Heat Roadmap Europe 2050
A low-carbon heating and cooling strategy

4DH
4th Generation District Heating Technologies and Systems

reINVEST

Market Structures and Smart Energy Systems

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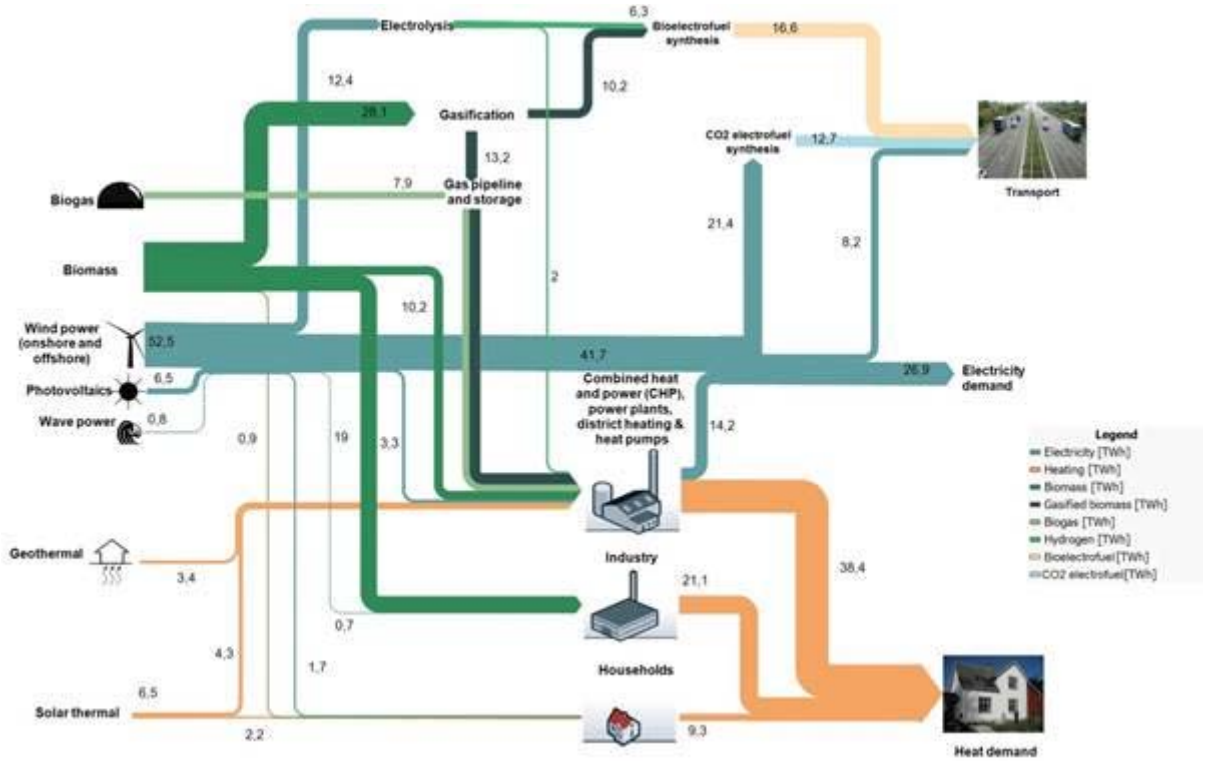
DENMARK

100% renewable energy systems



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3rd international conference on
SMART ENERGY SYSTEMS AND 4TH GENERATION DISTRICT HEATING
Copenhagen, 12-13 September 2017

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Wind Power and Current Market Structures: Theoretically

