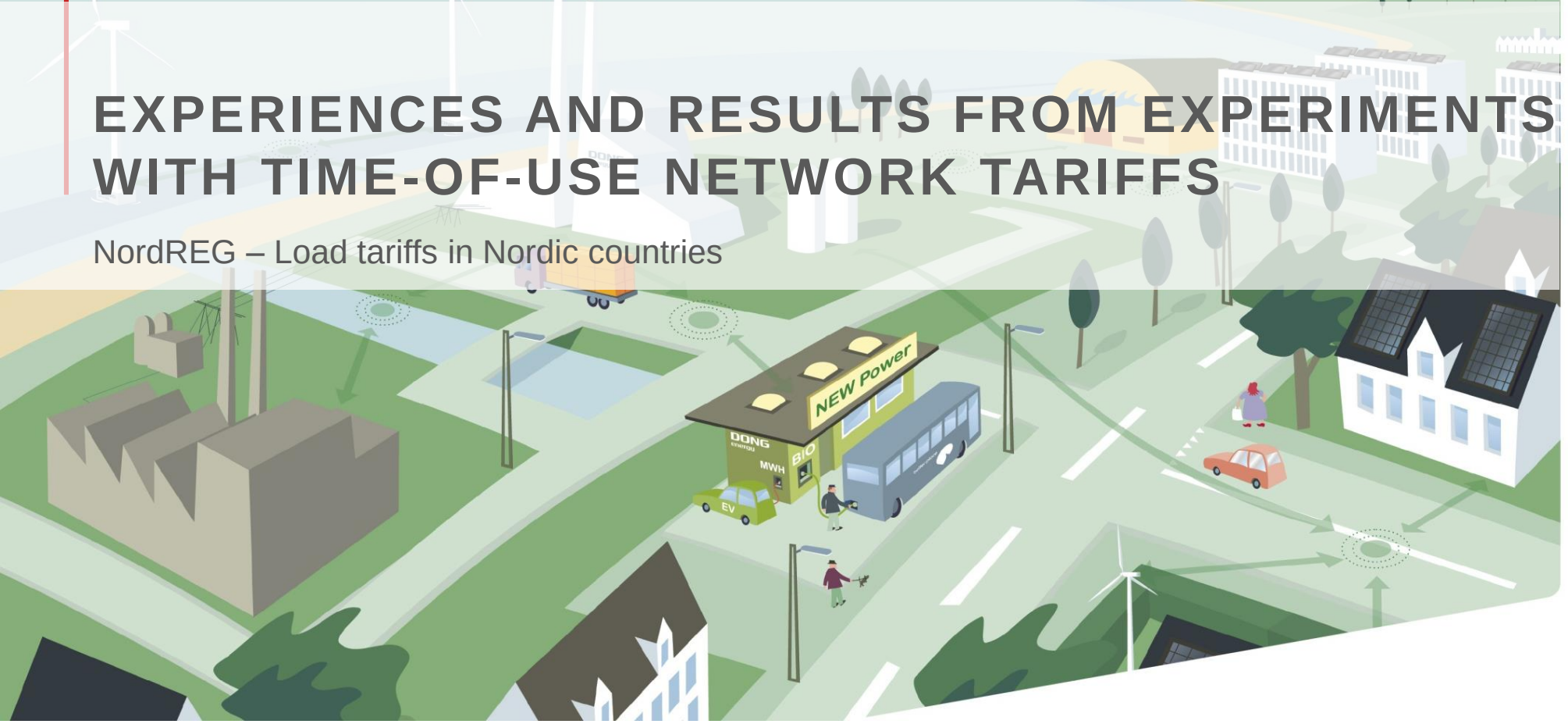
EXPERIENCES AND RESULTS FROM EXPERIMENTS WITH TIME-OF-USE NETWORK TARIFFS

NordREG – Load tariffs in Nordic countries



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Stockholm 