Return on Nuclear Investments:

Does It Worth?

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Prague, November 27th, 2024

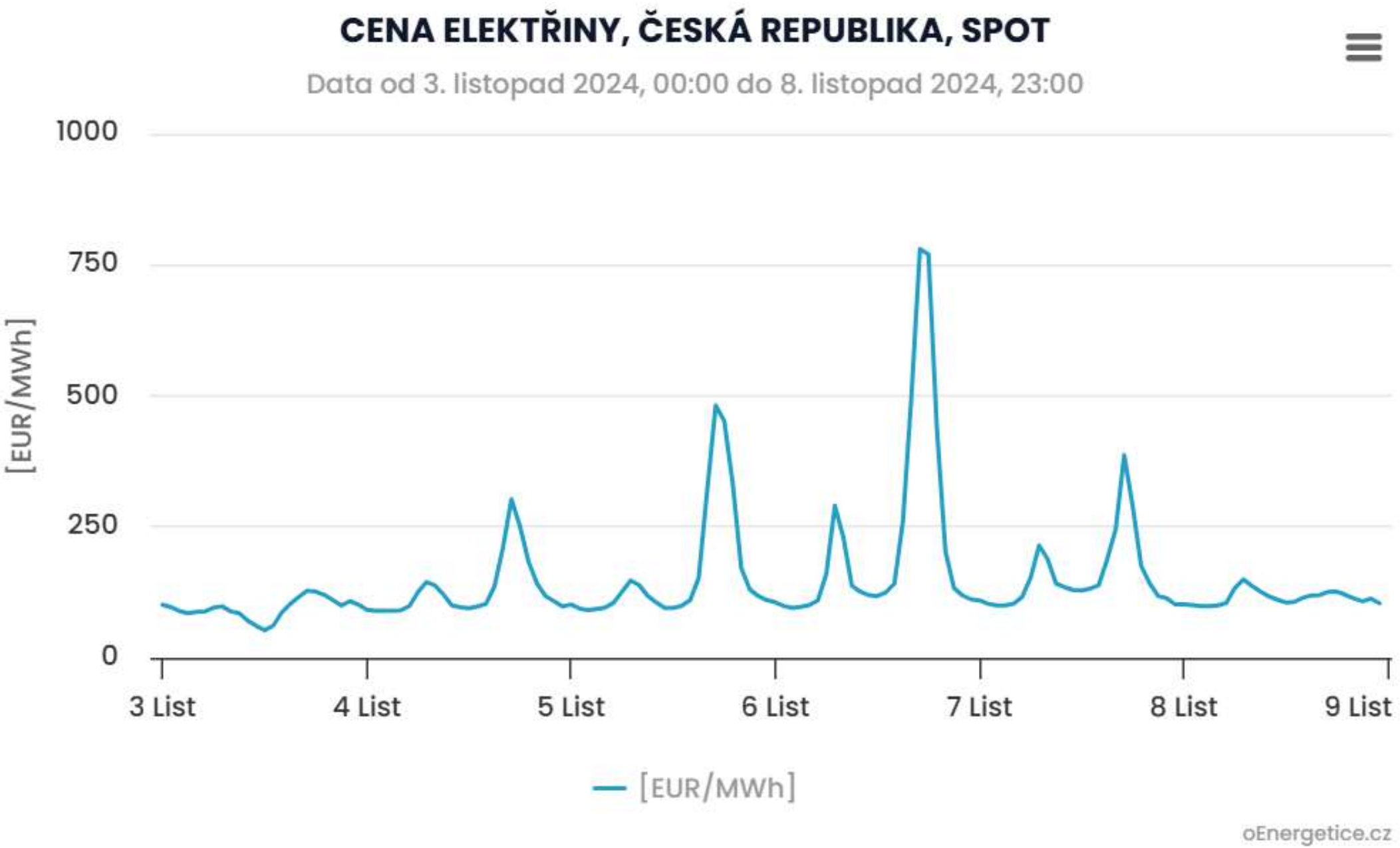
Economic Challenges

- Challenges:
  - Nuclear is too costly to alternatives
  - Too long construction time makes it even less viable
  - Market financing difficult
- Advantages:
  - Construction boost to economy
- Benefits:
  - Security of supply

- Standard Economics:
  - The price is determined by the nature of the good, the place, and the time
  - The price changes to balance demand and supply
- Specifics of electricity:
  - Cannot be economically stored in sufficient quantities
  - Can be delivered via a distribution network only
  - **At a given time, production (supply) adjusts to consumption (demand) at a given price**
  - A paradigm shift from the central scheme means a shift from an emphasis on the substance (of the commodity) to the **TIME and PLACE**

