The change from fossil fuel- to Renewable Energy based District Heating Systems

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1. Type of change

Interesting/difficult change

a. In Denmark fossil fuel based district heating is the “heat side” of cogeneration.

   This is a very efficient system, but not efficient enough for the future.

b. Therefore the fossil fuels have to be replaced by conservation and renewable energy.

c. This change is interesting and difficult because we have to get rid of a very efficient fossil fuel technology.

   That to some extent places us in a fossil fuel “lock in” situation. (Marginally one GJ coal produces 2.5 GJ of heat at the consumer level! But linked to fossil fuel electricity production)

The general question of institutional “lock in”.

a. Fossil fuel based District heating is one example described here.

b. CCS is another upcoming example. Once build, it has very low marginal costs. Needs to be baseload and thus hinders fluctuating energy sources.

c. Nuclear power is an established example with low short run marginal costs and the need of being baseload.

d. Large vertical integrated companies are “institutional” examples where the ownership structure produces very low short run marginal costs. And thus strong institutional path dependency.

e. May be energy efficient fossil fuel cars versus renewable energy based electric cars.

In general it therefore is not enough to have CO2 taxes, CO2 quotas etc. Direct specific politics must also influence the concrete tariff-, barriers to entry- , and ownership constructions.

Characteristics of the technical scenarios

1. Reduction of heat demand 25-50%.
2. Expansion of district heating area from 47% to 60% of heat market.
3. Change to renewable energy supply systems based on wind-, solar-,biomass-, geothermal sources
4. Establish heat systems that are able to integrate fluctuating renewable energy sources. (Low temperature,heat storage,heat pumps, etc.)

The dilemma

Our technical Scenarios tells that:

a. We should get rid of fossil fuel based supply in the district heating network.

b. In this process we should reduce heat consumption by up to 50%.

   But this is not at all economically in todays market construction, and will never happen automatically.

   How can we make it economically?

