International Energy Agency

Towards Sustainable Transport

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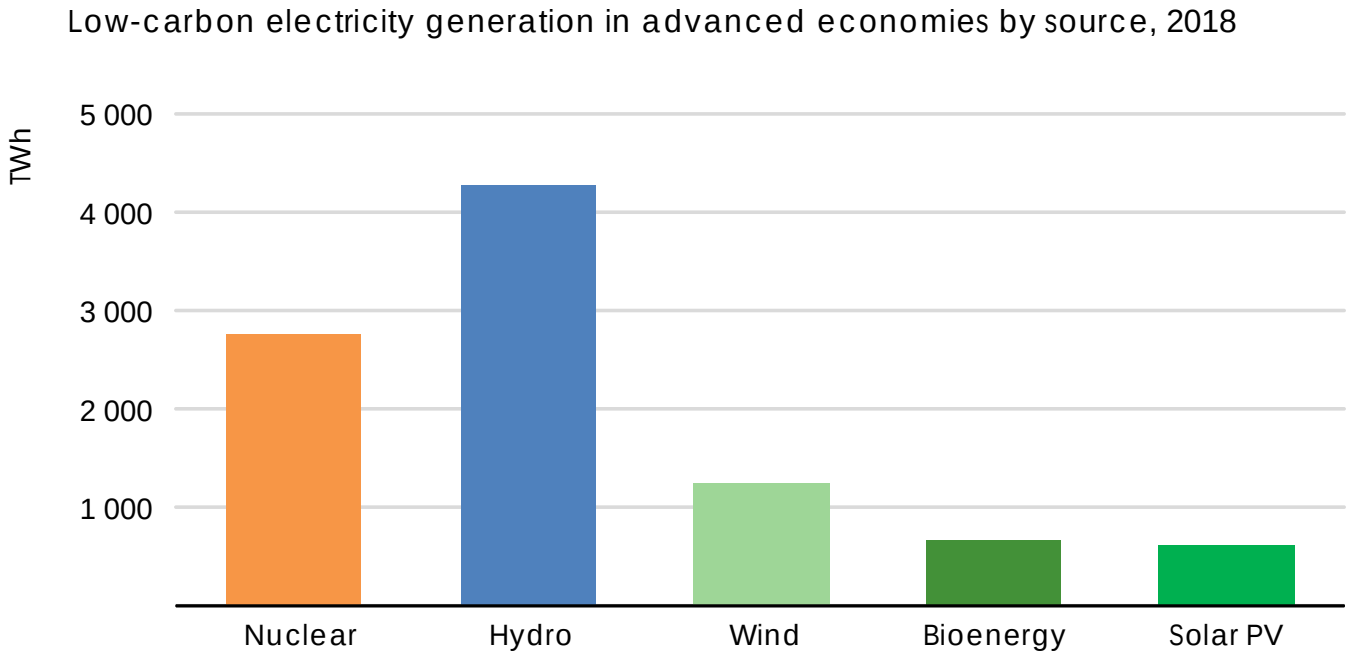
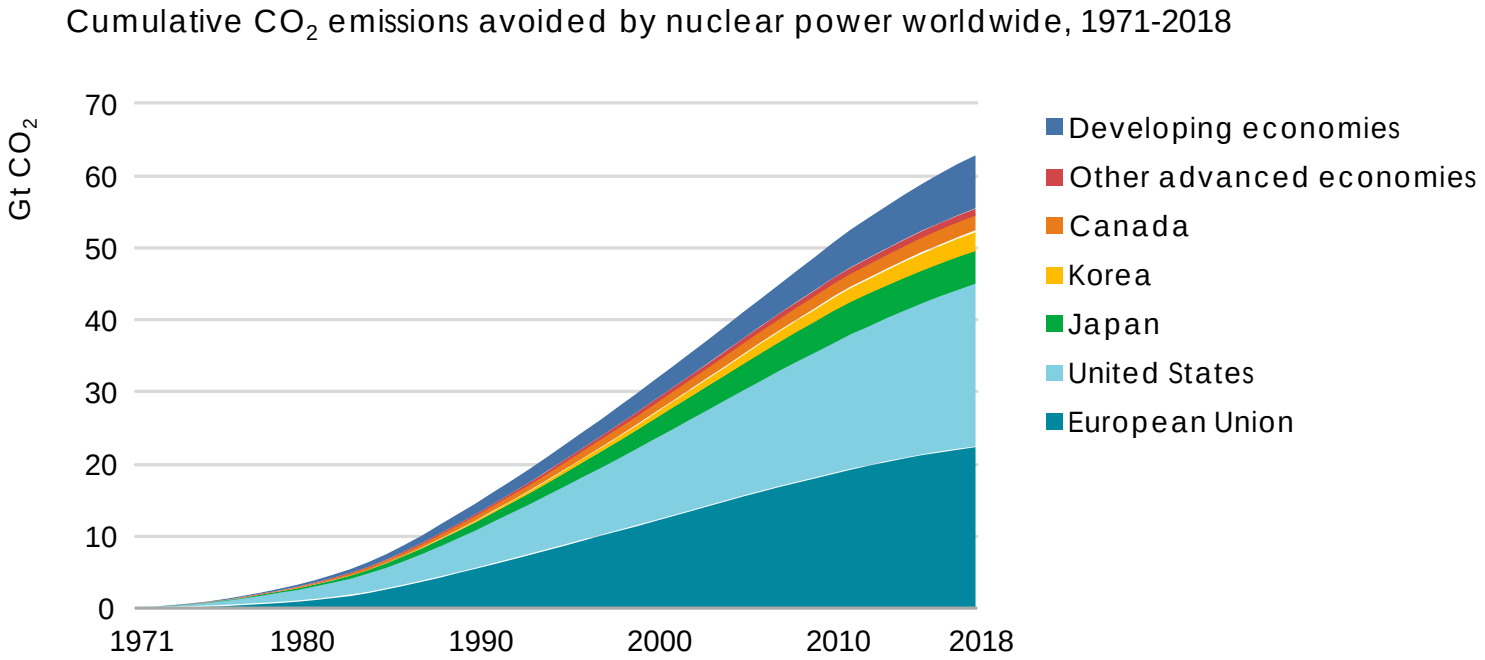
Nuclear is a leading source of clean electricity today



