

Cross Sectorial Integration of Nuclear and Intermittent Renewables for Low Carbon Society

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Nuclear
Technology
for Climate

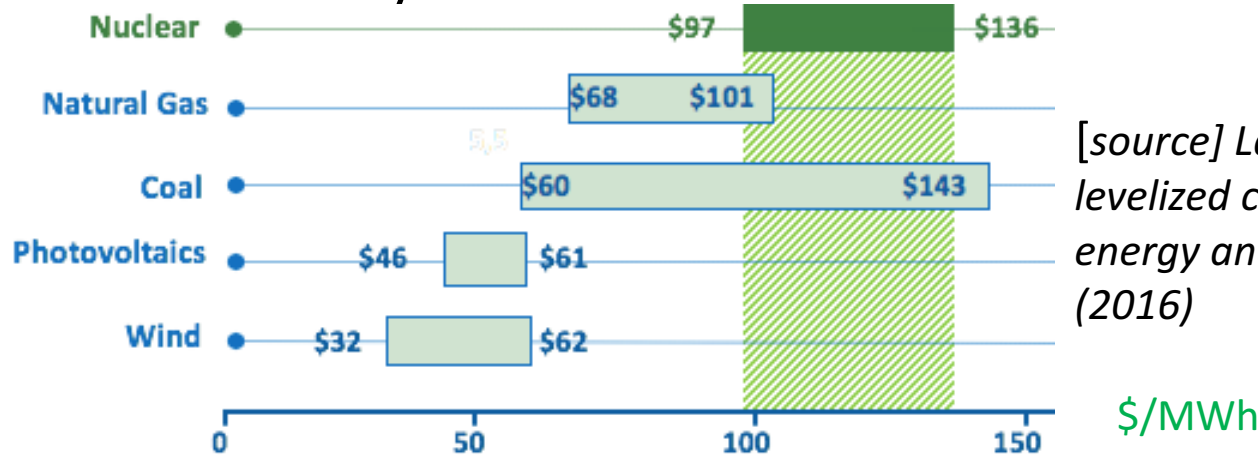
Mitigation, Monitoring, Adaptation

18–19 September 2018



✓ **“Solar becomes the cheapest source of electricity generation in many places including China and India”** (F. Birol, IEA OECD, 2017 World Energy Outlook)

✓ **Comparison of unsubsidized levelized cost of electricity, not including social/environmental externalities nor intermittency-related cost**



[source] Lazard's levelized cost of energy analysis (2016)



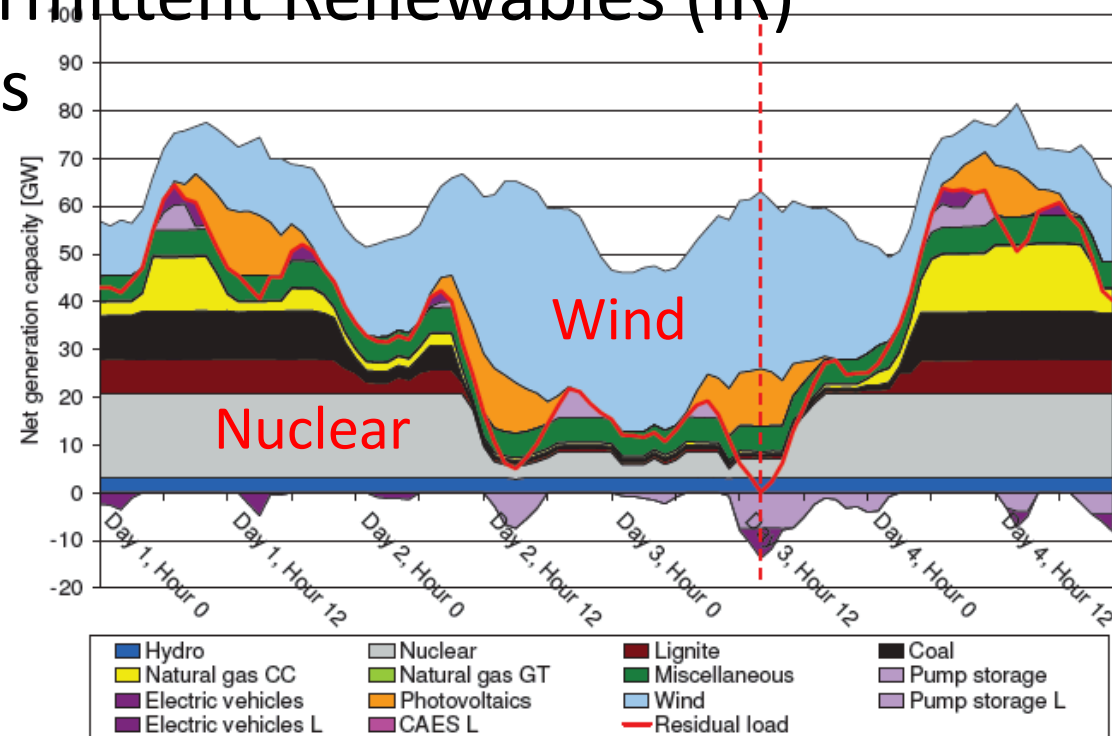
✓ **However, merely increasing the share of solar/wind power does not necessarily lead to GHG emission reduction nor affordable electricity**