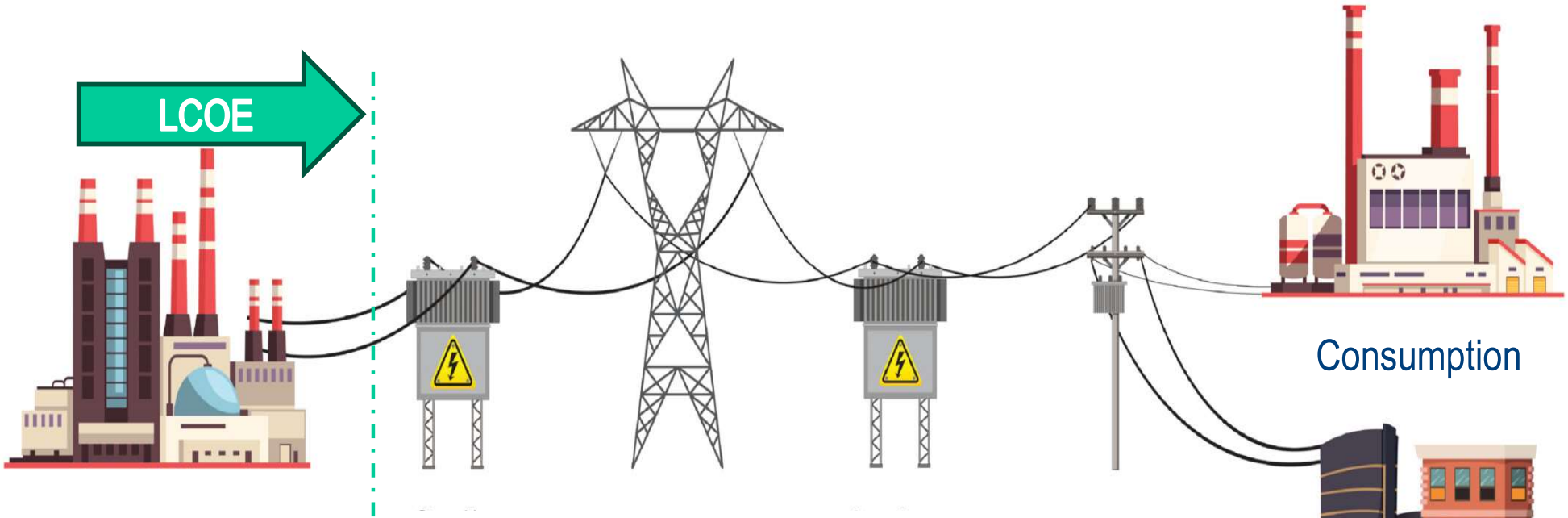
- Physical restrictions apply first and only then the economic restrictions apply
  - The price is determined by the final (most expensive) power supply necessary for balance
    - Today gas, formerly coal, sometimes oil
  - Balancing principle of the electricity network and grid system:
    - **Production varies according to the demand (consumption)**

Beginning of November 2024…..No Sun Neither Wind



- Energy Efficiency Directive and Green Deal should:
  - Decrease total consumption
  - Distributed generation with local self-supply (communities)
  - Achieving this means **Lower transported volumes**
- However
  - **No decrease of network operators (DSO/TSO):**
- Costs
  - INDEPENDENT on VOLUME
  - Determined by PEAK CAPACITY
  - Mainly FIXED costs
- **Costs per unit of volume INCREASE**

