

# ***Picking Winners: No room for the Elephant?***

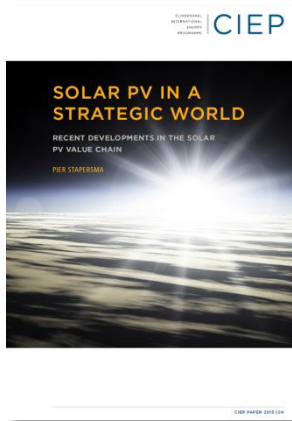
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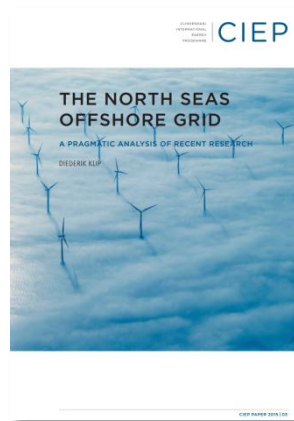
*CIEP contribution to 'The Nuclear Elephant' seminar, 3 March 2017, Amsterdam.*

# Changing Energy Markets

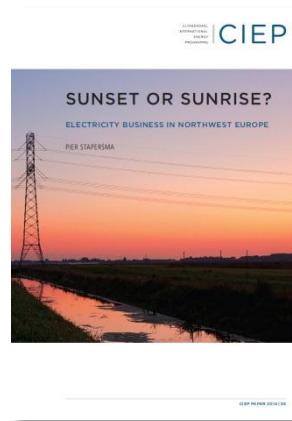
- At CIEP we've been working on changing energy markets for a while



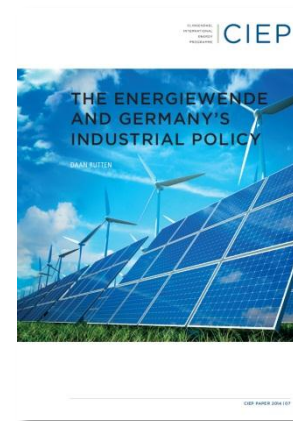
*Solar PV in a  
Strategic World*



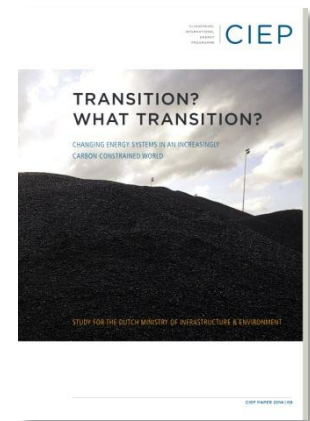
*The North Seas  
Offshore Grid*



*Sunset or Sunrise?  
Electricity Business  
in Northwest Europe*



*The Energiewende  
and Germany's  
Industrial Policy*



*Transition?  
What Transition?*

- These and more publications are available at [www.clingendaelenergy.com](http://www.clingendaelenergy.com)

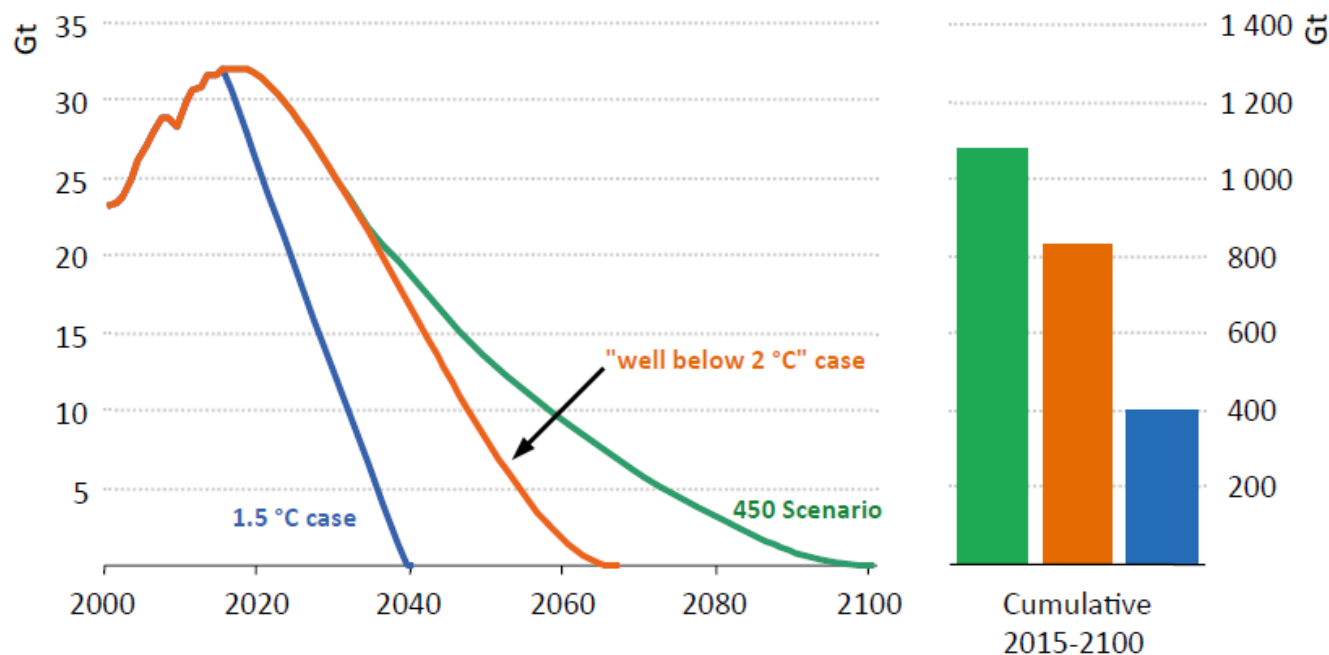
# Agenda

1. Global Energy Needs and Carbon Constraints
2. Progress with Renewable Energy Technologies
3. Complexities that arise with Solar & Wind Technology
4. Picking Winners in Europe: Effects on Markets
5. A Glimpse into the (future) European Energy Mix

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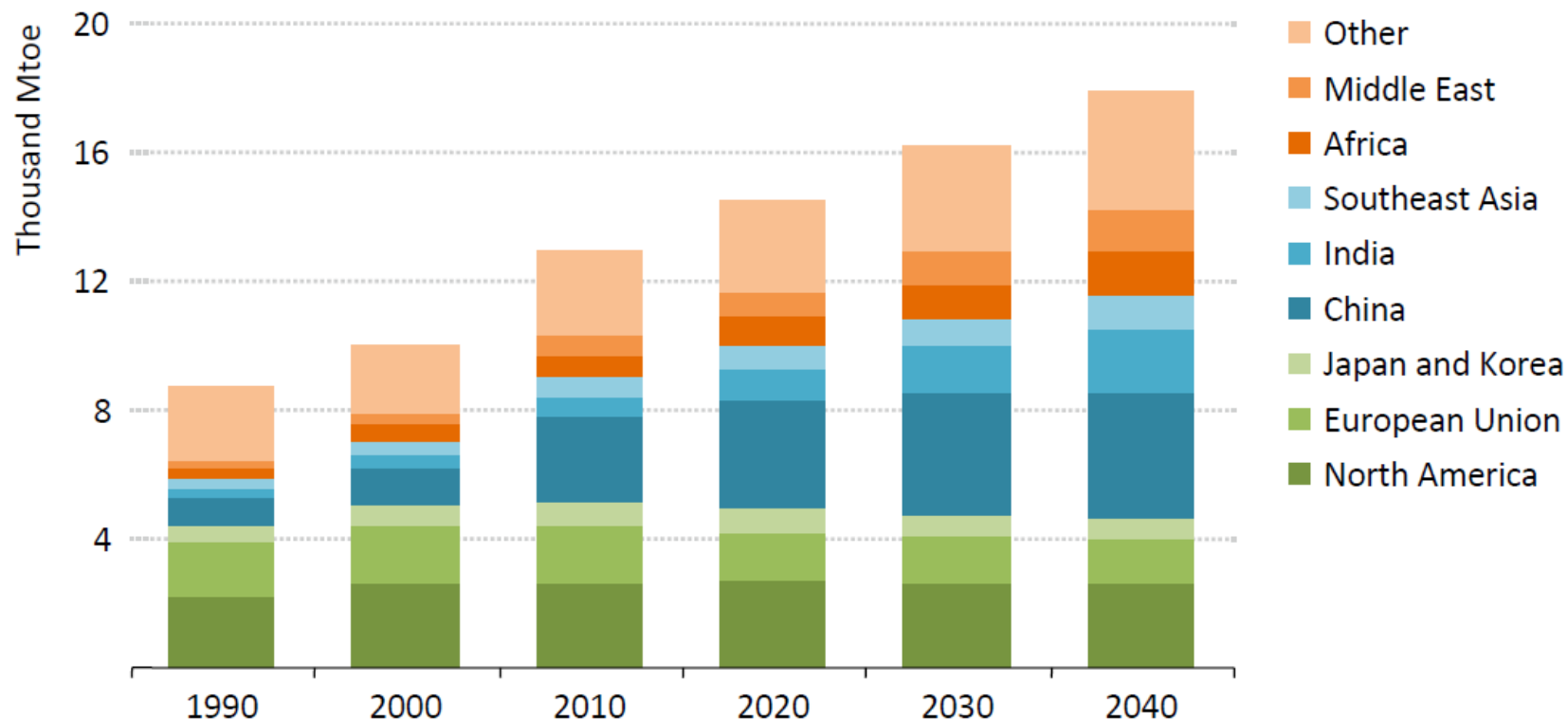
# Energy Sector CO<sub>2</sub>-emissions



*Without net-negative emissions, energy sector CO<sub>2</sub> emissions fall to zero by 2040 for a 50% chance of 1.5 °C and around 2060 for a 66% chance of 2 °C*

