

---

# ***THE COST AND VALUE OF ENERGY STORAGE SYSTEMS***

***Session: Energy and Industrial Competitiveness***



**Prof. Manfred Weissenbacher**

Institute for Sustainable Energy

**University of Malta**

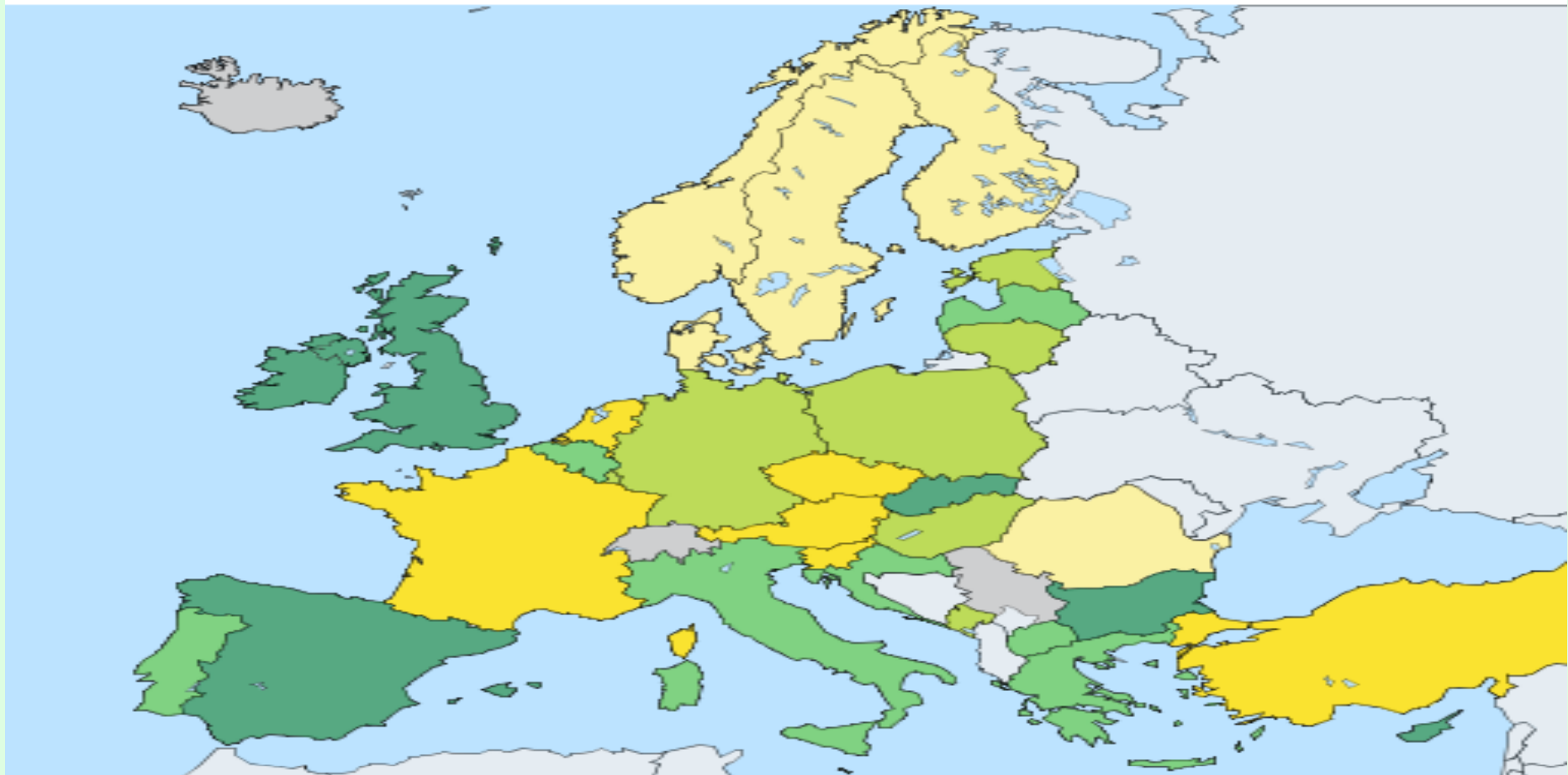
*AIEE Energy Symposium, 30.11.-2.12.2016, Milan/Italy*



# Electricity prices by type of user

EUR per kWh - 2016

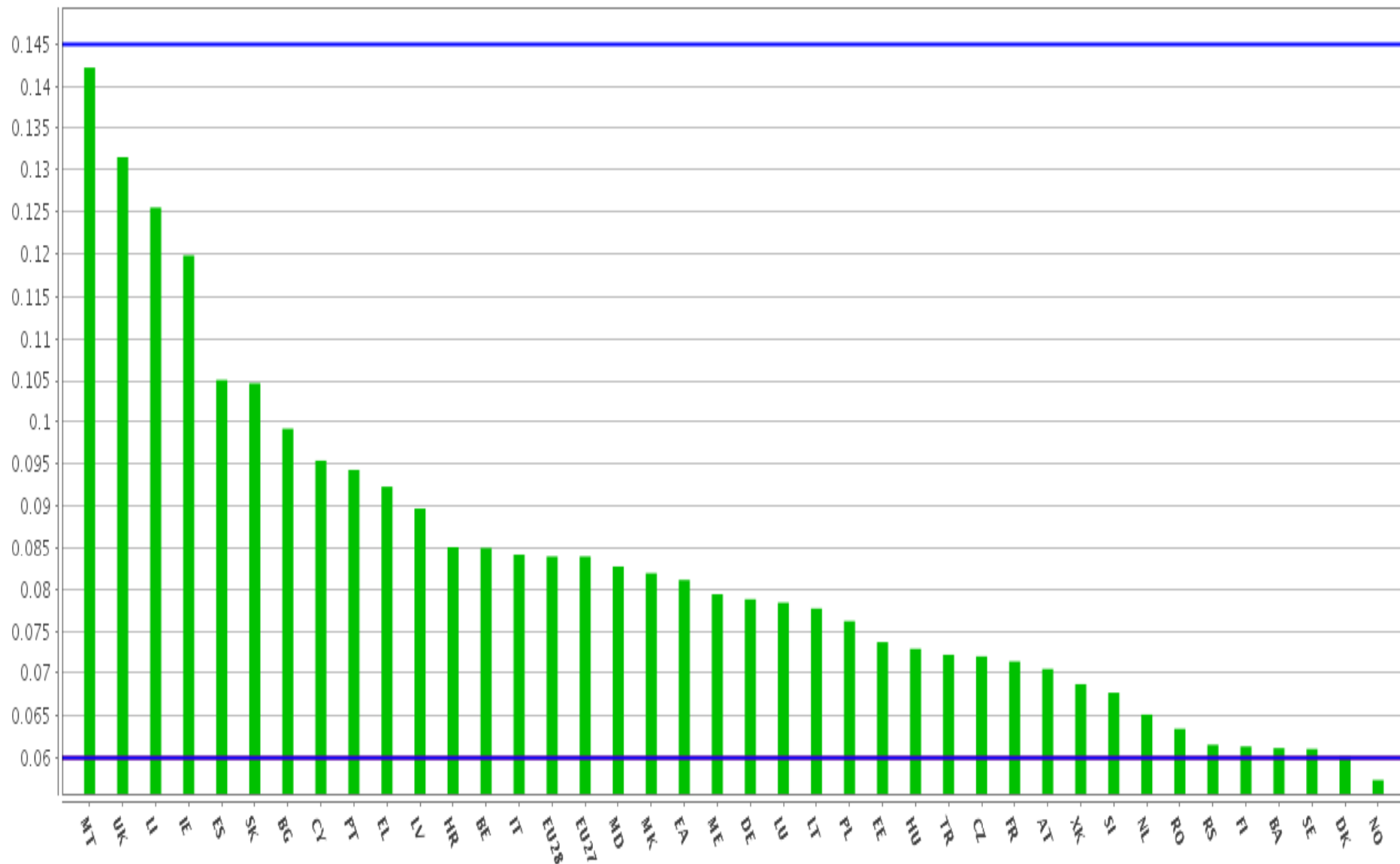
Medium size industries



# Electricity prices by type of user

EUR per kWh

Medium size industries



---

This indicator presents electricity prices charged to final consumers.