5th of November

DONG energy

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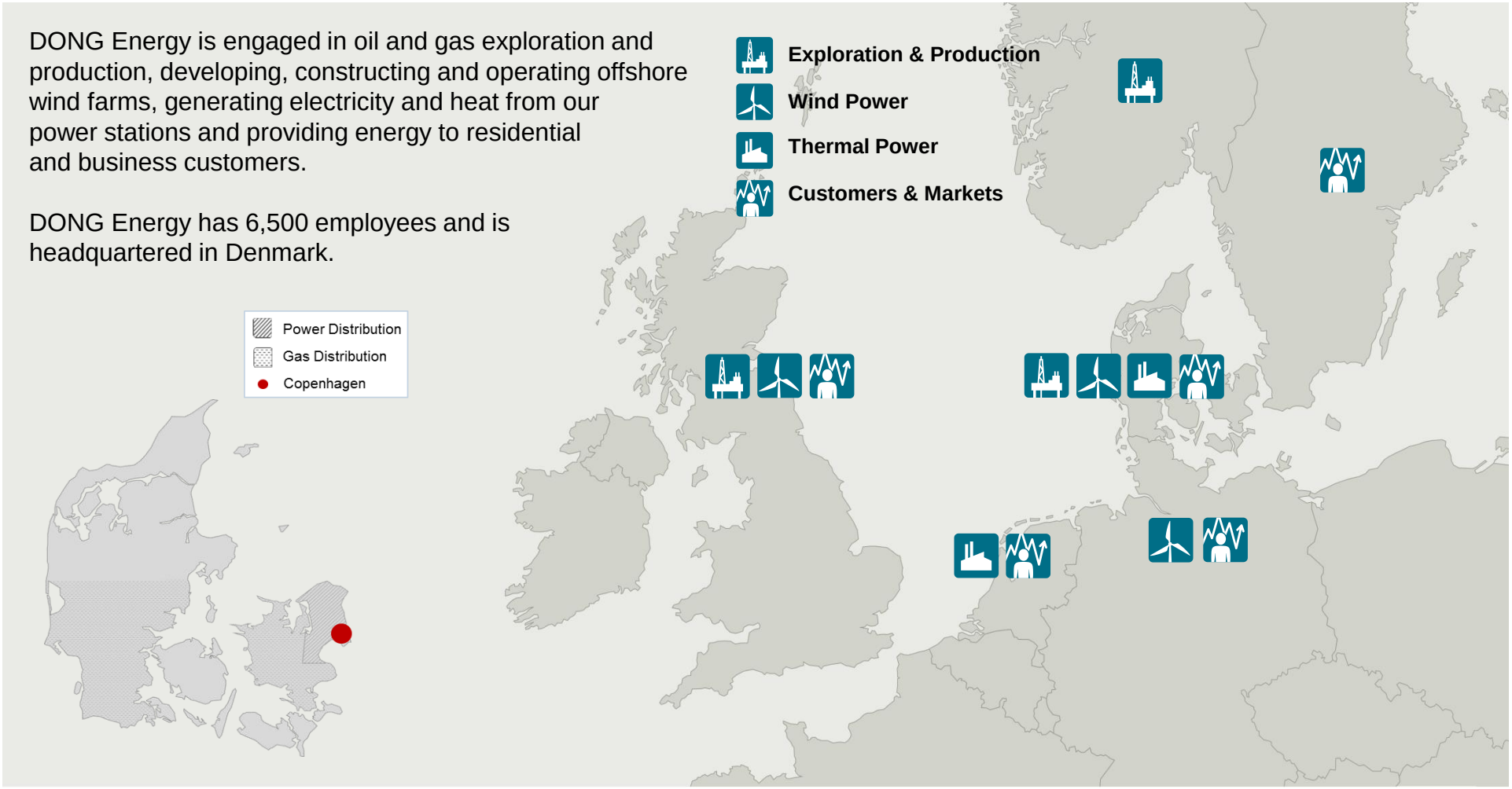
DONG Energy is one of the leading energy groups in Northern Europe