*Source: IEA (2016)*

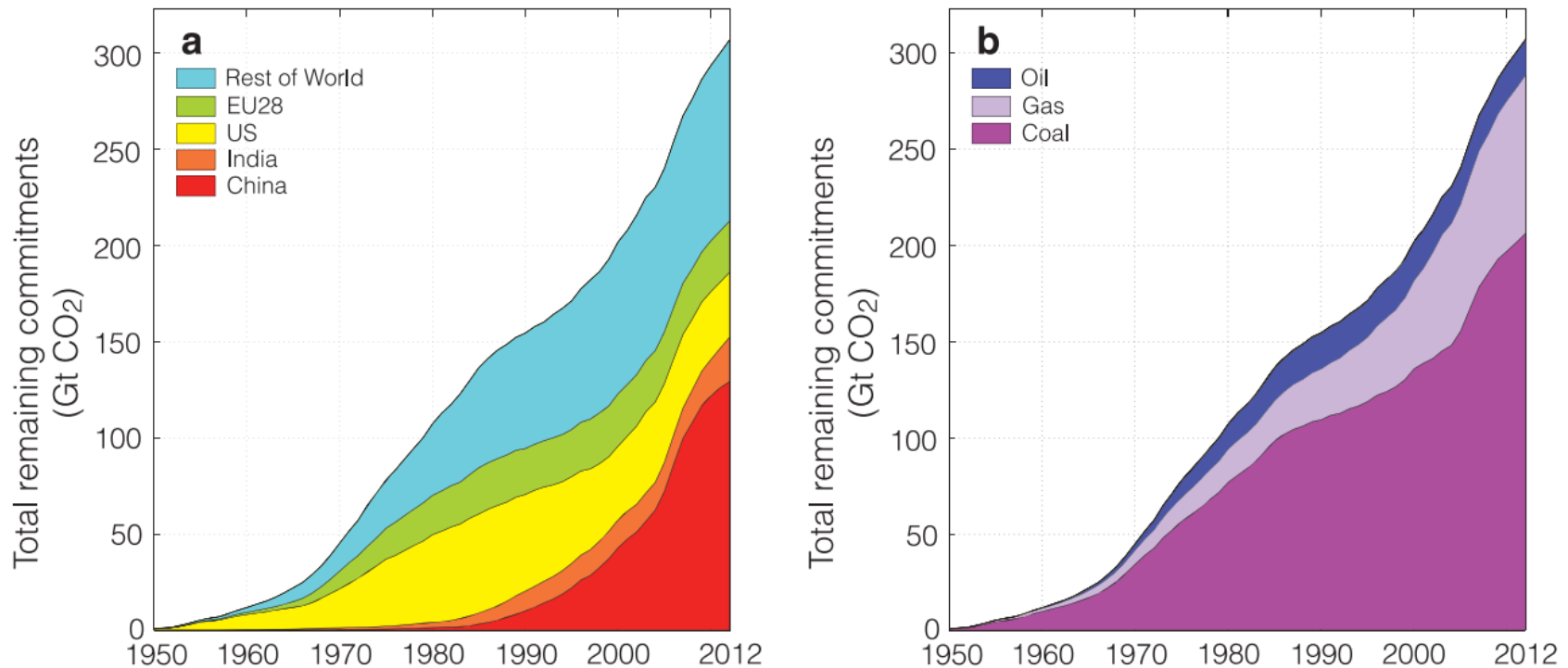
# Energy Demand: OECD vs. Non-OECD



*The geography of global energy demand continues to shift*

*Source: IEA (2016)*

# CO<sub>2</sub> 'lock-in' from power generation



Source: Davis & Socolow (2014)

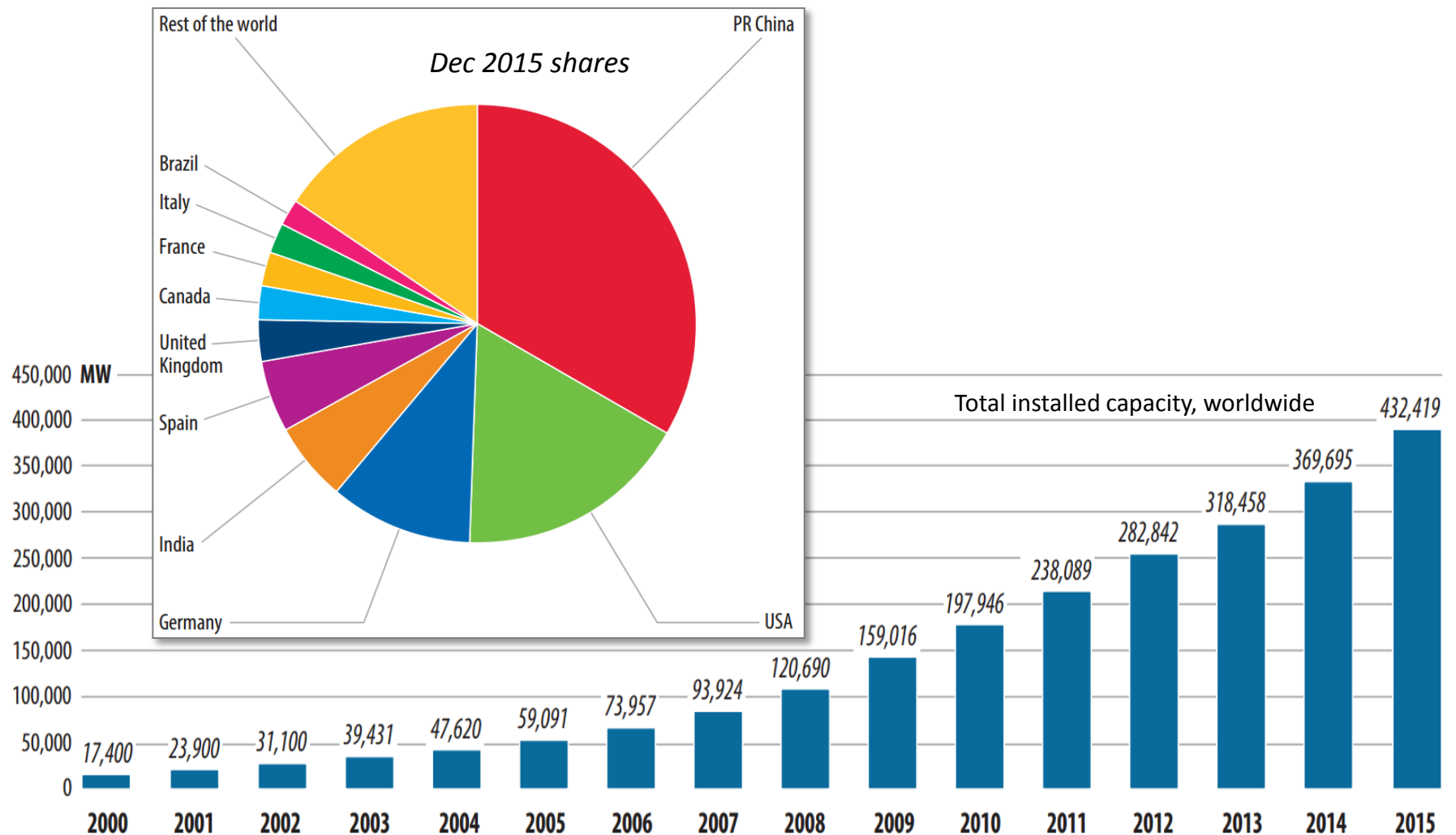
- The graphs show estimations of *future* emissions from power plants
- Emerging economies (China, India) gained in relevance since 1990s/2000s
- Without addressing the position of 'coal', emission targets are hard to achieve

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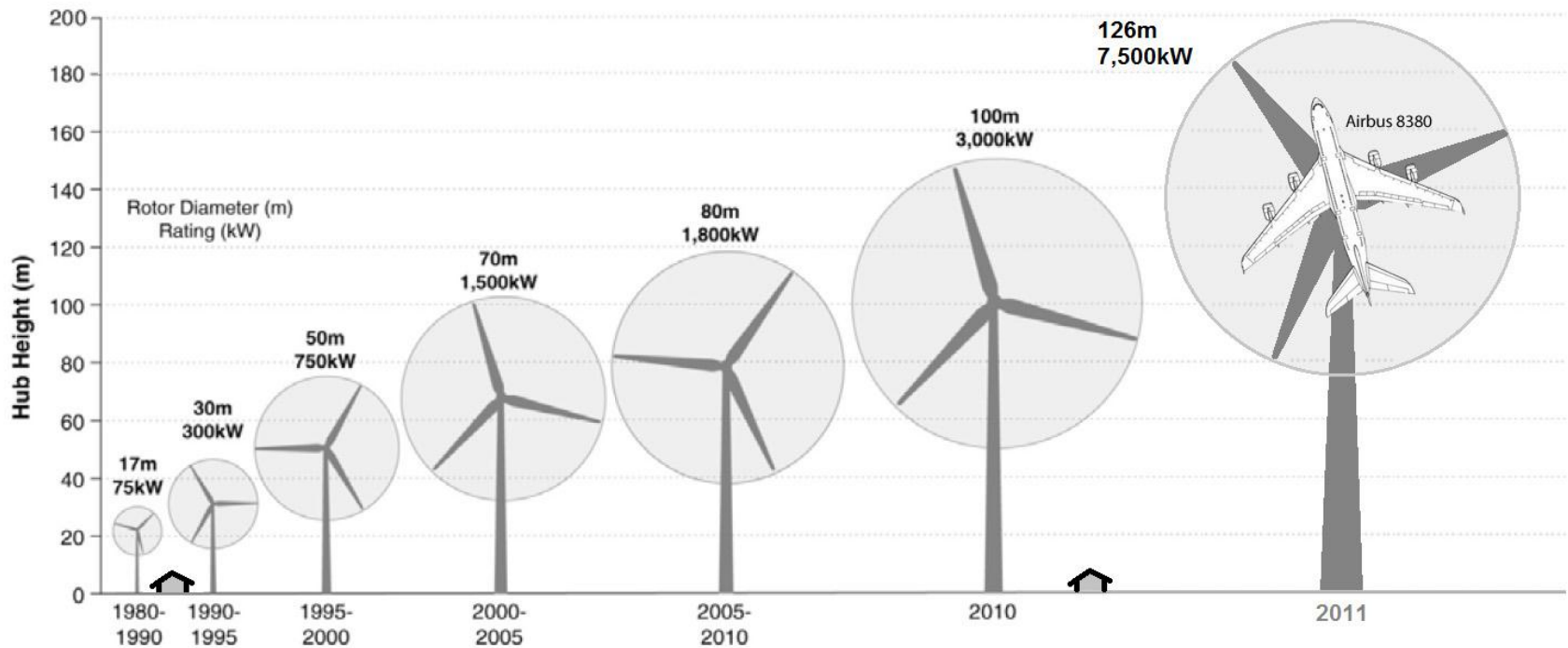