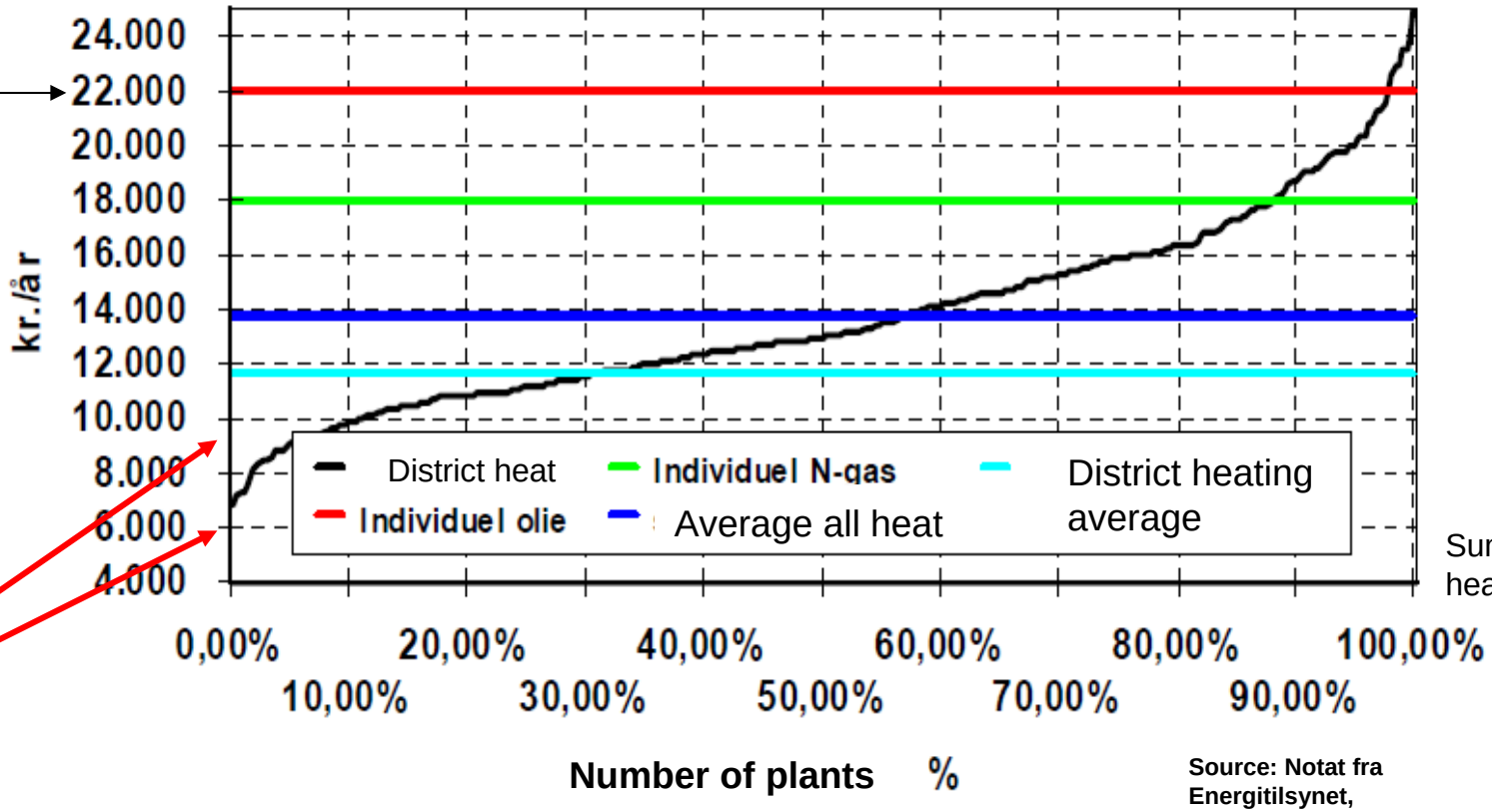
2. The present tariff situation

It is a general conclusion that a concrete and specific institutional analysis is necessary.

Heat prices incl. VAT 2006/2007.

(130 m2 house with 18.1 MWh in annual consumption.)

