



The role of nuclear and new renewables in the future Swiss electricity system

Dr. Jonas Savelsberg

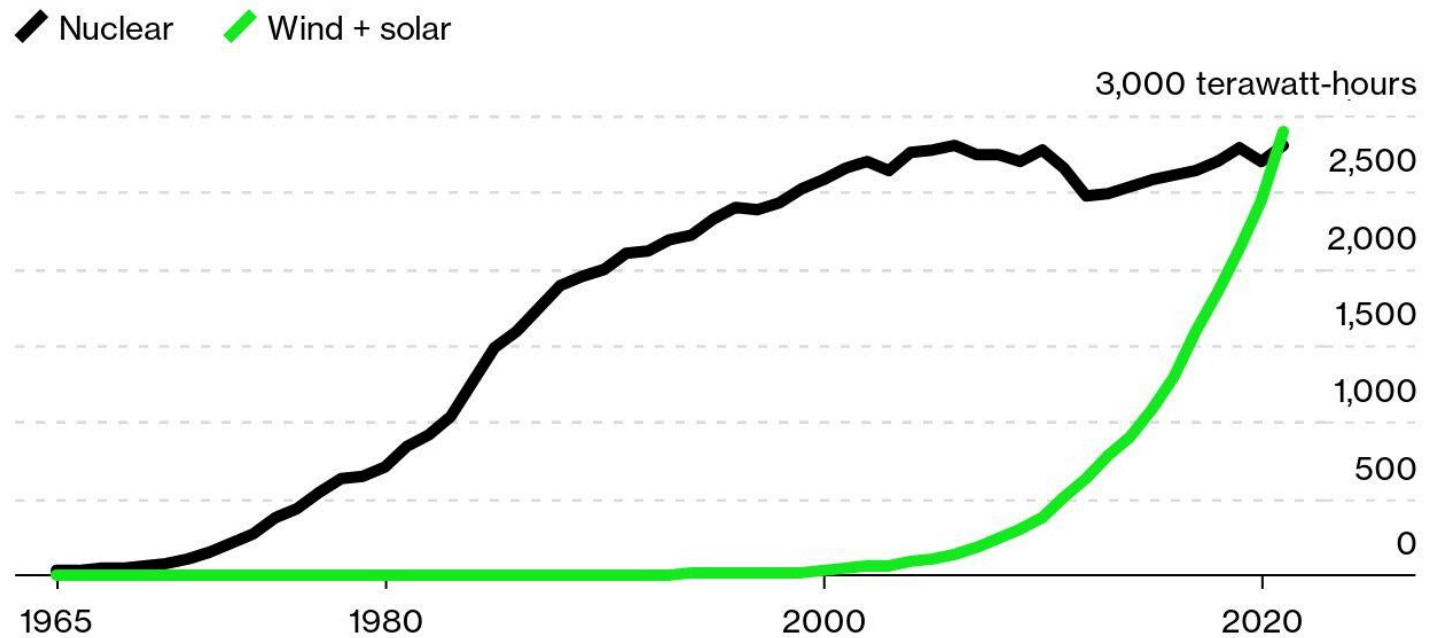
Energy Science Center jsavelsberg@ethz.ch

Photo by [Markus Spiske](#) on [Unsplash](#)

Wind and solar have been growing rapidly globally since 2000

Jagged Lines and Smooth Curves

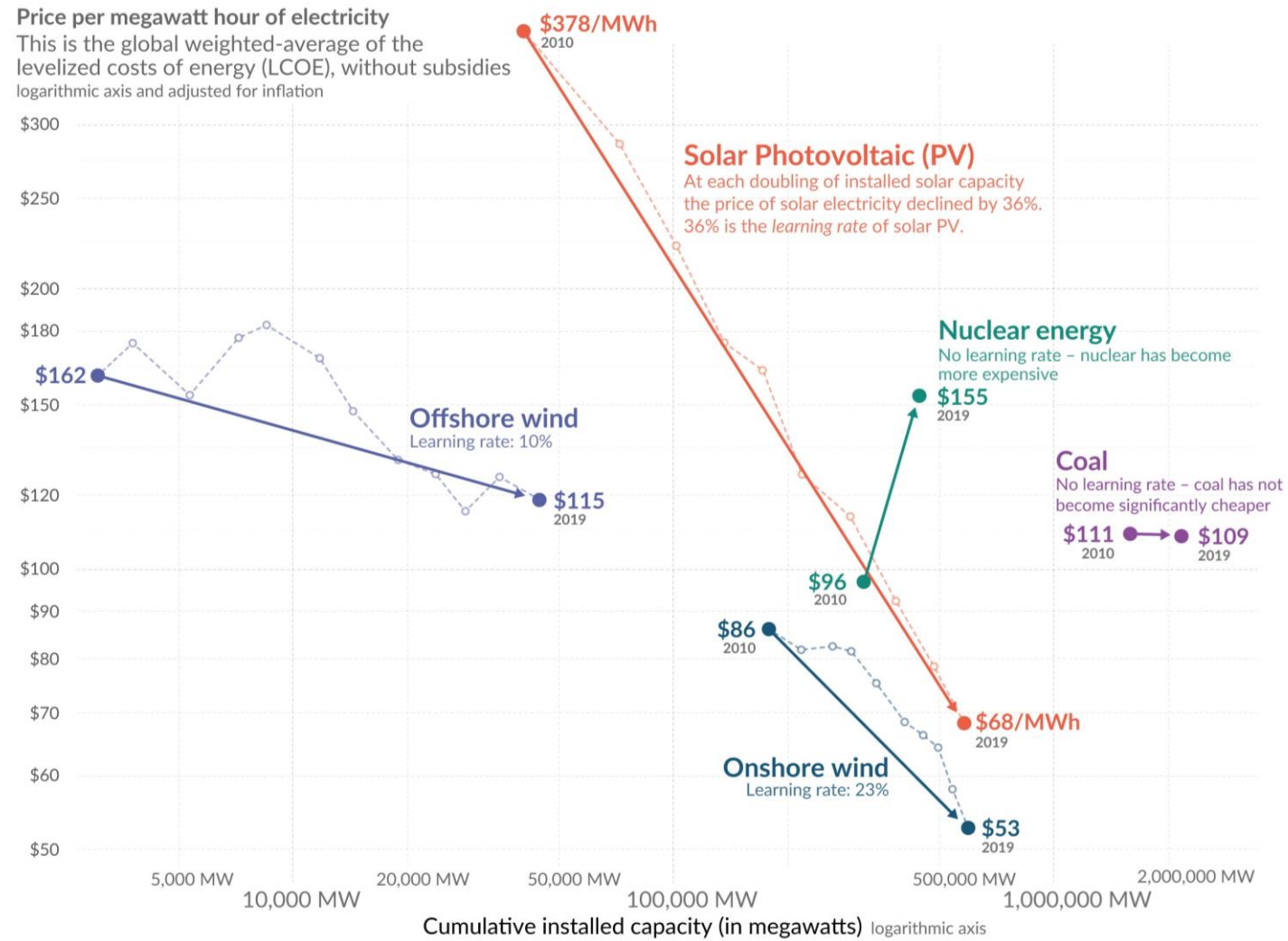
Global power generation from nuclear and wind + solar