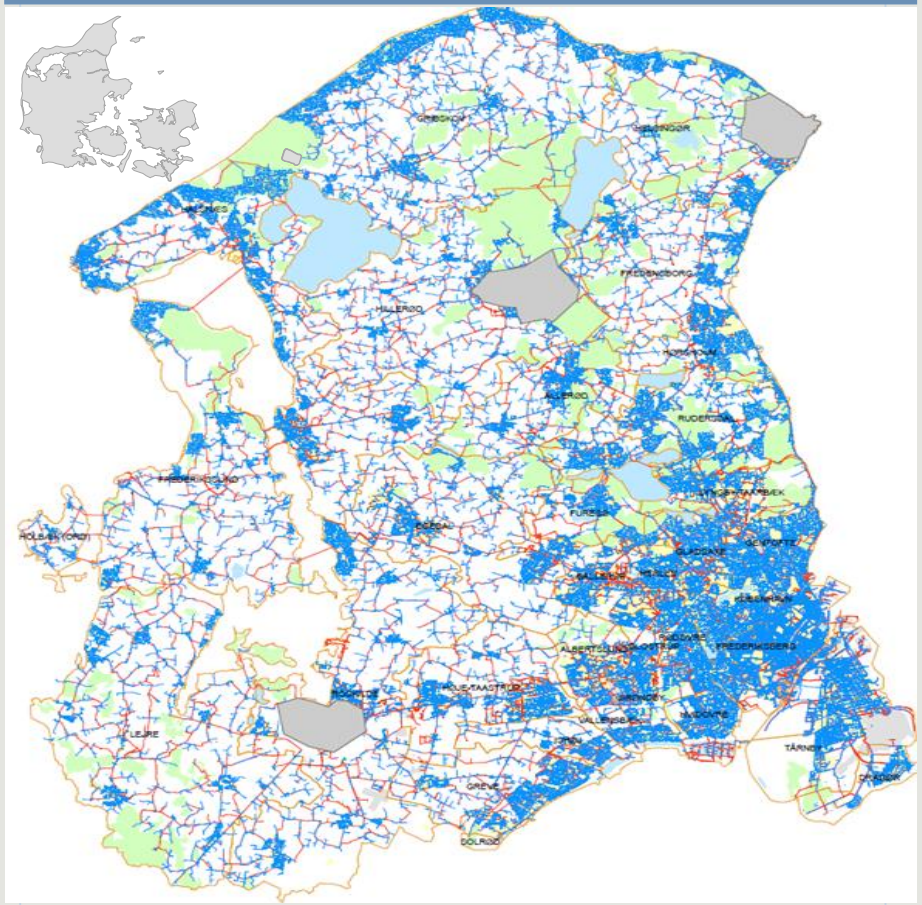
DONG Energy is engaged in oil and gas exploration and production, developing, constructing and operating offshore wind farms, generating electricity and heat from our power stations and providing energy to residential and business customers.

DONG Energy has 6,500 employees and is headquartered in Denmark.



Basic facts about DONG Energy Power Distribution A/S (DEE)

DEE is in and around the greater Copenhagen area



Some basics

Key figures from the Regulatory Accounts, 2013

Item	EURm*
Revenue	258.8
Operating cost	108.2
Depreciations	62.7
Asset value EoY	1,346.5
Distributed volume, GWh	8,597
Grid loss (4.2%), GWh	365
Number of meters = customers	983,688

Key changes on the way…

- A new market model will be in place from March 2016 - the Supplier Centric Model (SCM). The SCM redefines the responsibilities of sales vs. distribution
- Requirement for roll out of remotely read meters to all
- New Tariff model (industry standard) by March 2016
- Regulatory review: New economic regulation expected by 2017 (income cap regulation)

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The role of the power grid companies…
… and the pricing policy to support it

The role of the power grid companies is to facilitate efficient exchange of power between producers, consumers and prosumers

- First of all the network companies pricing policy should encourage economic efficiency

- Also the network companies pricing policy should be in line with overall policy objective:
  - promote well-functioning of the electricity markets;
  - support energy efficiency;
  - support the development of distributed generation;
  - contribute to system flexibility through demand response

- A specific tariff structure should be developed with respect to the following considerations (guiding principles):
  - Transparency
  - Simplicity
  - **Cost reflectiveness**
  - Fairness (collectiveness)
  - Infrastructure cost efficiency

