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The policy reform results in positive present values in all district heating areas.

Specific heat incentives in different district heating areas.

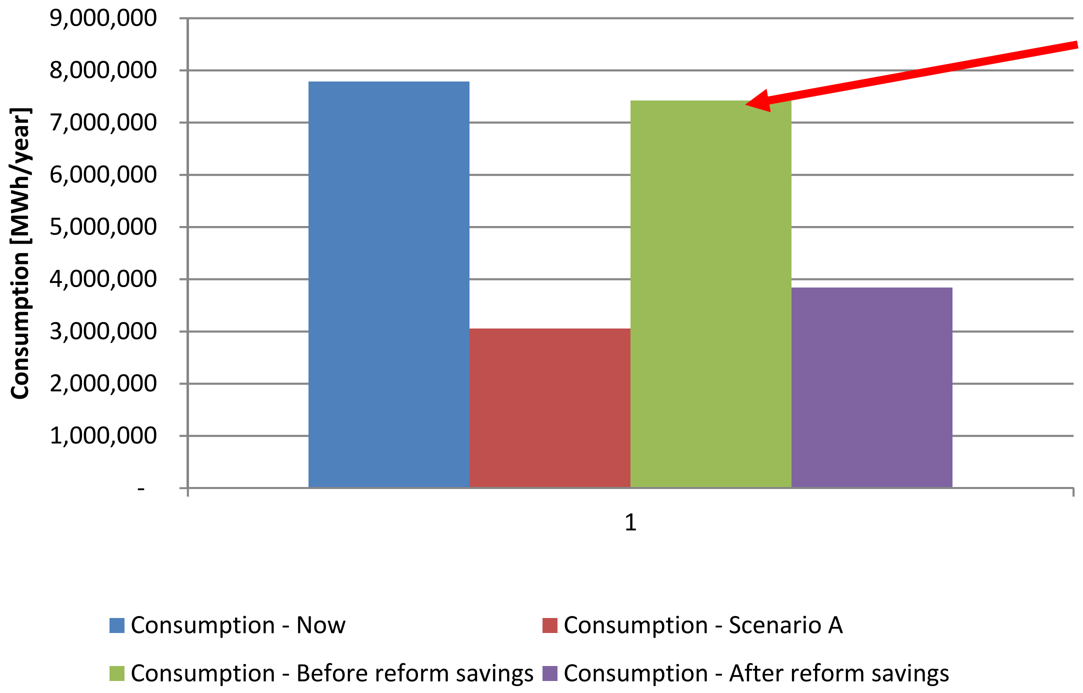
City	Consumption MWh/year		Heat savings with present heat tariffs Business economy 20 years			Heat savings with 100% variable tariffs Business economy 30 years				Socio economy
	Current	Scenario A	4%	Savings 4%	6%	2%	4%	MWh/year	6%	4%
Albertslund	40.799	15.518	0%	-	0%	100%	100%	25.281	92%	100%
Esbjerg	192.181	74.850	0%	-	0%	100%	76%	88.949	42%	100%
Fredericia	100.149	38.859	0%	-	0%	99%	73%	44.794	20%	73%
Frederiksberg	651.746	255.225	0%	-	0%	100%	41%	162.727	11%	41%
Gentofte	252.037	99.827	0%	-	0%	100%	65%	98.469	10%	100%
Gladsaxe	152.192	59.404	0%	-	0%	100%	96%	89.163	44%	100%
Helsingør	117.607	45.895	51%	36.604	0%	100%	100%	71.712	98%	100%
Herning	107.572	42.303	0%	-	0%	100%	100%	65.269	89%	100%
Holstebro	68.925	26.861	24%	10.105	0%	100%	100%	42.033	70%	100%
Horsens	124.668	49.279	0%	-	0%	100%	99%	74.522	40%	99%
Hvidovre	123.406	47.927	0%	-	0%	100%	98%	74.326	75%	100%
Høje-Taastrup	85.188	32.465	0%	-	0%	100%	100%	52.687	93%	100%
Hørsholm	45.251	17.530	27%	7.435	0%	100%	100%	27.721	100%	100%
Ishøj	52.297	19.865	0%	-	0%	100%	100%	32.432	100%	100%
Kolding	121.377	47.881	39%	28.957	0%	100%	100%	73.496	99%	100%
København	2.801.692	1.106.005	9%	158.368	0%	100%	100%	1.695.687	46%	100%
Køge	70.323	27.357	88%	37.935	71%	100%	100%	42.966	88%	100%
Næstved	91.443	35.780	0%	-	0%	100%	99%	55.185	62%	100%
Odense	367.716	144.380	0%	-	0%	99%	46%	103.136	17%	72%
Randers	187.738	73.586	47%	53.310	8%	100%	100%	114.152	74%	100%
Roskilde	122.610	47.801	0%	-	0%	100%	83%	62.370	56%	100%
Rødovre	88.310	34.432	0%	-	0%	100%	100%	53.878	100%	100%
Silkeborg	93.550	37.210	0%	-	0%	100%	80%	45.183	59%	100%
Slagelse	140.376	54.673	0%	-	0%	100%	98%	84.399	56%	98%
Tårnby	91.942	35.953	0%	-	0%	100%	100%	55.989	100%	100%
Vallensbæk	19.313	7.467	0%	-	0%	100%	100%	11.846	99%	100%
Vejle	159.334	62.567	0%	-	0%	100%	69%	66.965	38%	100%
Viborg	97.586	38.191	46%	27.065	28%	100%	100%	59.395	71%	100%
Aalborg	444.301	174.640	0%	-	0%	100%	49%	131.069	22%	74%
Aarhus	771.708	302.094	0%	-	0%	100%	73%	341.993	17%	73%
Total [MWh]	**7.783.337**	**3.055.825**		**359.780**				**3.947.793**		

Heat conservation in MWh/year before reform with positive investment present value.

Heat conservation in MWh/year after reform with positive investment present value

Energy consumption for heating and hot water before and after reform.

(Under the assumption that heat conservation is implemented, when the present value is positive, and not implemented if the present value is negative)



Consumption if only investments with positive present value are implemented. The savings are higher when the renovation building codes are included. How much is difficult to say.

Requirements to heat conservation again-

1. Heat conservation should	2. Why these requirements?
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a. Supports low temperature systems.	c. To make it possible within the existing district heating pipe capacity to supply the needed heat with low temperature systems - and thus minimize investments in new district heating pipes. d. To support a high efficiency/COP of heat pumps powered with mainly wind power.

Thank you!