The Economic Costs of Mixing Renewable and Nuclear:

LCOE vs. Consumers

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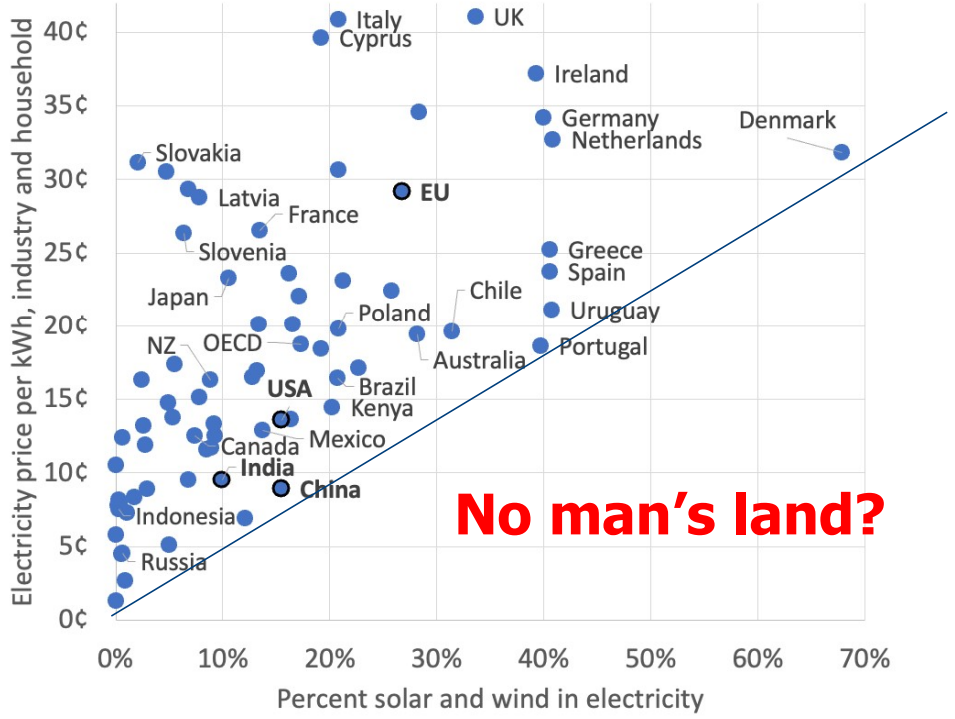
The views expressed are those of the presenter and do not reflect the position of any of the institutions mentioned.

Expensive Solar and Wind

You are constantly told that solar and wind are cheap
Reality: The more solar and wind, the costlier it gets
That is because solar and wind are worthless when not sunny and windy
Data for 2023, but same result for 2019, just before Covid and Ukraine war



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Levelized Costs of Energy: we shall get there…

Technology	LCOE [USD/MWh]
Biomass	90
Coal (USC)	83
Natural Gas CC	40
Nuclear	88
Solar PV	36
Wind	40

Source: Idel, Robert. Levelized Full System Costs of Electricity – 2023 Updates, 2023.

…or not at all ?

- School example: only **fixed costs** for nuclear and PV matter
  - Nuclear plant costs to cover……..1200 a year
  - Consumer pays……100 monthly
- Suppose we build additional PV RES for half of the price
  - PV plant costs to cover……600 a year
  - Consumer pays…… 50 monthly

- How much will consumer save?
- As we want electricity also during the night, we need BOTH
  - Nuclear plant costs to cover……1200 a year
  - PV plant costs to cover……600 a year
  - **Consumer pays……150 monthly**

Demand and supply – how they differ in energy

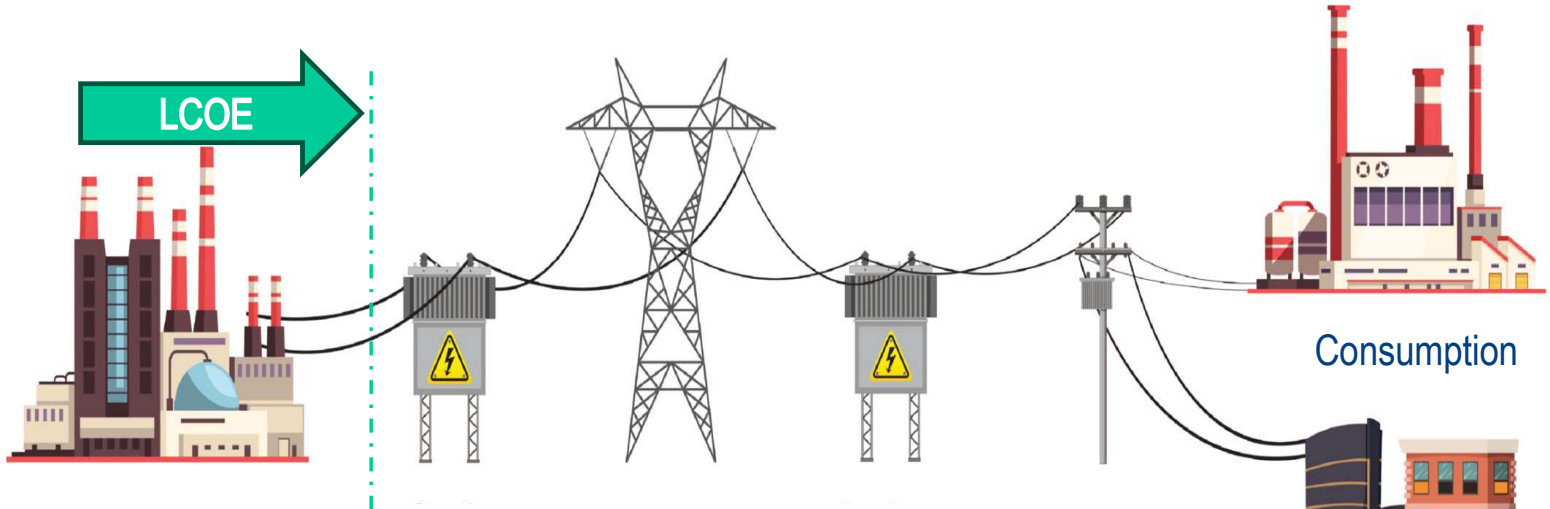
- Standard economics:
  - Price is determined by the nature of the good, location, and time
  - Price changes to balance demand and supply