Source: BP Statistical Review of World Energy 2022

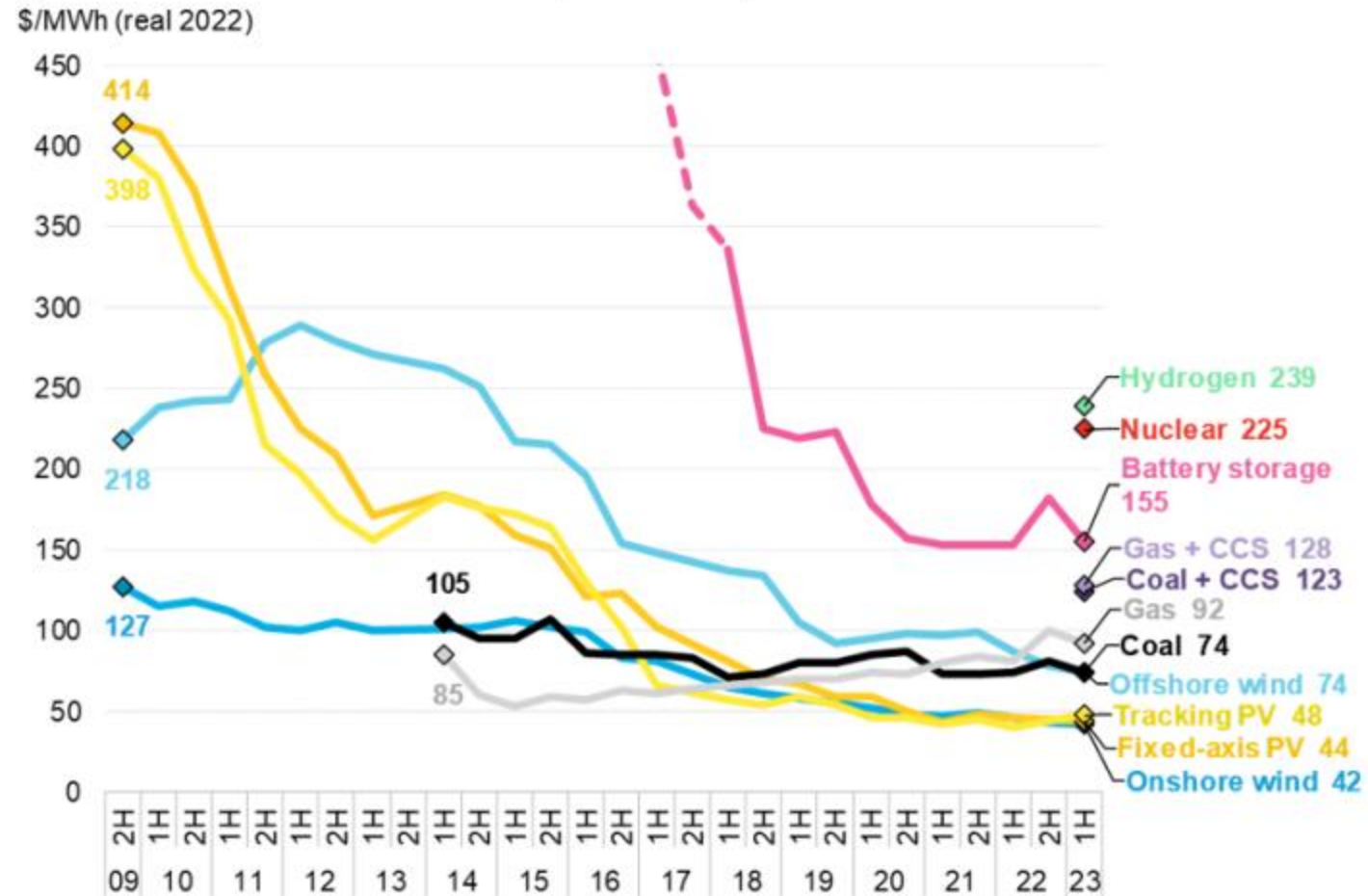
Bloomberg Green

We observe high learning rates for wind and solar.

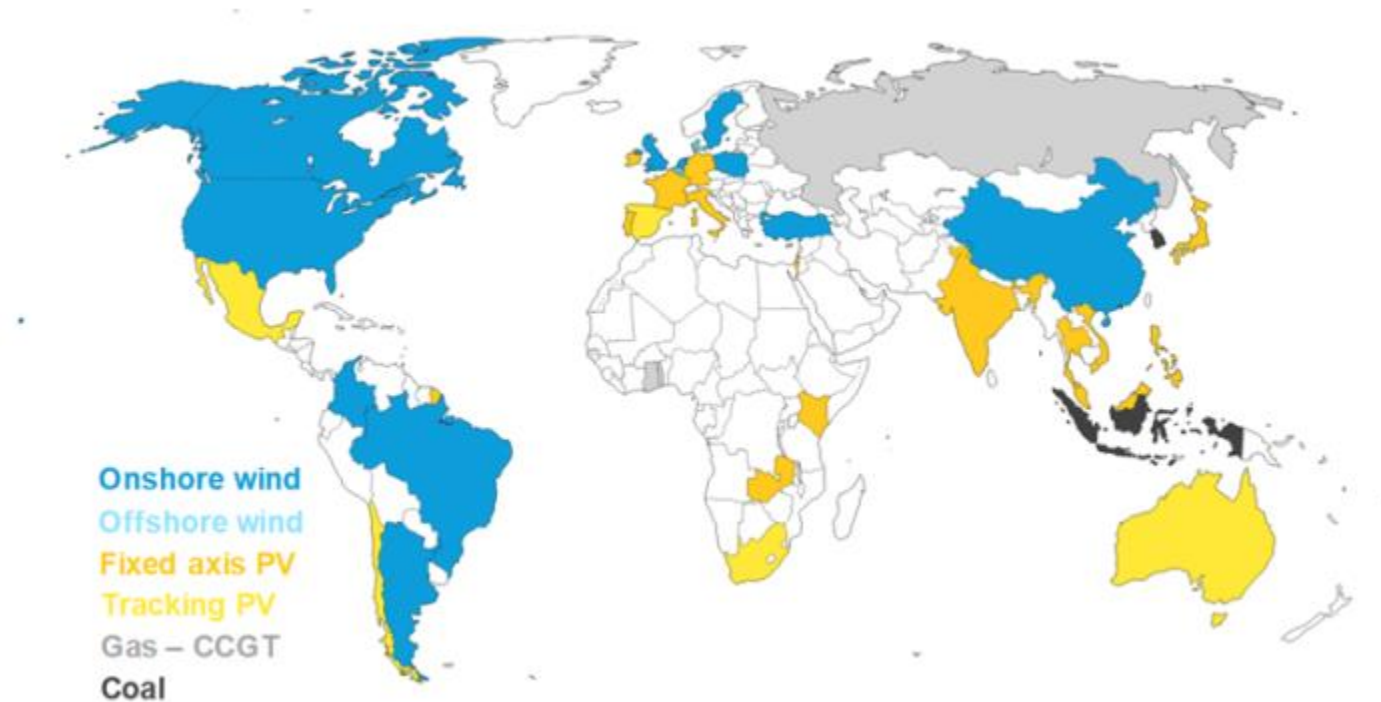


Similar developments can also be seen for battery storage systems.

