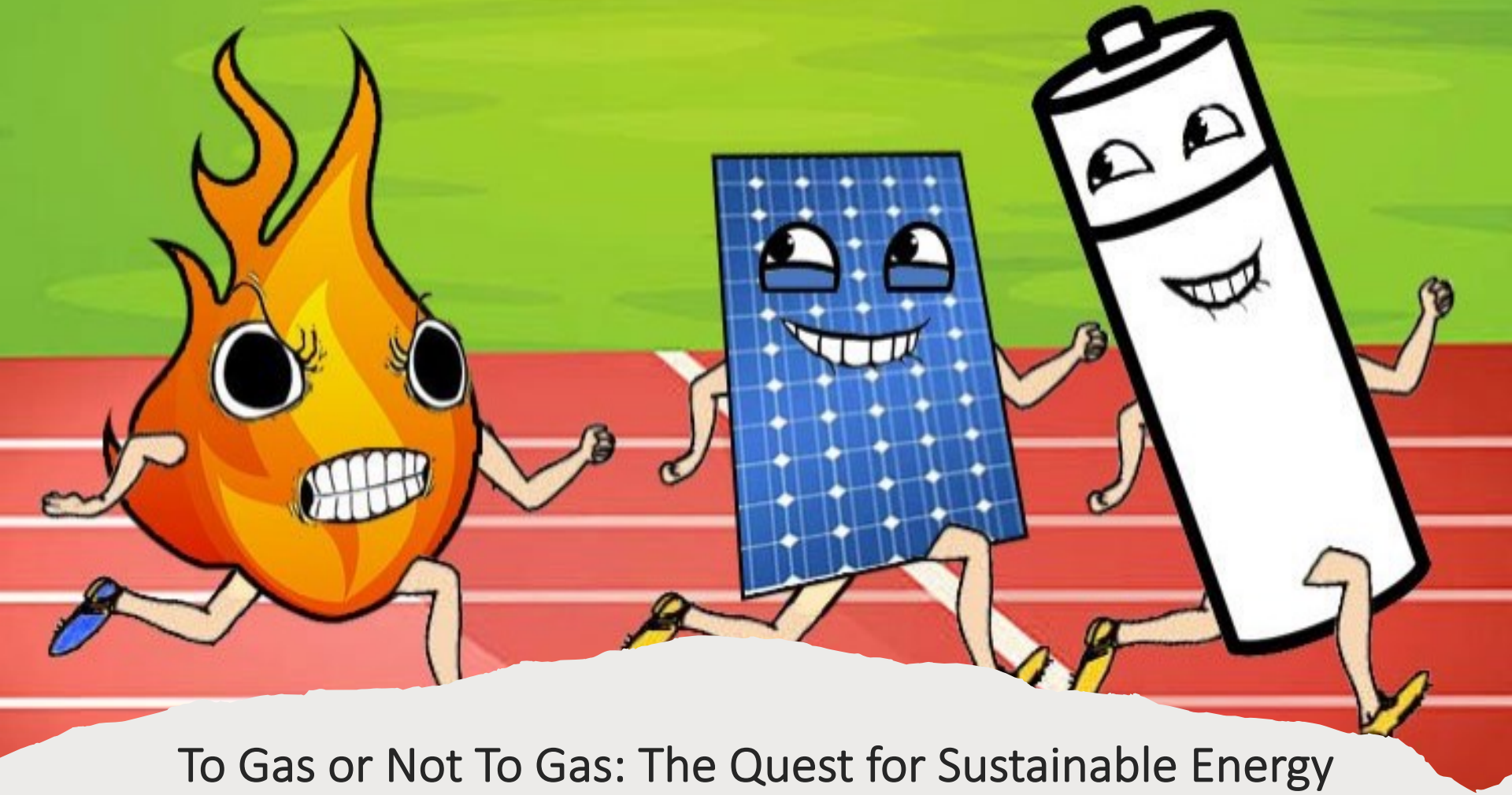


To Gas or Not To Gas: The Quest for Sustainable Energy

Outline – Not to Gas

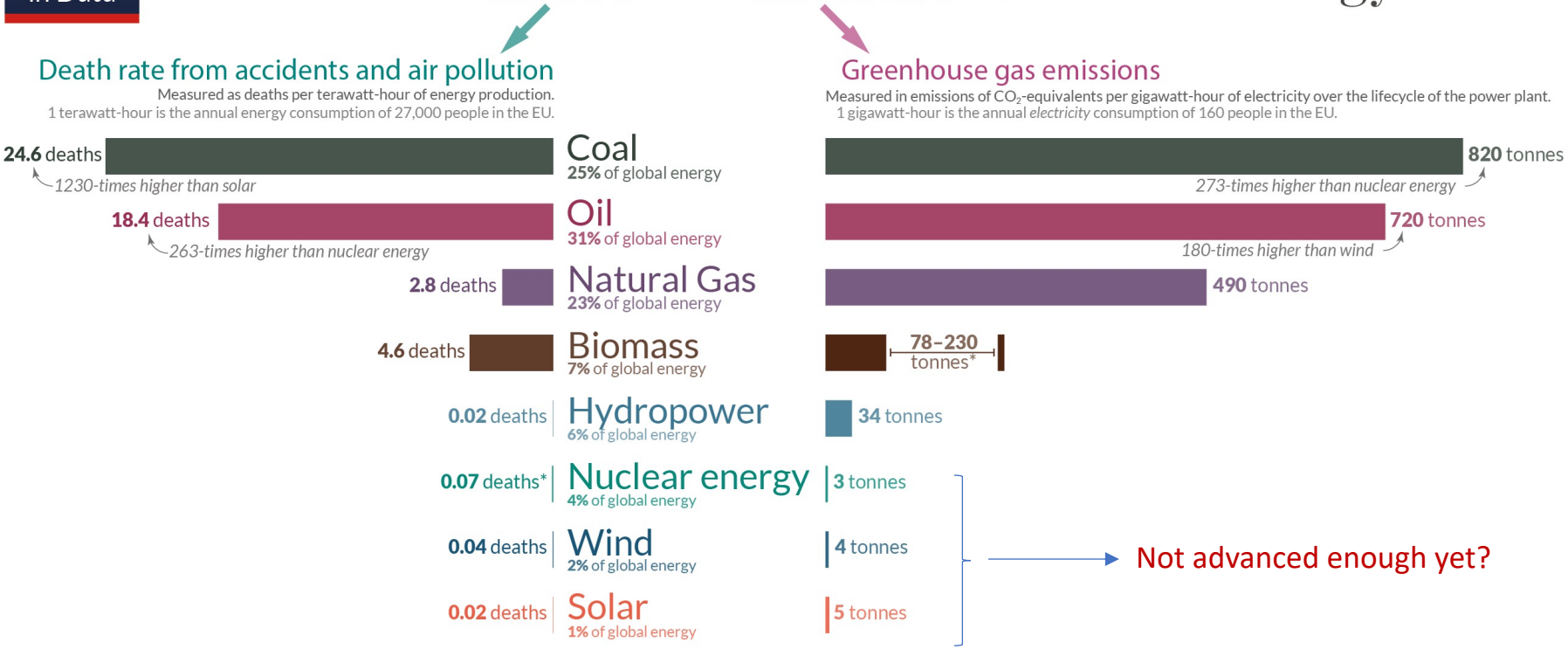
- Background
- Climate Perspective
  - Natural gas as a ‘bridge fuel’
  - Impact on 1.5-2 deg target
- Technical Perspective
  - Limitations of renewables
  - Role of storage and batteries
- Economic Perspective
  - Cost comparison
  - Virtuous Cycle
- Geo-political Perspective
  - Energy Security
  - Decentralization

What is Natural Gas?

- Natural Gas is a **fossil fuel** which is much cheaper, and emits lesser carbon emissions than other fossil fuels
- ‘Bridge fuel’ that supports energy transition

Our World in Data

What are the safest and cleanest sources of energy?