Typical network diagram and LCOE



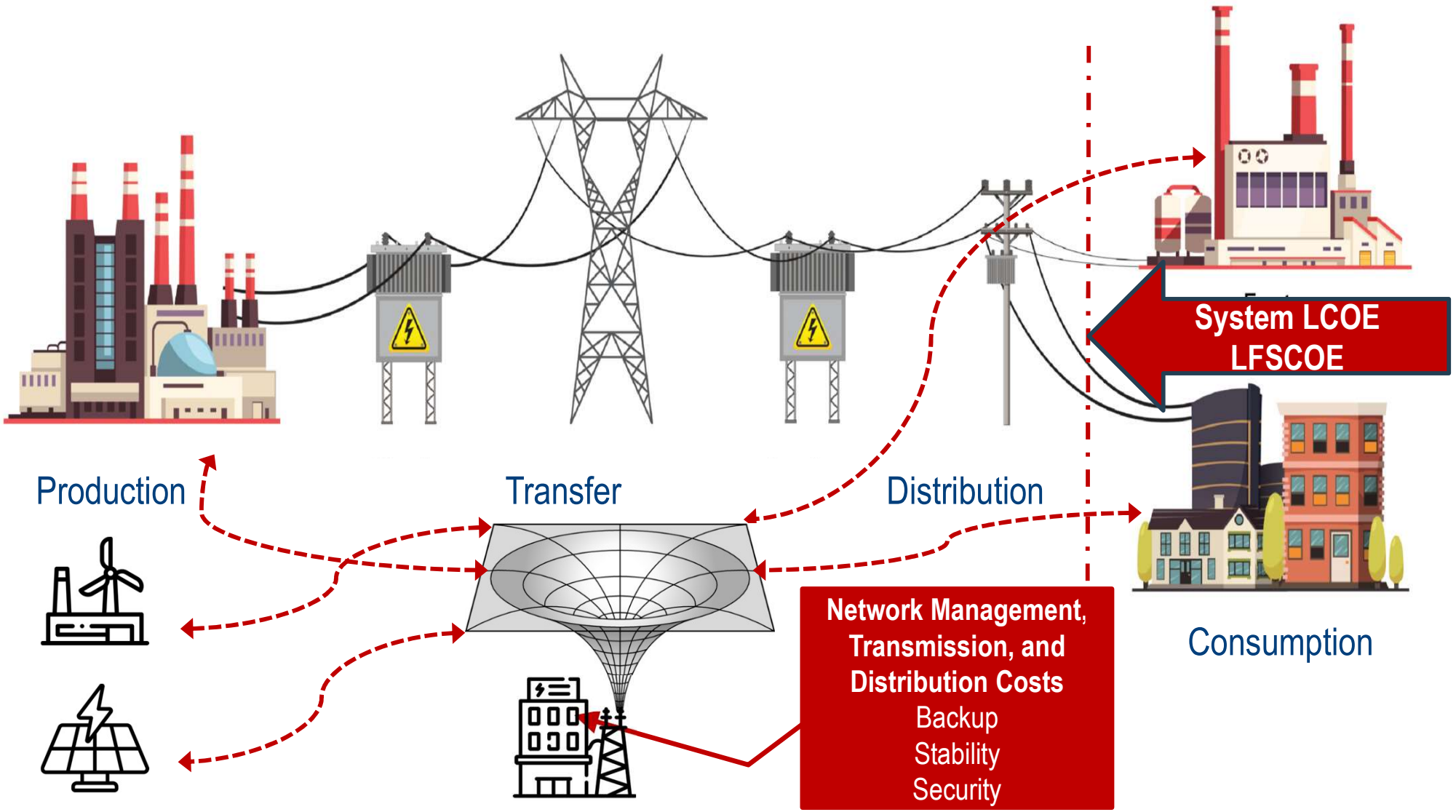
Technology	LCOE [USD/MWh]
Biomass	90
Coal (USC)	83
Natural Gas CC	40
Nuclear	88
Solar PV	36
Wind	40

LCOE = Investment perspective:

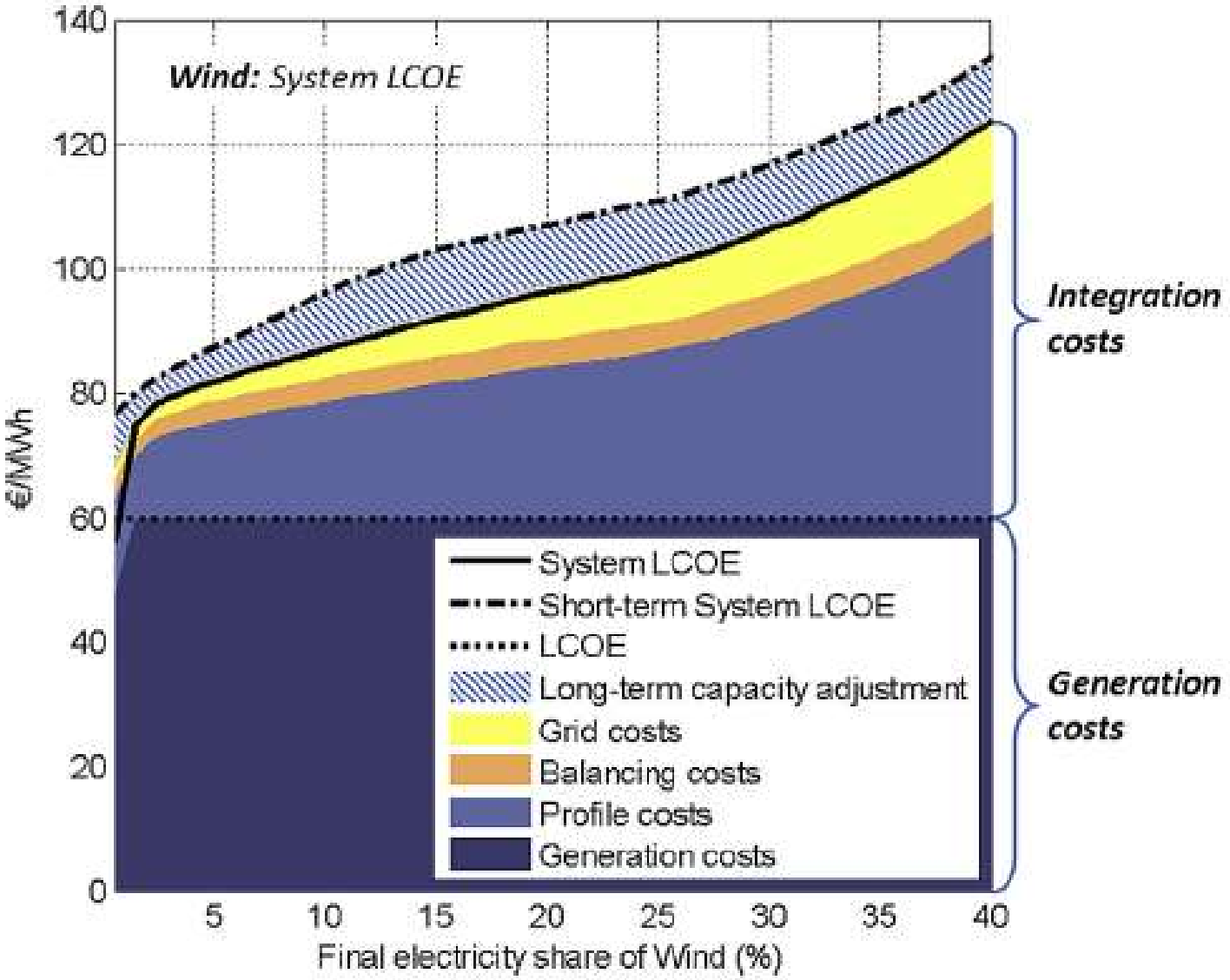
For how much do I have to sell for to make the investment worthwhile

- LCOE – Levelized Costs of Electricity
  - Comparable price for investment decisions
- Social optimizer view, Customer's view
  - Internalizing the costs of uncontrollability and intermittentness
- Internalization of costs
  - **System LCOE** – LCOE plus the costs of the system for the stability of supply, reliability and induced changes in distribution
  - **LFSCOE** – LCOE plus the costs of system stability, reliability and network change when fully covering demand **exclusively with the given type of source** (with storage)