2.900 Euro

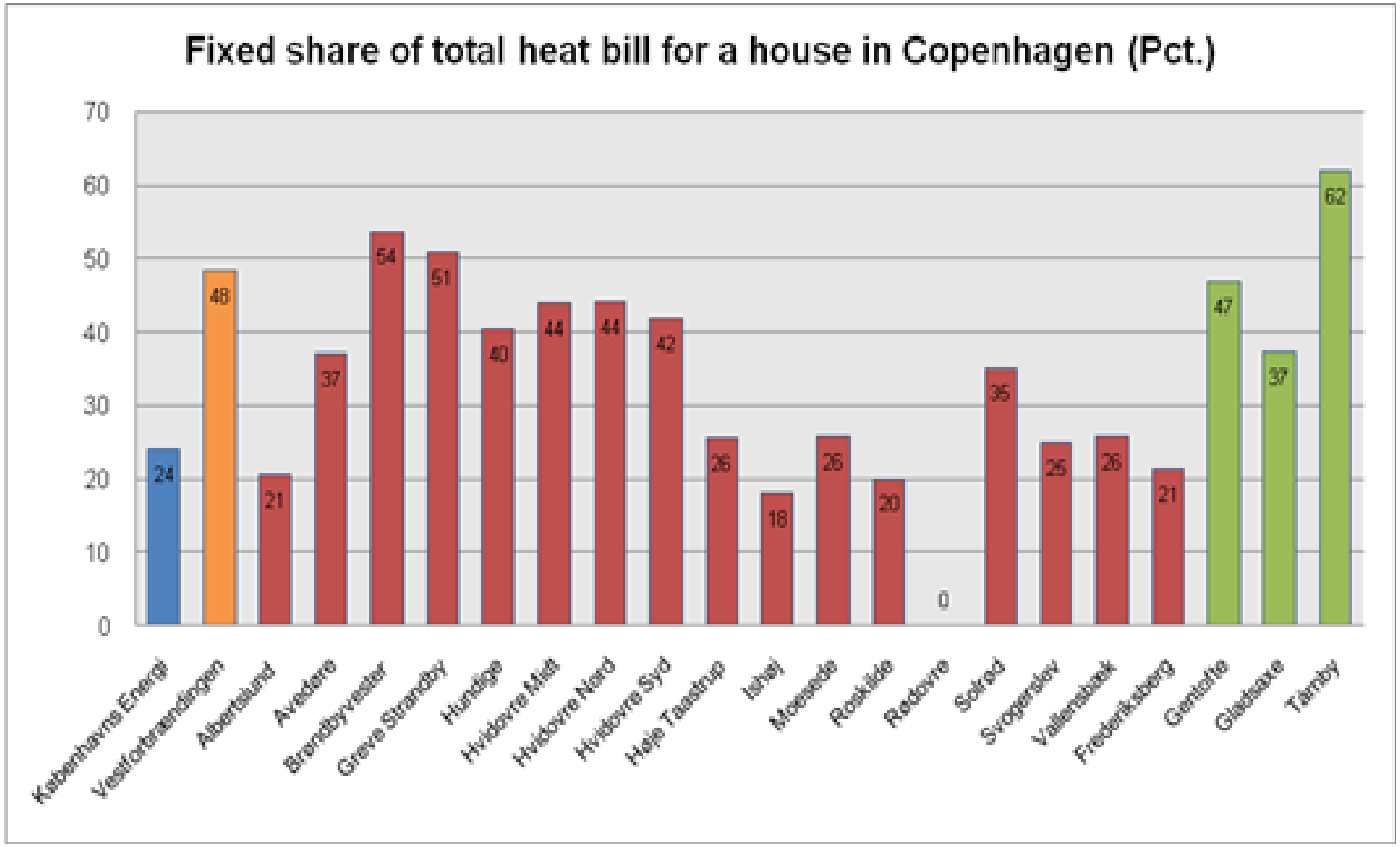


Sum of heat cons.

Typical levels of variable prices

Husstørrelse: 130 m² - 18,1 MWh/år
Olie/gaspriser: Gennemsnit 2006 til september
Virkningsgrader: Olie: 72%, N-gas: 85% - ingen afskrivninger, »gamle anlæg«

Source: Notat fra Energitilsynet, "Fjernvarmepriser i Danmark- resultatet af prisundersøgelsen I 2006, 16 okt.



Source: Anders Larsen: “Towards a sustainable district heating system in Copenhagen”

Payment/year 150m2 house annual consumption 60 GJ

Aalborg District heating system

	Payment per GJ	Euro/year
Fixed payment		430 (40%)
Variable payment	10.6	636 (60%)
Total heat bill		1.066

The Copenhagen case/some examples (18.1 MWh/year house)

	Annual heat payment euro.	Annual variable payment euro	Annual saving in case of 25% house improvements euro.	**Break even investment (6% discount rate/15 year lifetime- 25% house improvement.**
Tårnby	1.710	**651** (38%)	176	**1.578**
Gentofte	1.315	**697** (53%)	174	**1.693**
Albertslund	1.815	**1.434** (79%)	358	**3.482**
København Energi	1.776	**1.350** (76%)	337	**3.277**
Brøndby Vester	1.315	**605** (46%)	151	**1.469**
Frederiksberg	1.315	**1.039** (79%)	259	**2.524**