# Installed wind capacity worldwide

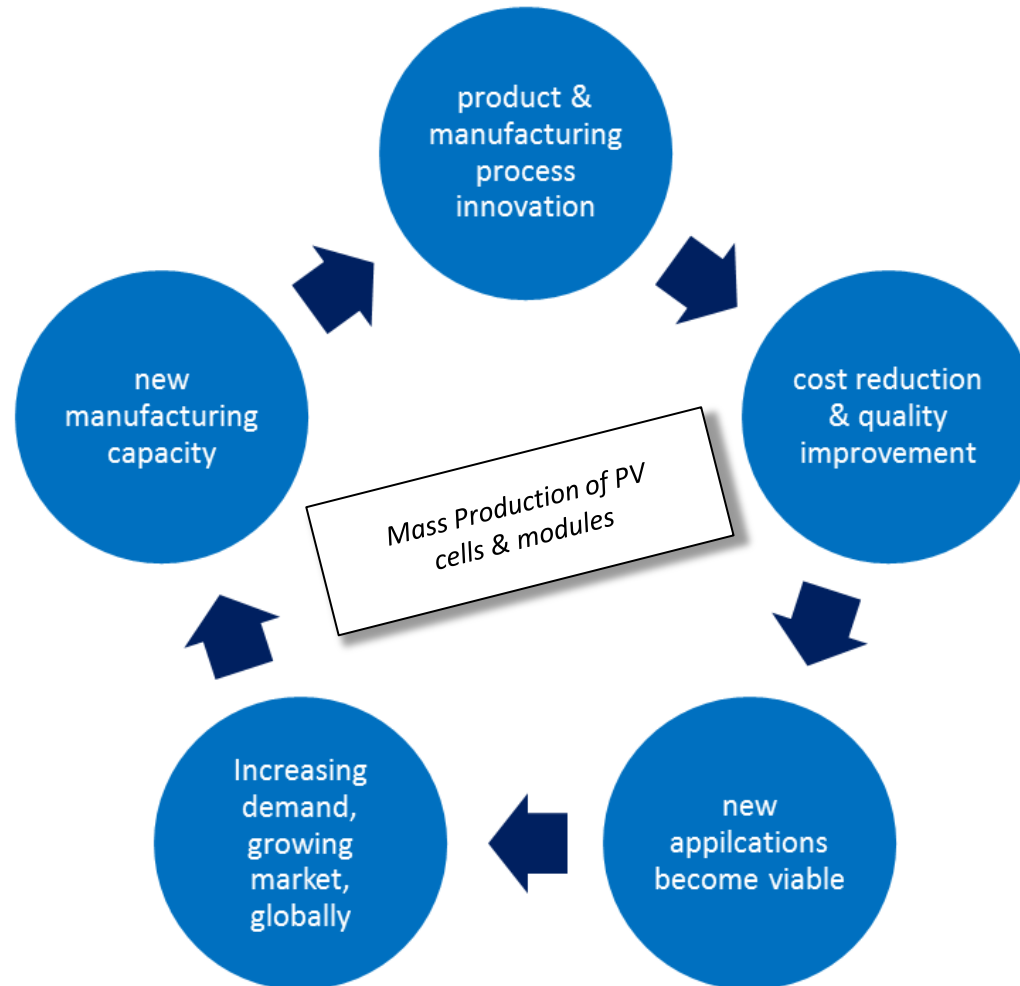


Source: GWEC (2016)