	<u>Sweden</u>	<u>France</u>	<u>Denmark</u>	<u>Germany</u>
gCO2/kWh	11	46	174	450
cent/kWh	20	22	41	40
Intermittent Renewables	10%	5%	51%	18%
Dispatchable clean energy	88%	88%	15%	25%

[source] IEA CO2 Emission from combustion 2017

➤ Deep penetration of Intermittent Renewables (IR)

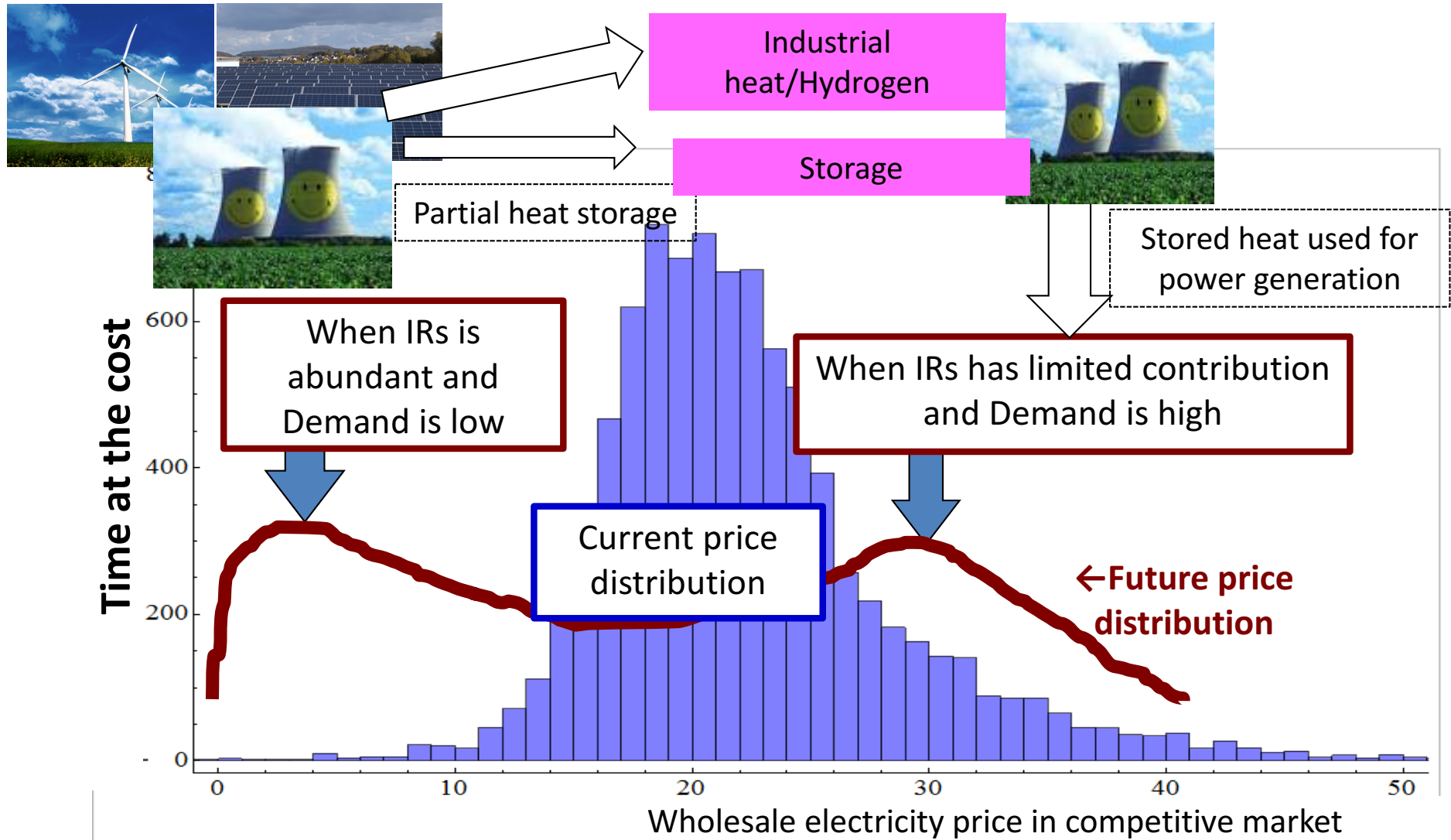
- Electricity price collapses at a time the share of renewables is high (low marginal cost)



➤ Compatibility with increased share of intermittent renewables requires **system flexibilities** to deal with Intermittency (variability & uncertainty) :

- flexible generation
- storage and/or hybrid production of energy carriers
- smart grid management including Demand side

- **Store partial heat in Nuclear**, when Sun is shining or Wind is strong
- ➔ Use stored heat for electricity generation when Sun/Wind is not strong
- **Nuclear Hybrid production**: depending on supply from Sun/Wind



- **Both N and IR (Intermittent Renewables) are important for**
 - Reduction of GHG emissions, of oil/gas import
- **Deep decarbonization without Nuclear merely by IR** raises electricity price significantly due to storage to cope with intermittency.
- **The issue is: How we can achieve low carbon energy system by complementary use of Nuclear & IR with minimum burden to the Society?**
- **We need:**
 - Innovation in institutional arrangement (Clean energy equality to meet 2DC goal, Incentivize storage, flexible resources management)
 - Innovation in technologies: storage and nuclear hybrid production by high temperature)