- A specific scheme should ensure full recovery of all allowed network costs and reasonable return on capital

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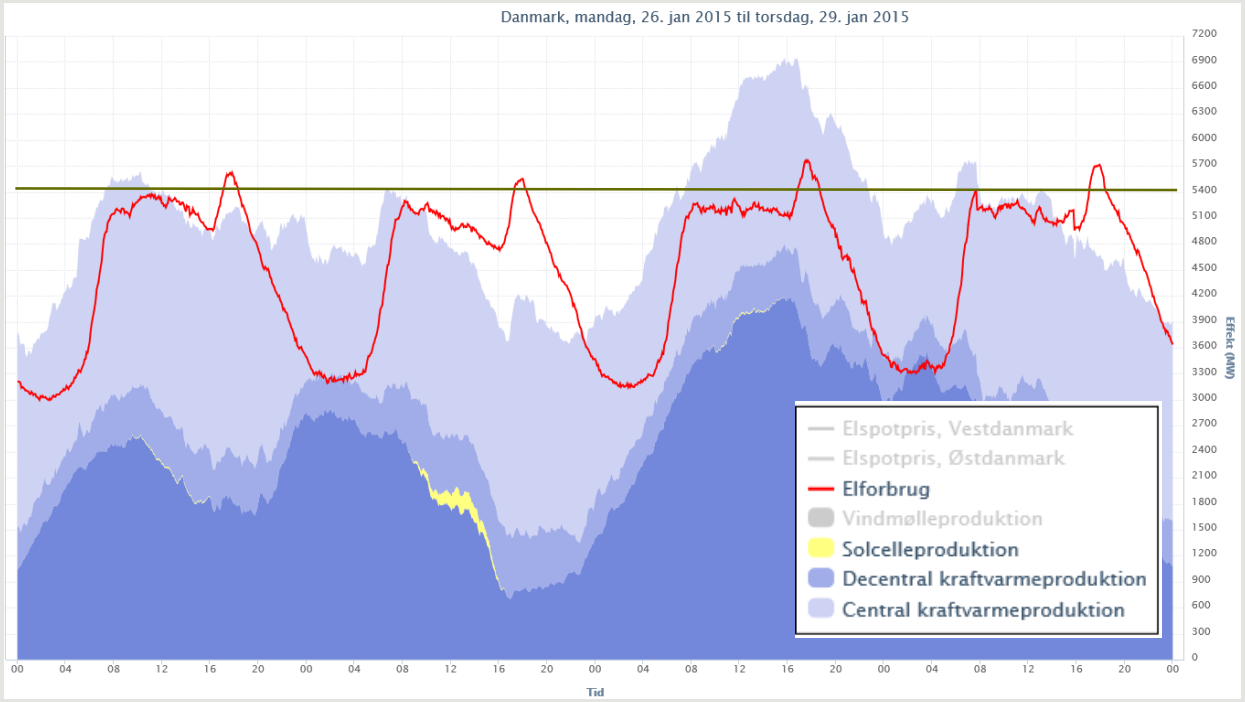
Why consider a new tariff design?

- In Denmark, there is a lot of focus on **incorporating (non-controlable) wind power** efficiently in power system
- Network companies should **support this development**
- But the key role is to facilitate exchange of electricity between producers, consumers and prosumers
- But at the same time the network companies should focus on the more **immediate challenge of leveling out of consumption**
- **Peak consumption drives costs** challenging the traditional net tariff structure with flat or fixed rate



Better price signals needed!

- Cost reflectiveness
- Infrastructure cost efficiency

- Differentiated tariffs?
- Load tariffs?

Could this shave the top of the peaks?