*Life-cycle emissions from biomass vary significantly depending on fuel (e.g. crop resides vs. forestry) and the treatment of biogenic sources.

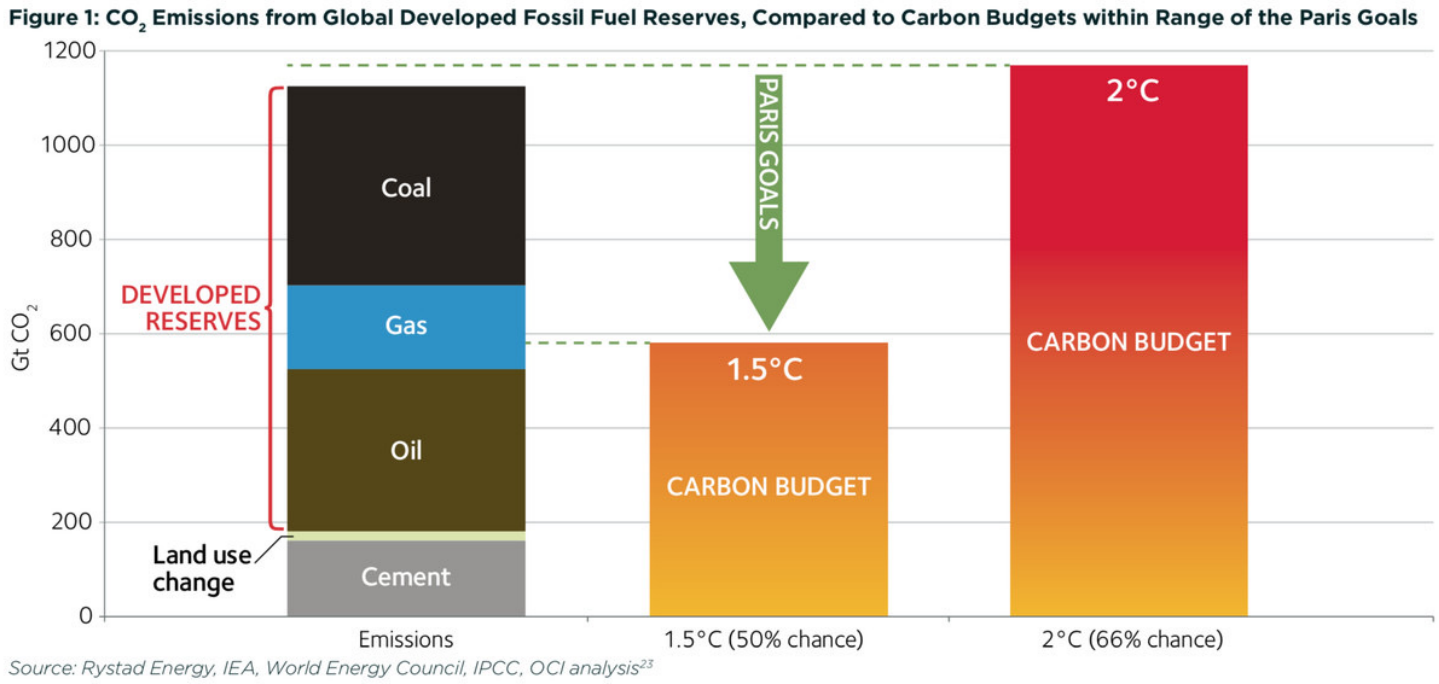
*The death rate for nuclear energy includes deaths from the Fukushima and Chernobyl disasters as well as the deaths from occupational accidents (largely mining and milling).

Energy shares refer to 2019 and are shown in primary energy substitution equivalents to correct for inefficiencies of fossil fuel combustion. Traditional biomass is taken into account.

Data sources: Death rates from Markandya & Wilkinson (2007) in *The Lancet*, and Sovacool et al. (2016) in *Journal of Cleaner Production*;
Greenhouse gas emission factors from IPCC AR5 (2014) and Pehl et al. (2017) in *Nature*; Energy shares from BP (2019) and Smil (2017).

