

Working toward sustainability – a stormy experience

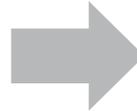
Andreas Regnell, Vice President Strategy and Sustainability



Vattenfall's overall ambition

Vattenfall will deliver

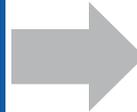
**Sustainable
heat and electricity
production and
distribution**



High level description

**Be one of the leaders in
developing environmentally
sustainable energy
production**

**Sustainable
energy consumption**



**Deliver smart
energy solutions**

**Sustainable
economic performance**



**Meet our financial targets
"Excellence
in everything we do"**

The reality 1 - What is required to decarbonize according to the EU Roadmap 2050?

Significant reduction in energy consumption

+

Significant growth in renewables

+

Coal with CCS (Carbon Capture and Storage) or
Nuclear

Reality 2 - Politicians are defining the speed and path to decarbonization

There is currently very limited need (significant oversupply) of new capacity in Germany, Netherlands and Nordic. Situation likely to remain 10-15 years.

Thus – without political intervention (subsidies/capacity payments) transformation would halt completely

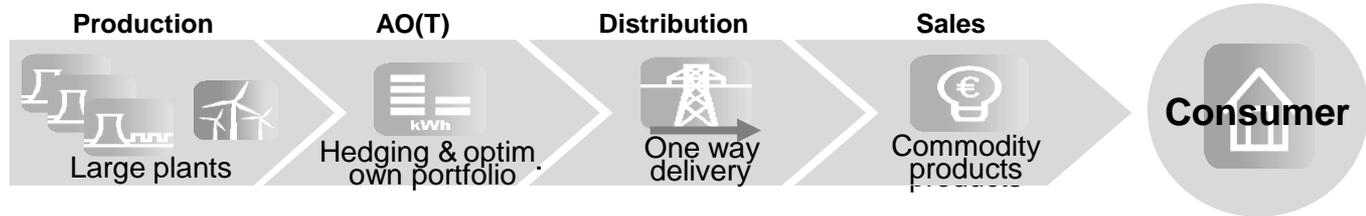
Politicians are hesitating and defining nation specific frameworks

- "Explosion of subsidy costs"
- Unwillingness to restructure ETS and bring CO2 price to 30-40 Euro which is required to get a significant switch from coal to gas
- Energiewende in Germany, Electricity Market Reform in the UK and National Energy Agreement in the Netherlands