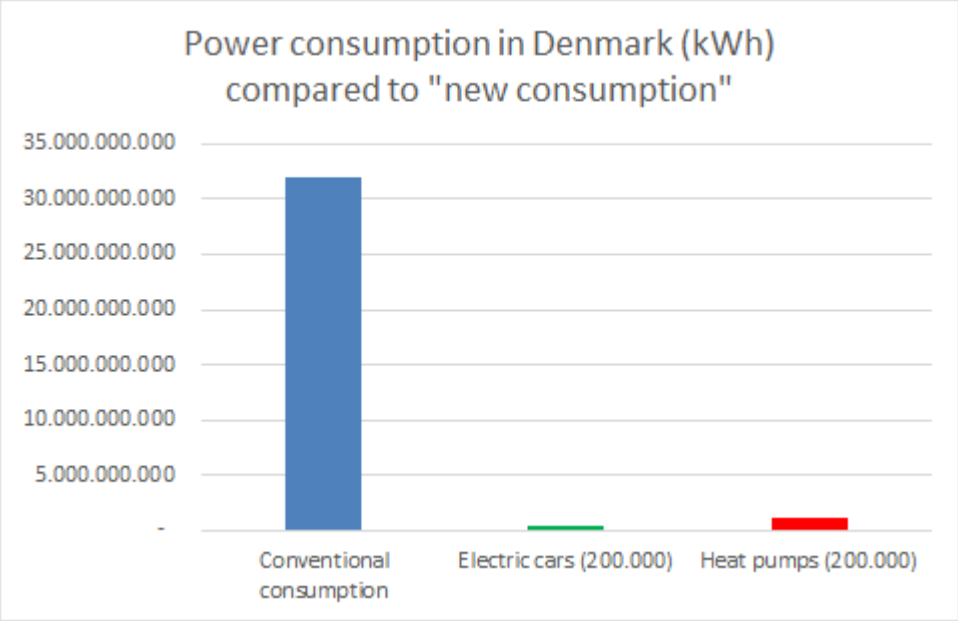
At least there is a potential (long term) benefit if peaks could be reduced

Sleeping flexibility in the conventional consumption?

- A lot of talk about value creation from **flexibility from electric cars and heat pumps**
- Consumers can increase use of power when prices are low and vice versa

- But what about the **conventional consumption?**

- If we can push the conventional consumption just a little bit this might provide more flexibility than the flexibility that we can get from new consumption from electric cars and heat pumps



- Conventional consumption in Denmark: 32.000 GWh
- 200.000 electric cars: 525 GWh
- 200.000 heat pumps: 1.100 GWh

- Potential flexibility could be activated through hourly billing and time-of-use tariffs (on the way in DK)

- The flexibility potential from the conventional consumption could be 10 times higher than from electric cars and heat pumps by 2020 according to own estimation…

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Time-of-use tariffs implemented in 2012
An economic incentive to promote efficient network use

In 2012 DEE implemented time-of-use tariffs

- Time-of-use tariffs can potentially shift consumption to off peak periods, by stimulating reduction of peak demand through higher tariffs at peak times
- However, this was not the objective of DEE
- The rationale behind the decision was more simple:
  - Differentiated tariffs would **better reflect the true costs** of the service provided compared to a flat tariff (fairness)
  - If the scheme shifted consumption it would be a bonus

- Different tariffs in line with the available grid capacity
- The scheme consist of a **three tariffs**
- Only small difference between the high and low tariff
- In practice – the differentiated tariff scheme only affected large customers with remote meters (>100.000 kWh)

Variable volume tariff for B customer (1.1.2012)		
	Period	cent(€)/kWh
Low	Night and weekend	2,07
Normal	Daytime working days	2,52
Peak	Morning and afternoon peak hours	3,01
Average		2,24

Effects on consumption of large customers

- Did the new tariff scheme affect consumption?

- Simple analyses carried out – no use of advanced econometrics (or corrections for possible confounders)
  - 480 random customers selected
  - Consumption in 2011 compared to 2012

- The share of **peak load consumption reduced by 1,1%**
- A very small but yet **statistically significant** difference
  - However, other factors might have influenced the result…

- The elasticity of demand (only distribution tariff): -0.03
- The elasticity of demand (total power price): -0.15

- Increase the relative price difference between average and peak price by 10% and peak load is reduced by 1.5%
- A very small effect… but still a positive effect…

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Move! (Flyt dig!)
An experiment with time differentiated grid tariffs

Basics

- Move! was carried out in a collaboration between SEAS-NVE Net A/S and DONG Energy Eldistribution A/S
- The **purpose** of Move! was to find out to what extent ordinary households without electric heating would change their consumption behavior when time-differentiated tariffs were used instead of fixed grid tariffs

Why "Move!"?