Natural Gas as ‘bridge fuel’

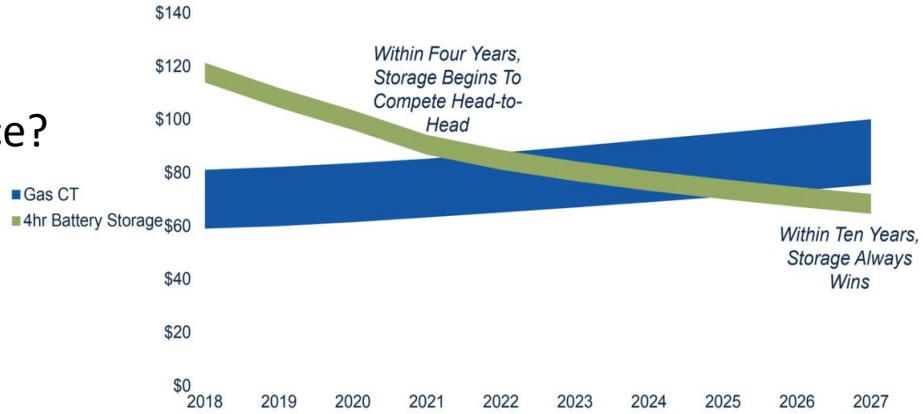
Do we have time for a ‘bridge’?



Technical Perspective

Main limitation of Renewable sources

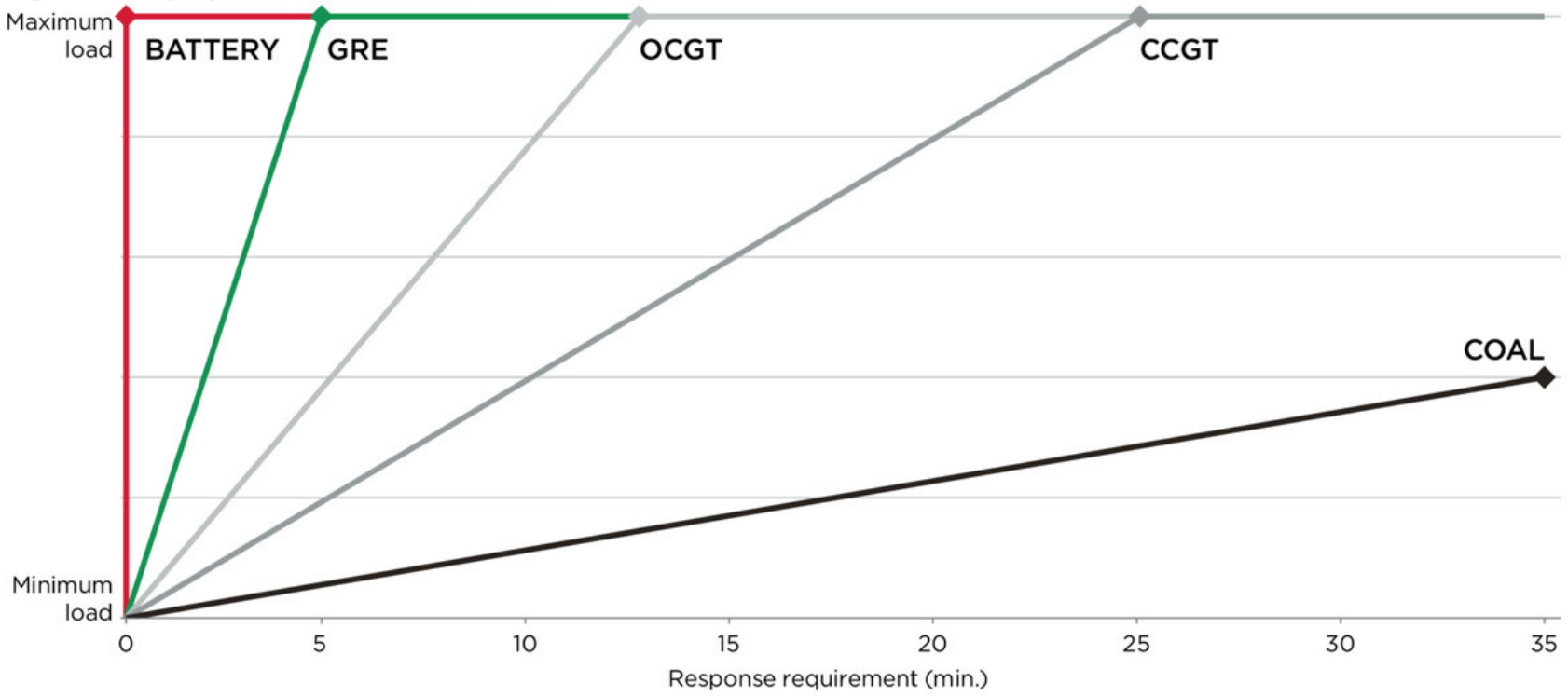
- Intermittency
- Reduced reliability, flexibility and resilience?
- Is Natural Gas the ‘only’ solution?