Electricity prices for industrial consumers are defined as follows:

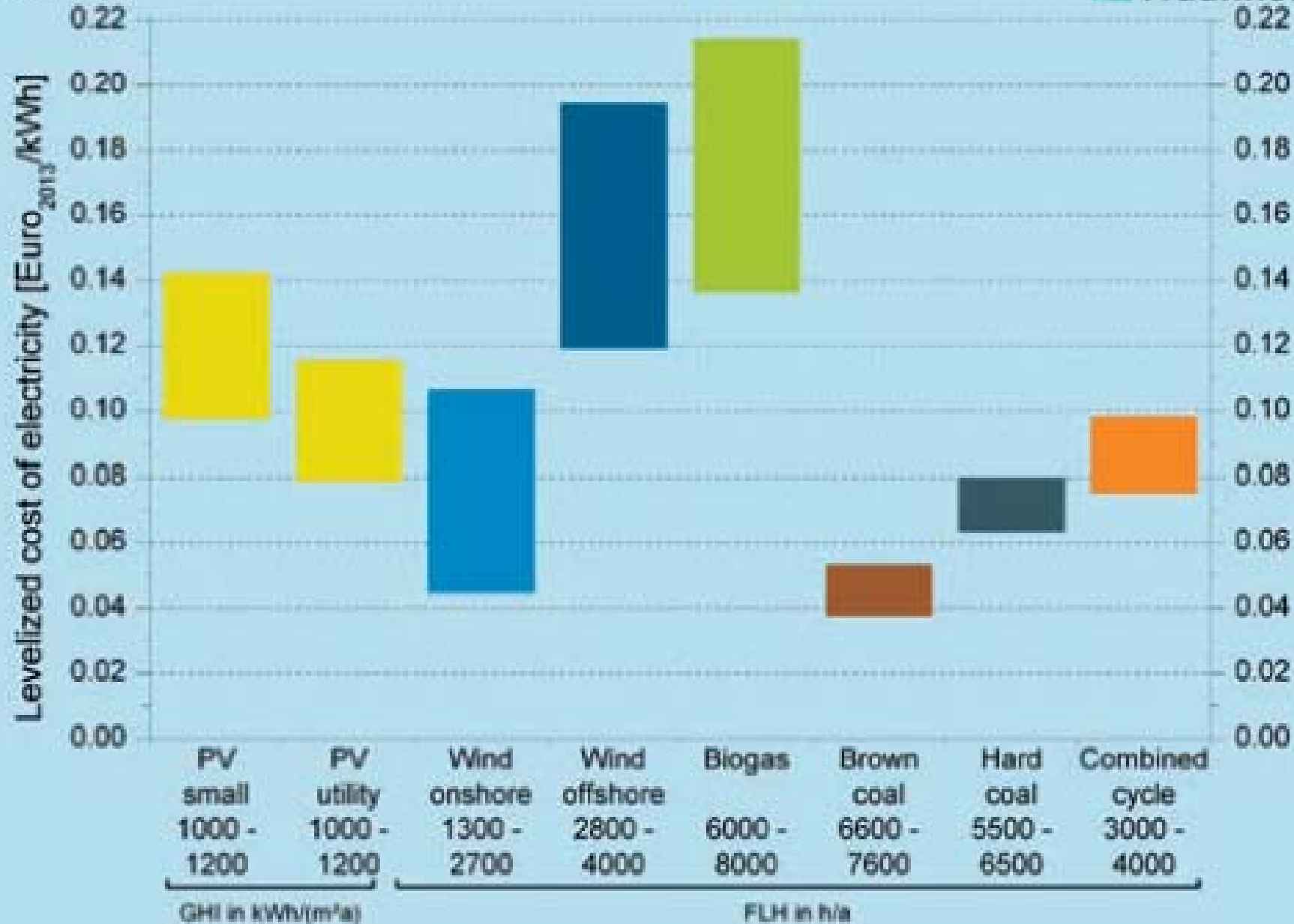
Average national price in Euro per kWh without taxes applicable for the first semester of each year for medium size industrial consumers (Consumption Band Ic with annual consumption between 500 and 2000 MWh).

## Non-Residential kWh Consumption Tariff rates

(exclusive of VAT)

<b>Band</b>	<b>Cumulative Consumption (kWh)</b>	<b>Rate (€)</b>
1	0 - 2,000	0.1215
2	2,001 - 6,000	0.1275
3	6,001 - 10,000	0.1373
4	10,001 - 20,000	0.1485
5	20,001 - 60,000	0.1613
6	60,001 - 100,000	0.1500
7	100,001 - 1,000,000	0.1403
8	1,000,001 - 5,000,000	0.1275
9	5,000,000 & over	0.1080