Tariff problems/characteristics

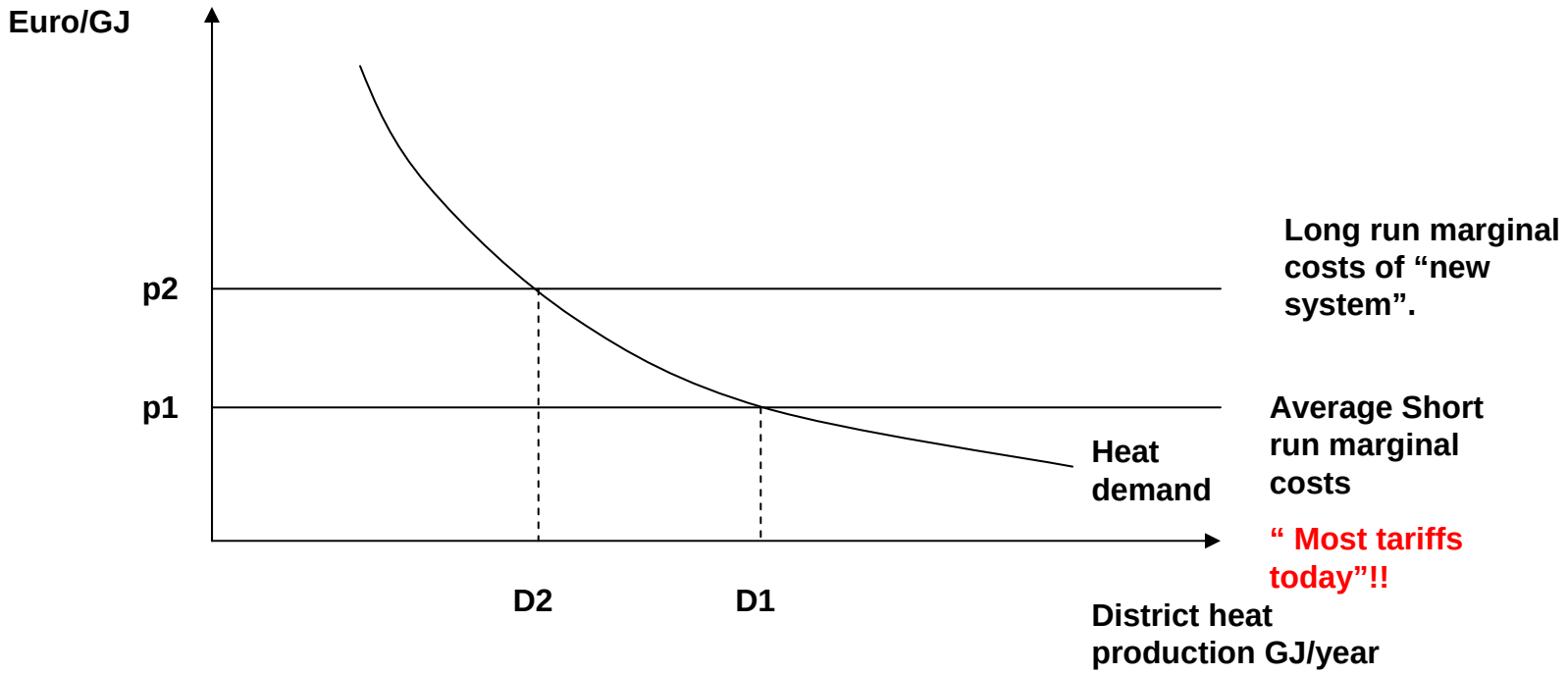
1. Factor 4 differences in heat prices. Amongst others due to differences in energy taxes. This gives regional and social problems!
2. High fixed prices reduces the motivation for energy conservation.
3. Factor 4 differences in fixed share of the tariff. The fixed share varies from 18%- 62% of the heat price in the Copenhagen area. (best practice 18%)
4. Heat prices in the large cogeneration cities are low. Between 790 and 1.842Euro/year.

Conclusion regarding tariff problems

1. It does not pay to make 25%-50% heat conservation in most district heating areas
2. 'It does not pay to introduce renewable energy technologies for heat.
3. No motivation for "absorbing " fluctuating energy sources.
4. Social problems linked to high energy prices in some areas.
5. New public regulation measures are needed.
6. So it is not enough just to introduce CO2 quotas, taxes etc. A new tariff policy has to be introduced.