  .
- Specifics of electrical energy:
  - Cannot be economically stored in sufficient quantities
  - Can only be delivered where there is a distribution network
  - **At any given time, production (supply) adjusts to consumption (demand) at the given price**
  - The paradigm shift from a central scheme means a move from emphasis on essence (commodity) to

    TIME and PLACE

Typical grid scheme and LCOE: energy becomes cheaper

At the terminals of the generator: Cheap commodity production => **Cheap electricity**



Production

Transmission

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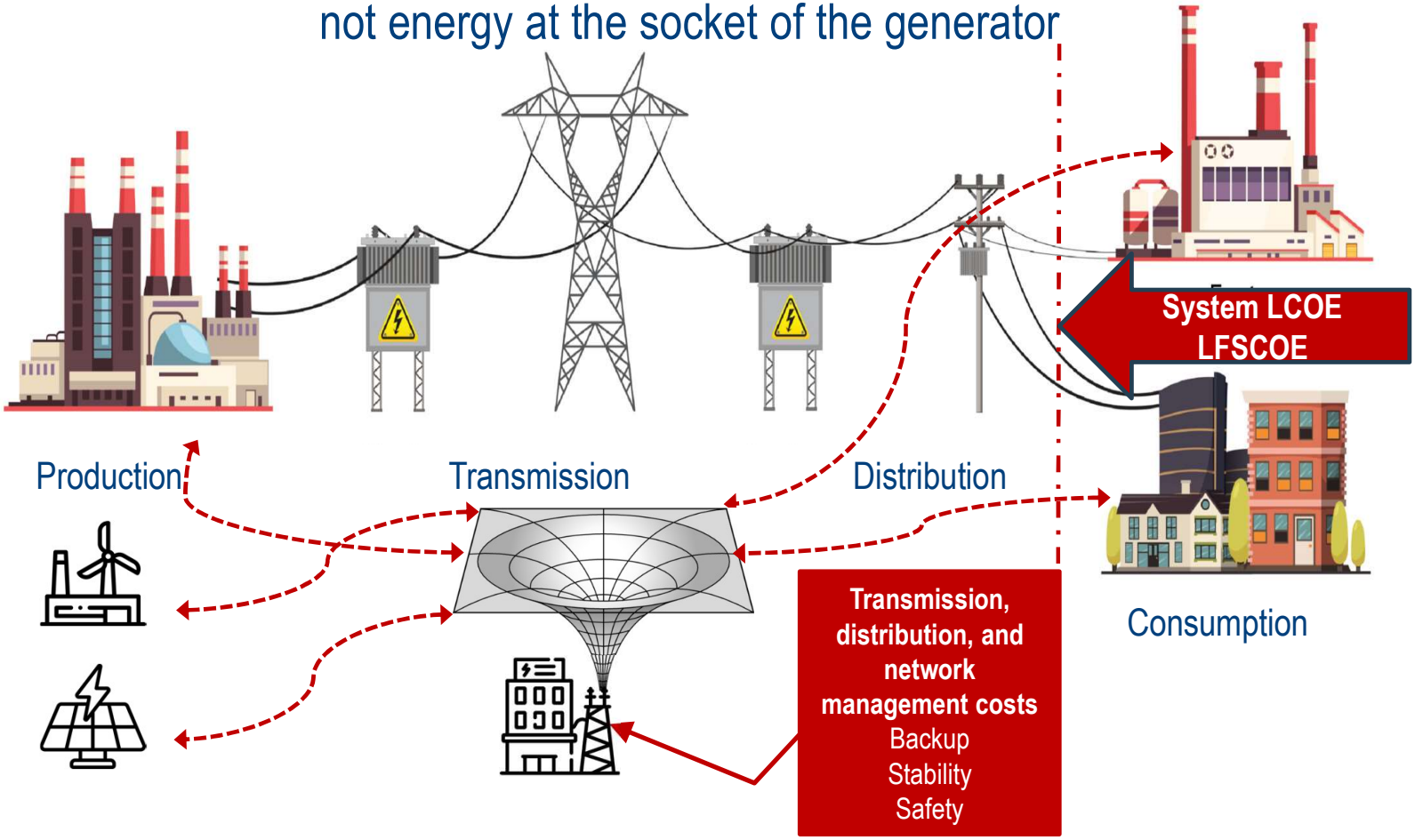
LCOE = Investment perspective:

At what price do I need to sell for the investment to pay off

Consumers purchase **delivery of energy service according to their needs**,

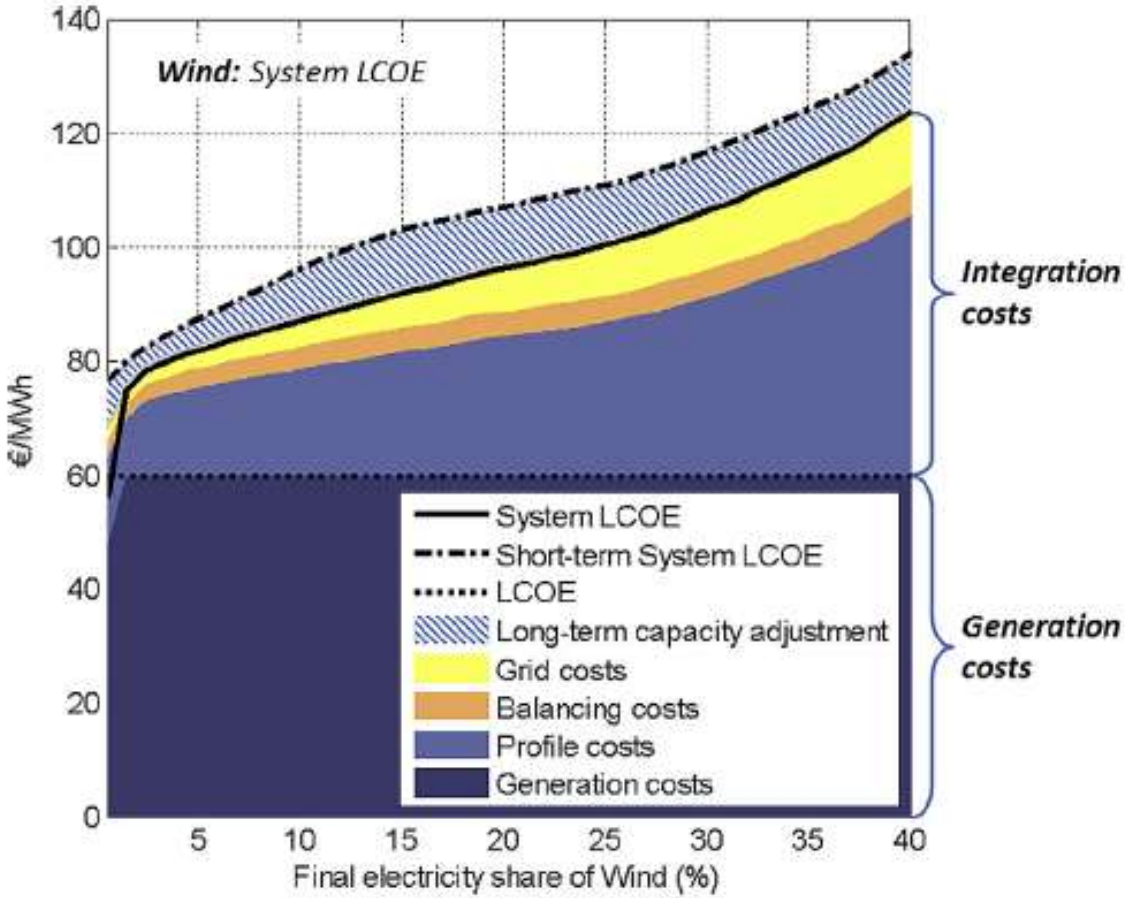
not energy at the socket of the generator



National Economy Perspective: System LCOE

- LCOE – Levelized Costs of Electricity
  - Comparable price for investment decision-making in the construction of a source
  - National Economic Perspective, perspective of the consumer:
  - How much does the service (supply) cost the economy
- **Internalizing the costs of non-controllability and intermittency**
- Total service costs including induced costs **System** LCOE
- = LCOE plus costs of the given system and of the stability of supply, reliability, and with induced changes in distribution

System LCOE



- In 2012 for calculation: Permit ~20EUR (was ~ 10 EUR), Gas ~ 25EUR, nuclear operating

Source: Ueckerdt, Falko, Lion Hirth, Gunnar Luderer, Ottmar Edenhofer, System LCOE: What are the costs of variable renewables?, *Energy*, 63: 61-75, 2013.

Comparison of LFSCOE and LCOE

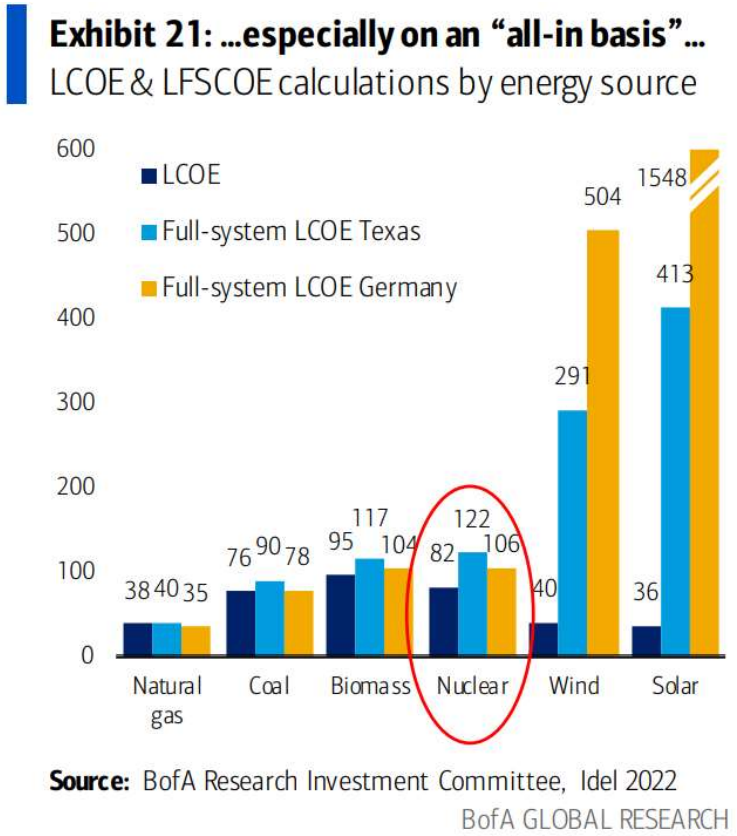
- LFSCOE = LCOE plus system costs using **exclusively** given type

Technology	LCOE	LFSCOE	
		Germany	Texas
	[USD/MWh]	[USD/MWh]	[USD/MWh]
Biomass	90	109	126
Coal (USC)	83	110	124
Natural Gas CC	40	41	46
Nuclear	88	114	134
Solar PV	36	1465	456
Wind	40	587	358

Source: Idel, Robert. Levelized Full System Costs of Electricity – 2023 Updates, 2023.
LFSCOE = LCOE plus system costs for full demand coverage using exclusively the given type
Levelized Full System Costs of Electricity – 2023 Updates, 2023.