Figure 1: Global levelized cost of electricity benchmarks, 2009-2023

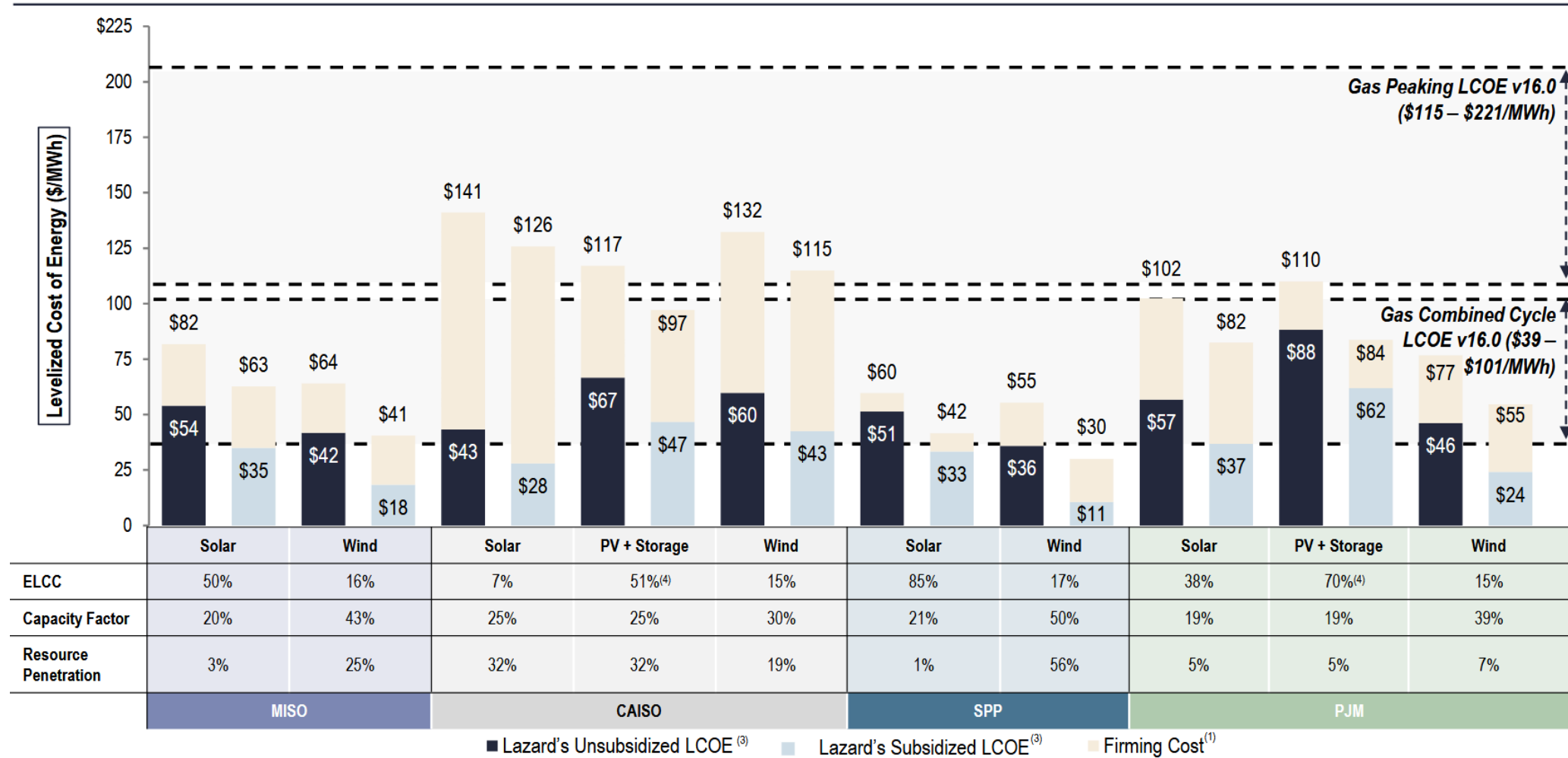


In many regions, wind and solar are already cheaper than new coal- or gas-fired power plants.



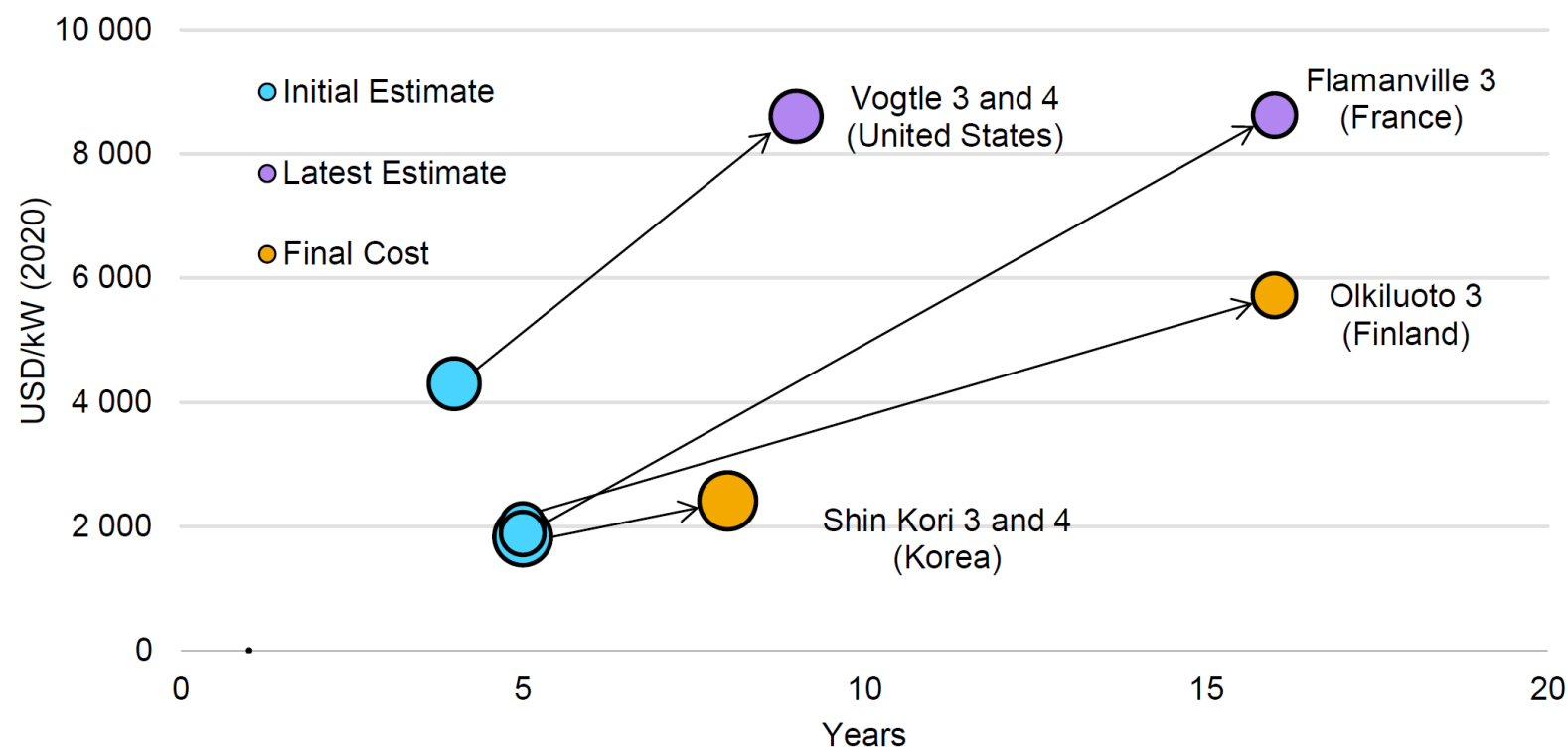
This also results in low levelized firming costs

LCOE v16.0 Levelized Firming Cost (\$/MWh)⁽³⁾



Costs and construction times for current nuclear projects are usually significantly higher than initial estimates.