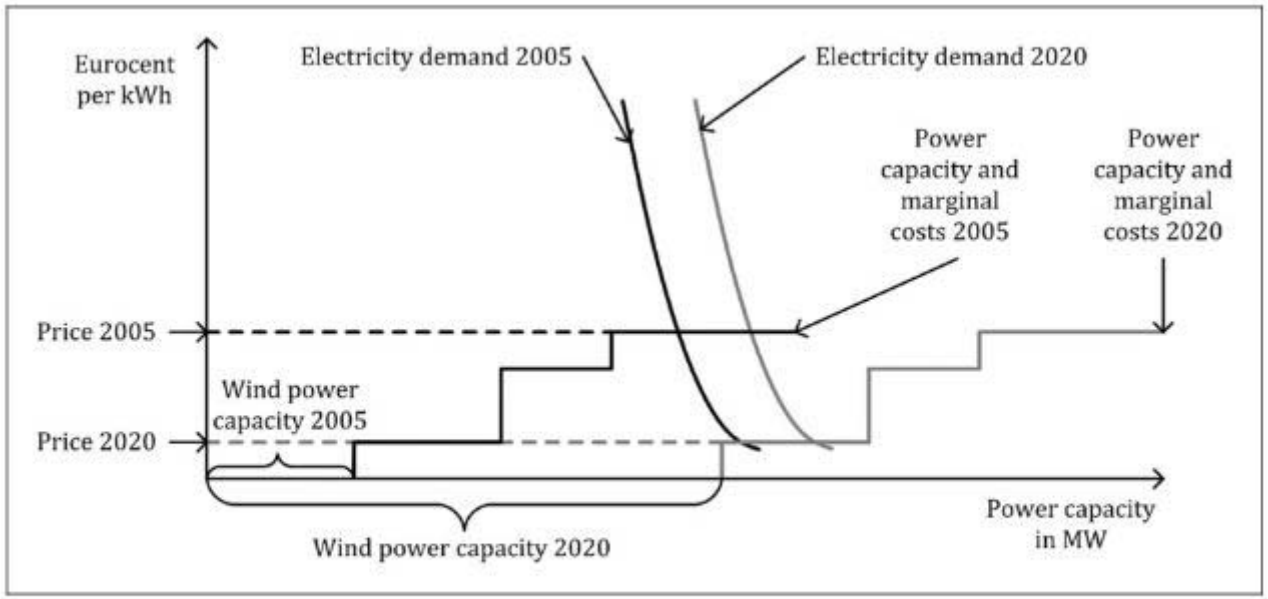
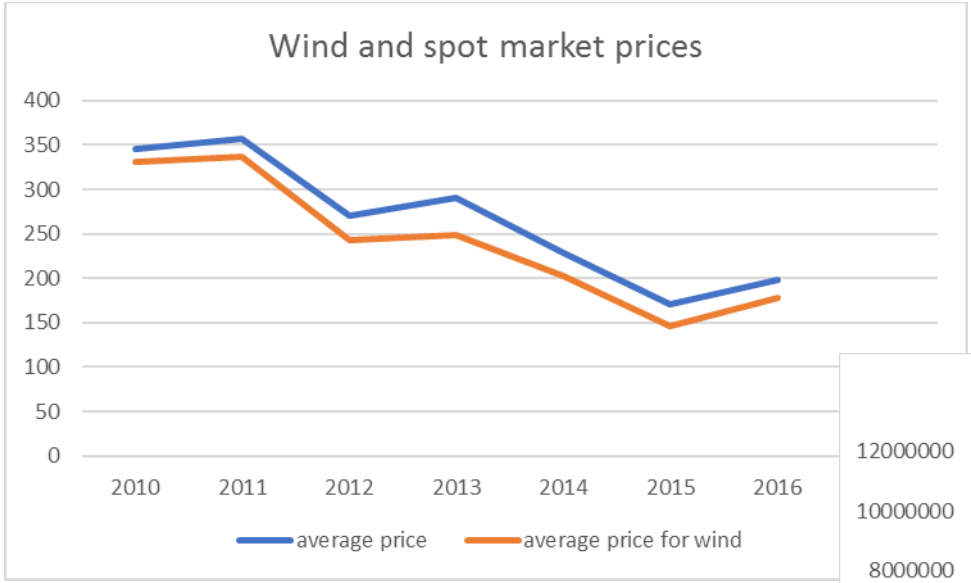
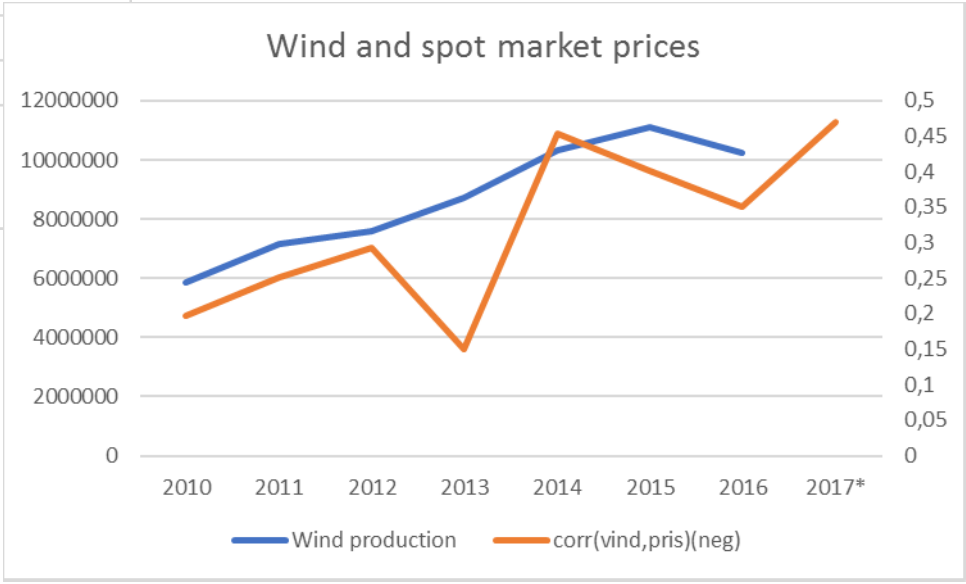