LCOE vs. System LCOE a LFSCOE

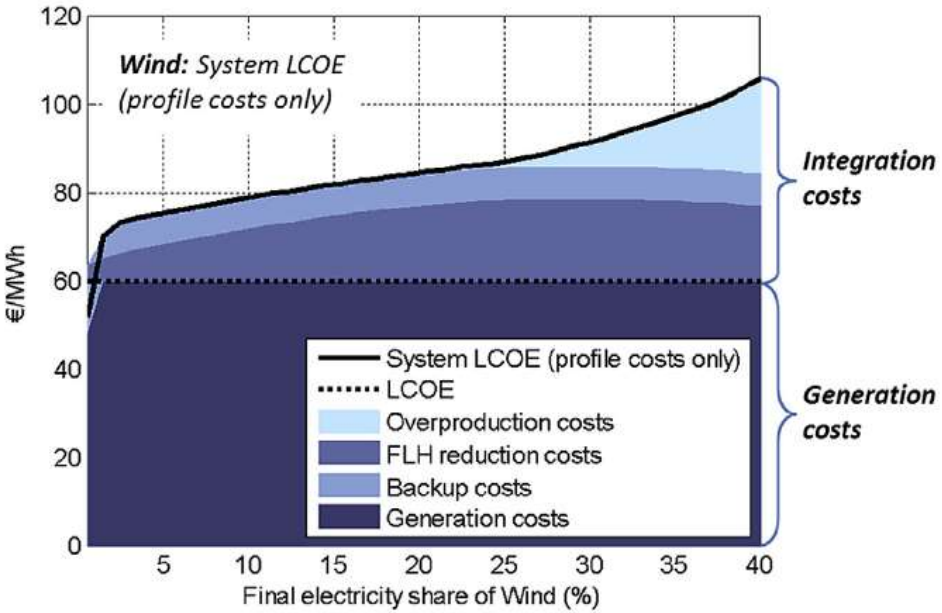


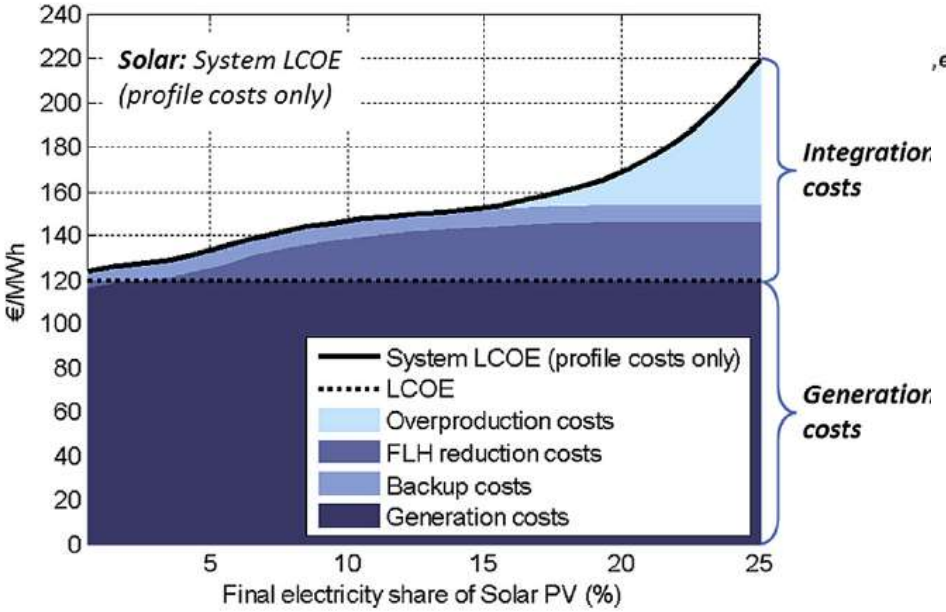
System LCOE



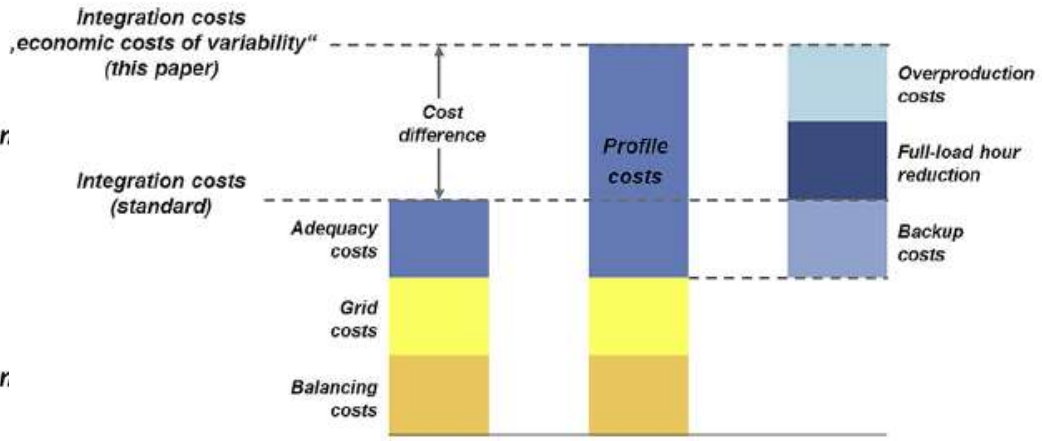
Source: Ueckerdt, Falko, Lion Hirth, Gunnar Luderer, Ottmar Edenhofer, System LCOE: What are the costs of variable renewables?, *Energy*, 63: 61-75, 2013.