Role of Storage and Batteries

- A cleaner alternative
- Solar and wind coupled with batteries already compete with natural gas in cost
- Batteries offer higher flexibility as they can ramp up/down faster than natural gas plants

Figure 7: Ramp-up Times for New Power Plants



Source: Bloomberg New Energy Finance, 2H 2018 LCOE Update[m]

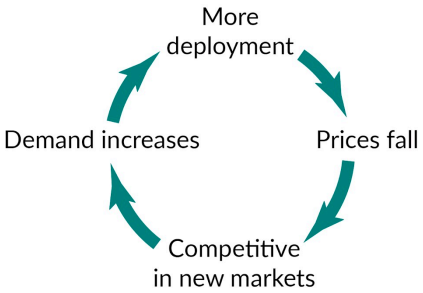
m Ramp-up times assume a hot start.

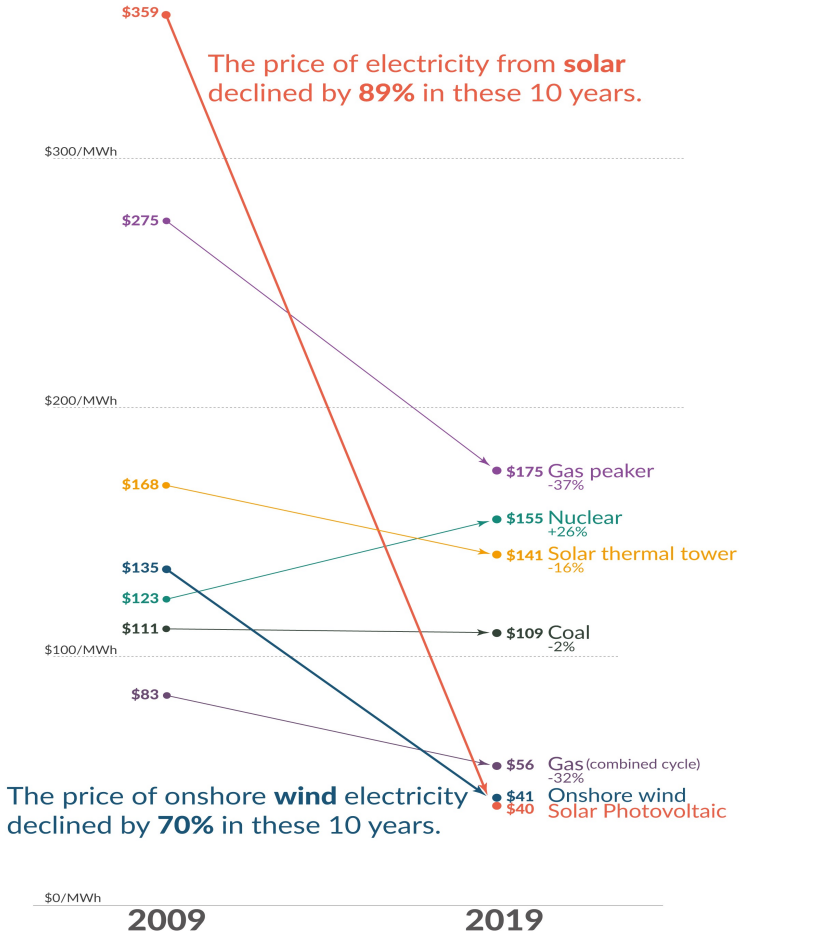
Economic Perspective

Levelized Cost of Energy (LCOE) includes both Installation and Operational Costs

Virtuous Cycle

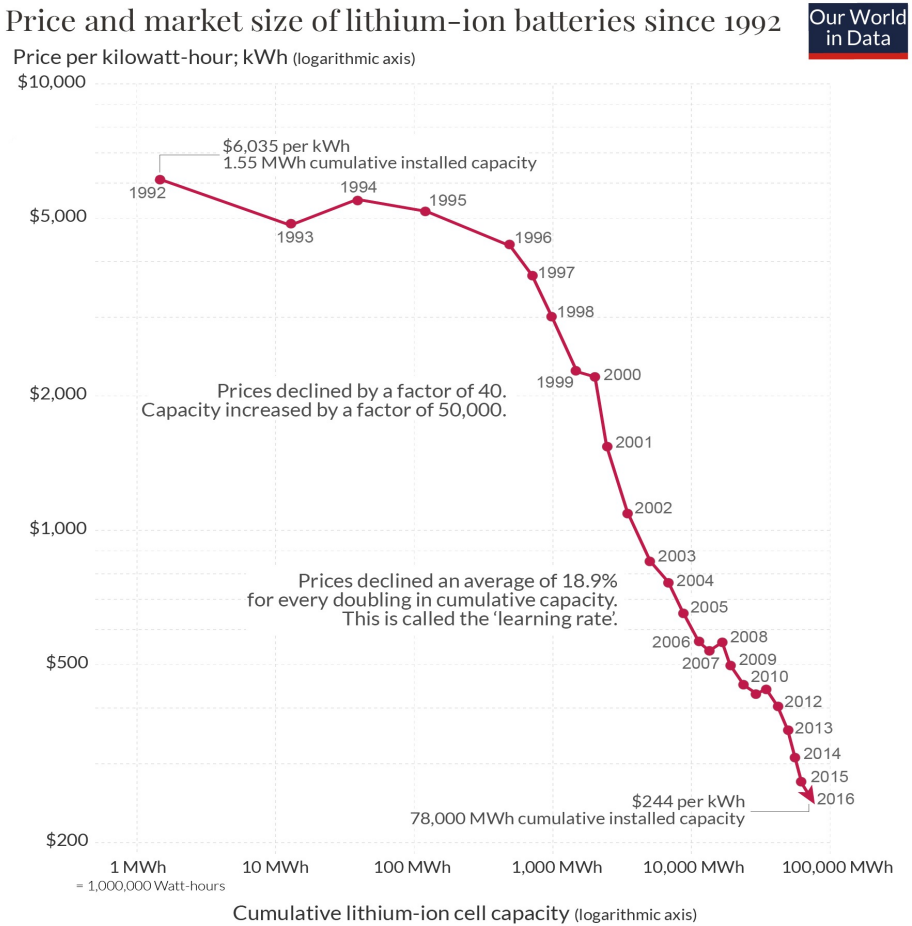
Technologies that become cheaper with increasing production enter a virtuous cycle