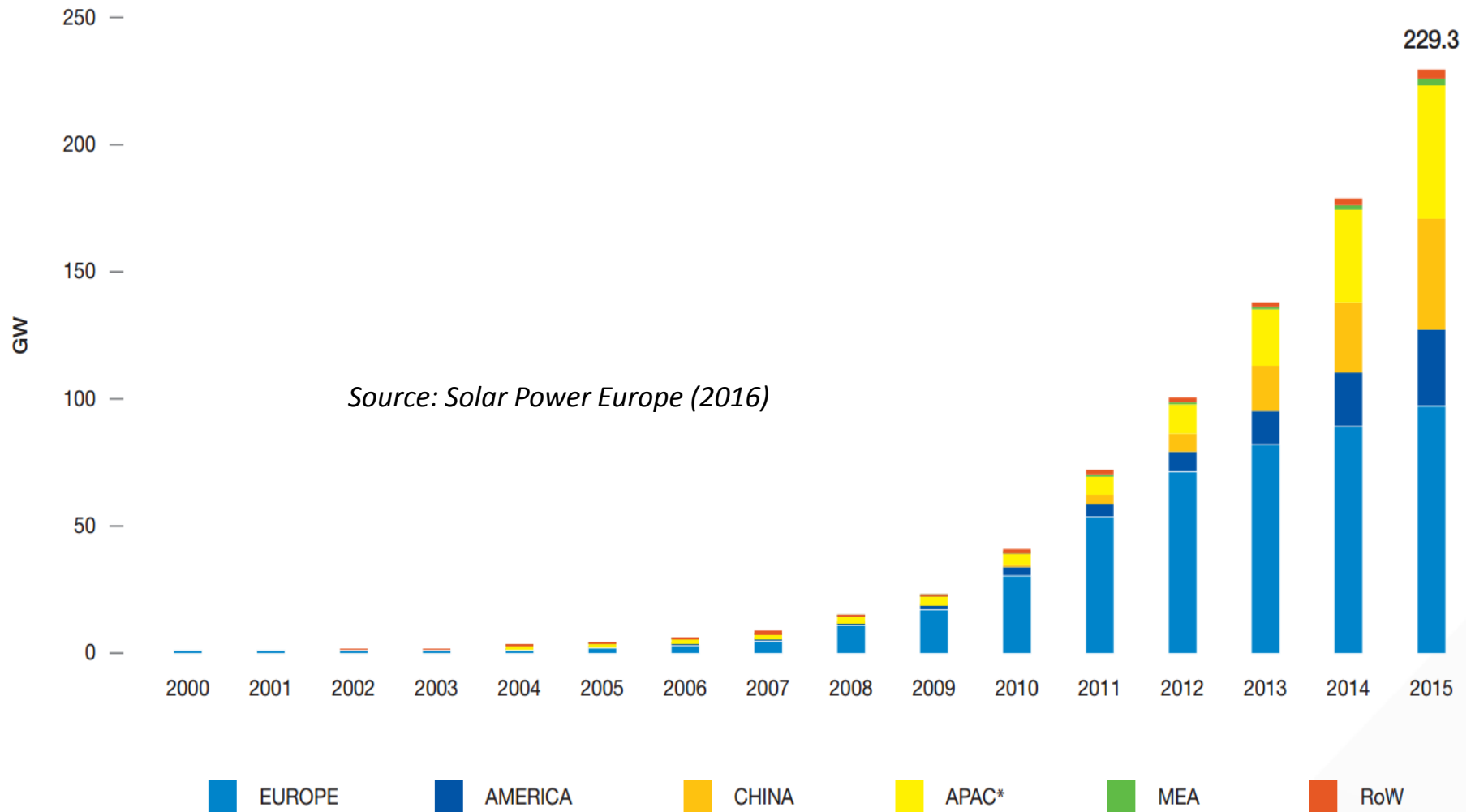
# Wind: A Matter of Scale



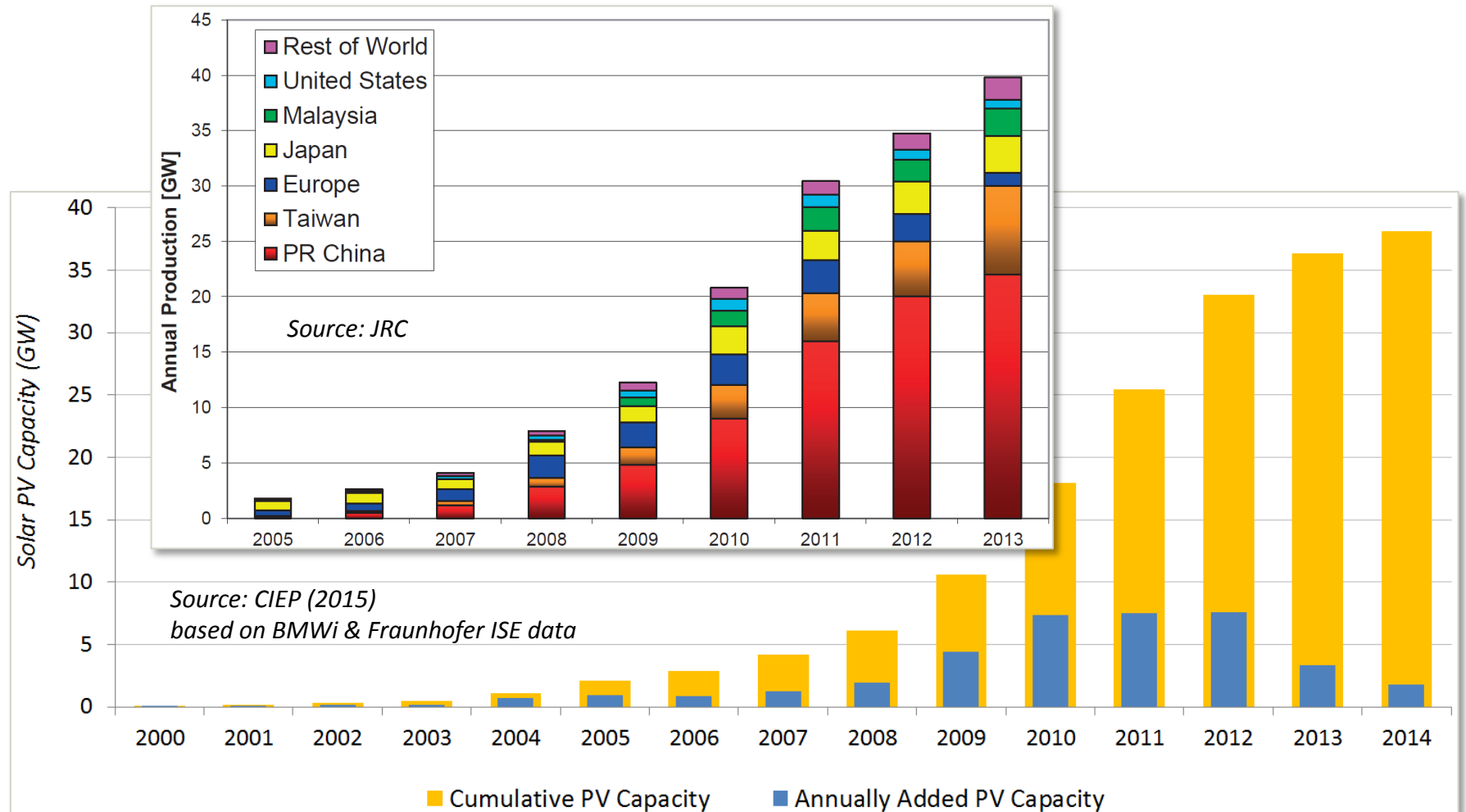
# Solar PV: Mass Production



# Solar PV capacity worldwide



# German pull... meets Chinese push...



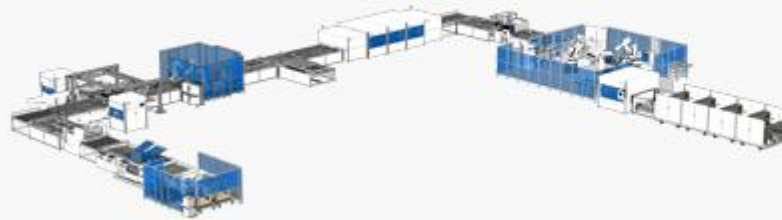
# PV Equipment Suppliers

## CELL LINE

When the mono or multi-crystalline solar cells are finished processes for throughputs of 1100-6600 wafers per hour different factors, such as how capable of expansion the c level of the cell efficiency rate is determined through the p

6600 W/H, MONO/MULTI

## EXAMPLE OF FULLY AUTOMATED STANDARD LAYOUT



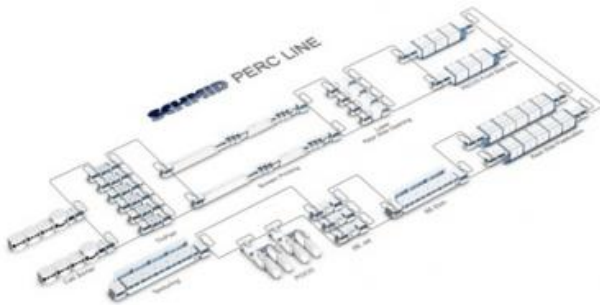
## KEY BENEFITS

**Fully Automated Standard module production line**  
60 MW to 120 MW

- Fully automated module production line for high throughput rates
- State-of-the-art, highly efficient production equipment
- Low personnel requirement for process monitoring and quality control

## Horizontal Cluster Process Line with simple Automation Technology

- Turnkey lines for mono and multi-crystalline wafers with a capacity of 30 to 200 MW per year.
- All equipment and processes from one source
- Automatic clusters.
- Minimal Co
- Quick Ran
- High mach
- Simple cap upgrading production
- Possible to process cl concept.
- Possible to technology
- Integrated monitoring Factory Co
- Guarantee