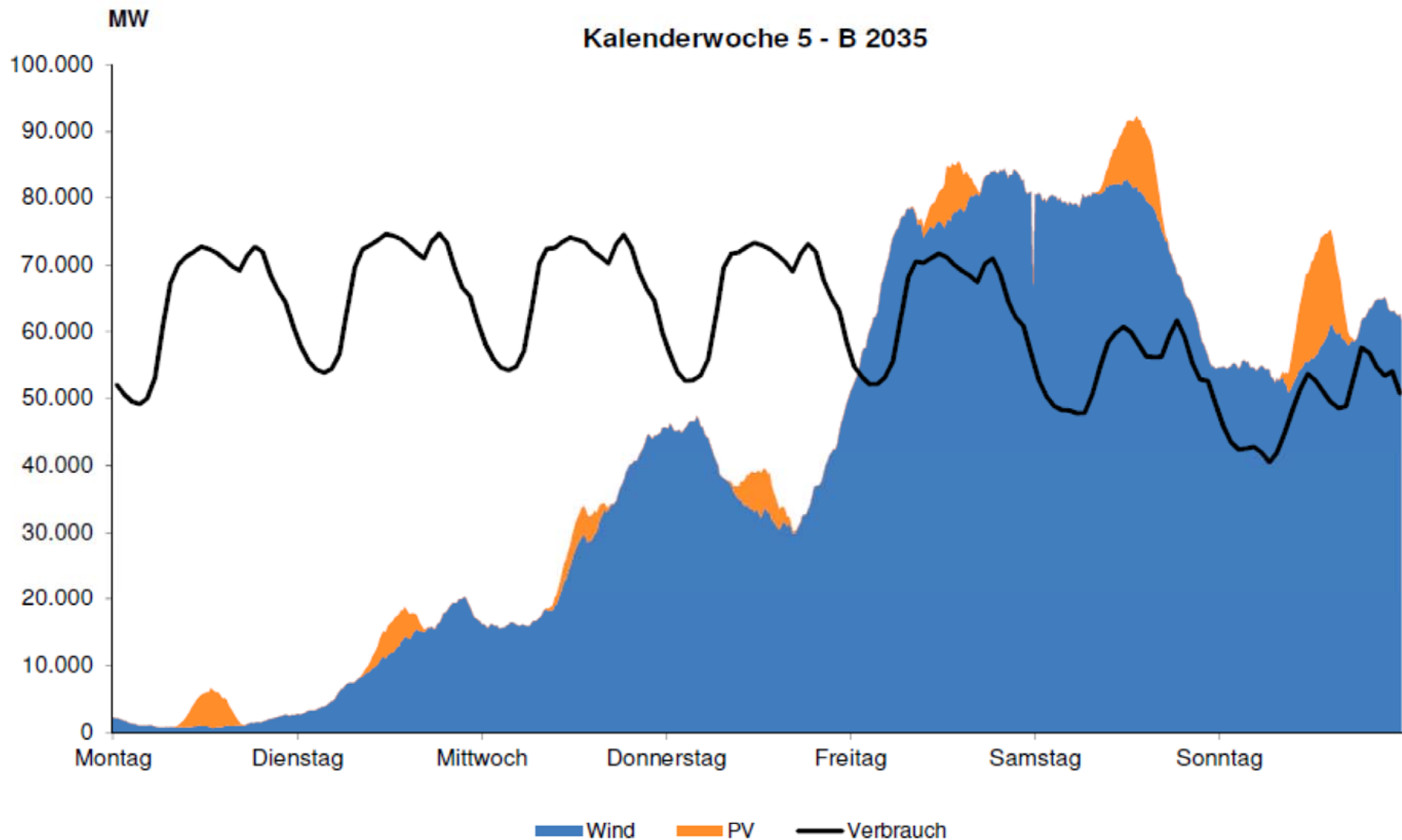
Version: Nov. 2013



► Fraunhofer, 2013

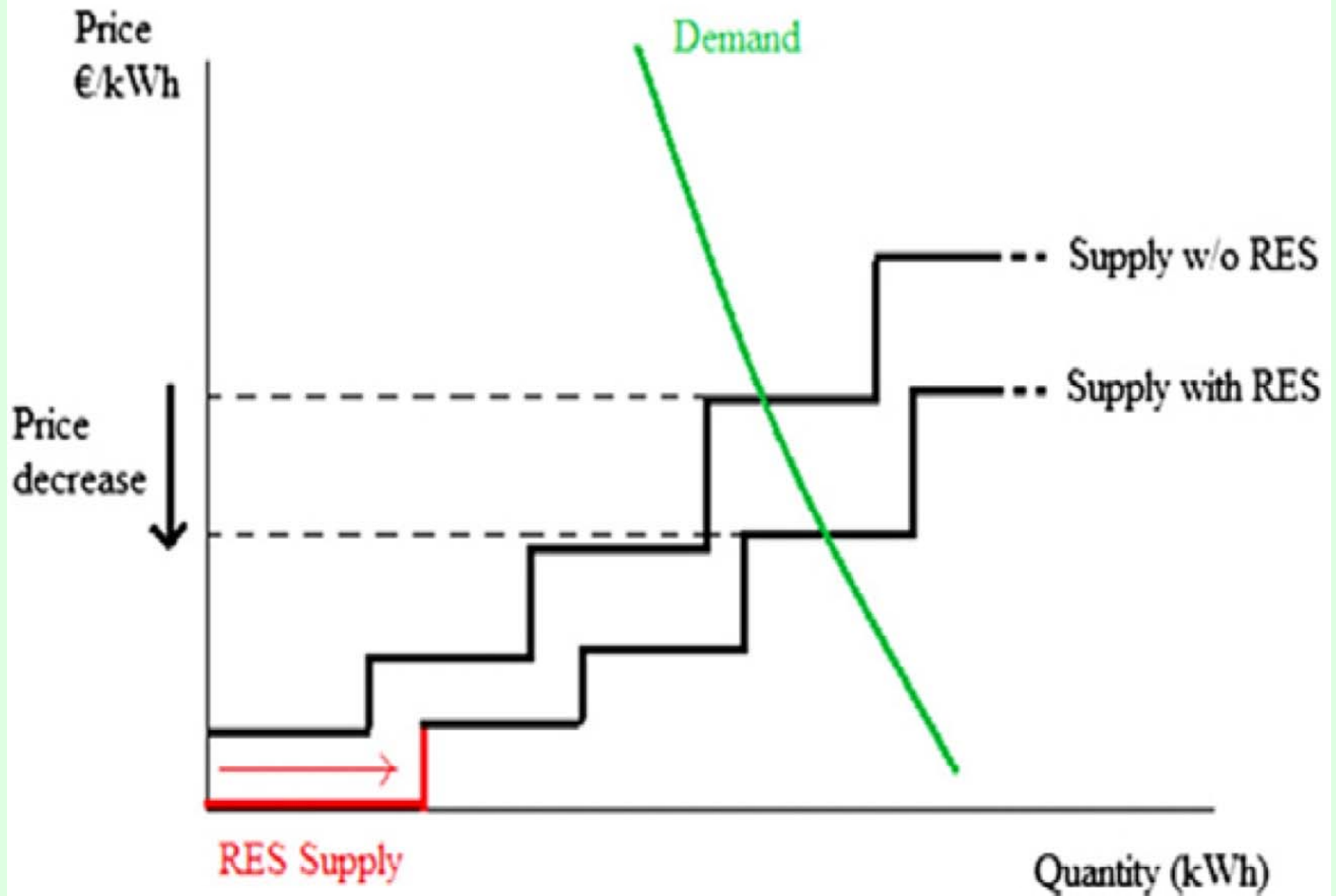
M.Weissenbacher, AIEE Energy Symposium 2016