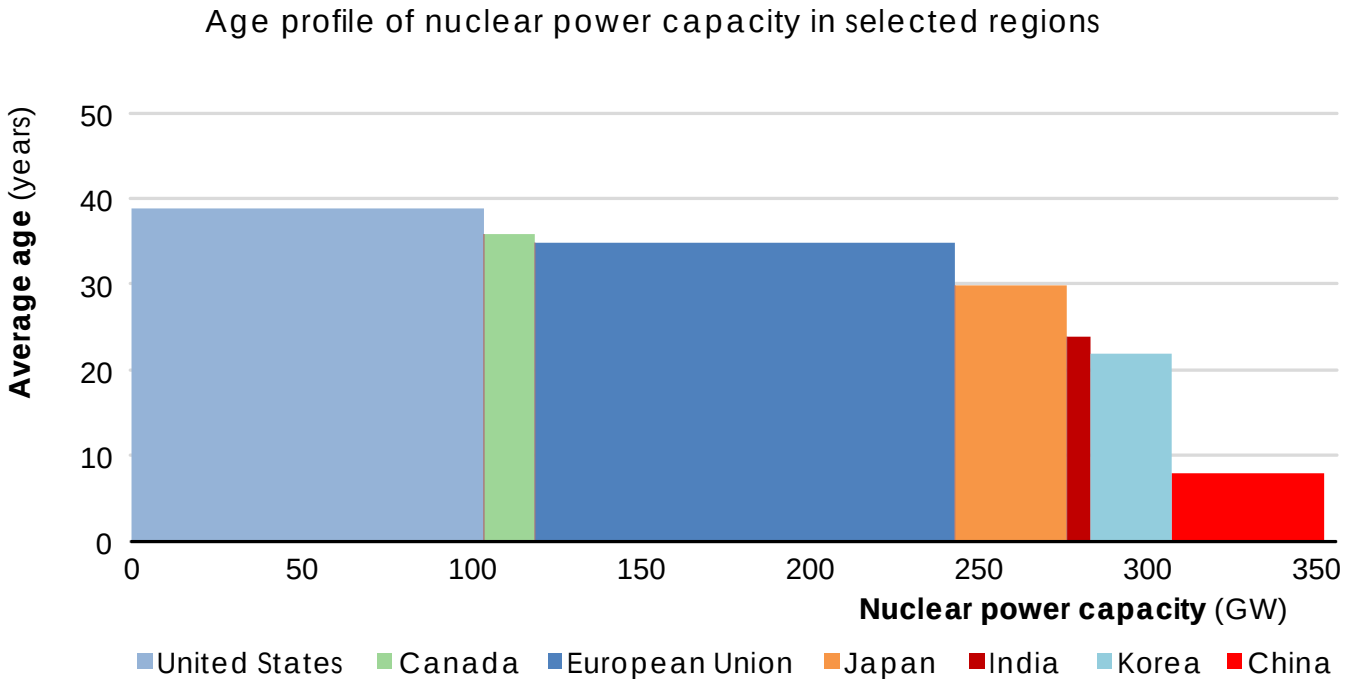
Nuclear power provided 10% of electricity supply worldwide in 2018, while in advanced economies, it has been the largest clean source of electricity for over 30 years.