System LCOE: Comparison 2012 and 2024





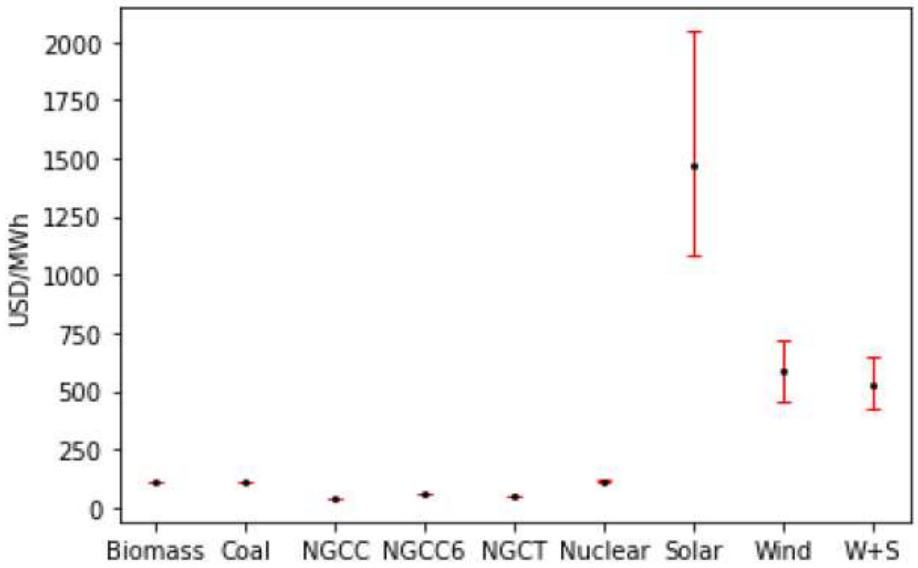
- In 2012 for calculation
  - ETS ~20EUR (was < 10 EUR)
  - Gas ~ 25EUR
  - ? Gas long term contract < 25EUR
- Changes from 2012 to 2023/4
  - ETS ~80EUR, 60-70EUR
  - Gas ~ 50EUR, ~40EUR



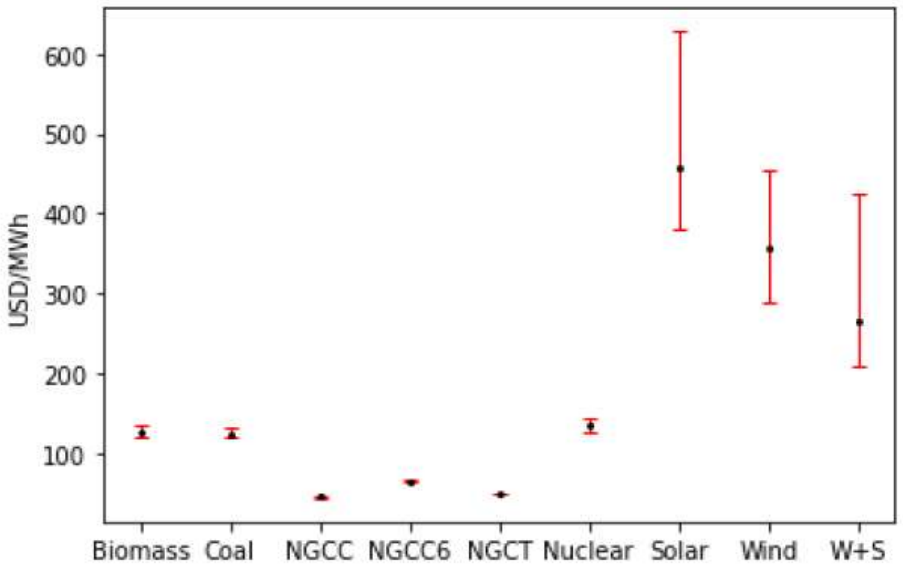
Source: Ueckerdt, Falko, Lion Hirth, Gunnar Luderer, Ottmar Edenhofer, System LCOE: What are the costs of variable renewables?, *Energy*, 63: 61-75, 2013, own estimation added.