View from the USA on LCOE & LFSCOE

- Where to invest if the source bears the additional incurred costs?
- There will be an internalization of externality caused by instability and insecurity of a particular technology

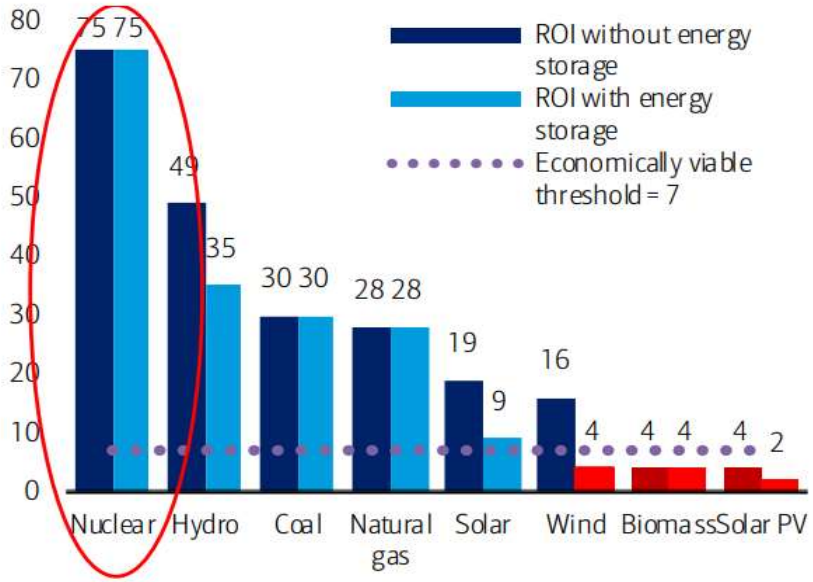


Source: BoA 2023, https://advisoranalyst.com/wp-content/uploads/2023/05/bofa-the-ric-report-the-nuclear-necessity-20230509.pdf

View from the USA on EROI

Exhibit 22: ...and has the highest energy ROI

Energy returned on energy invested, by source



Source: BofA Research Investment Committee, D. Weißbach, G. Ruprecht, A. Huke, K. Czerski, S. Gottlie, A. Hussein; Red signals EROI below economically viable threshold

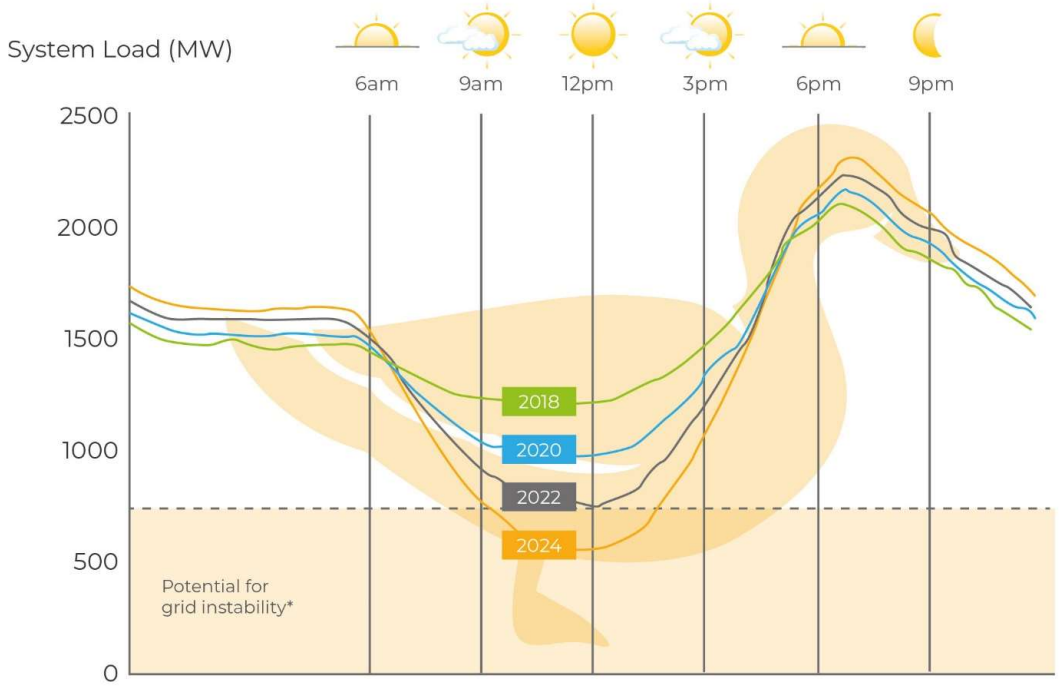
BofA GLOBAL RESEARCH

- Avoid money
- Use physics
- EROI
  - Return on Energy Invested

Source: BoA 2023, https://advisoranalyst.com/wp-content/uploads/2023/05/bofa-the-ric-report-the-nuclear-necessity-20230509.pdf