Nuclear power has avoided CO_2 emissions for 50 years



Without nuclear power, CO_2 emissions from electricity generation would have been almost 20% higher over the period.

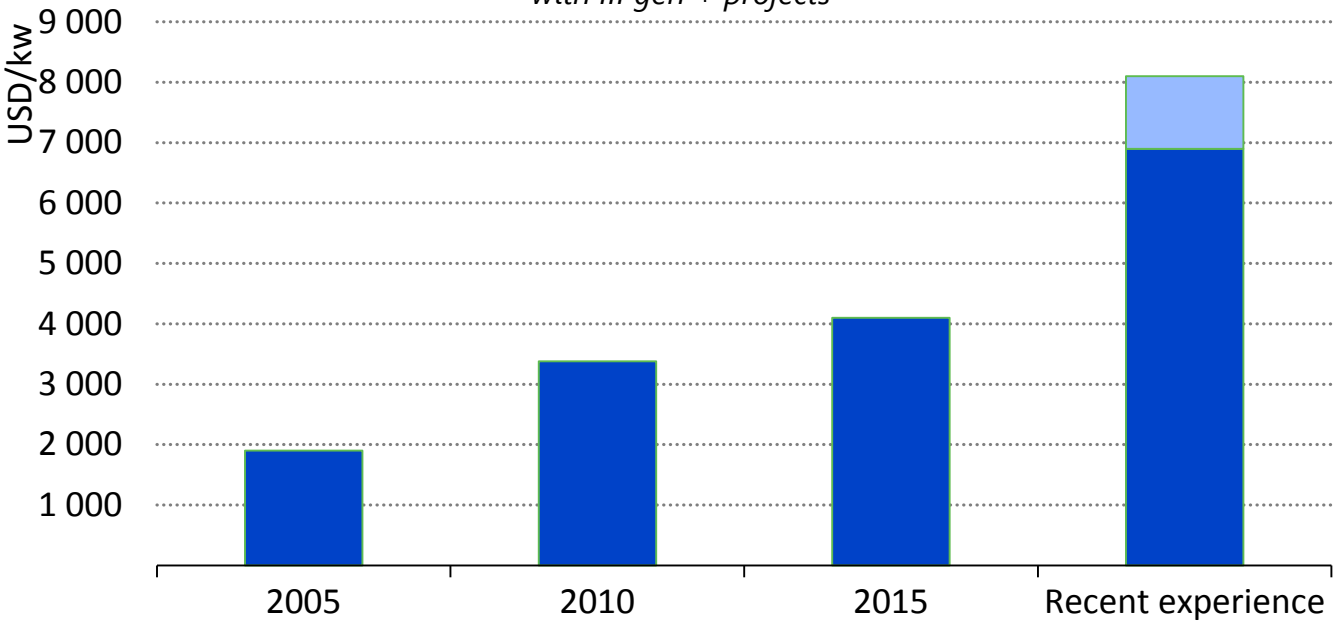
The nuclear fleet is ageing



Many nuclear power plants in advanced economies are facing retirement as they approach the end of their original 40-year design lifetime.