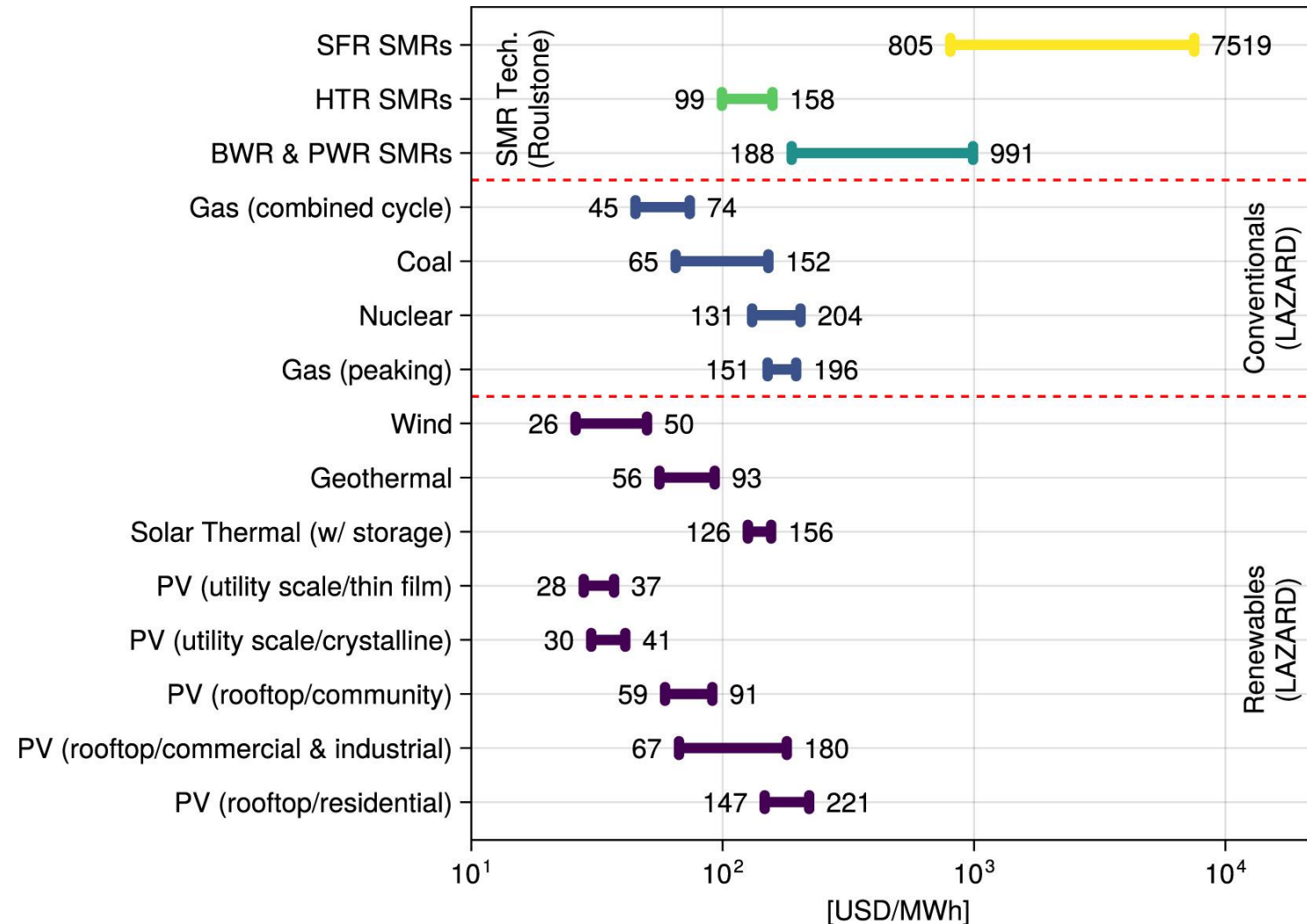
Overnight cost and construction times for selected recent nuclear projects



IEA. All rights reserved.

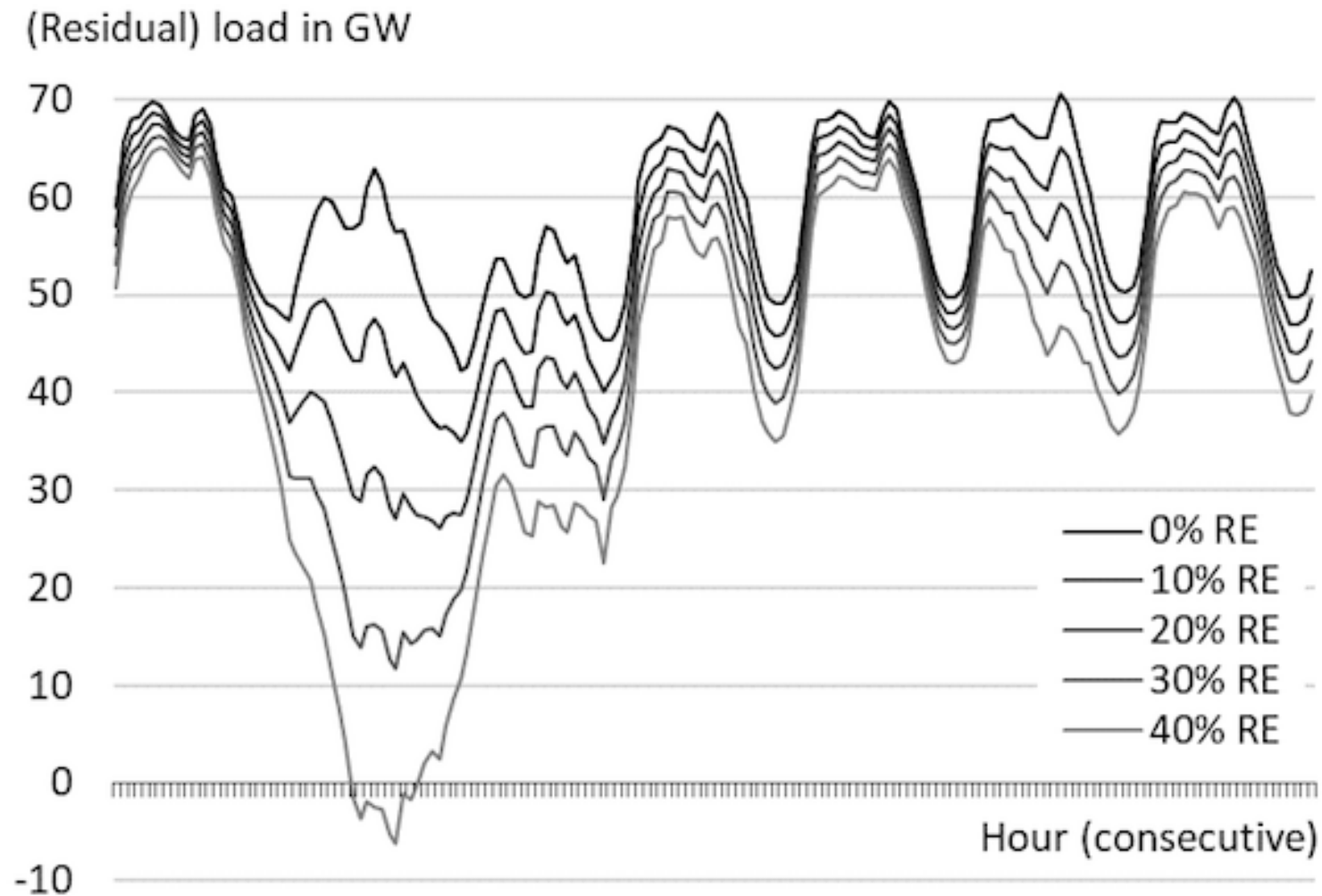
Source: Nuclear Energy Agency (2020), [Unlocking Reductions in the Construction Costs of Nuclear](#).