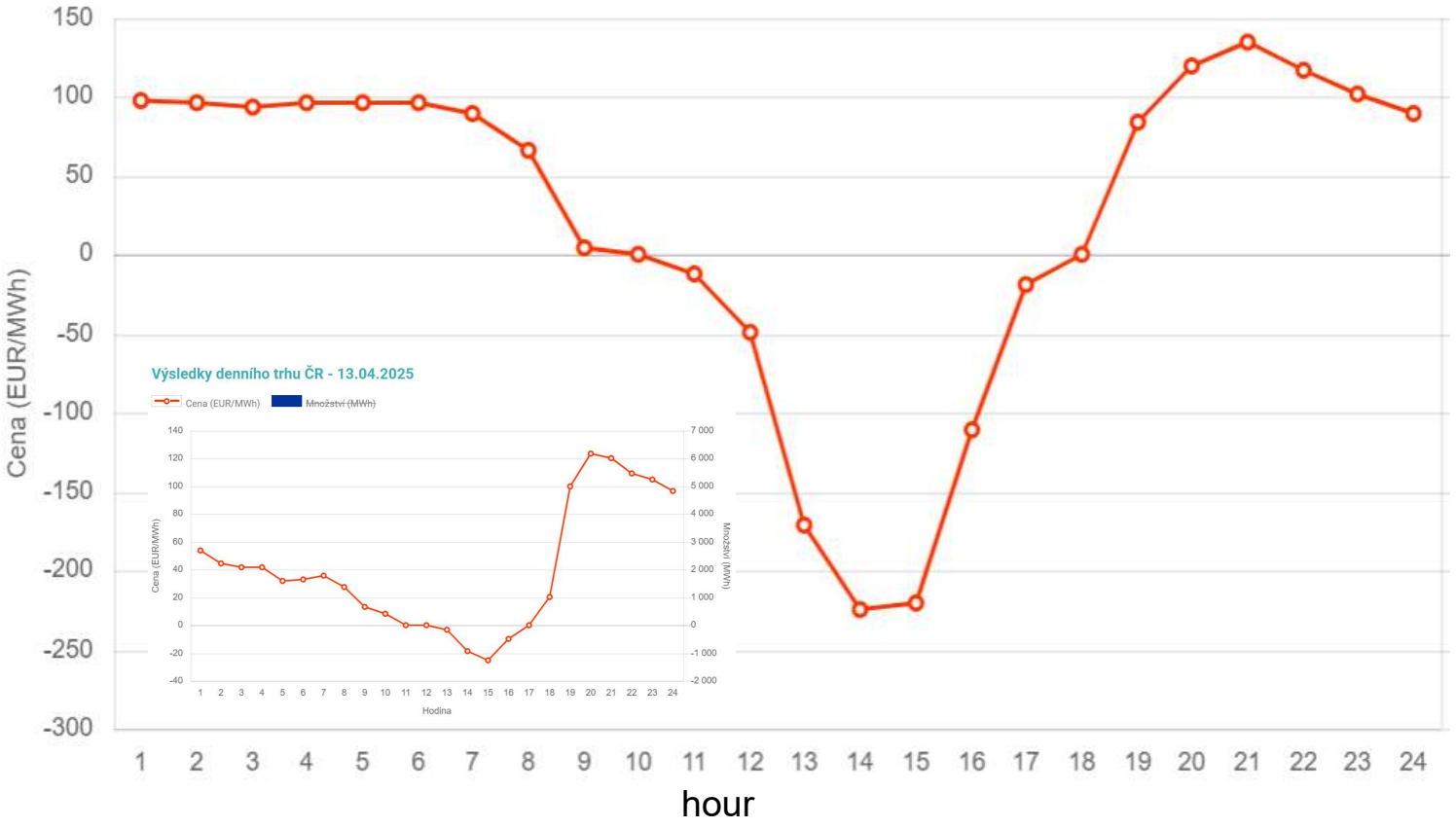
Demand and price volatility daily

- Physical balance is not a guarantee of trade (financial) balance equilibrium when seasonal and daily patterns exist
- Duck curve - Australia