Unfavorable new construction experience both in the US and Europe

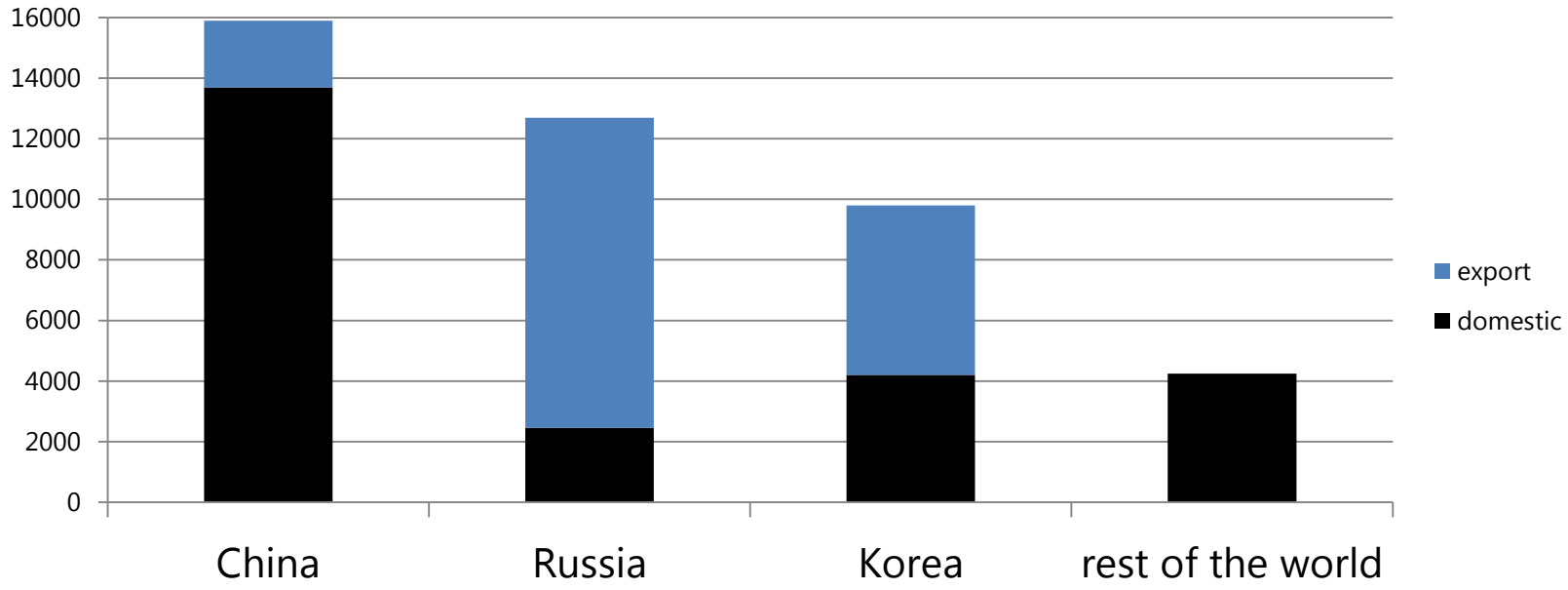
Nuclear investment costs from the 2005 - 2015 editions of Projected Cost of Power Generation and recent US/EU experience with III gen + projects



Project management problems, cost inflation and competition from gas and renewables hit the investment appetite for nuclear