SMRs are facing similar problems to more traditional nuclear power plants.

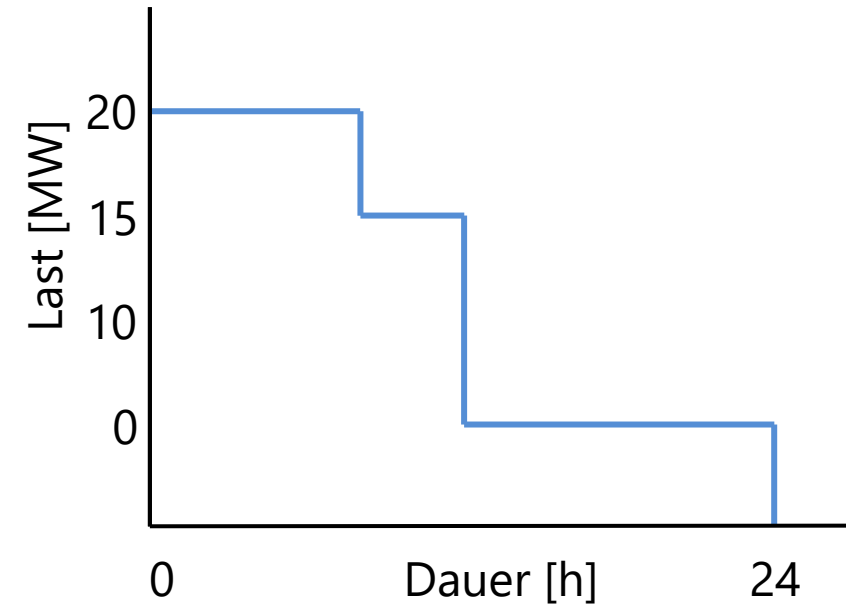
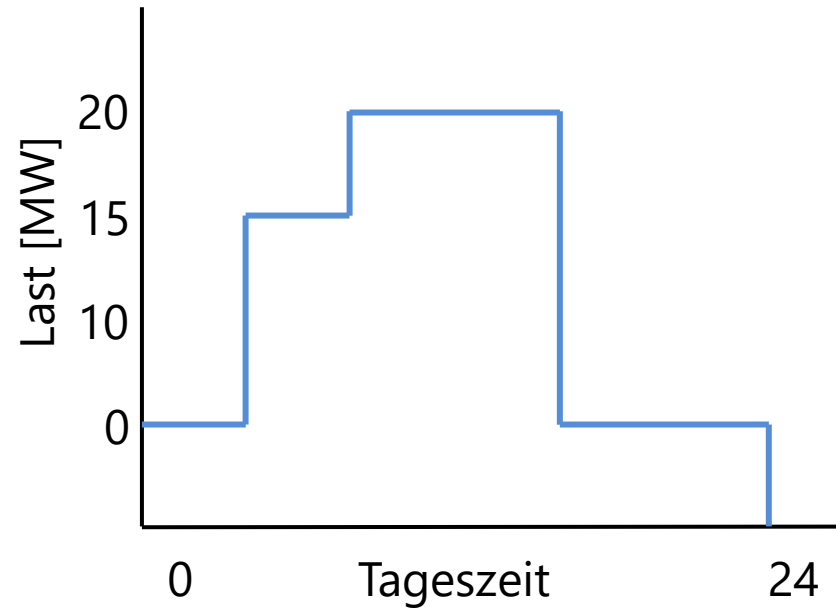