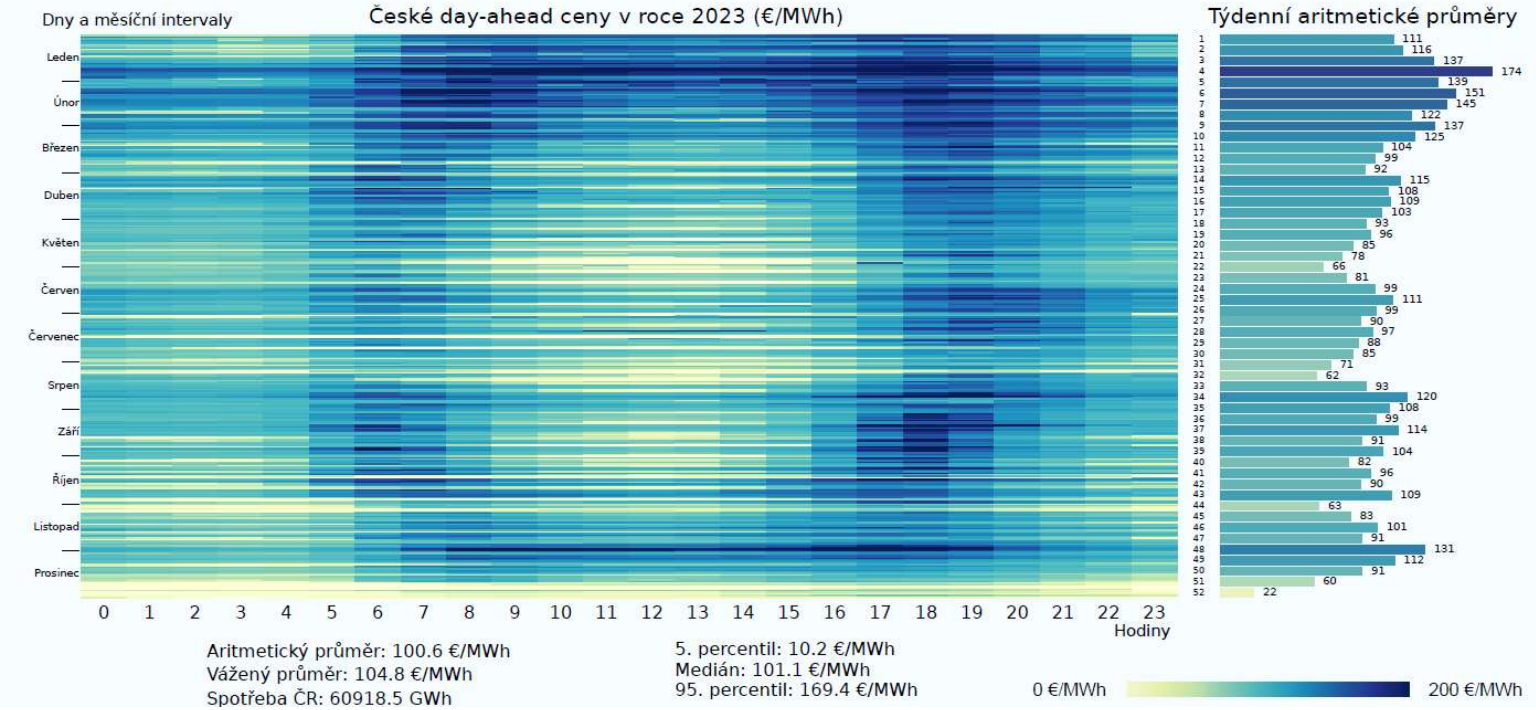
Daily Market CZ 11.05.2025

Cena (EUR/MWh) **Price**



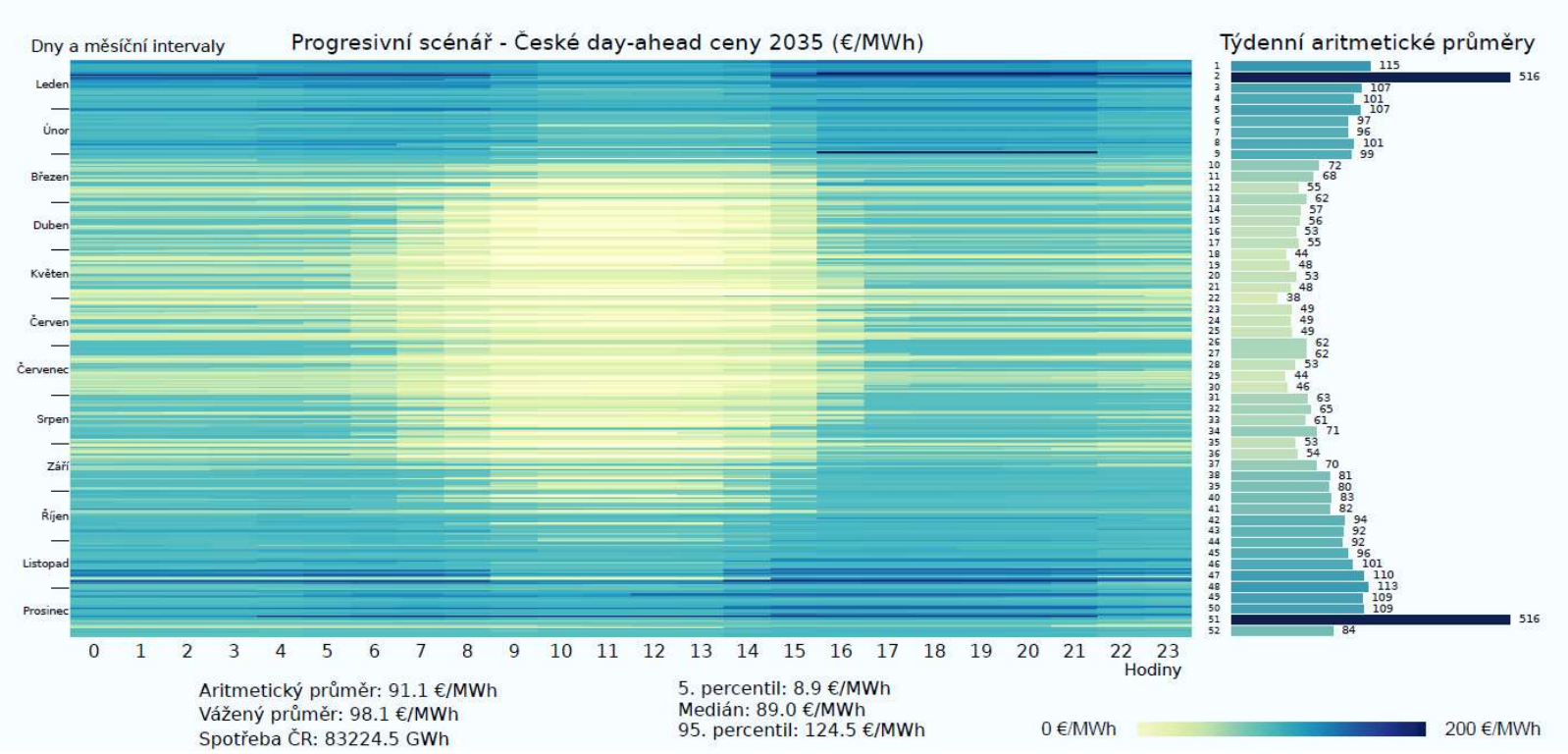
- Yearly Heatmap for 2023

Obr. 7.12 Heatmapa českých day-ahead cen v roce 2023