An emerging China – Russia dominance in nuclear development

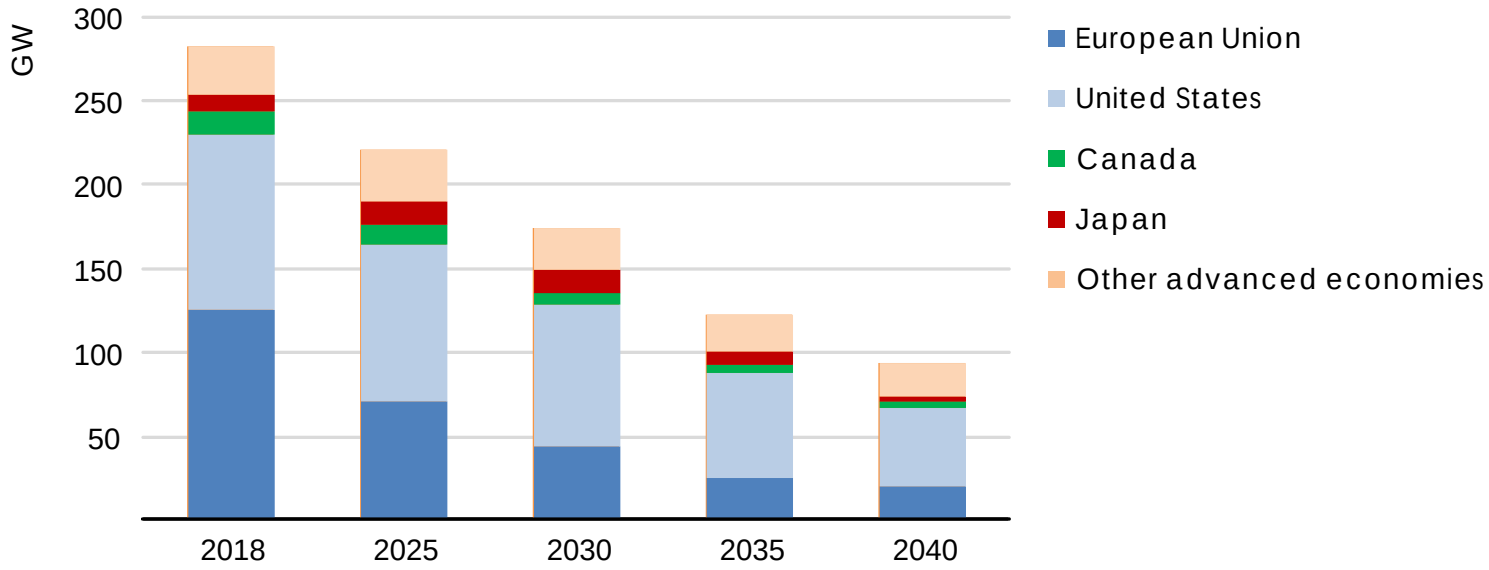
New nuclear construction starts by technology provider, 2012 – 2018



The last Korean export project started in 2015, recent policy decisions by the Korean government are less favorable to nuclear