DEUTSCH ENGLISH

HOME COMPANY PHOTOVOLTAICS PCB DISPLAY AND OPTICS AUTOMATION / MONTRAC CYKLOS WORLDWIDE

## NEW: SCHMID InfinityLine

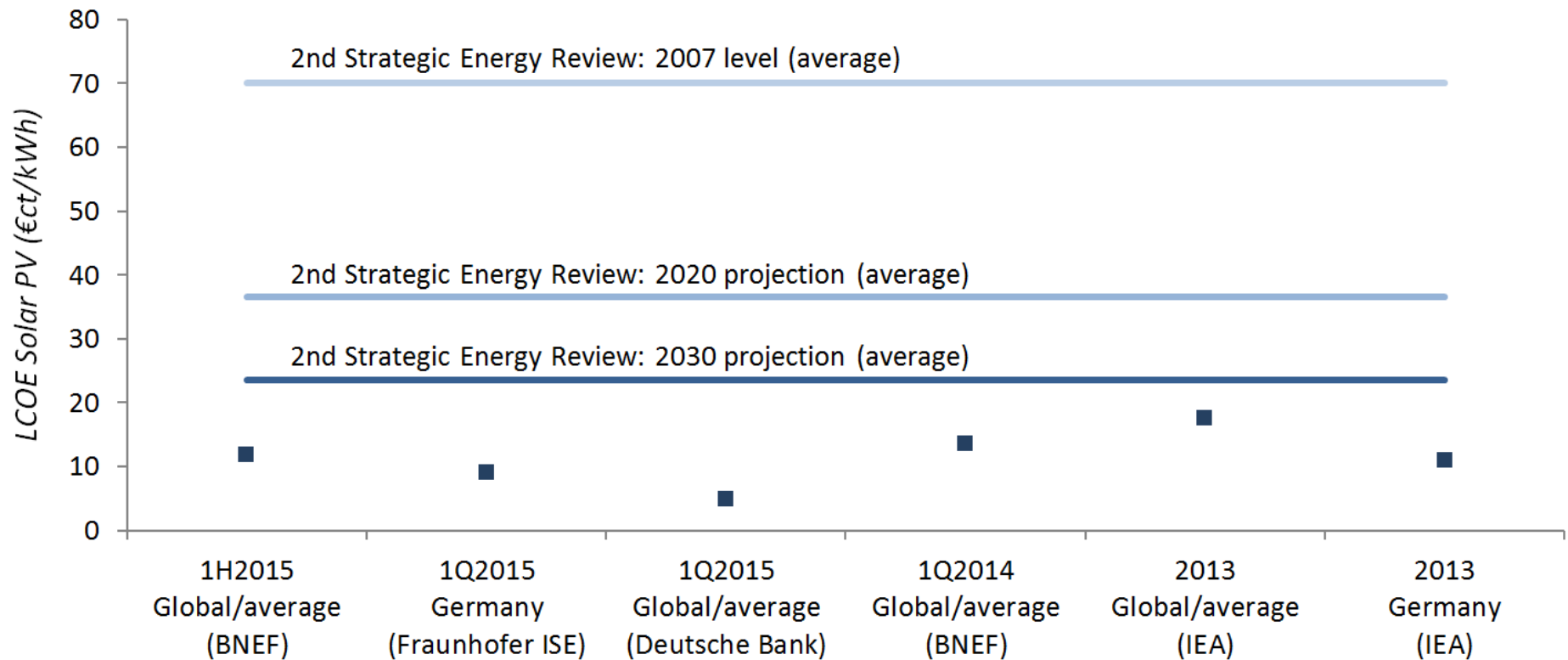


Visit us at  
productronica  
Nov. 10-13, 2015  
hall B1, booth 203

**Discover something new**  
We present our intelligent  
SCHMID InfinityLine with  
New Etching Options (NEO).

Source: SCHMID Group company website

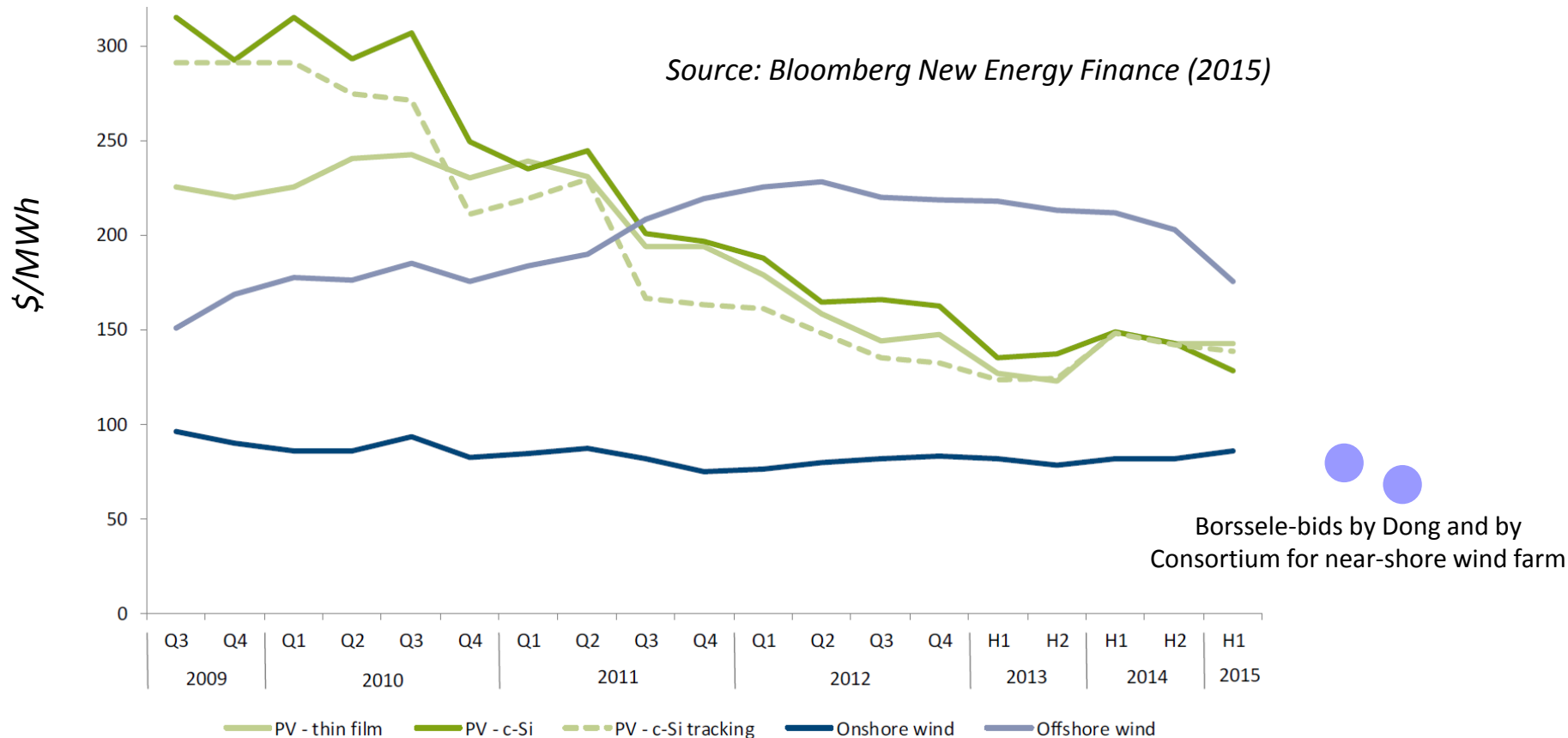
# Levelized Cost of Electricity for PV



Significantly below levels anticipated by many!

- Fuzzy picture because of rapid change...
- ... Cases observed below 5 €/kWh (Dubai & India) and 7 €/kWh (Germany)

# Recent cost developments solar & wind



Dong: 72,7 euro + 14 euro grid connection

Consortium: 54,5 euro + 14 euro grid connection

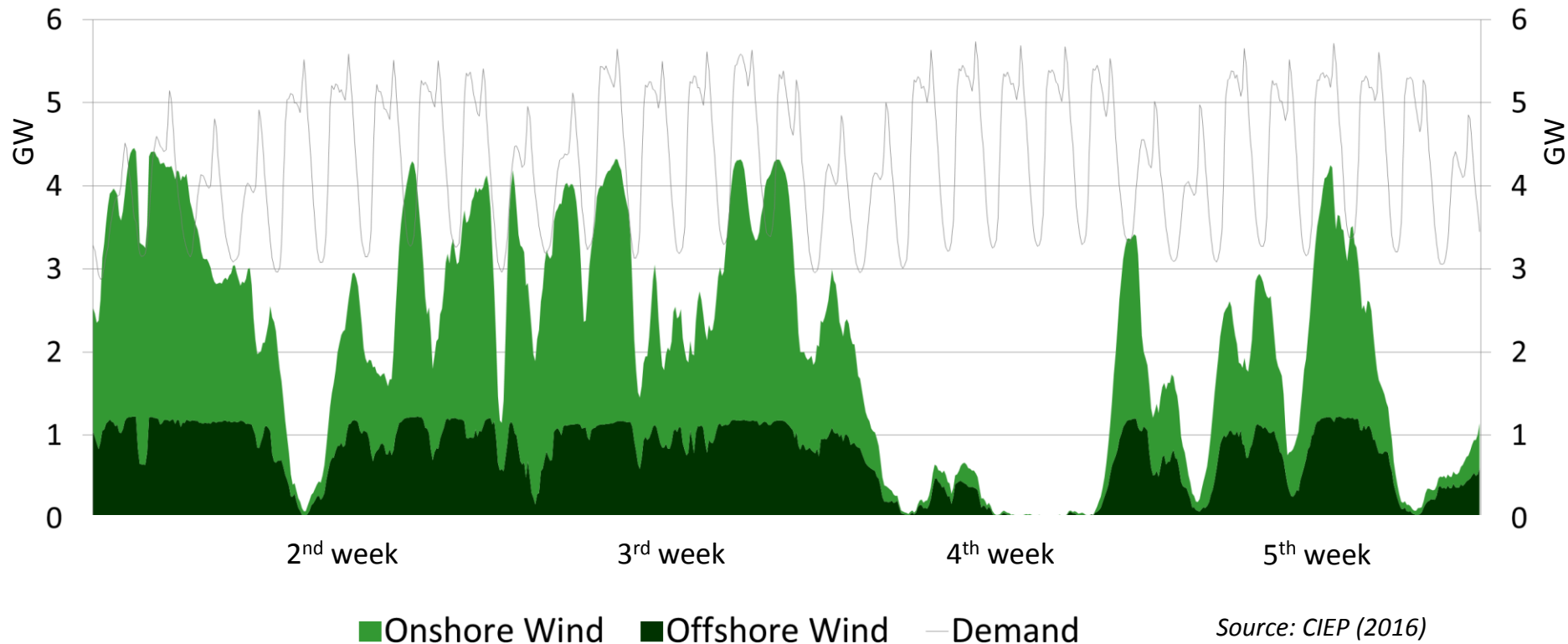


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# Lessons from Denmark

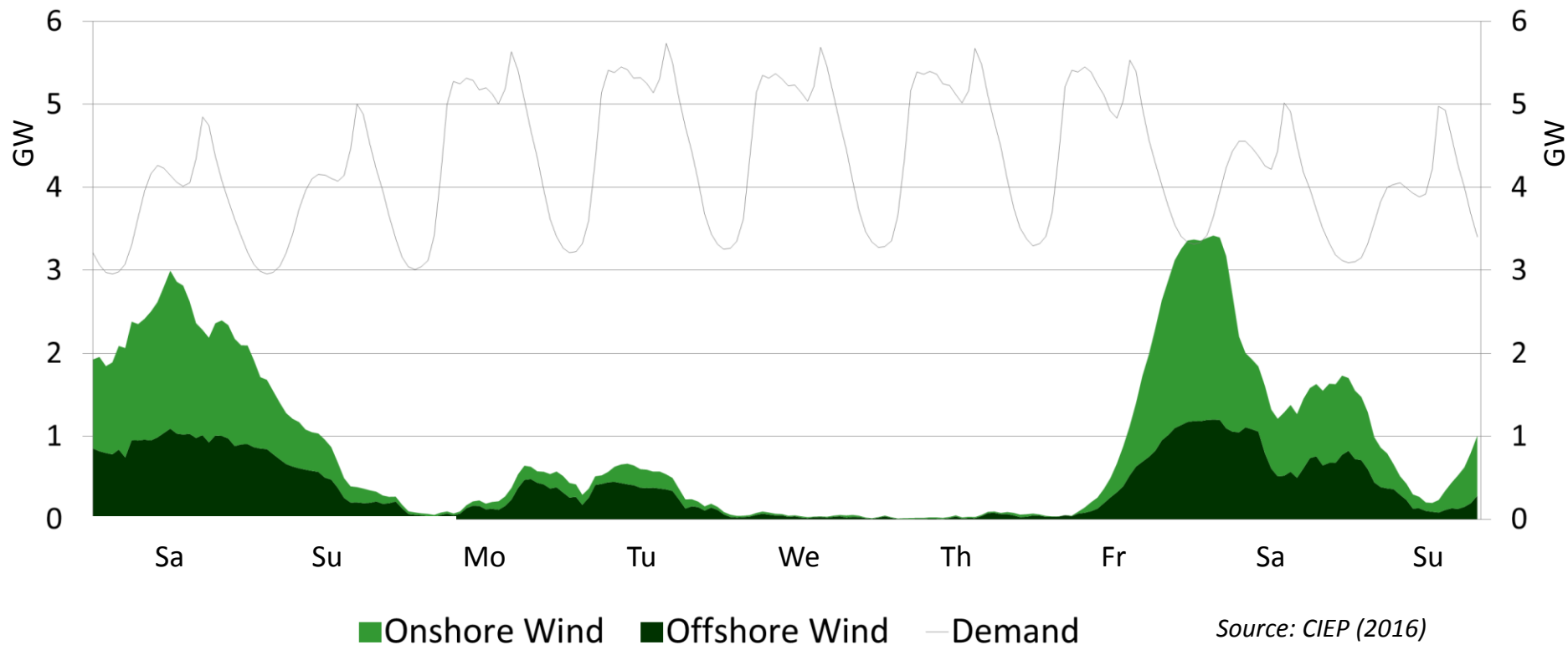
- Generation from wind turbines is variable
- Production varies from minute to minute, every day again!
- The graphs below shows Denmark in **January 2015**