## 97% der EE-Anlagen sind auf Verteilernetzebene angeschlossen.



Peter Franke | 23. Handelsblatt Jahrestagung | © Bundesnetzagentur

21.01.16

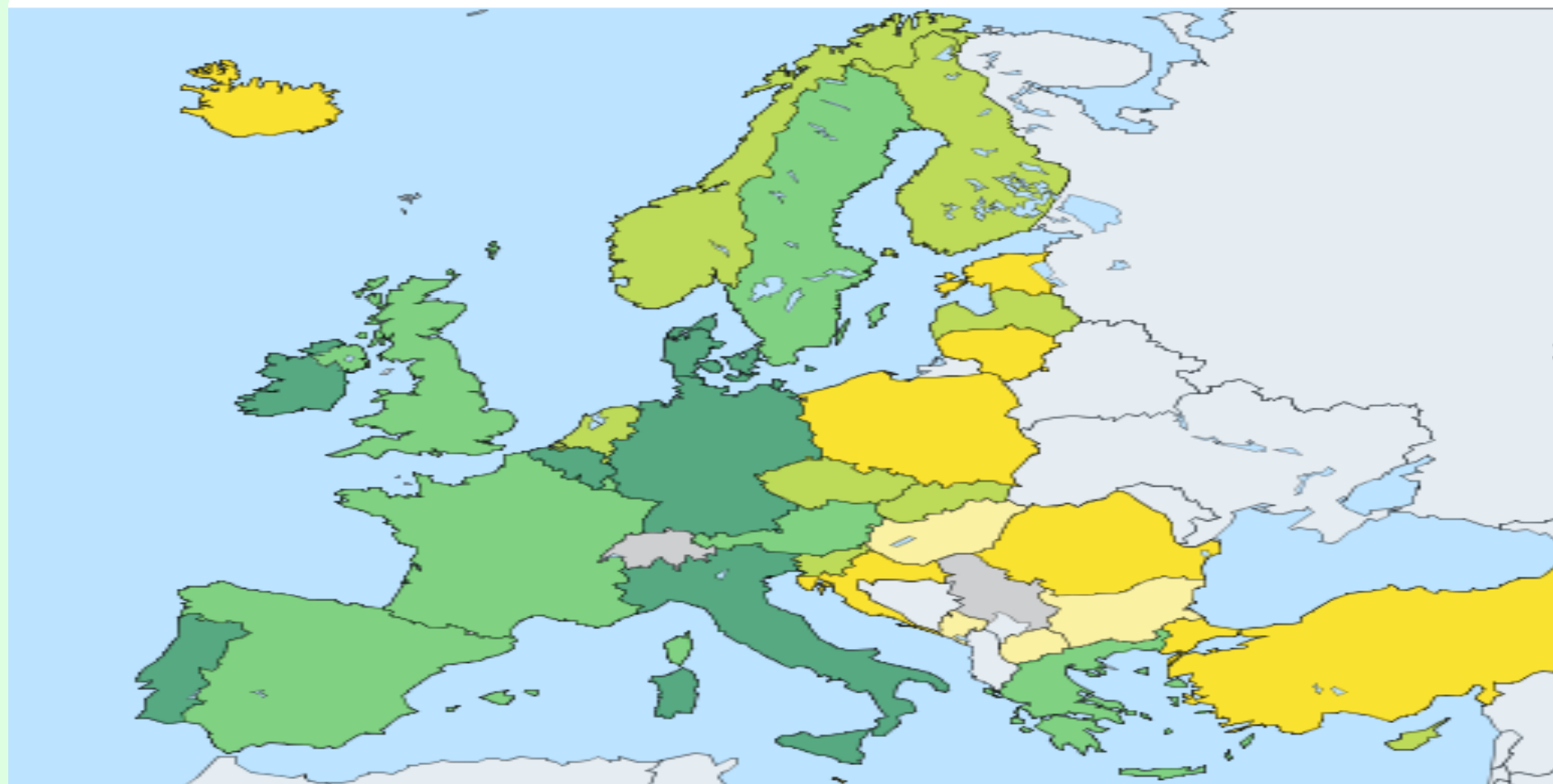




# Electricity prices by type of user

EUR per kWh - 2016

Medium size households



Legend

0.059 - 0.1114

0.1114 - 0.1332

0.1332 - 0.1628

0.1628 - 0.2185

0.2185 - 0.3088

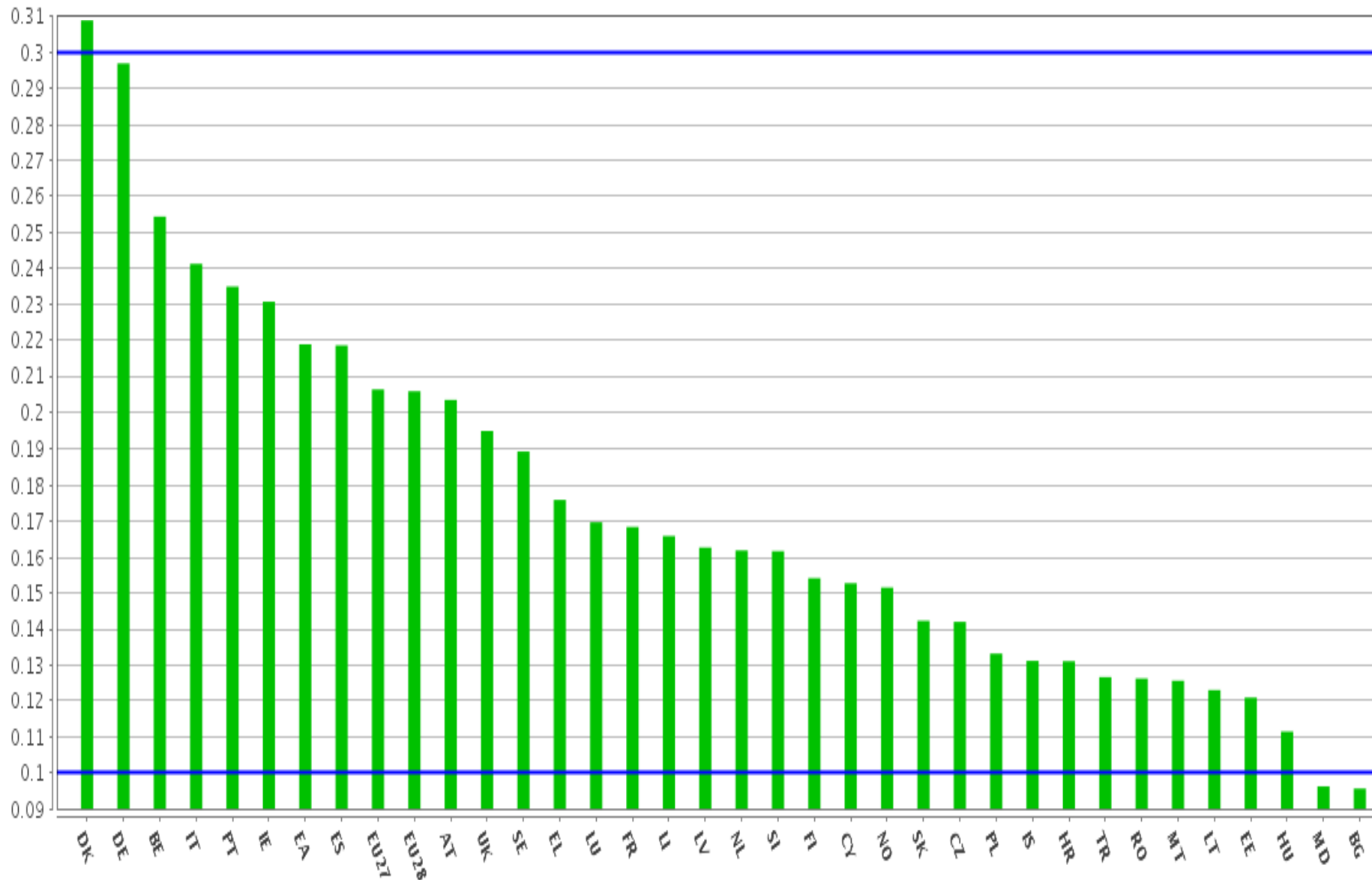
Not available

Minimum value:0.059 Maximum value:0.309