Nuclear could face a steep decline in advanced economies

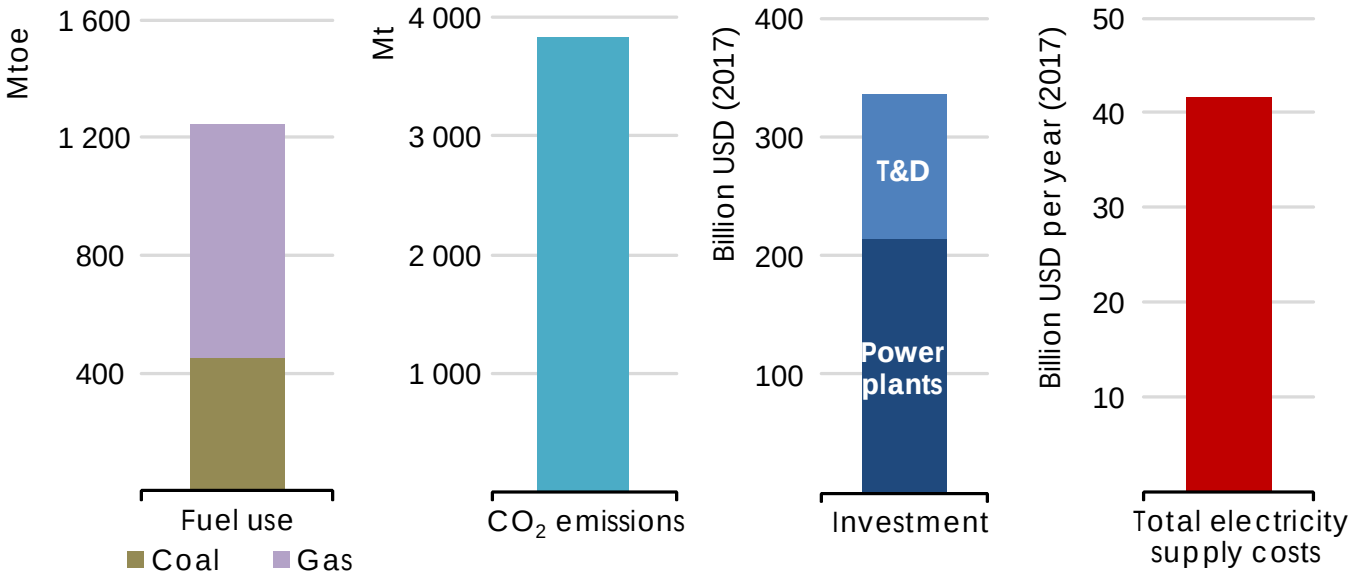
Nuclear power capacity (operational) in advanced economies in the *Nuclear Fade Case*, 2018-2040



Without additional lifetime extensions or new projects, nuclear capacity in advanced economies would decline by two-thirds by 2040.

Lower nuclear raises CO_2 emissions and supply costs

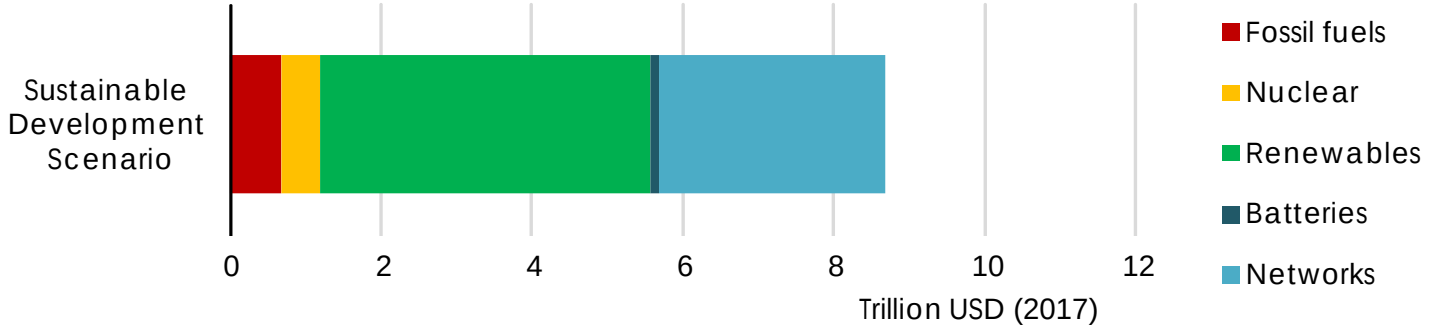
Change in key indicator in advanced economies in the *Nuclear Fade Case* under current policies, 2019-2040



Lower nuclear raises fossil fuel use and power sector CO_2 emissions by 5% to 2040, raising investment needs by close to $600 billion to 2040 and supply costs to consumers.

Nuclear power is part of a cost-effective clean energy transition

Power sector investment needs in advanced economies on a sustainable energy pathway, 2019-2040



Investment needs to achieve the energy transition are $1.6 trillion higher without nuclear complementing renewables in the fight against climate change.