3. Tariffs for change

Long run or short run cost tariffs?



The tariff dilemma!

1. SRMC (Short Run Marginal Cost) tariffs are regarded as economically "correct" on a short term base. They are linked to strong District heat organisations.

   But they don´t lead to the goals!

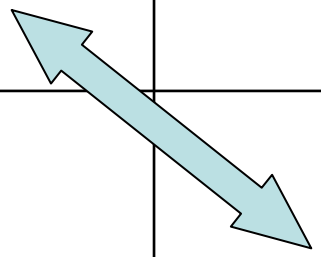
1. LRMC (Long Run Marginal Cost) tariffs are "economically correct" on a long time base,

   And they lead to the goals we have!

   But it might costs money for a while, and they will meet a strong opposition in the district heating companies.

The "coming" will never come, if prices are the present SRMC tariff. (Euro/150m2 house)

	1.Present coal based district heating system	2. "Coming" wind-heat pump-heat storage system
a. (SRMC) Variable cost	400 (Present SRMC tariff)	170
b. Annual fixed costs	632	688
c. Total costs (LRMC)	1.032 (Future costs if SRMC tariffs)	858 (Future costs if LRMC tariffs)



This should be the tariff

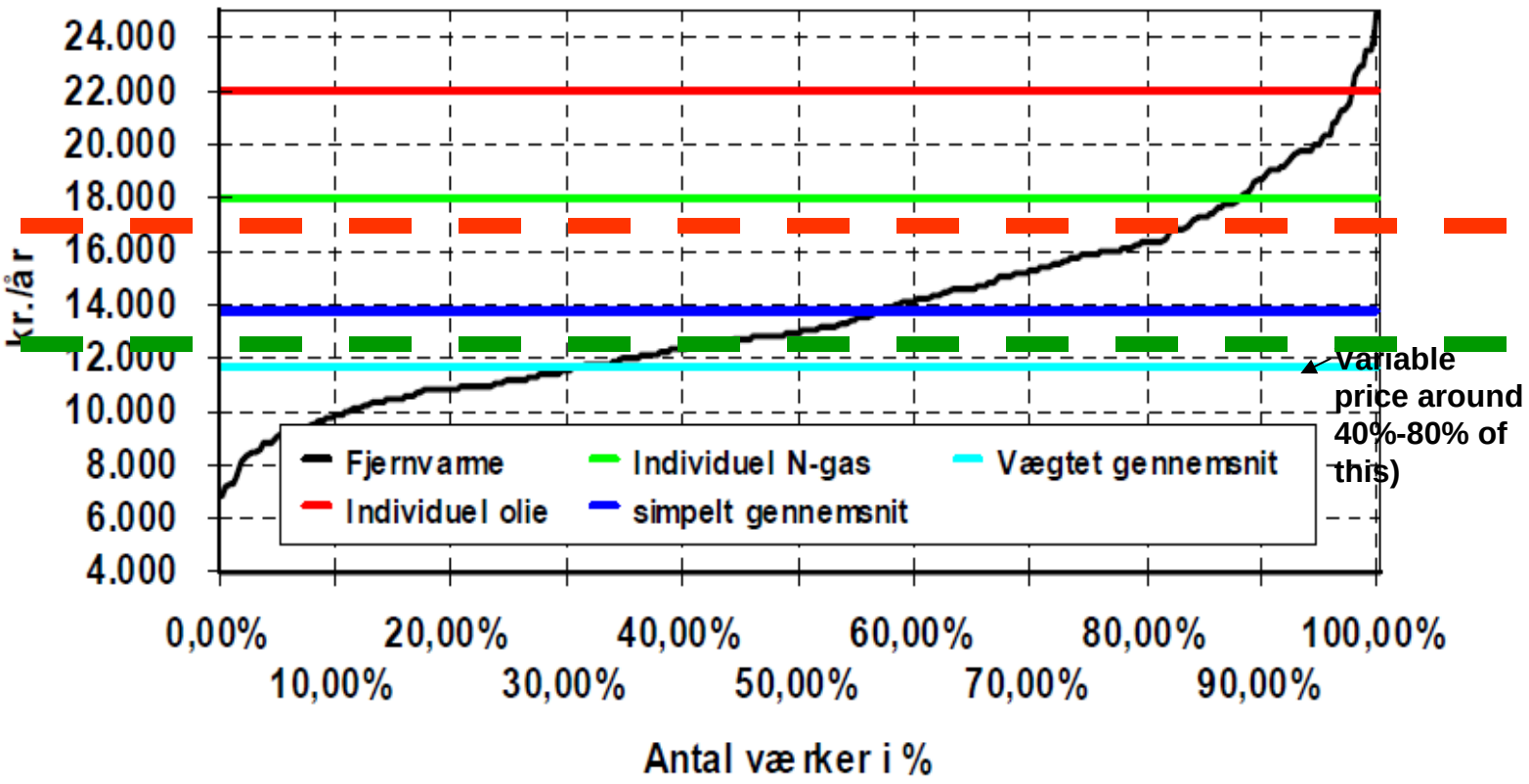
Conclusion on “the right tariff” question.