The Theory

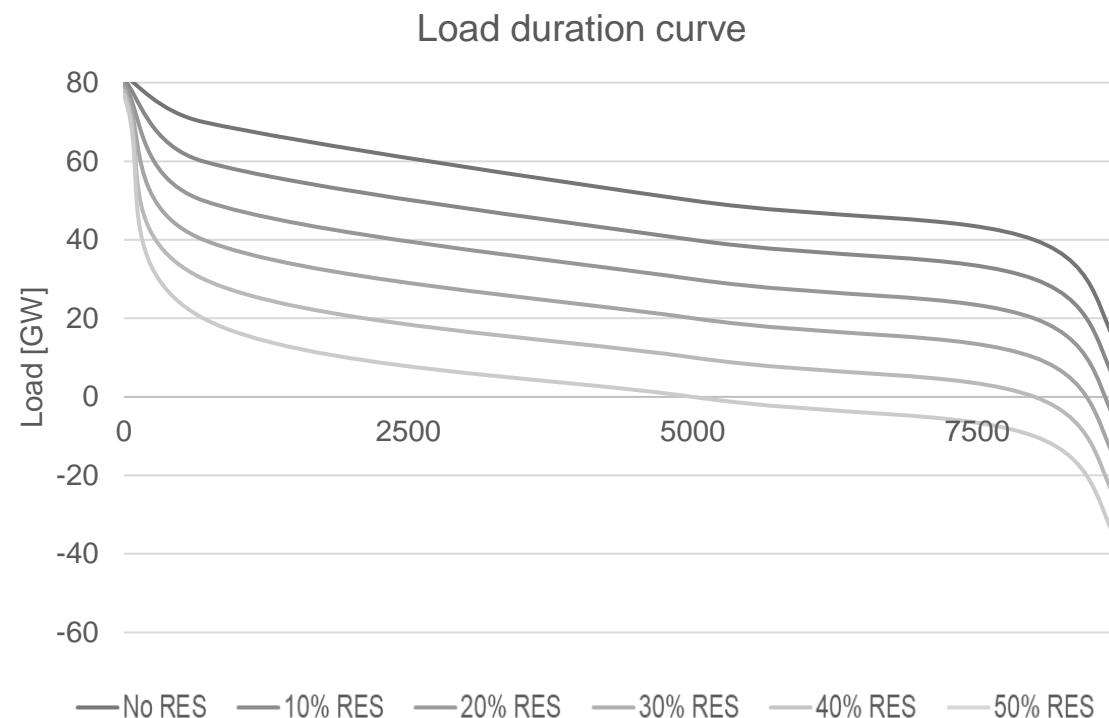
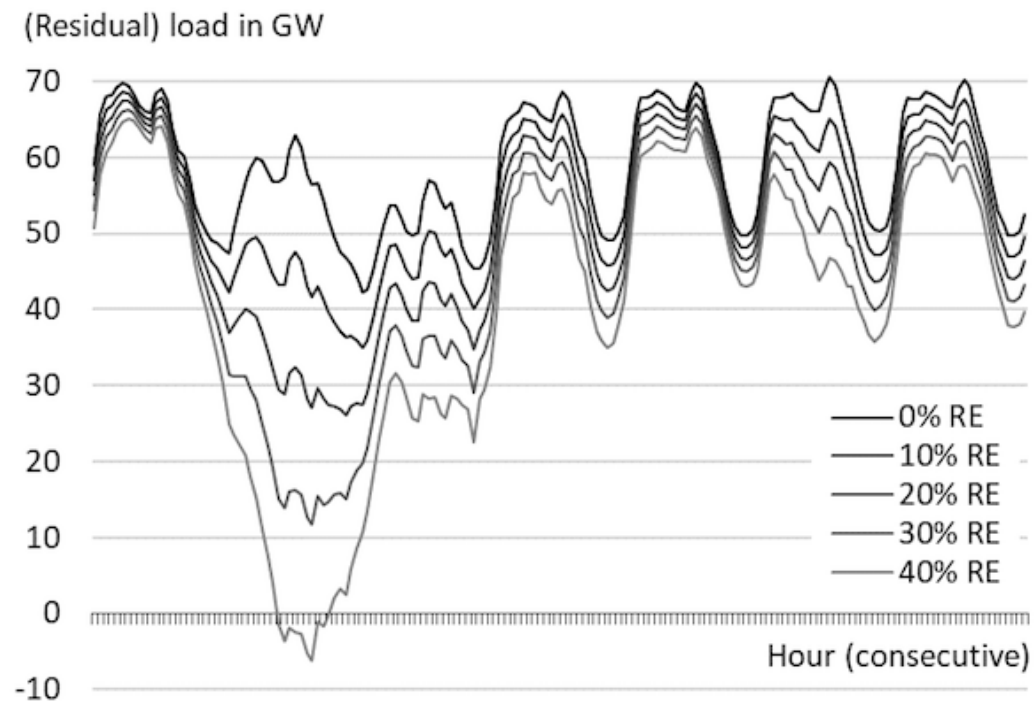
Residual load decreases with increasing share of renewables.



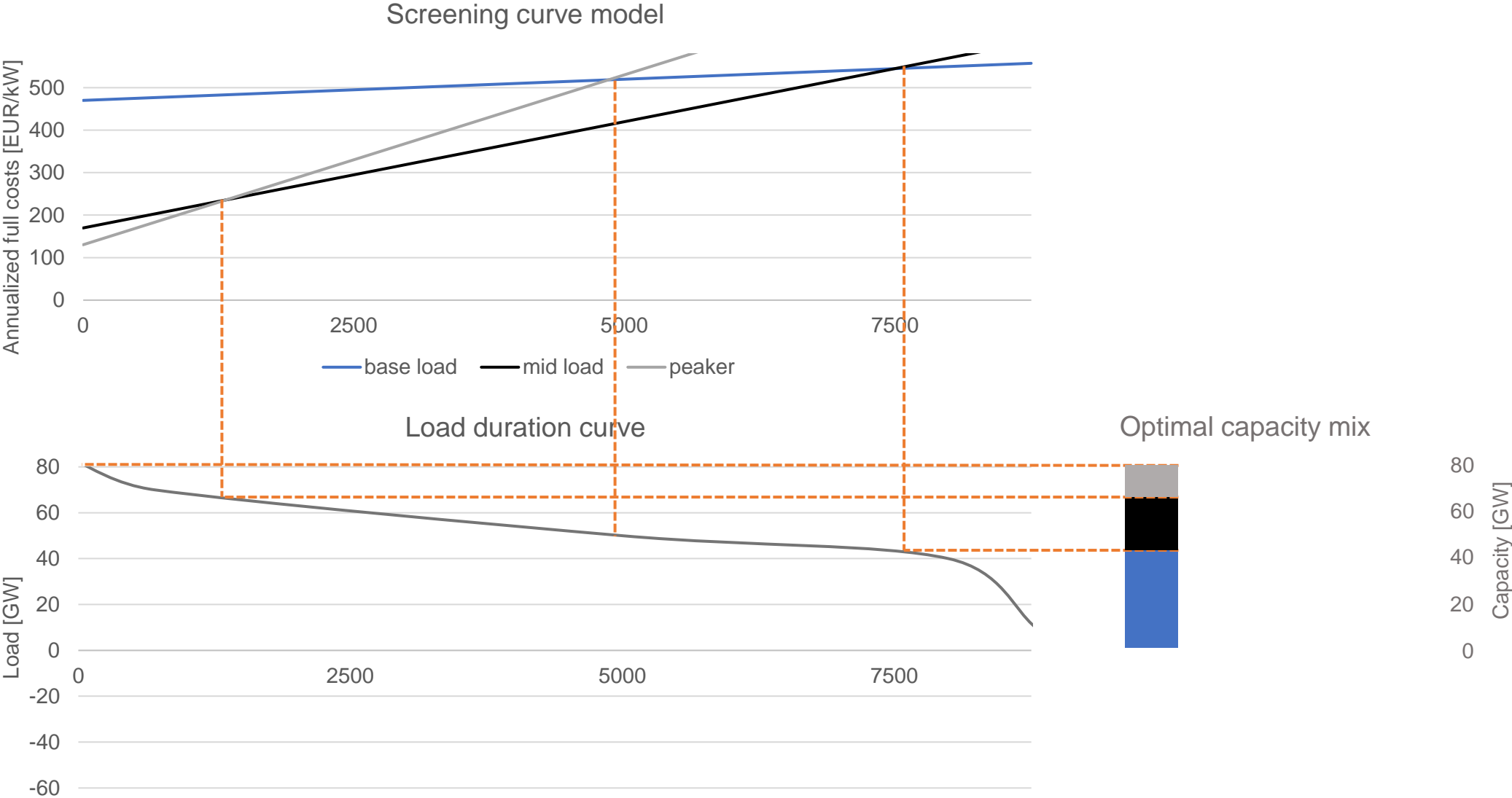
From the Load Curve to the Load Duration Curve