# Electricity prices by type of user

EUR per kWh

Medium size households

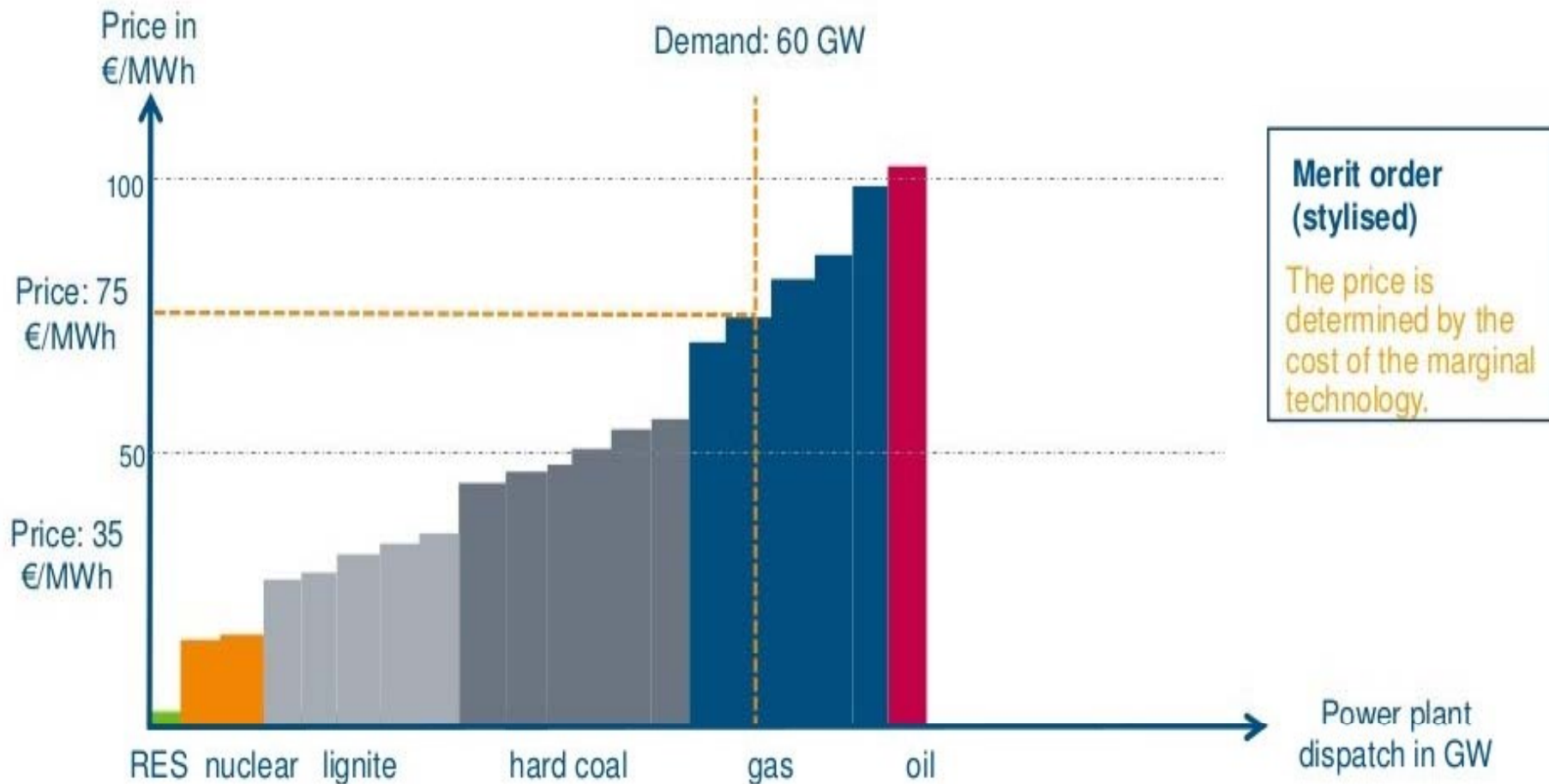


---

Electricity prices for household consumers are defined as follows:

Average national price in Euro per kWh including taxes and levies applicable for the first semester of each year for medium size household consumers (Consumption Band Dc with annual consumption between 2500 and 5000 kWh).

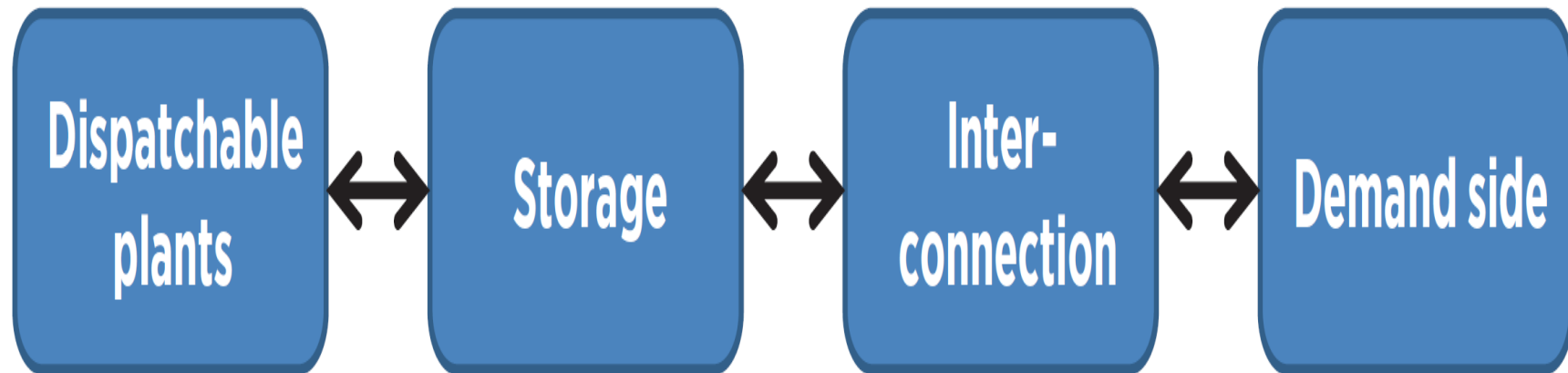
# Wholesale market pricing with merit order