1. The future supply system should be defined.
   (Here we define it as a system of wind power + heat pumps+ heat storage. It also could be combined with Geothermal energy)
2. This system is calculated to have a cost of 8-10 Eurocent per kWh at the consumer level.
3. Furthermore there is a variable cost linked to the district heating network. This will be estimated later, but is here estimated to be 1-2 Eurocent per kWh.
4. Consequently the variable tariff should be between 10 and 12 Eurocent per kWh before VAT.
5. For a 18.1 MWh/year house the annual variable heat price would then be around 18.000-19.000 Dkr/year.
6. If houses are improved, and the hot water and heat consumption reduced by 40%, the annual heat bill will be around 11.000-12.000 Dkr.(plus some extra investment in insulation etc.)

Heat prices incl. VAT 2006/2007

Future cost 18.1 MWh/year

Future cost after conservation 12 MWh/year



Variable price around 40%-80% of this)

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4. Conclusion/suggestions

Summary

Supply system

1. LRMC tariffs based upon estimates of future RE systems.
2. Open access for renewable energy sold to the district heating system for RE combined with heat pumps and heat storage.
3. “Feed in” price of around 8-10 EuroroCent for 80 degree C water for such systems.
4. Right to sell heat back to the system from households for the variable heat price they pay.

Demand system

1. LRMC tariff system
2. 30% subsidy for energy conservation investments proposed/accepted by energy consultants.

   Paid by the surplus accumulated in the district heating companies.
3. Establishment of consultancy service for heat and electricity.
4. Long term low interest loans. May be with “District heating company” guaranty.

Policy for single houses outside district heating area.

1. System: Heat pump/heat storage/wind power systems.
2. Policy:

   - 0 energy tax for up to 8.000 kWh/year if system 1 is established according to certain specifications. (only electricity used with a minimum efficiency of the heat pump)