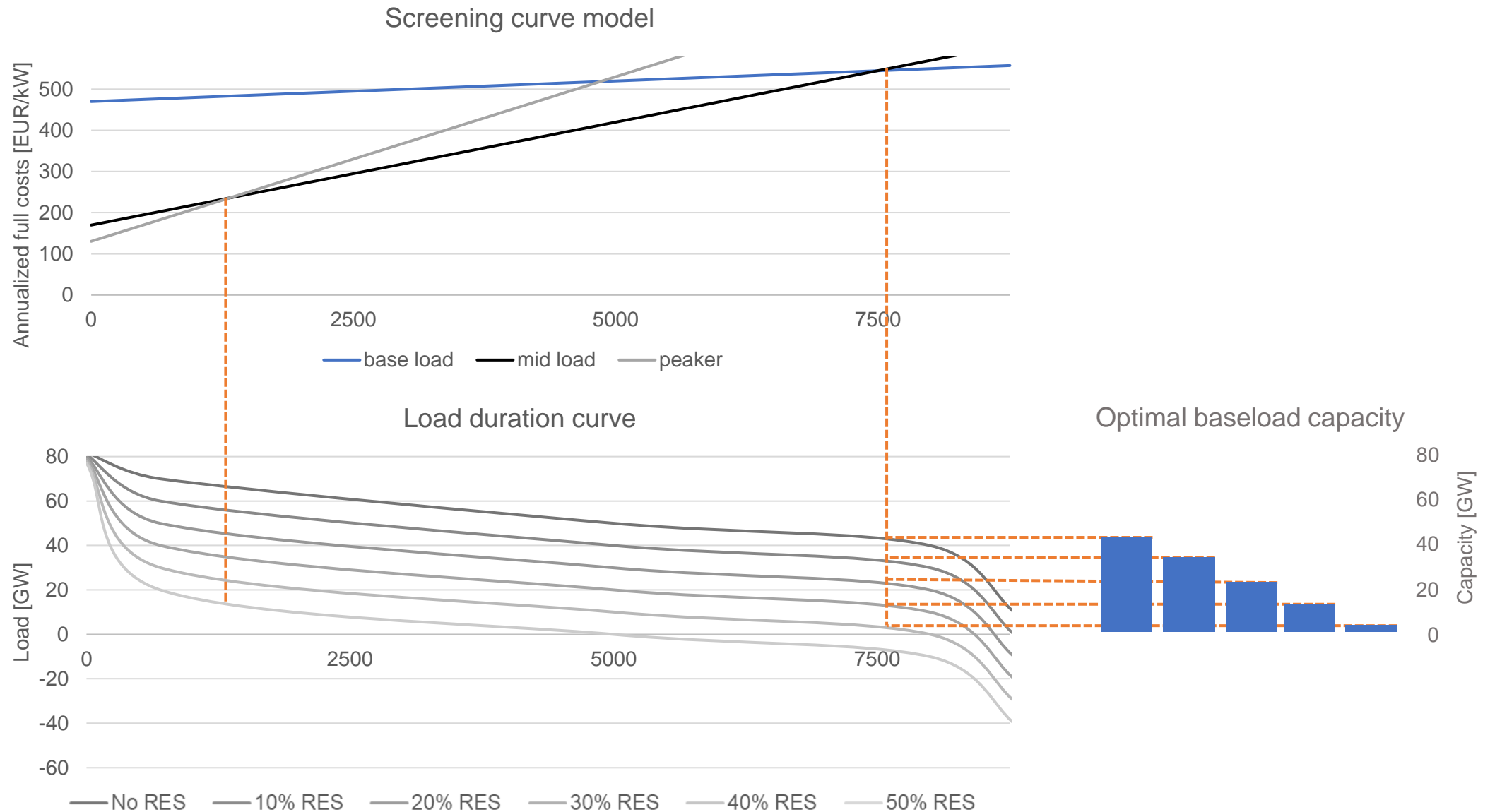
From the Load Curve to the Load Duration Curve



How can the optimal capacity mix be determined?



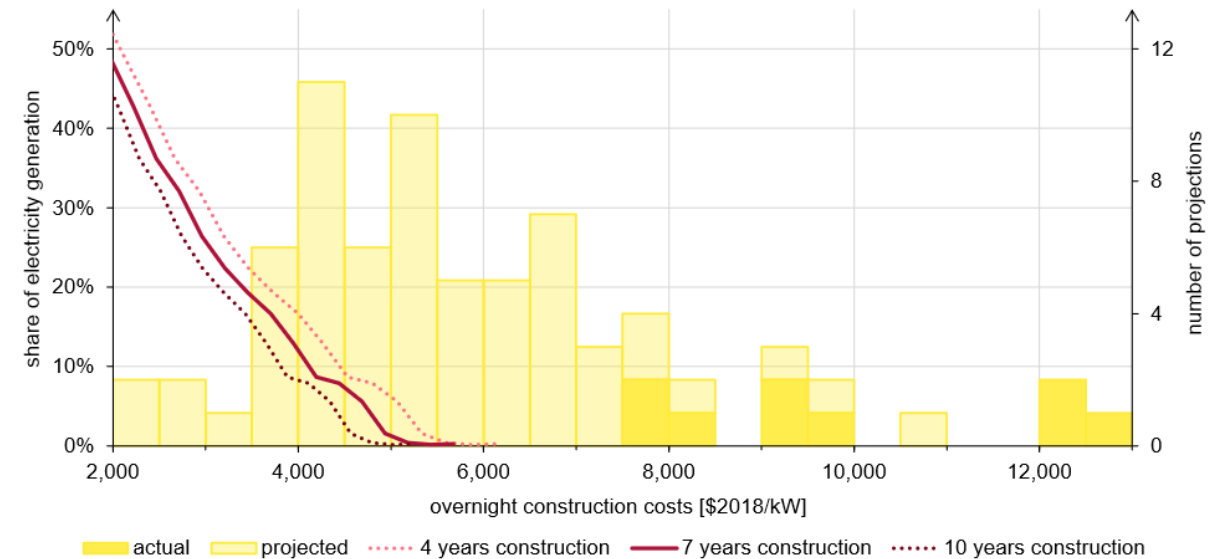
What happens to the base load demand?