Source: TU Wien, DIW Berlin, 2013

*Renewables shift the merit order and lower price levels.*

# Flexibility resources in the electricity system



*Source: Based on IEA, 2011*

# PV Integration Study, Gozo

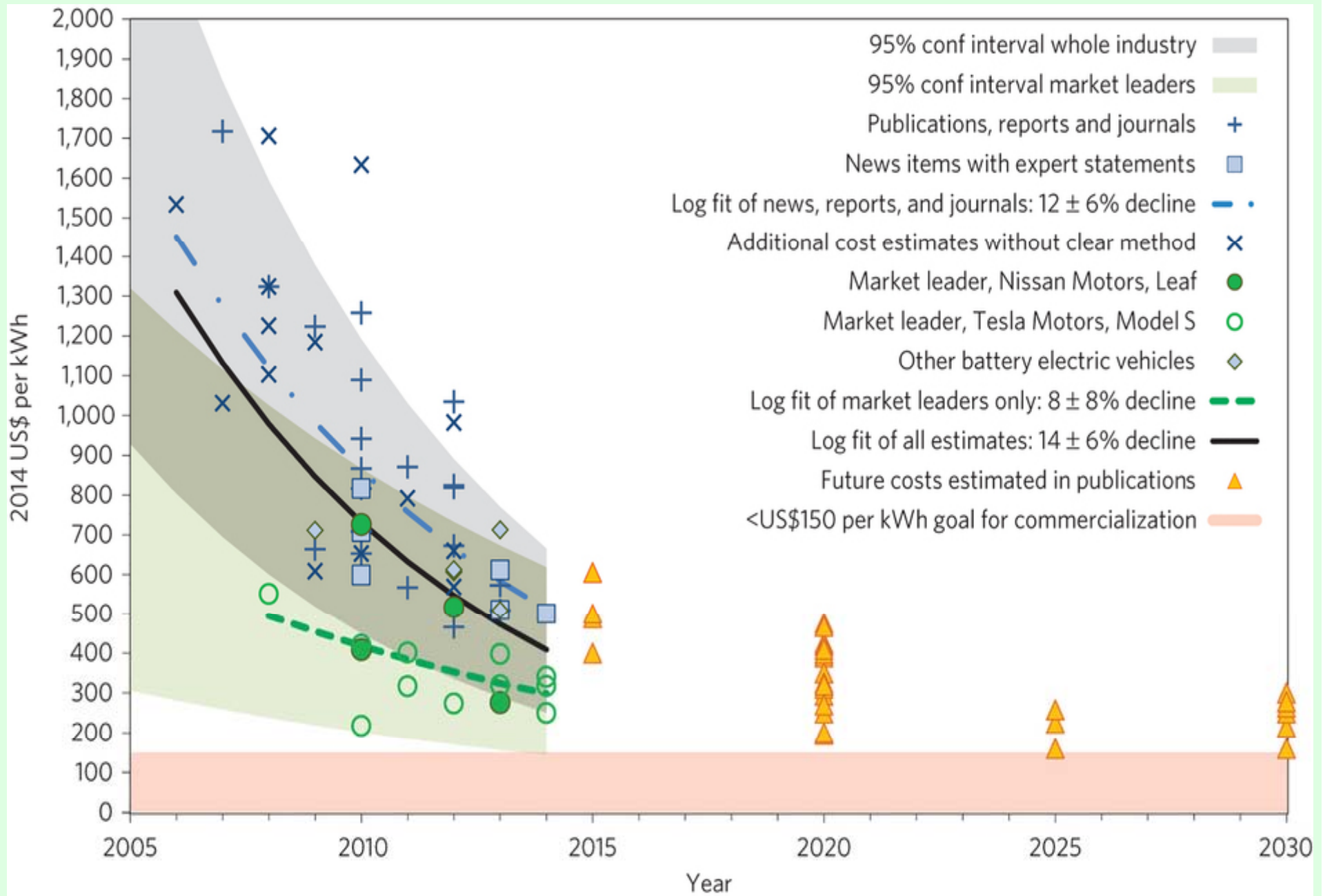
---

“+2kWp”: transformers had to be replaced to allow for greater tapping flexibility:

- ▶ Sub-station A: OLTC 11kV:400V 9-step tap change transformer was required since two tap changes had to happen during the same day to keep all feeders within limits.
- ▶ Sub-station B: switching inverters to reactive power  $Q(V)$  control, or else new manual tap changing transformer (from 11kV:433V to 11kV:400V)
- ▶ Energy storage (households vs substation)

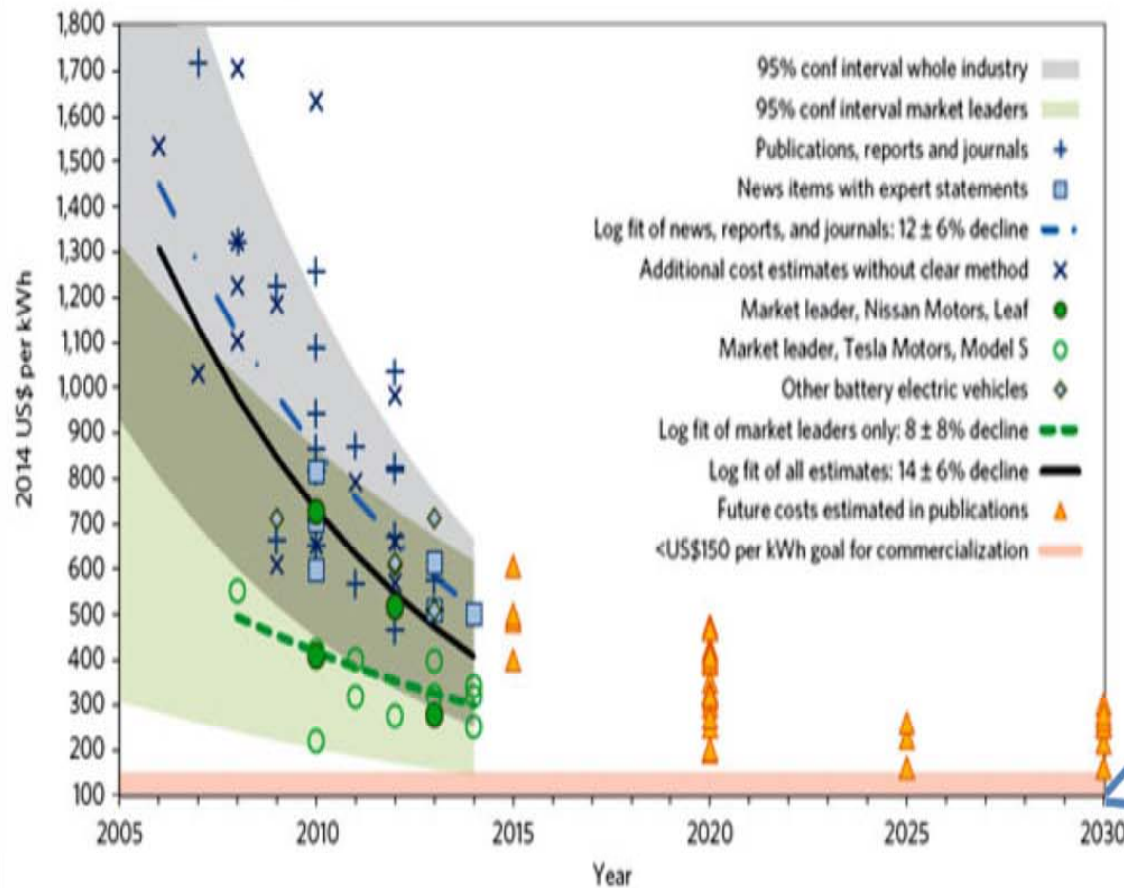
Battery technology	lead-acid	li-ion
Battery power (kW)	5	5
Battery capacity (kWh)	14.4	5.5
Depth of discharge	50%	80%
Useable capacity (kWh)	7.2	4.4
Number of cycles	2800	3000
Price (EUR)	8900	7500
EUR/kW	1780	1500
EUR/kWh	618	1364
EUR/useable kWh	1236	1705
EUR/useable kWh/cycle	0.44	0.57

Residential, Germany, 2012





## Cost of Li-ion battery packs in battery electric vehicles



"Rapidly Falling Costs of Battery Packs for Electric Vehicles," *Nature Climate Change*, 2015