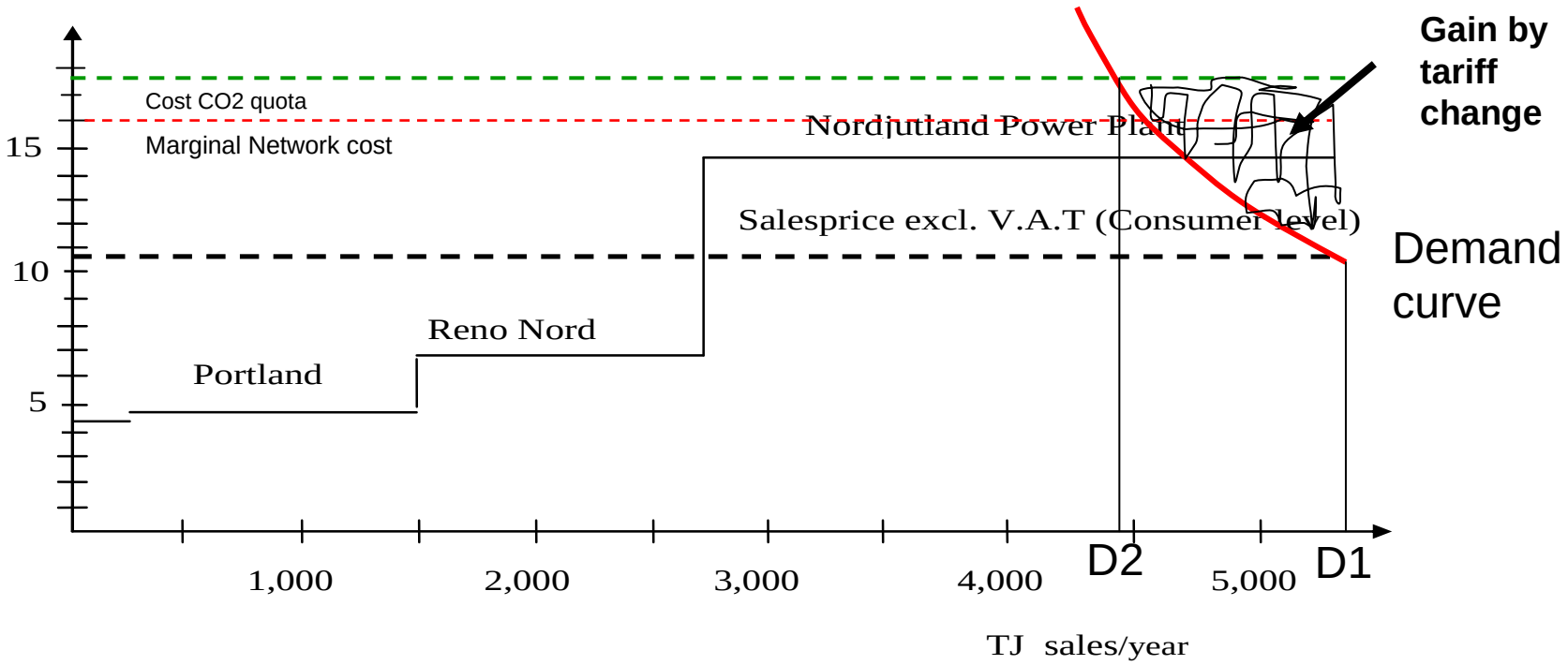
   - 30% in subsidy to such systems.
3. Right to ownership share of new wind turbines.

   This system will replace oil and natural gas, and lower the energy bill at the single houses by around 30% seen in relation to oil furnaces.

5. Further analysis

Energy plan for Aalborg.

Economic gain and conservation First step



1m3 hot water= 46 kWh

Tariff changes

1. The present variable tariff in Aalborg is 3.9 Eurocent (incl. V.A.T). We need to go up to 10-12 Eurocent-, but how?
2. First step by charging the marginal costs instead of the average marginal costs, brings economic gains and the price 6.4 Eurocent per kWh. A tax change decided in 2009 increases the price to 7.2 Eurocent/kWh.
3. The next step up to 10-12 Eurocent per kWh should be taken, and the money transferred to a municipal energy conservation fund. To be used for energy consultancy and energy conservation subsidies/financing/quaranties.

General knowledge

a. The market is always embedded in specific institutions that have to be studied in detail.

b. Concrete changes in these institutions must be introduced.

   It is not enough with CO2 quotas, CDM/JI, CO2 taxes, CCS, etc. This is the general message to Copenhagen 2009.