Current studies on the topic

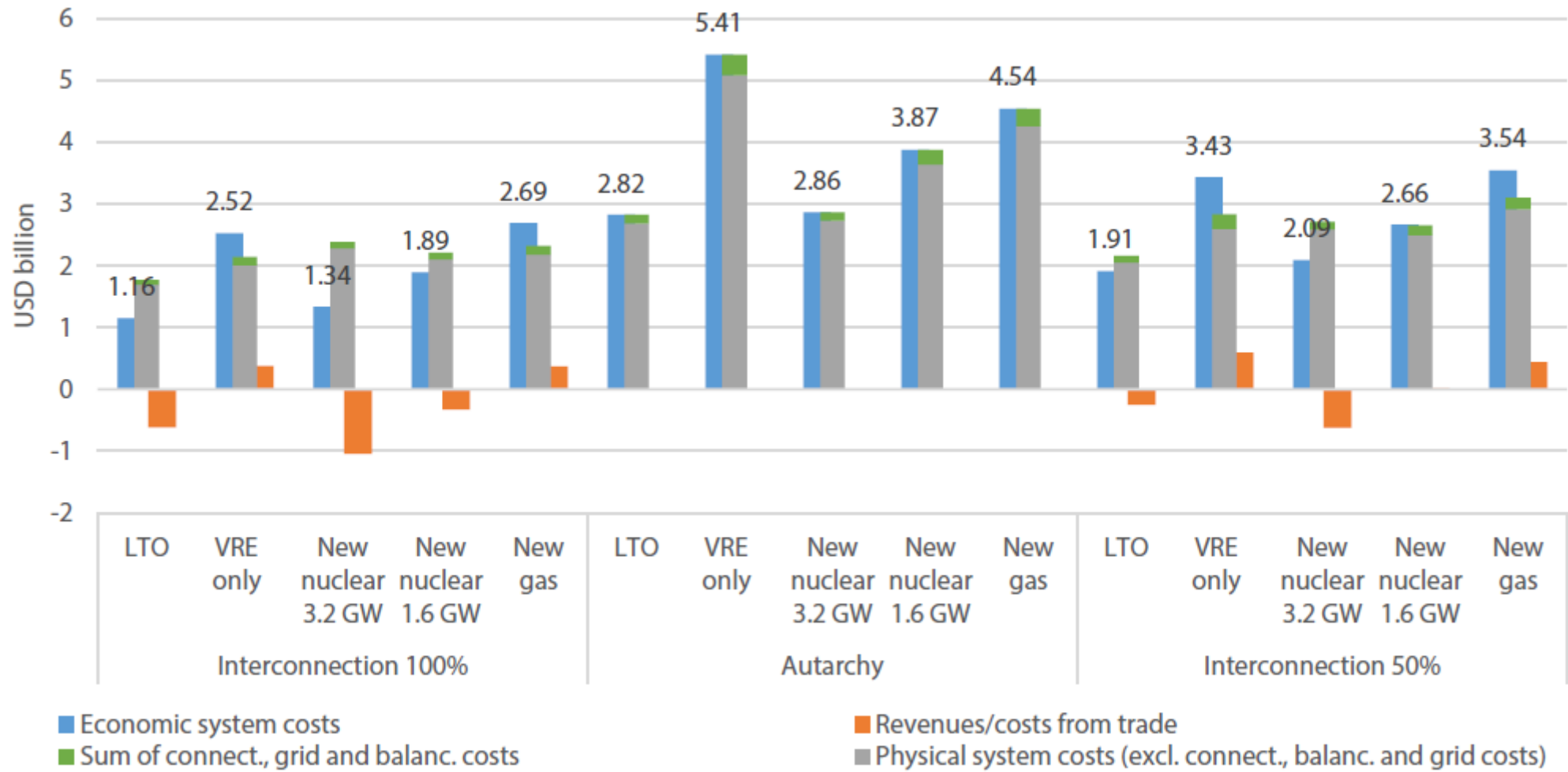
Economics of nuclear power in decarbonized energy systems (Göke, Wimmer, von Hirschhausen 2023)

- Use a detailed energy planning model.
- At costs of nuclear of 4,000 US-\$2018 per kW and construction times remain below 10 years, the cost efficient share of nuclear power in European electricity generation is only around 10%.
- Analysis omits social costs of nuclear power, such as the risk of accidents or waste management.
- To recover investment costs, nuclear plants must operate inflexibly and at utilization rates close to 90%.
- Grid infrastructure, flexible demand, and storage are more efficient options to integrate fluctuating wind and PV generation.



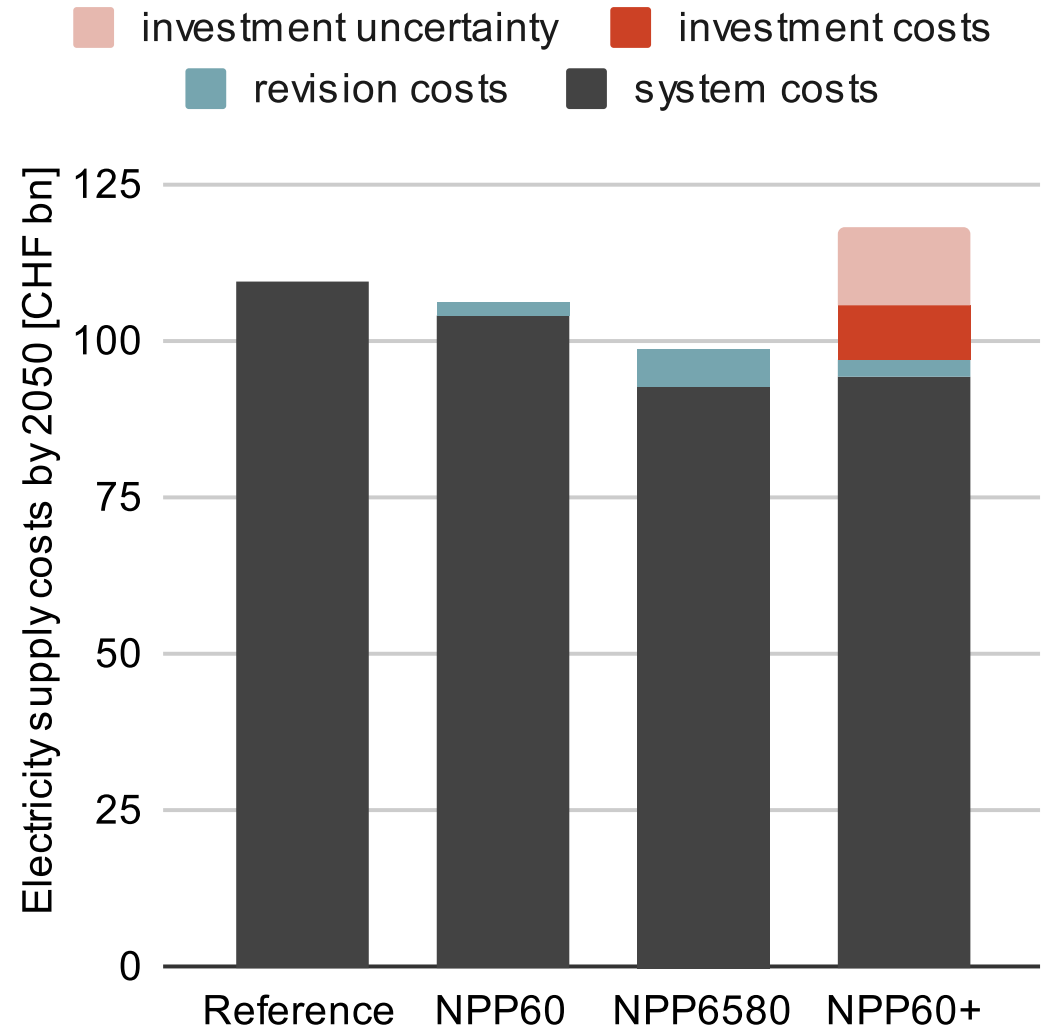
Göke et al. 2023

NEA 2023



ETH Study on Nuclear Energy

- Study commissioned by Economiesuisse.
- Time horizon of study only until 2050.
- The capacity factor of Swiss nuclear power plants decreases as the share of renewables increases.
- Power plants need to operate more flexibly.
- Runtime extension can reduce system costs.
- New power plant pays off with investment costs of less than 4500-5000 CHF/kW.
- The risk of accidents, the costs of the final disposal of nuclear waste, the dependence on uranium imports or imponderables in the duration of planning and construction are not taken into account.



Conclusion

1. The future electricity system will be characterized by wind, PV and flexibility.
2. Baseload power plants are losing more and more market share.
3. New technologies must be flexible and have low investment costs in order to add value to the overall system.
4. Whether new nuclear power plants can be part of a cost-efficient power system depends largely on investment cost developments.

Jonas Savelsberg, PhD
jsavelsberg@ethz.ch



cepe

Centre for Energy Policy and Economics
Swiss Federal Institutes of Technology

ETH zürich