Source: CIEP (2016)  
based on energinet.dk

# Lessons from Denmark

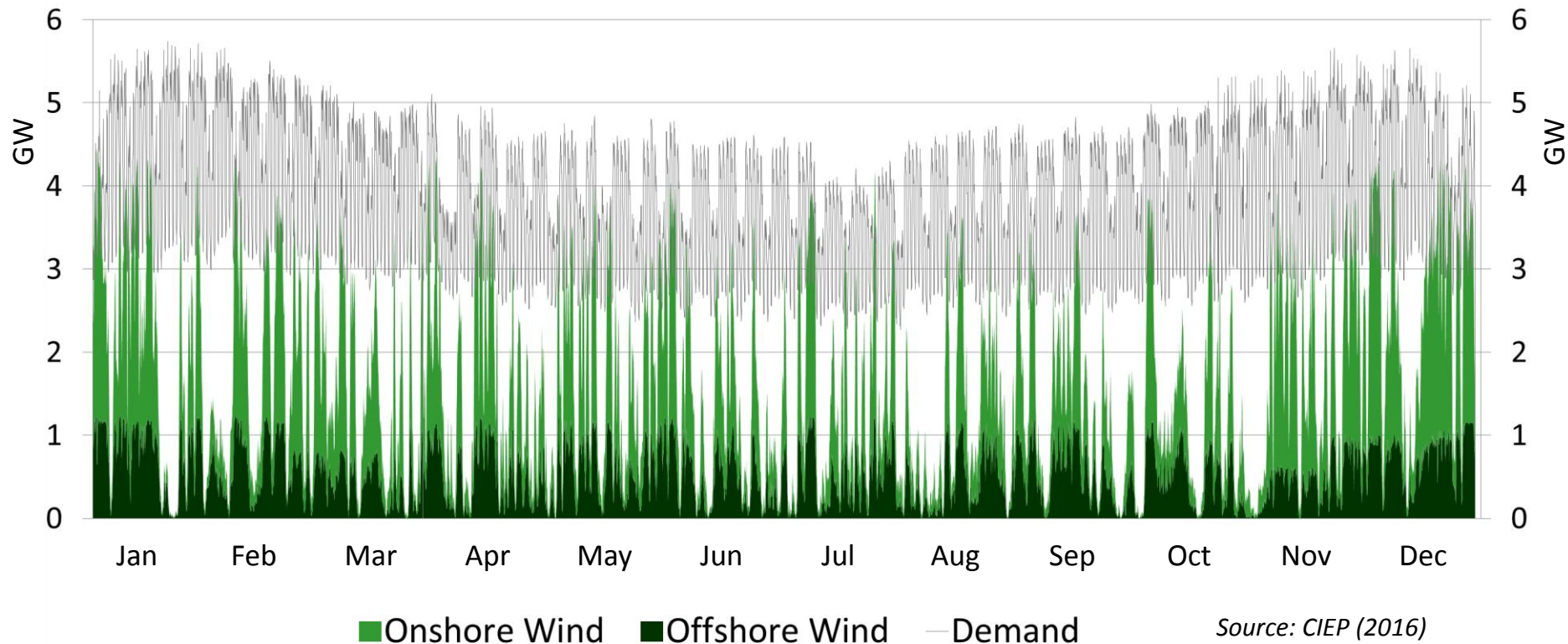
- Some periods can be particular challenge, such as the 4th week of 2015
- The figure below shows the period from **Saturday 17 to Sunday 25 January**
- Hardly any wind energy was available for a full workweek



Source: CIEP (2016)  
based on energinet.dk

# Lessons from Denmark

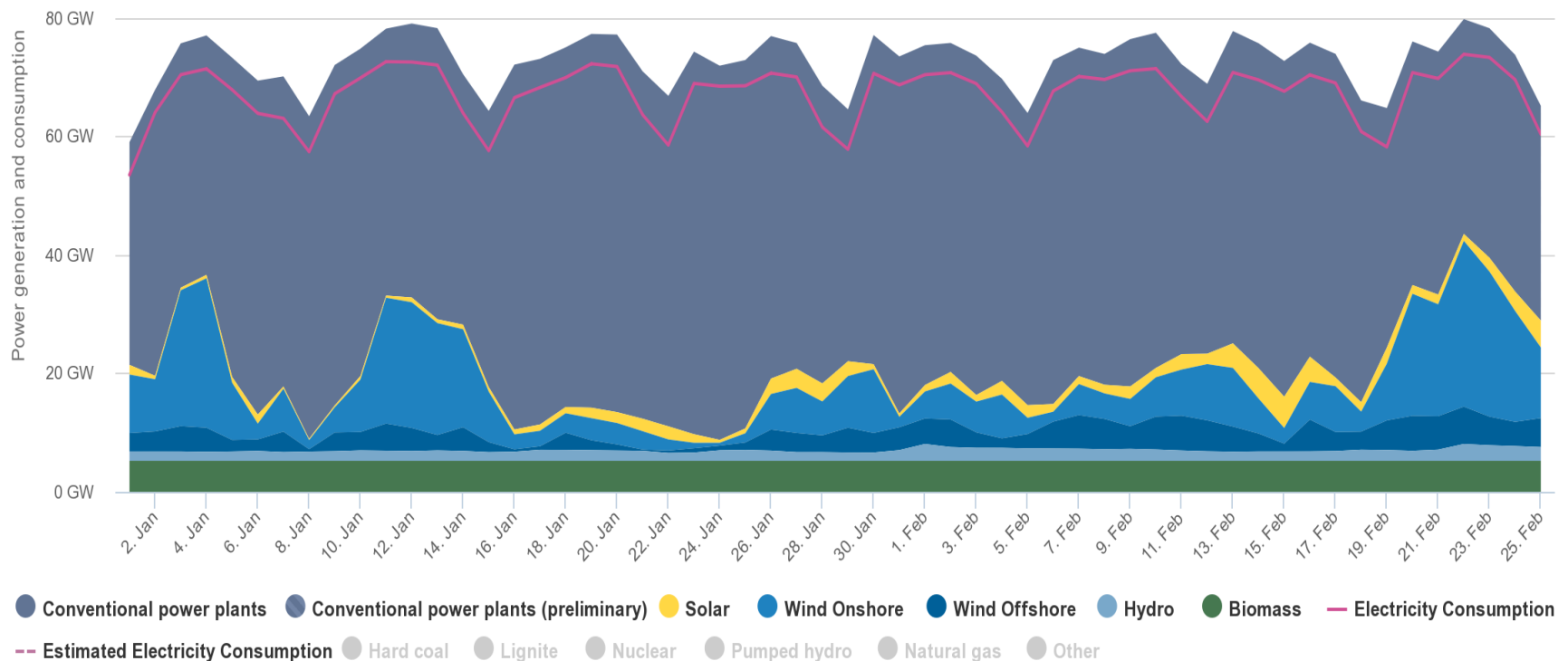
- In 2015, the share of wind energy in the Danish *electricity* mix was 42%
- But keep in mind that actual generation is variable throughout the year
- The figure below shows Denmark in **the full twelve months of 2015**



Source: CIEP (2016)  
based on [energinet.dk](http://energinet.dk)

# ‘Dunkelflaute’ in Germany, winter 2017

- Earlier this year (2017), we had a ‘cold spell’ in Europe
- Coincidence of big cold, little wind, and little sun, for almost a month
- The Germans invented a word for this (not unusual) event: ***Dunkelflaute***



Source: Agora Energiewende (2017)

# Heat vs. electricity: Netherlands example

- While *electricity* demand is difficult to meet at such moments...
- ... keep in mind that *energy* demand for *heating* is even much more challenging
  - Seasonality (high peak demand in winter)
- Electrifying heating needs must go hand-in-hand with reducing demand

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# NW-Europe and the Energiewende

November 11, 2015 1:13 pm

## FINANCIAL TIMES

Eon reports record loss of €7.25bn as it writes down power assets

Germany's Eon names spin off Uniper



## Vattenfall's strong wind year marred by losses elsewhere

SWEDEN: Utility Vattenfall's wind division EBITDA increased 22.5% in 2015, while the group recorded a SEK 23 billion (€2.5 billion) operating loss in its financial year due to impairment losses in its lignite, nuclear and coal businesses.

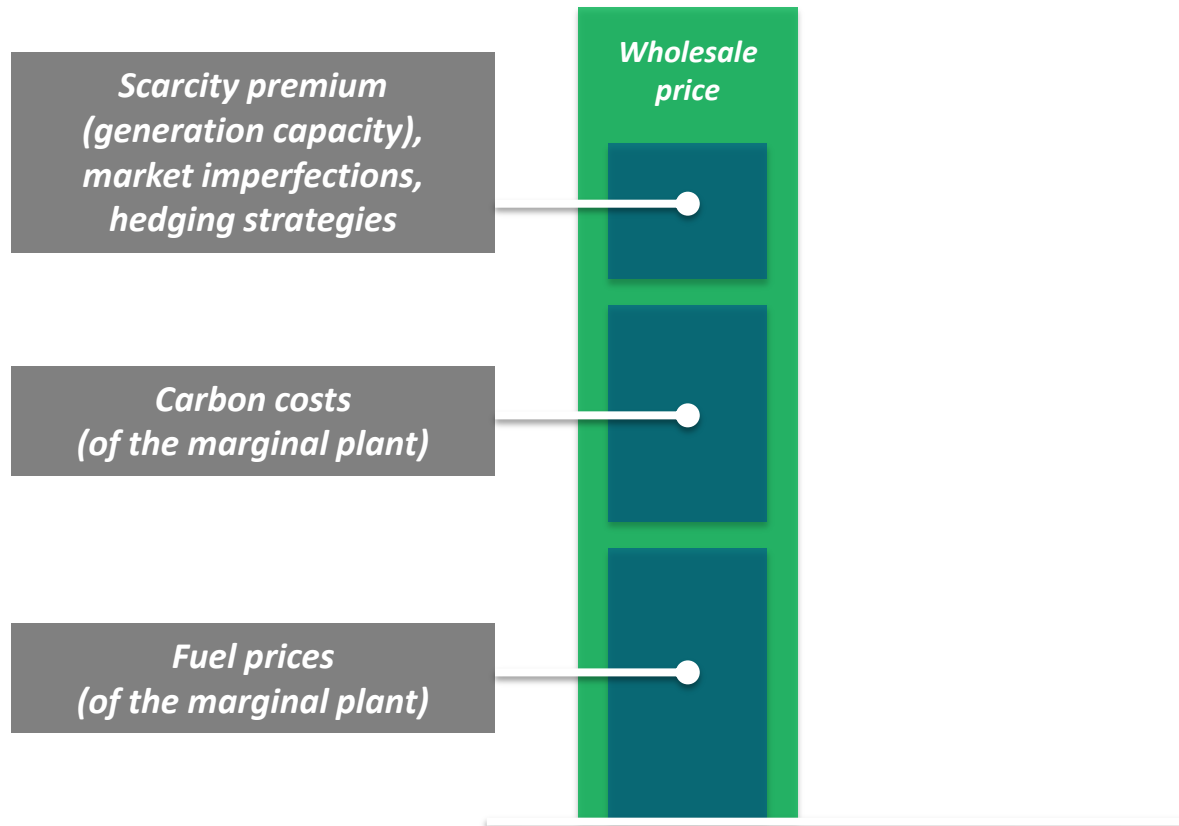
## BUSINESS THE WALL STREET JOURNAL.