- LFSCOE – Levelized Full System Costs of Electricity
  - LCOE plus system stability, reliability and grid change costs to fully cover demand using only the given type
  - **A social optimizer perspective, a customer's perspective**

Germany



Texas (ERCOT)



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

Comparison of LFSCOE and LCOE

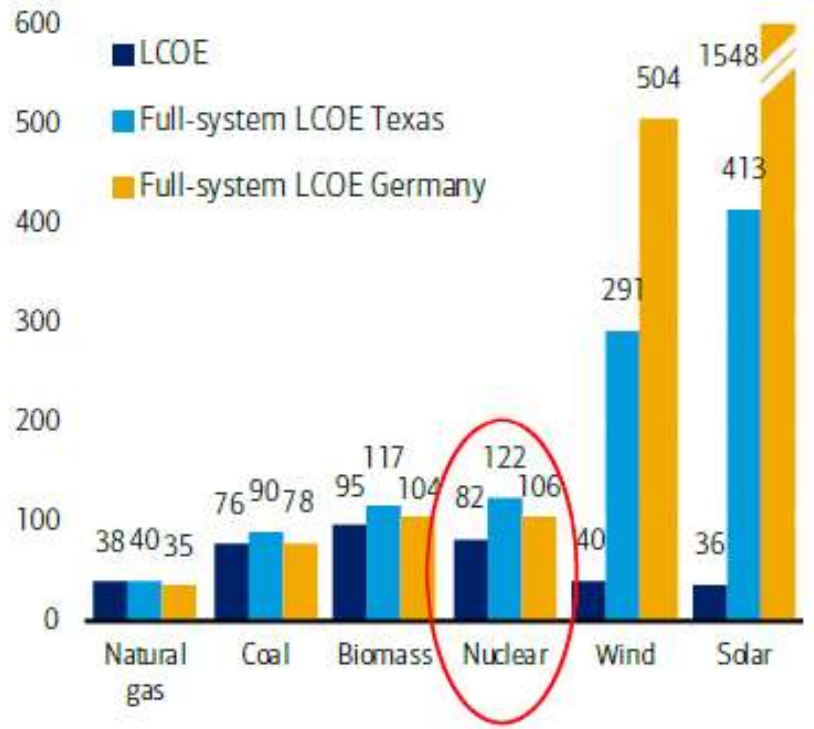
Technology	LCOE	LFSCOE	
		Germany	Texas
	[USD/MWh]	[USD/MWh]	[USD/MWh]
Biomass	90	109	126
Coal (USC)	83	110	124
Natural Gas CC	40	41	46
Nuclear	88	114	134
Solar PV	36	1465	456
Wind	40	587	358

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

USA: How LCOE & LFSCOE Do Differ?

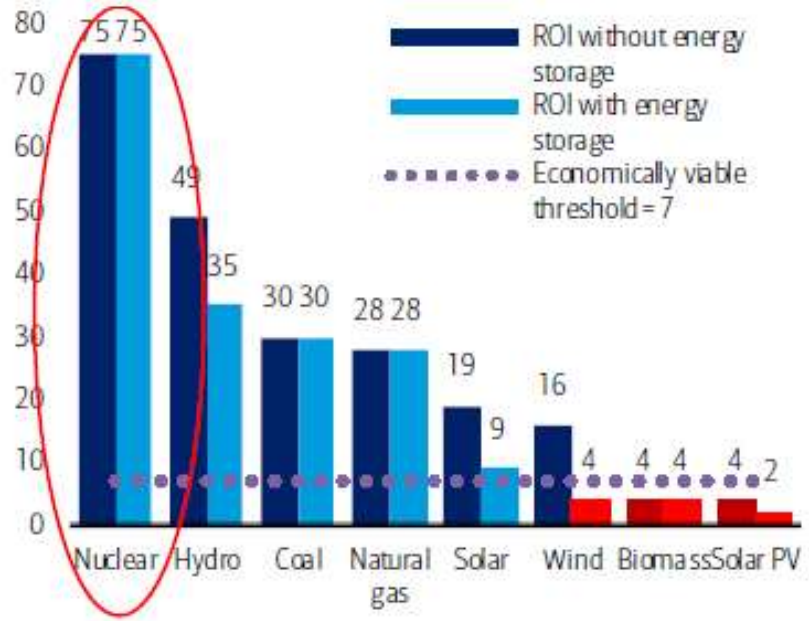
- Where to invest if the source will bear the cost of stability?
  - Internalization of the externality to instability originator

Exhibit 21: ...especially on an "all-in basis"...
LCOE & LFSCOE calculations by energy source