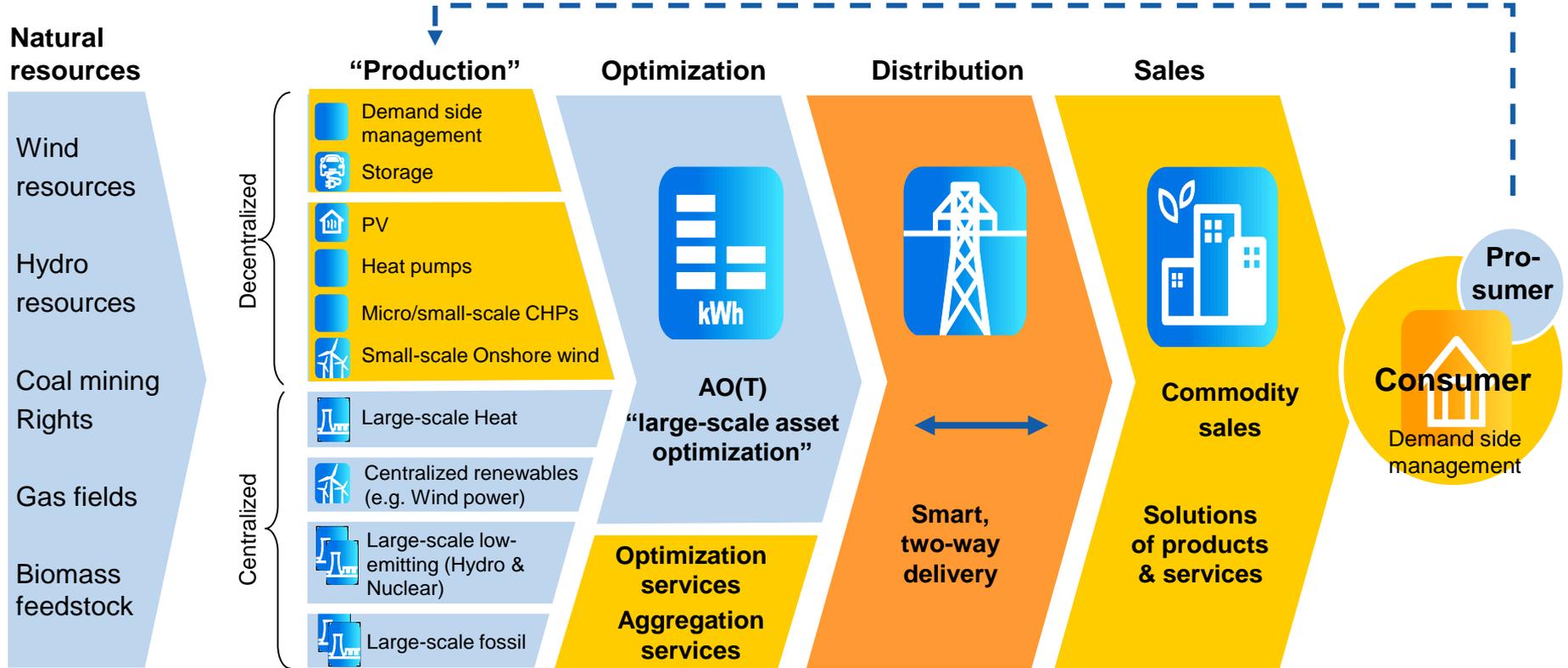
A new value chain is emerging

Increased customer participation in value chain increases “scope” of end-customer Sales

Traditional value chain



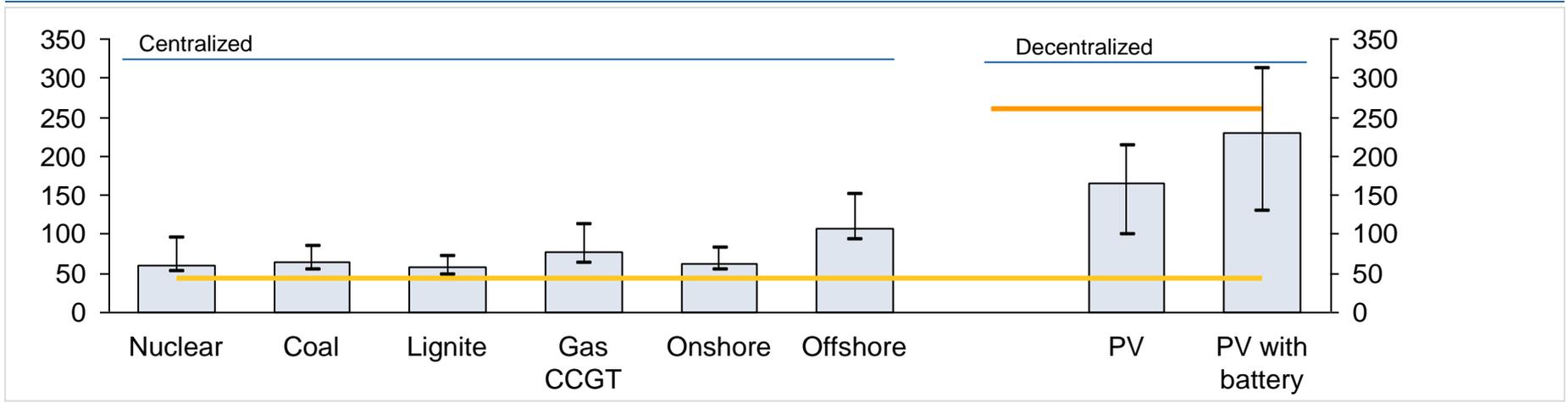
New value chain (New Energy Landscape)