- Only sparse information on the potential flexibility in the conventional consumption
- Sleeping flexibility in the conventional consumption?
- Soon we will have smart meters in all households – and hourly billing!
- How will an average households react to time differentiated tariffs?
- Potential benefit if the peak tops can be reduced

Move!
Approach and key data

- The experiment “Move!” covered 12 months
- Started on 1 April 2014, ended 31 March 2015

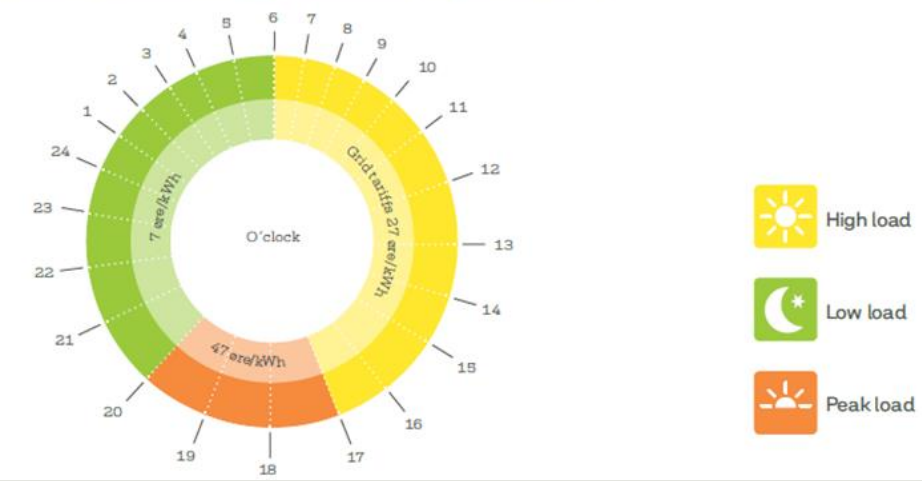
- 2 * 525 customers randomly selected in SEAS NVE grid (to ensure their representativeness)
  - Test group
  - Control group

- Control group were invoiced normal tariff
  - fixed tariff (DKK 0.2731/kWh at the start of the test)
- Test group were invoiced with a test tariff
  - low, high and peak price

- Test group customers had the opportunity of a financial gain experiment by movingtheir consumption of electricity
  - guarantee against a higher bill

- Move! only vary the grid tariff
  - taxes and power tariff unchanged
  - the grid tariff only a small faction of the total electricity bill

The time-differentiated grid tariffs in the experiment "Move!"



Tabel 4. Øvrige elementer af den samlede variable elpris pr. 1.4.2014

Øre/kWh	Pris
Net og systemdrift, Energinet.dk	6,90
PSO i alt	22,70
Elafgift	83,30
El	40,00
I alt ekskl. moms	152,90
Moms	38,23
I alt inklusiv moms	**191,13**

Move!
Key results and conclusions

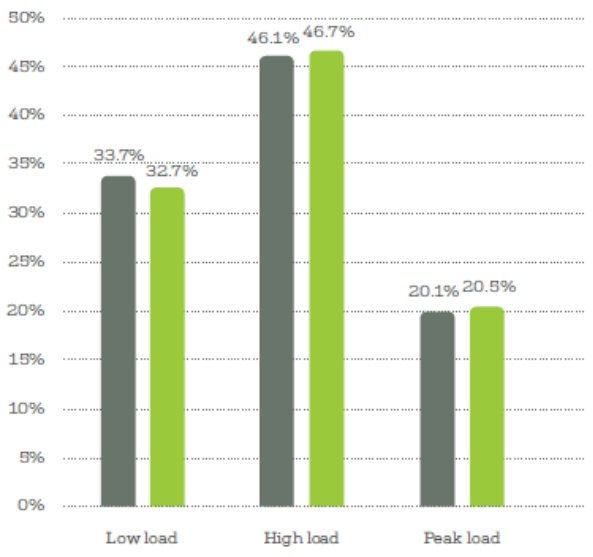
Key results:

- Data shows a **peak load reduction of a little more than 2.0%** in the test group in comparison with the customers in the control group (change by 0.4 percentage points)
- The effect is **statistically significant!!**
  - Average peak load in the two groups not equal ($p<0.05$)
- Total electricity **consumption not affected**
  - No “attention” effect (energy saving)
  - In fact a small increase in consumption in test group
- **Elasticity estimated to -0.19** (in relation to changed in total price of electricity)
  - When the peak load price is increased by 10% relative to the average price then peak load is reduced by 1.9%
- Average effect at the same over the full test period of 1 year

Conclusions :

- A small but statistically significant effect on peak load consumption
- The difference in peak load due to the time differentiated tariffs
  - Random selection eliminated confounders
- Results are only short time effects – long time effects unknown
- **There is a sleeping potential for levelling consumption….**
  - flexibility equivalent to 150,000 electric vehicles…

Figure 1. Distribution of the consumption over the load periods for the test and control groups

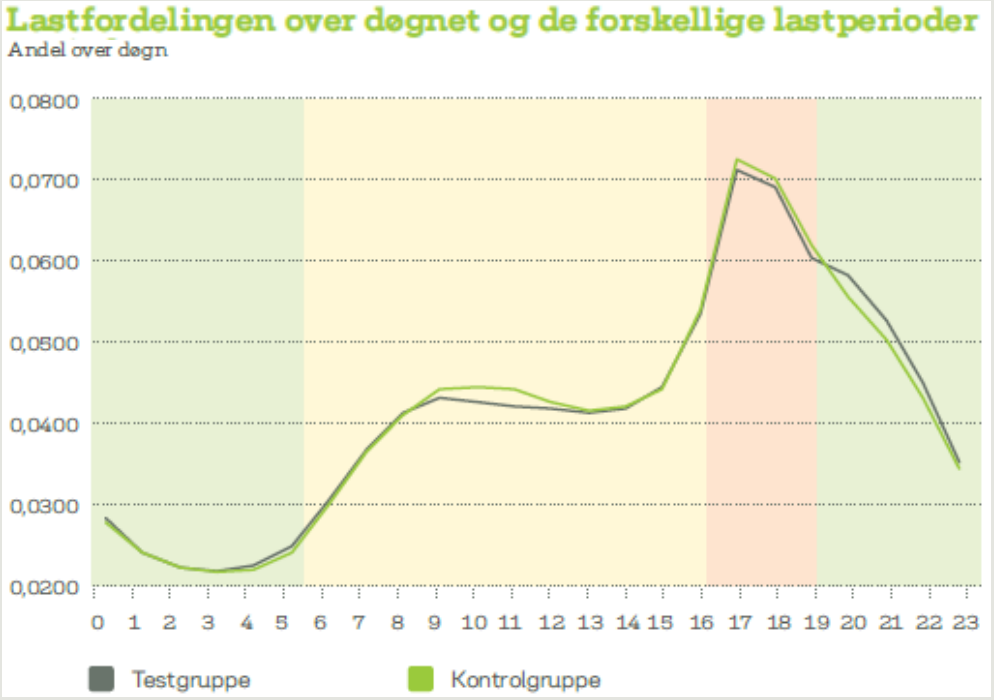


kWh	Testgruppe	Kontrolgruppe	Forskel i %
Lavlast	505.451	490.493	3,05%
Højlast	691.286	699.958	-1,24%
Spidslast	301.220	307.506	-2,04%
I alt	**1.497.957**	**1.497.957**	**0,00%**

Move!
A closer look on the effect…

A clear but small effect

- Test group customers consume less electricity in peak hours – and more in low load periods
- There is a clear “kick back” effect (more consumption between 20-21)