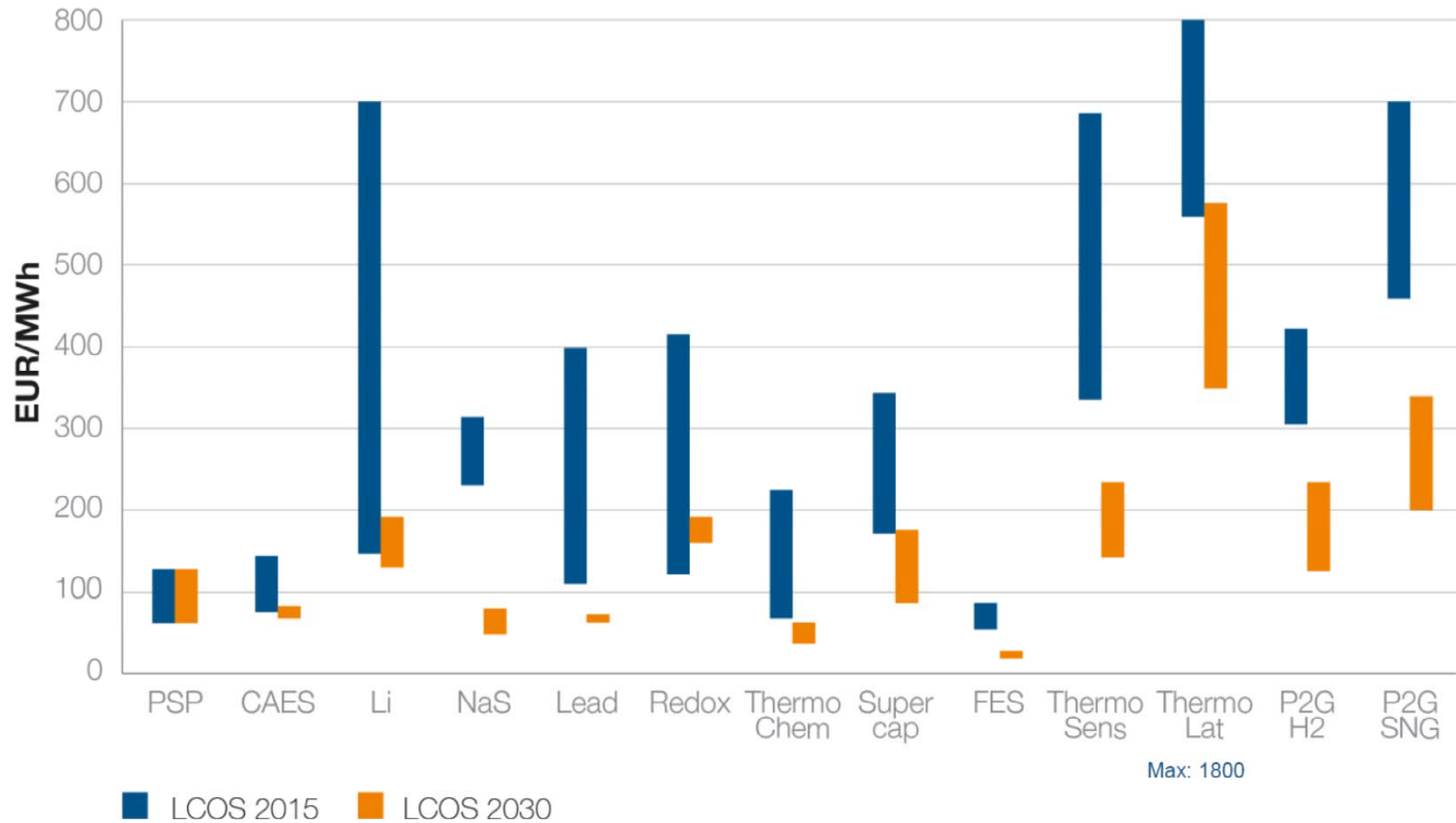
OVW 2 = 19,23 €/kWh

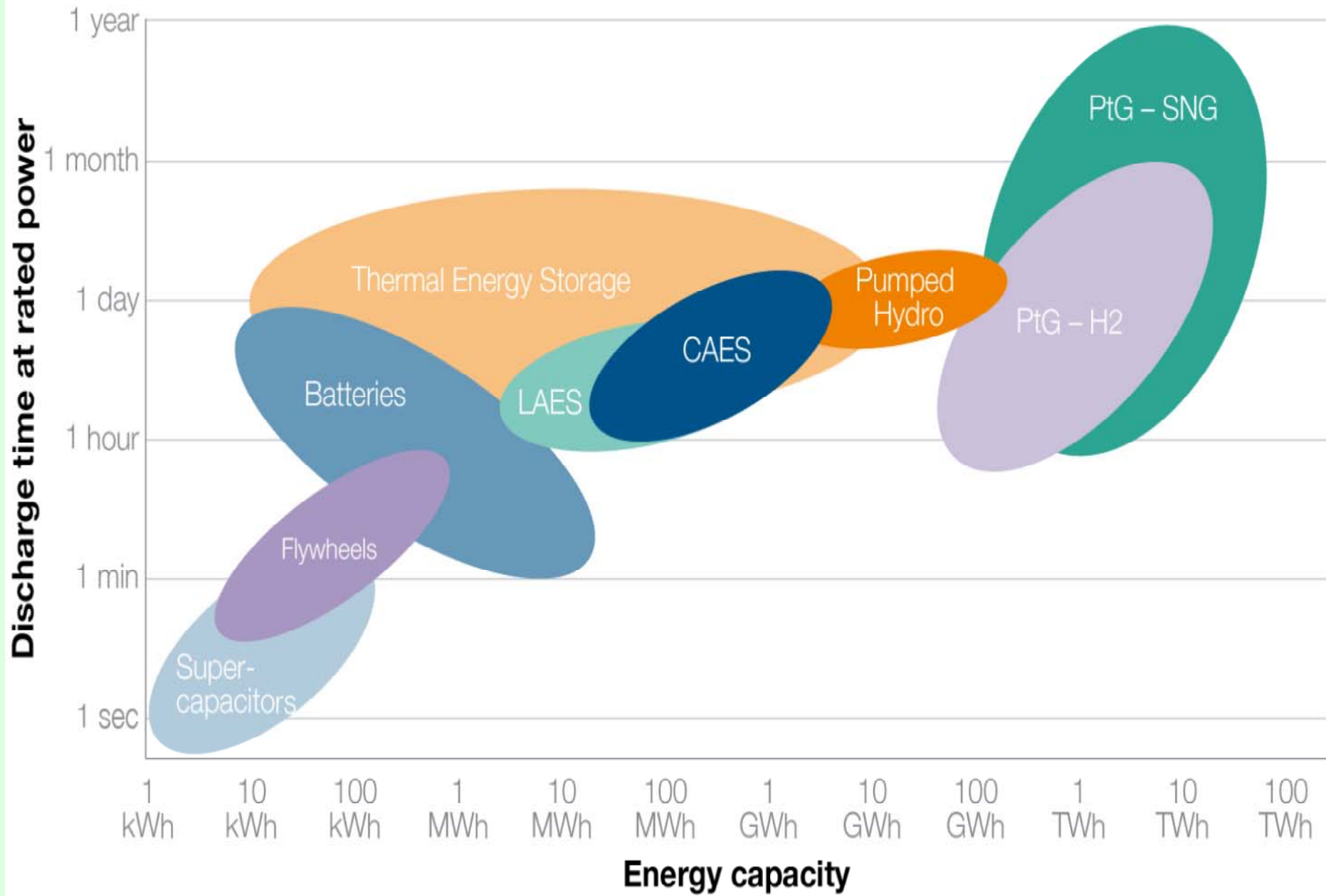
Lim2+3 = 10,76 €/kWh

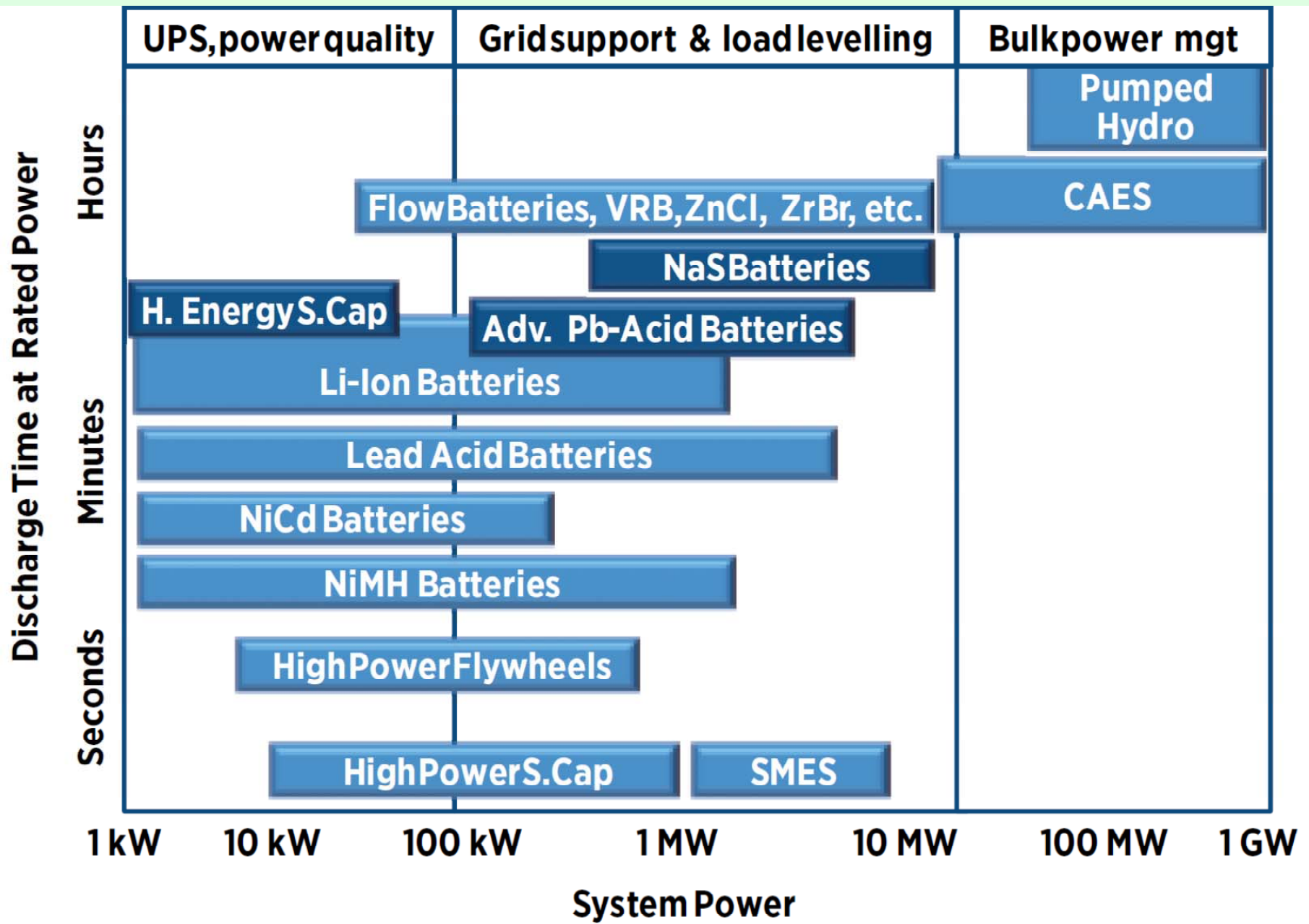
Kopswerk 2= 4,23 €/kWh

PSKW Limberg 2 und Limberg 3 ~ 850 Mio. € / 79 GWh → 10,76 €/kWh  
 Kopswerk II 360 Mio. € / 85 GWh → 4,23 €/kWh  
 Obervermuntwerk II 500 Mio. € / 26 GWh → 19,23 €/kWh