Forecasted Yearly Heat Map

- Yearly Heatmap for 2035

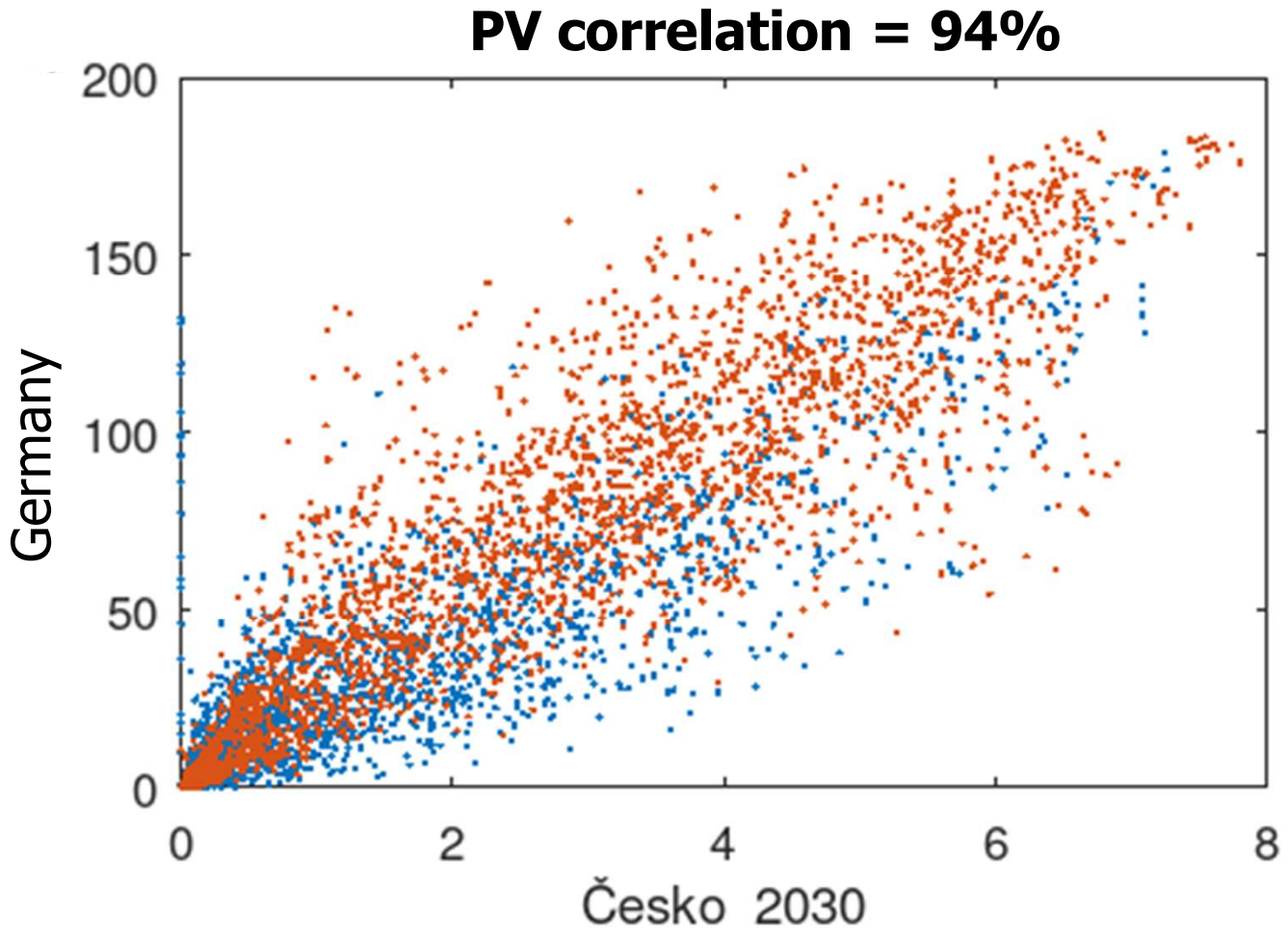


Interconnection will help reduce RES volatility!

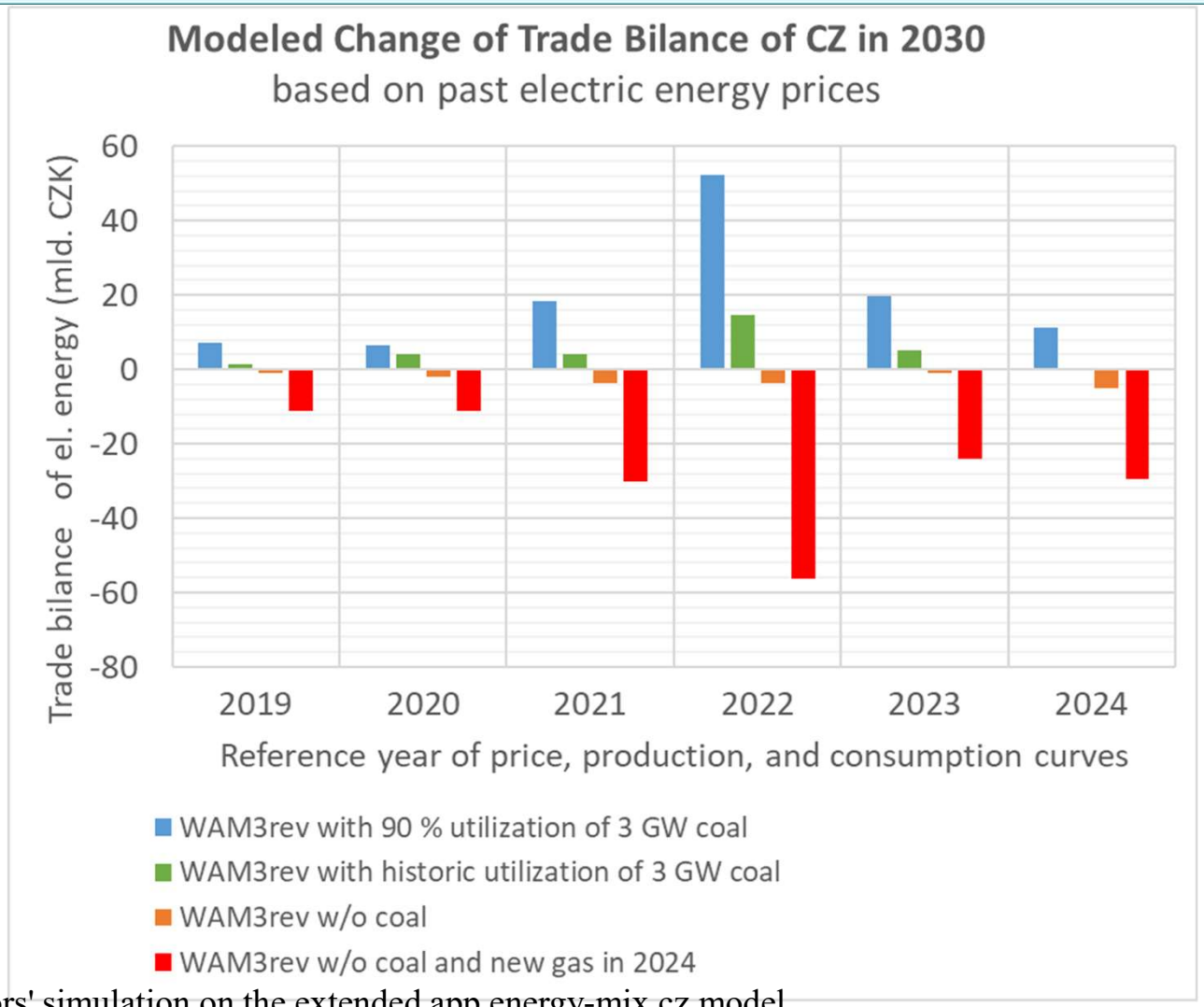
- But how much?