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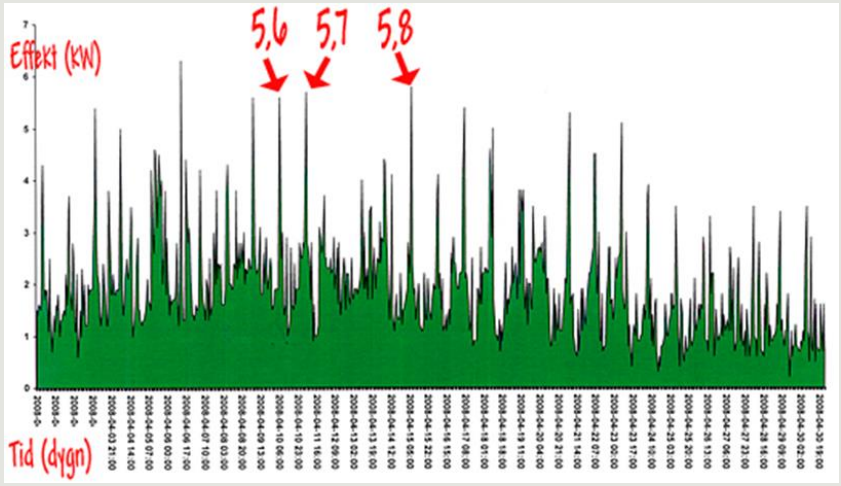
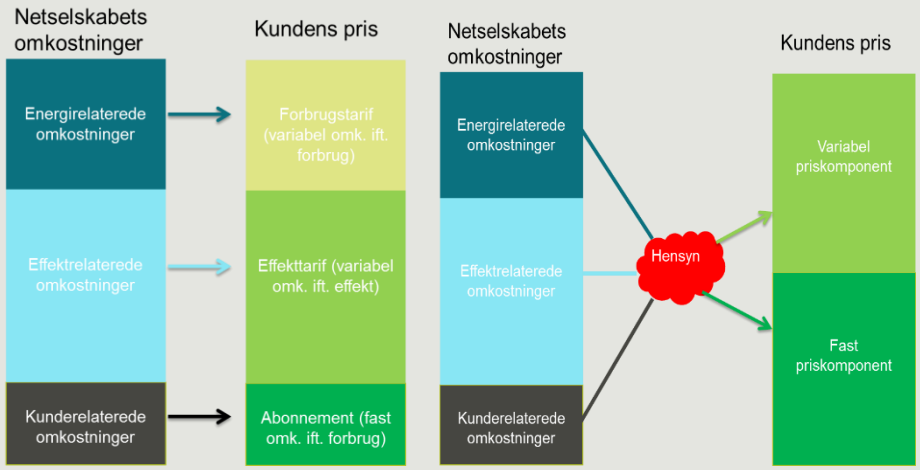
A few perspectives on load tariffs

- Ideally the pricing scheme should consist of three elements:
  - Fixed fee (eg. metering and billing)
  - Volume tariff (net loss)
  - Capacity/load tariff (investments and operational costs)
- Load tariffs potentially more cost reflective
- Some complication with load tariffs:
  - Load tariffs are hard for consumers to understand!
  - Grid designed with “non-simultaneousness” in consumption
  - Customers can not consume full load simultaneously
  - What if customers individual peak occurs during off-peak?
- Volume tariffs are a good proxy for load tariffs
  - especially if “max load” is the average over many hours
- Pragmatic pricing principle using fixed fee and volume tariff is reasonable…





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Conclusions and perspectives

- There is a sleeping **potential for levelling consumption**
- "Smarter prices" do have an effect on the customers consumption patterns
  - Even though the change is probably small

- Fair and efficient pricing – **Lets get prices right!**
  - Or at least more right than what they are today (fixed tariff)

- It is **a journey**
  - We need to get customers to join us on the journey

- Start by introducing **time differentiated tariffs**
  - They need to be simple and easily understandable so that the customers can react adequately to the signal
  - Clear incentives => High prices when load in high and vice versa
  - Expect no revolution

- The journey **might involve load tariffs….**
  - …but it may prove too difficult
  - take lessons on the way (how do customers react and are they ready for a more complex structure?)

- The **final destination o**f the journey could be **real-time (dynamic) grid tariffs?!??**
  - However, it is unlikely that customers can deal with this complexity without automation

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