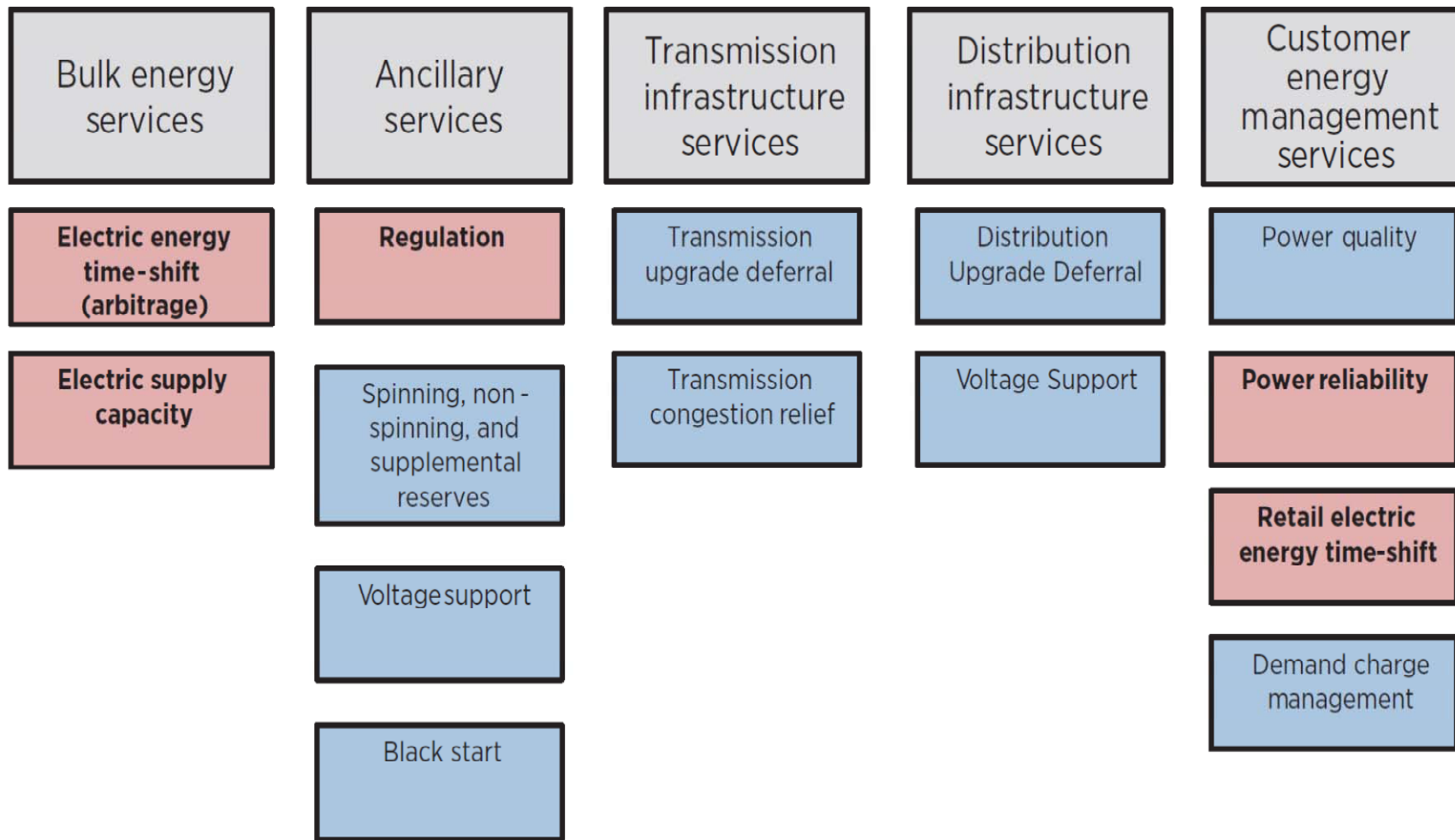
# Comparing general levelised cost of storage for 2015 and 2030 (€\_2014)







# Services provided by energy storage



Source: Based on EPRI and DOE, 2013

---

**Prof. Manfred Weissenbacher**

**manfred.weissenbacher@um.edu.mt**

**Institute for Sustainable Energy  
University of Malta**