Figure 4. Principle chart: The possible economic suicide of wind power, or the merit order effect (Hvelplund et al., 2013).

Wind Power and Current Market Structures: Empirically





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Wind Power and Current Market Structures

To what extent can wind power be sustained through **demand side initiatives**, given the current market structures?

Our expectation: It **is not enough to sustain current market structures** in a 100 renewable energy system.

Research question?

”Is the current market structure able to sustain the private economy of wind power in a 100% renewable energy system?”

Methods

1) Analysing a 100% renewable smart energy system
2) Identify the marginal producing unit in each hour
3) Identify the marginal cost in each hour
4) Summarize cost and earning
5) Calculate private return to capital for wind power investors

EnergyPLAN and IDA Energy Vision

Using IDA Smart Energy Vision to represent the energy system

Assumption is a fully connected energy system

Uses technical simulation to create a balanced system

Scenarios

The marginal price is based on fuel costs:

1) Low fuel costs
2) Medium fuel costs
3) High fuel costs

Two technology cost scenarios:

1) 2015 prices
2) 2050 prices

Key figures

Renewable Capacity

- 5000 MW onshore Wind
  - 16.2 TWh annual production
  - Payment in 55% of the hours
- 14000 MW offshore wind
  - 63.76 TWh annual production
  - Payment in 55% of the hours

Key figures

Marginal production prices (EUR/MWh)			
	Low fuel costs	Medium fuel costs	High fuel costs
Running power plant	52	66	79
Running central CHP	44	59	68
Running decentral CHP	49	64	73

Investment and O&M costs				
	Total onshore wind investment [M€/MW]	Annual onshore wind O&M [M EUR]	Total offshore wind investment [M€/MW]	Annual offshore wind O&M [M EUR]
2015 prices	1.07	173	2.46	1 076
2050 prices	0.83	140	1.39	590

Results

Offshore Wind			
	Low fuel costs	**Medium fuel costs**	**High fuel costs**
2015 prices	N/A	N/A	-11%
2050 prices	-5%	-2%	0%

Onshore Wind			
	Low fuel costs	**Medium fuel costs**	**High fuel costs**
2015 prices	N/A	-12%	-7%
2050 prices	-10%	-4%	-2%

Conclusions

- The internal rate of return does not suggest any feasible private investments
- This is in a system with large amount of system integration
- We need to consider how to make private investments feasible