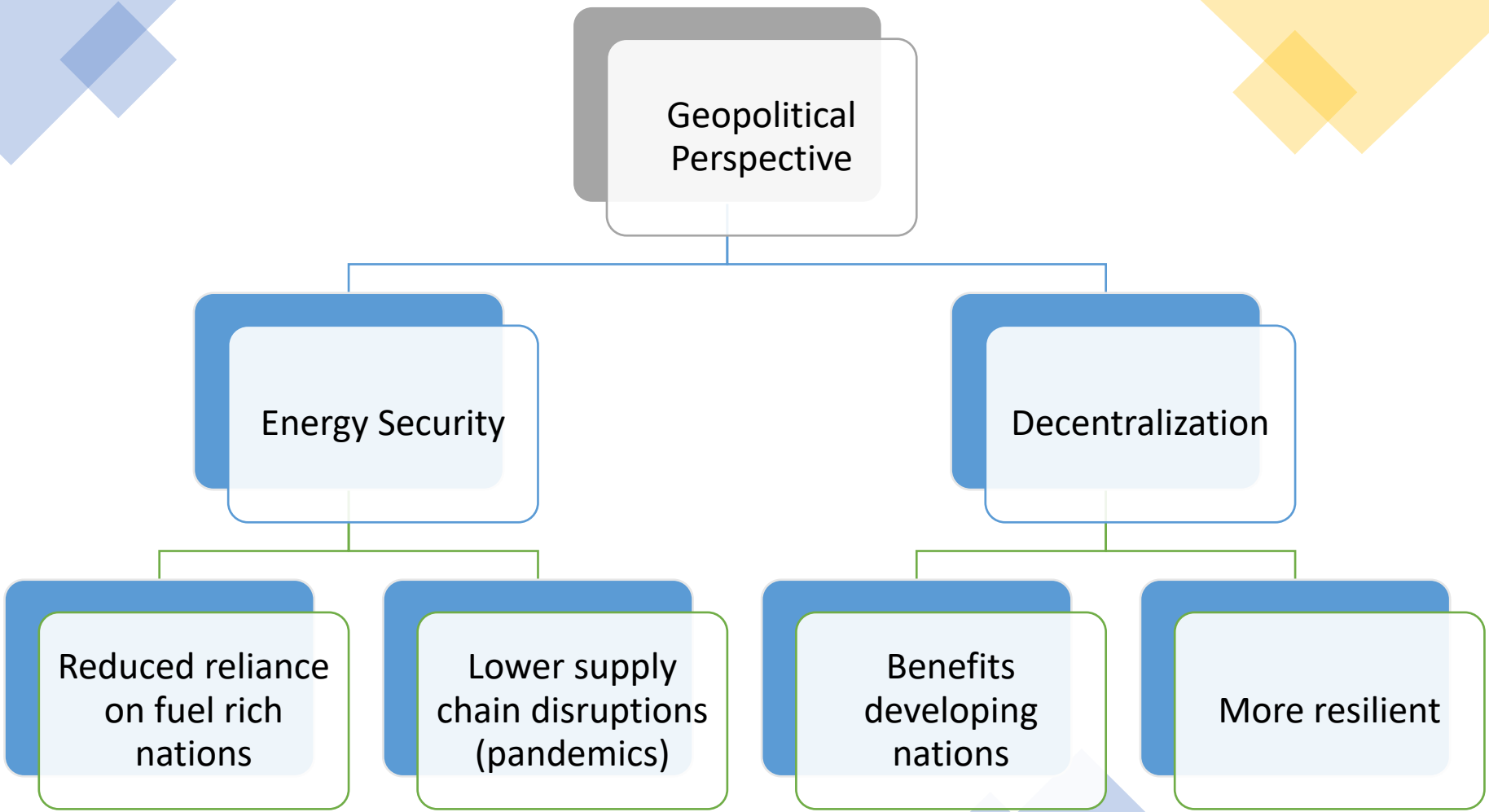




Data: Lazard Levelized Cost of Energy Analysis, Version 13.0
OurWorldinData.org – Research and data to make progress against the world's largest problems.

- Batteries and Electricity Storage follow virtuous cycle too
- New deployments of natural gas plants would result in avoidable carbon emissions and infrastructure costs




Geopolitical Perspective
Energy Security
Decentralization
Reduced reliance on fuel rich nations
Lower supply chain disruptions (pandemics)
Benefits developing nations
More resilient

“There is no room for new fossil fuel development — gas included — within the Paris Agreement goals.”

-Oil Change International (OCI)