Source: BofA Research Investment Committee, Idel 2022
BofA GLOBAL RESEARCH

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

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

- Challenges:
  - Nuclear is too costly to alternatives
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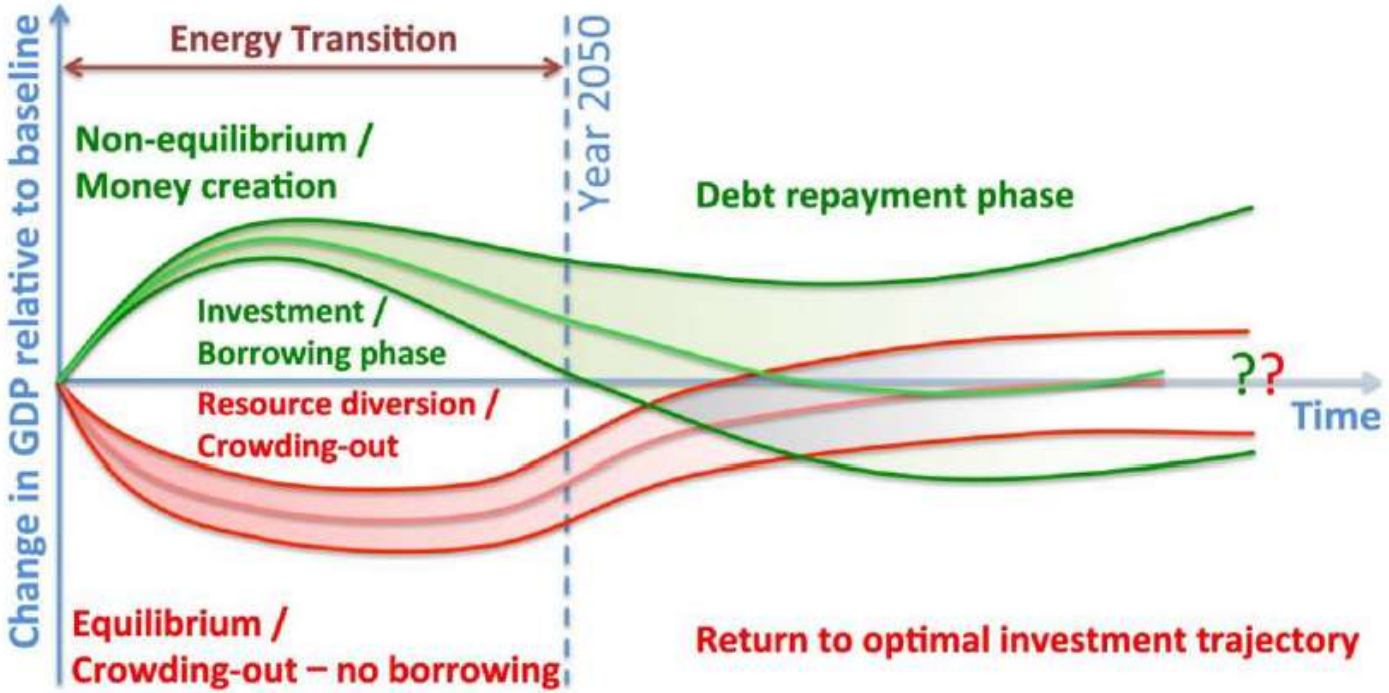
  - Market financing difficult
- Advantages:
  - Construction boost to economy
- Benefits:
  - Security of supply: still valid, remember oil crisis in 70'

Construction Boost? E3ME, SEEPIA, KPMG….

Figure 1.1: Equilibrium and non-equilibrium approaches



- Multipliers and post-Keynes type
- No crowding-out, no limits due to spare capacities
- Classical redistribution – hence no extra growth…

- Sounds bad, doesn't it?

Advantage of Nuclear for CZ Is Elsewhere!

- Back of the envelope calculation, counterfactual:
  - Now: Export of 10TWh ~ 20bil CZK
  - W/O Coal:
    - Import of electricity ~ 15 TWh ~ 30bil CZK
    - Import of gas for heating ~ 5-10bil m^3 ~ 50-100bil CZK
- Direct effect on net exports is 100-150 bil. CZK
- This is 1.5-2.5% lower GDP …. EACH YEAR

Economic Challenges – Or Misconceptions?

- Challenges:
  - Nuclear is not costly to alternatives - except gas
  - ~~Too long construction time makes it even less viable~~
  - Market financing difficult
    - as we actively promote a subsidize competing (but not complementary) technologies
- Advantages:
  - Future IMPORT reduction are the benefits for economy
- Benefits:
  - Security of supply: still valid, remember oil crisis in 70'

Thank You for Your Attention

It does worth…

…. but how shall we finance it when we aggressively subsidize and legally promote alternatives?

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