### RWE to Sell Part of its Renewable Energy Business

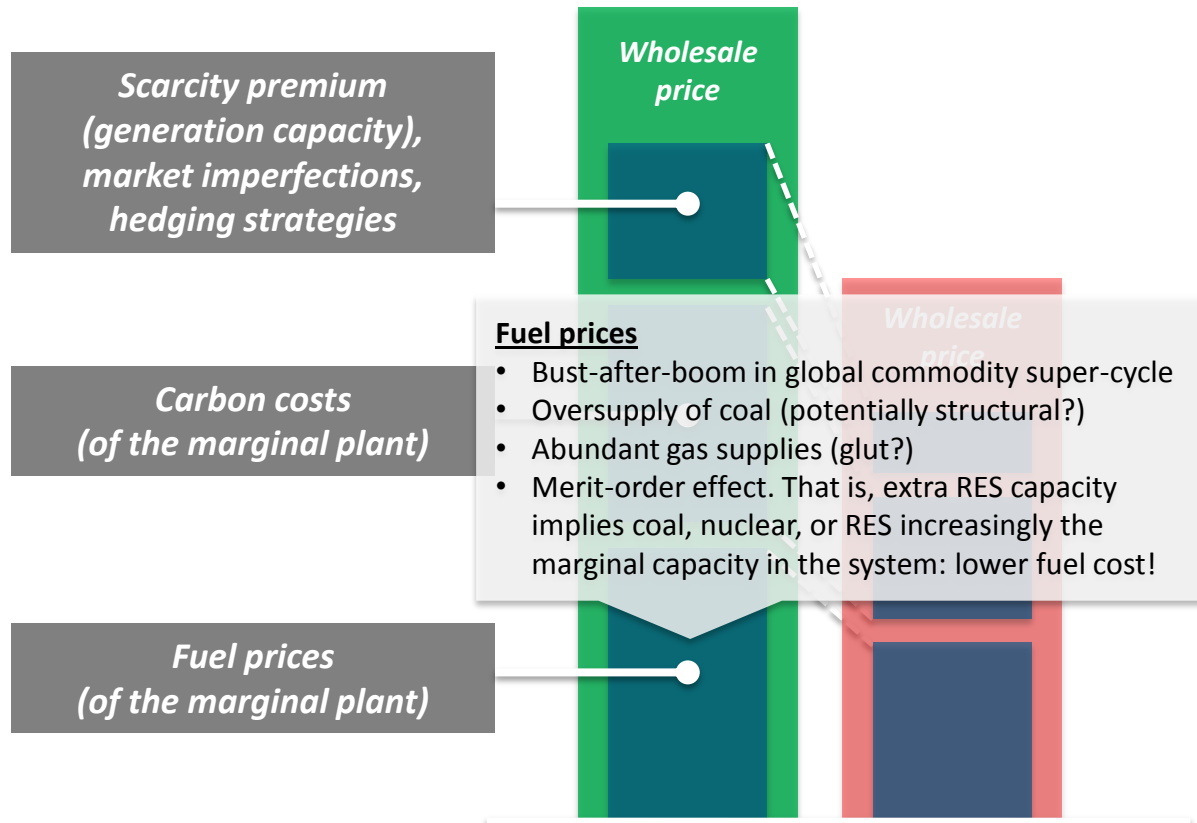
German utility is to restructure its business, creating a holding company with separate units



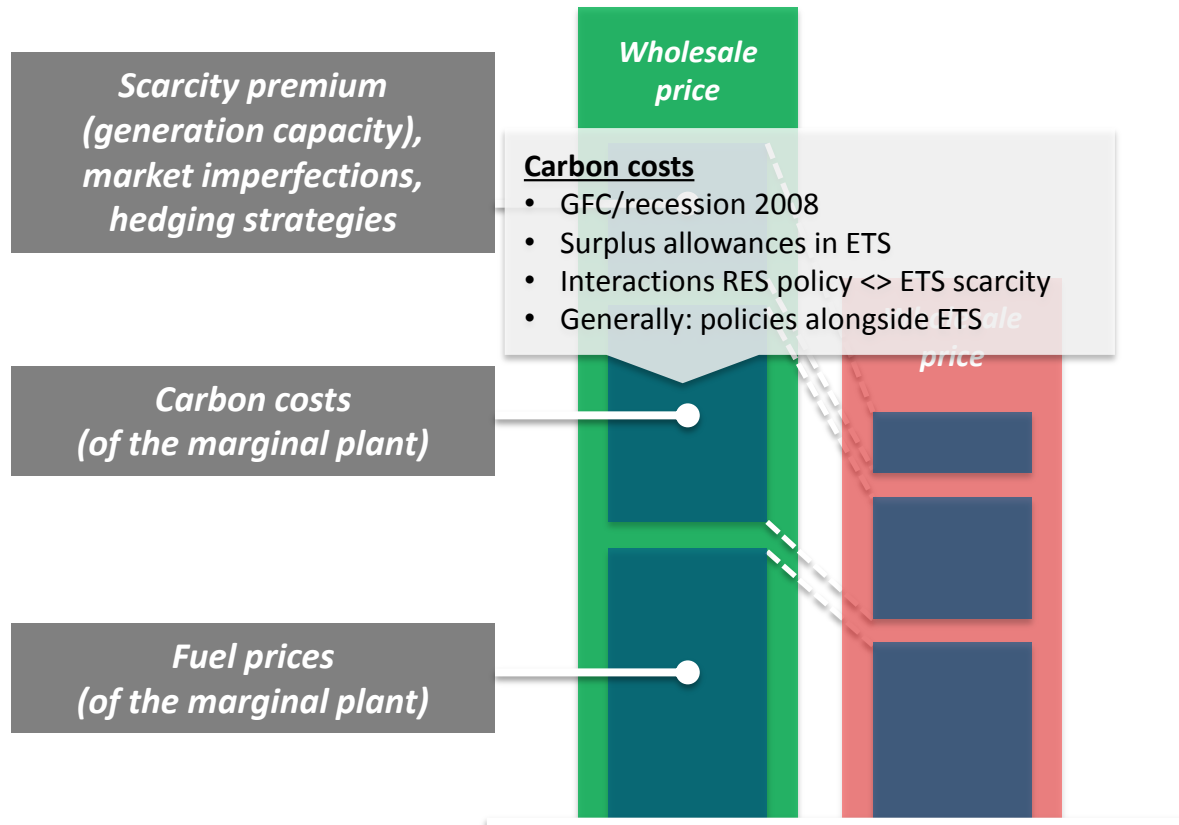
# Understanding wholesale electricity prices