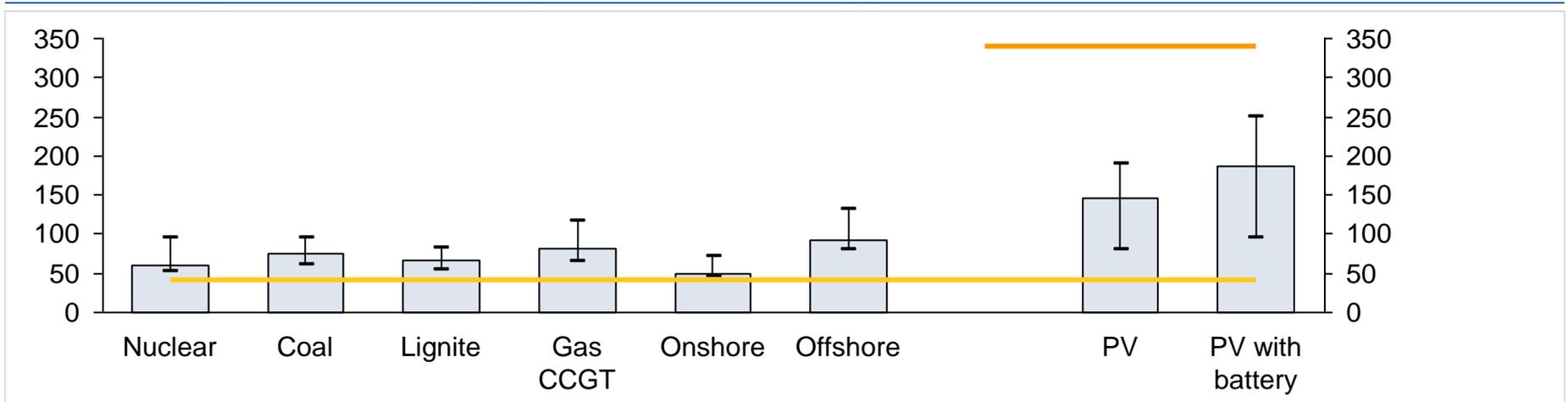
Levelized cost of electricity – differences declining

- Levelized Energy Cost
- End-customer bill (Germany)
- Wholesale (Germany)

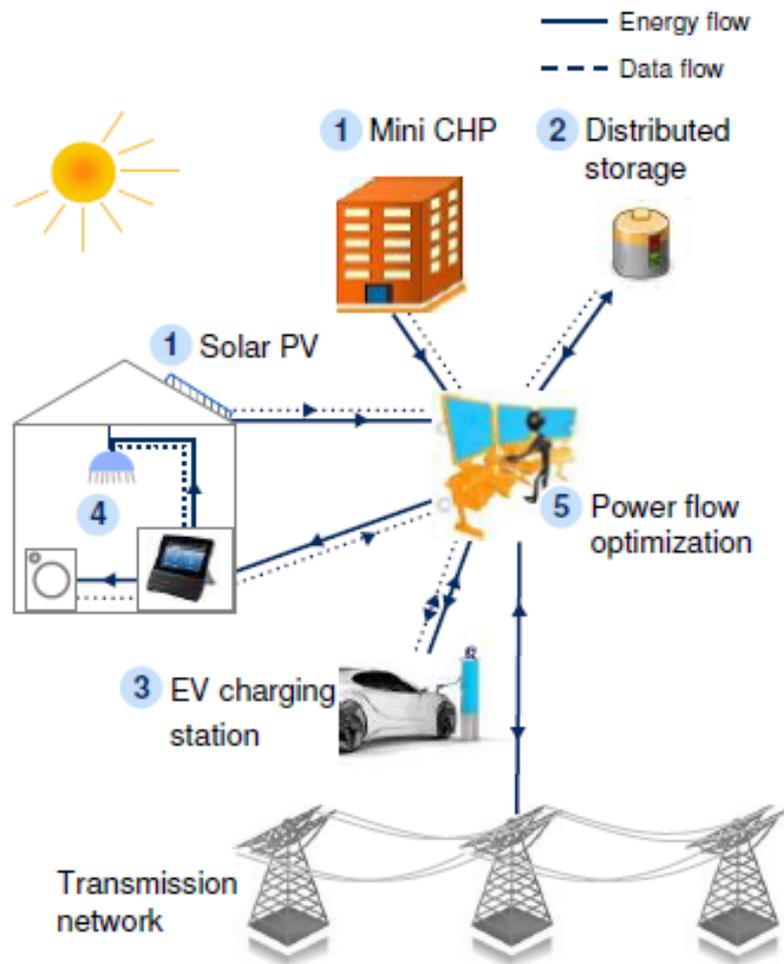
Levelized Energy Cost for newbuilds (2012) versus German electricity price, EUR/MWh



Levelized Energy Cost for newbuilds (2020) versus German electricity price, EUR/MWh



New downstream value pools emerging



New downstream value pools

1 Distributed generation

Installation, maintenance, and possibly ownership of:

- Solar PV systems
- Mini/micro CHPs

2 Distributed storage

Ownership, installation, and maintenance of battery storage at local distribution level

3 (Public) EV Infrastructure

- Grid connection works
- Ownership, installation, and maintenance of public charging points

4 New products and services at customer premises

- Installation, maintenance, and possibly ownership of products that:
 - Increase customer comfort and enable new services
 - Make home and other buildings more efficient

5 Power flow optimization

- Leverage local sources of net load flexibility (distributed storage, EV batteries, DSM, DG) to:
 - Optimize power flow at local and system level to manage congestions and stabilize grid
 - Shift net system load to capture price arbitrage opportunities

Our main areas of focus and interest

- Our focus – commercial technologies or soon to be
- R&D in Vattenfall – Development, Demonstration and Deployment

Some examples of R&D programmes:

- Flexibility in our power plants
- Cost/Capital efficiency in wind
 - Wind resource assessment and measurement
 - Maintenance off shore – safe AND low cost
- "New" solutions
 - Demand response
 - Energy Efficiency/Optimization
 - Storage

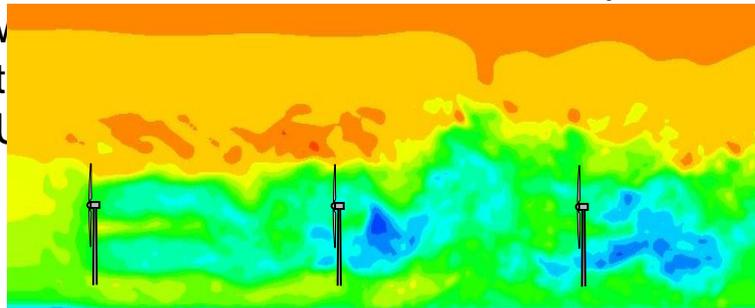
Project Example: Wind Power Wake Effects

Production Loss from Wake Effects

When wind turbines are clustered in large wind farms, most will operate in full or partial wake. This means lower wind speeds, production loss, and higher fatigue loads. We study these effects in support of the planning of park layouts.

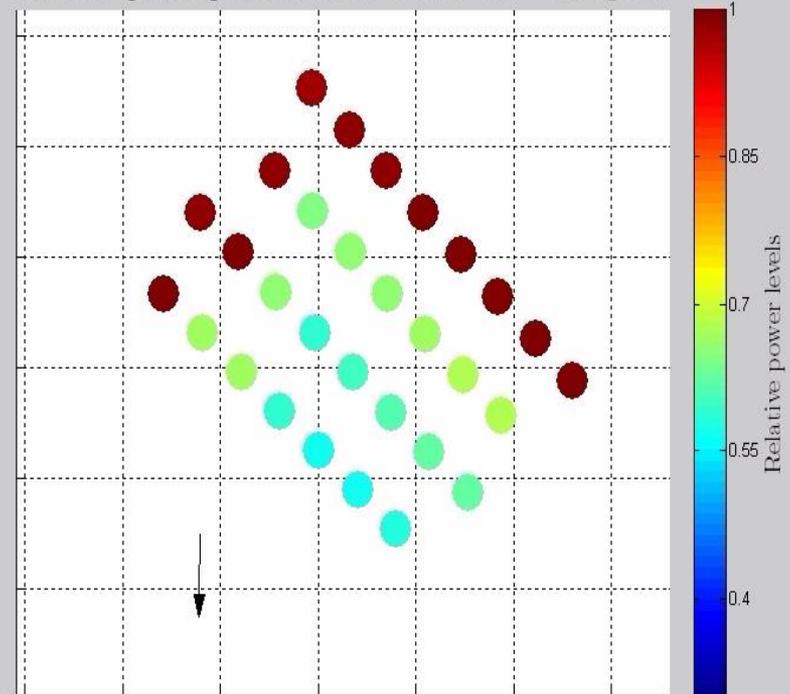
Benefits

- Big savings from intelligent park layout
- For example, a 1% reduction in the wake loss of the Ormonde wind park



Simulation: Ormonde wake effects

Relative power production at a wind dir =1 Degrees



The key messages

- Technological development will be key to reach a sustainable system by 2050
- Affordability (for society) will be crucial

But...

- It is in the end all determined by what the politicians decide to support