winter

summer



What if….. we had New Energy Mix in the past …

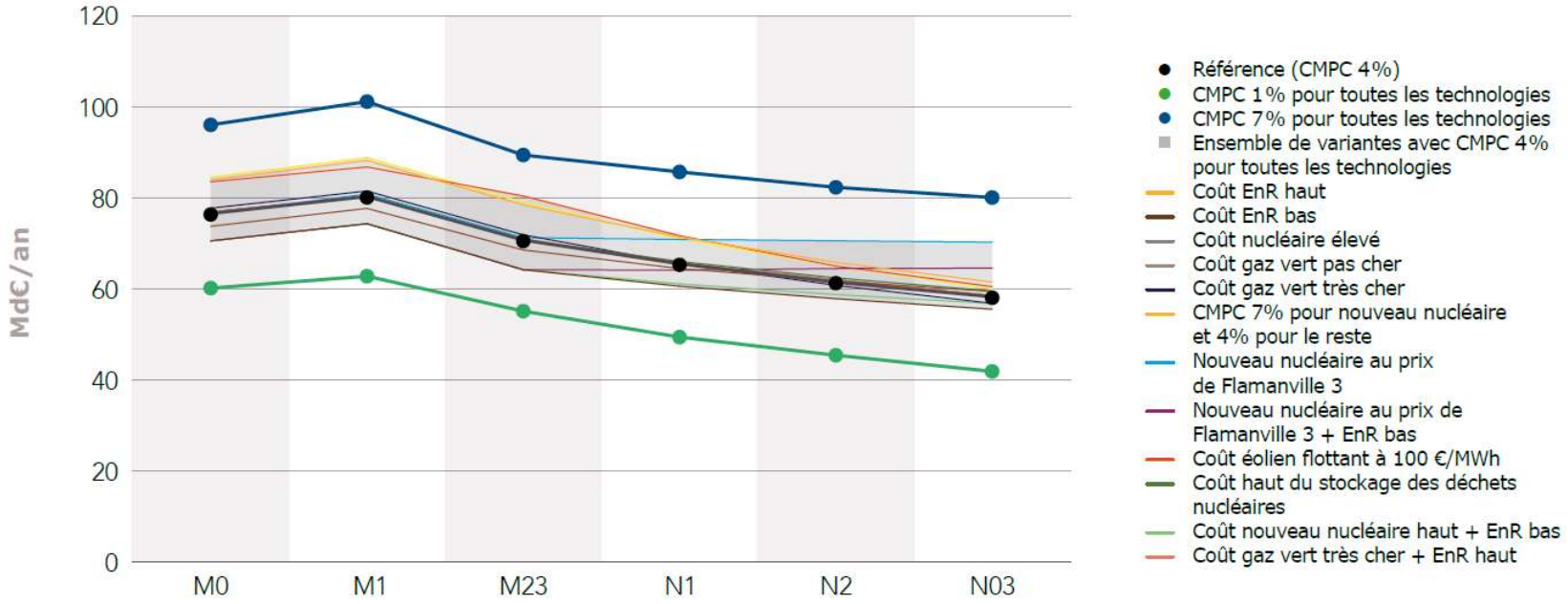


Source: Authors' simulation on the extended app.energy-mix.cz model

Prices in the given year applied to the selected production mix, change occurred without impact on prices

Excuse my French…

Figure 11.38 Coûts annualisés des scénarios en 2060, dans les différentes variantes et *stress tests* analysés



Source: Futurs énergétiques 2050, Rapport complet, Février 2022, RTE-Paris.
Scenarios: M=RES, N=Nuclear

- Maximum Nuclear scenario leads to lowest costs N03
- Maximal RES is the most costly

- Are we on the right path in the electricity sector to reduce prices and risks?

Not at all

- Financial world:
  - Choice of assets with negative correlation = reduction of portfolio risk

- Energy concept = leads to reduction of national diversities

Taking on risks both through concepts and through connections

- **STRATEGICALLY WRONG APPROACH**
- **WE NEED CHEAP STABLE BASELOAD**

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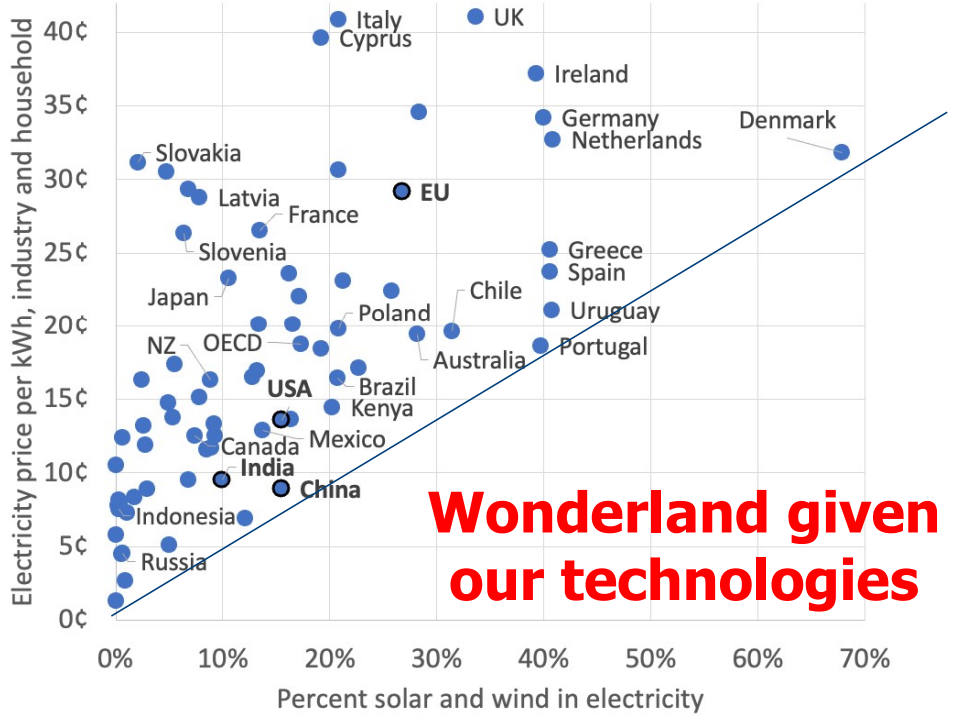

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Thank you for your attention

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