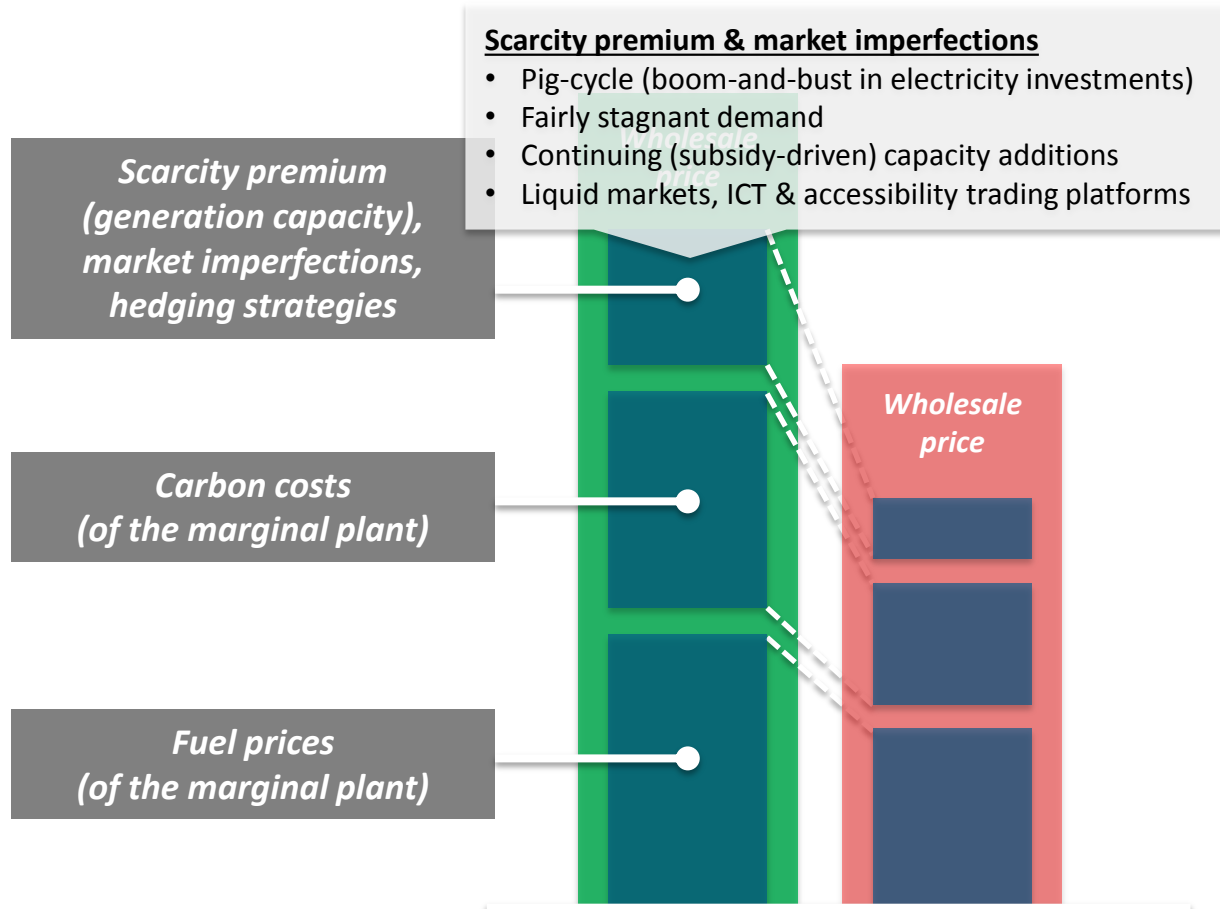
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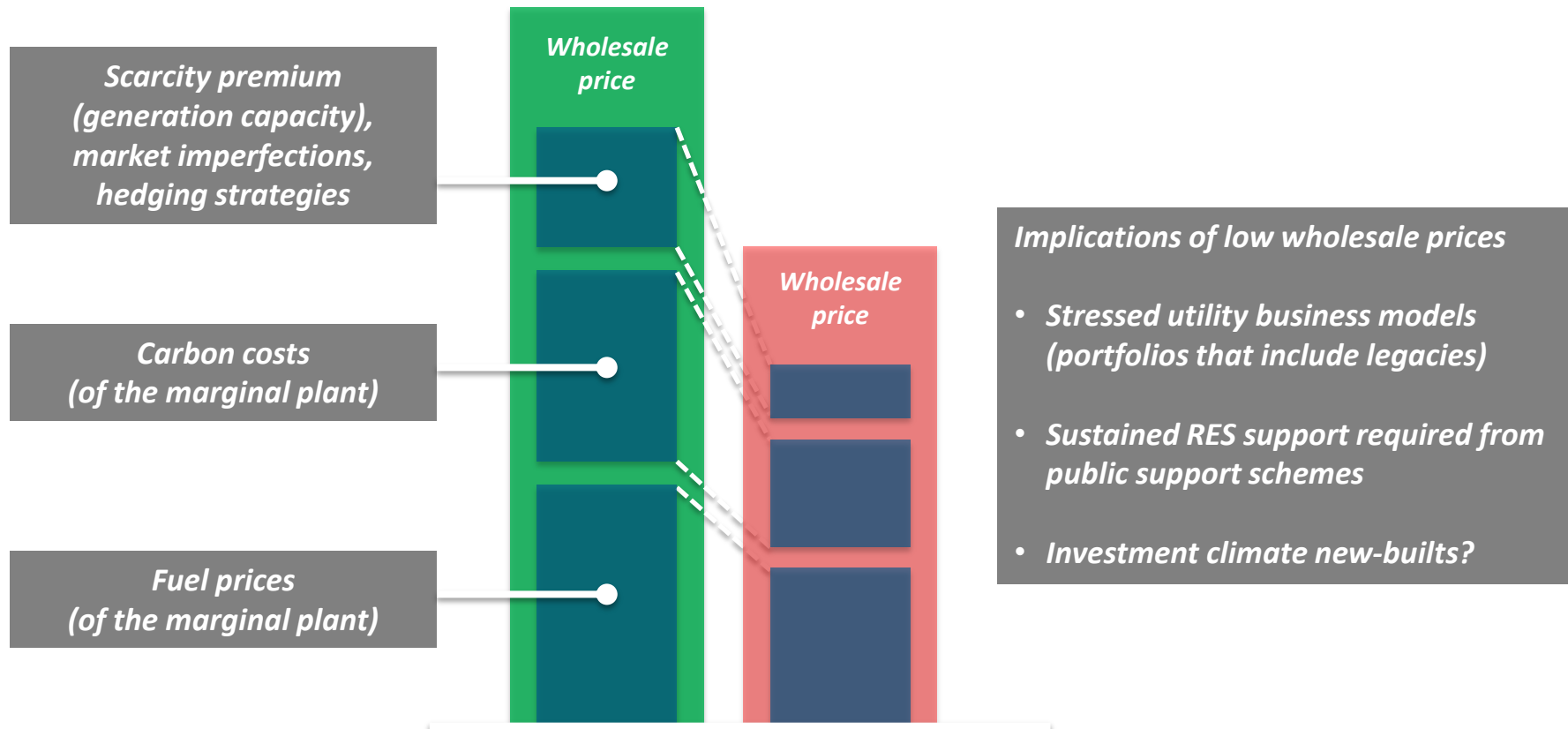
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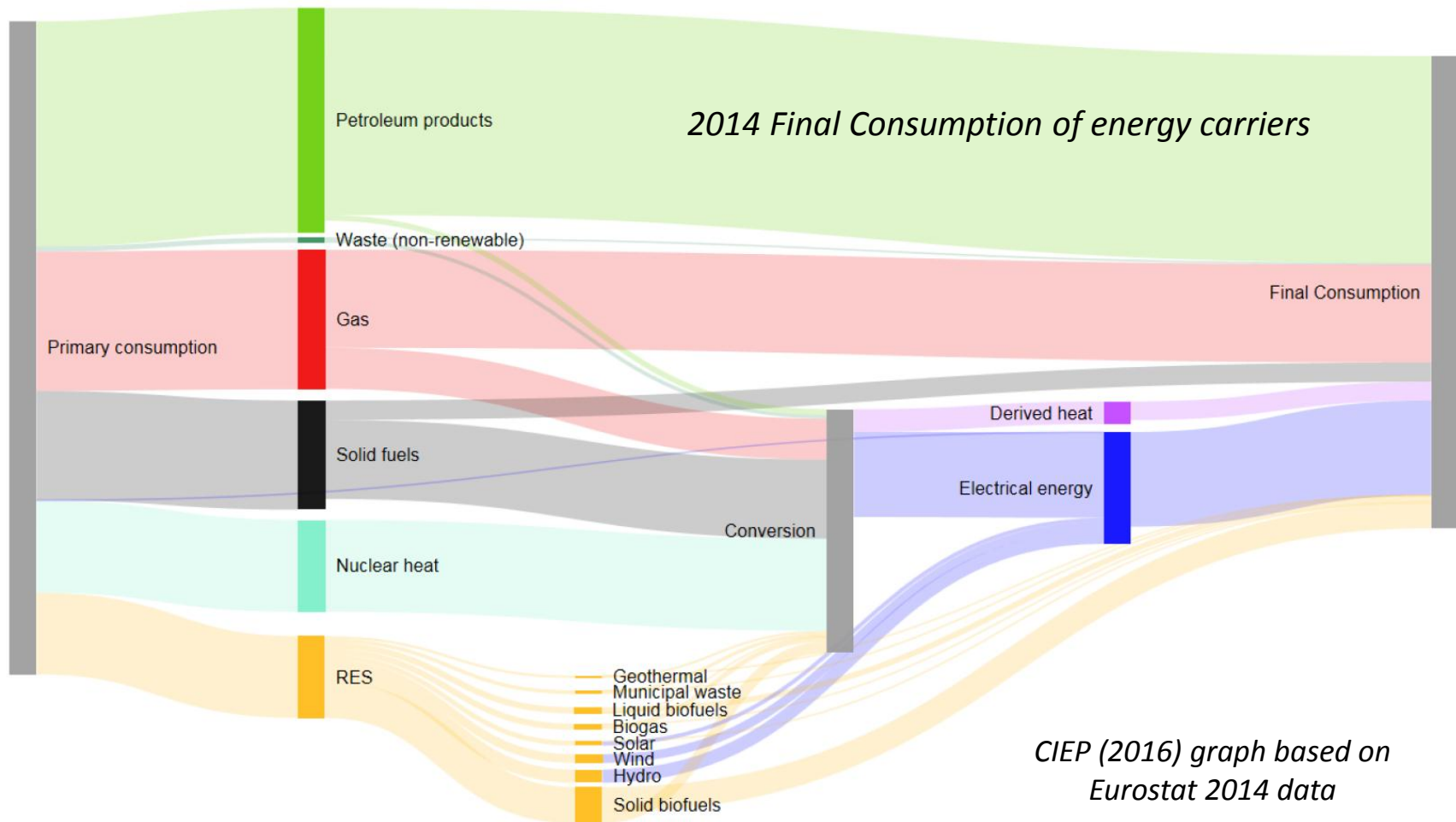
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# Back to the total picture for the EU...



***Thank you!***

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*CIEP contribution to 'The Nuclear Elephant' seminar, 3 March 2017, Amsterdam.*