Increasing network investment is not only a financial issue

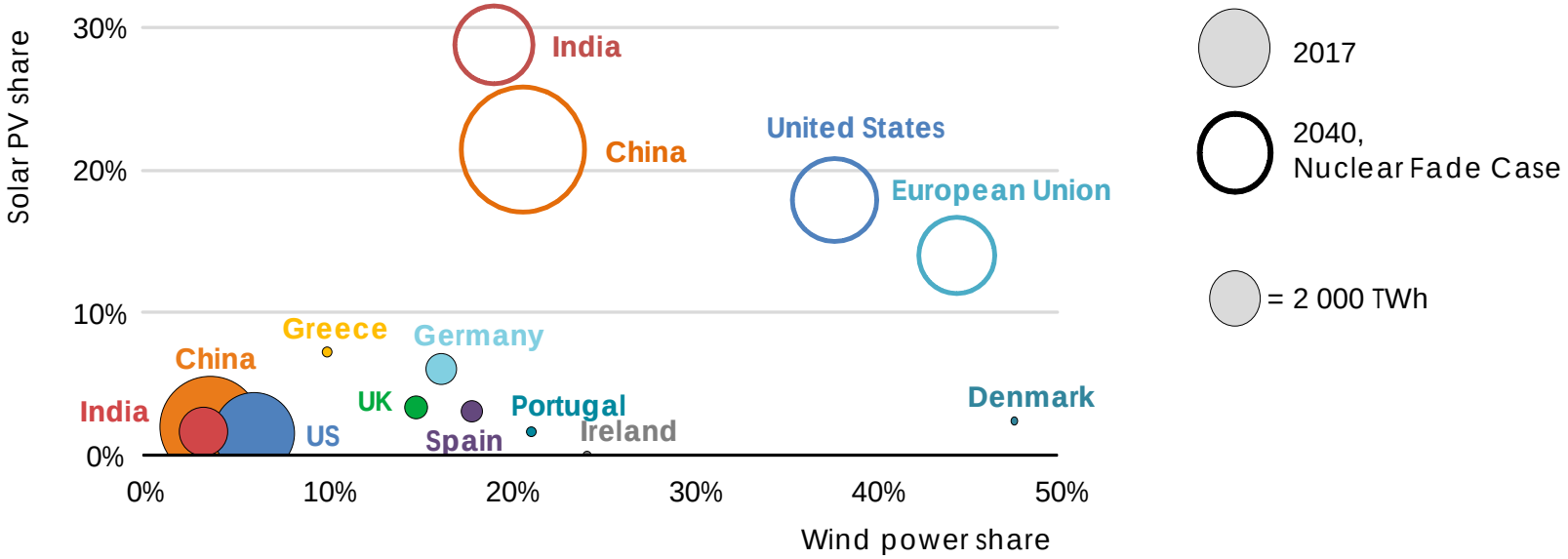
Bypassing social acceptance barriers increases capital costs

Undersea DC interconnection with a merchant business model, North Sea

Tunneling under the Alps for the France – Italy interconnector

Further emphasis on solar and wind raises integration challenges

Wind and solar PV shares of generation by region in the *Nuclear Fade Case* on a sustainable energy pathway



Rising shares of wind and solar PV require more flexibility in power systems, calling on power plants, grids, storage technologies and demand-side management.

A low carbon system in Japan without nuclear: possible, but

4000 km2 of solar panels

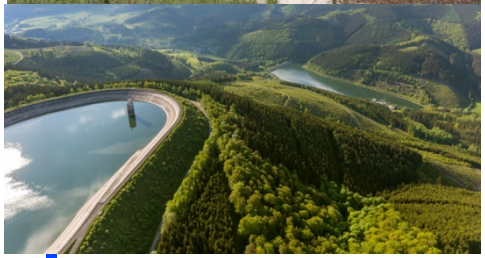
Twice the current German wind production from floating offshore and onshore Hokkaido

In the absence of nuclear wind and solar would have to do the heavy lifting, providing almost half of electricity by 2040

+ New dispatchable low carbon capacity for system adequacy

25 million tons/year CO2 captured from gas + CCS plants

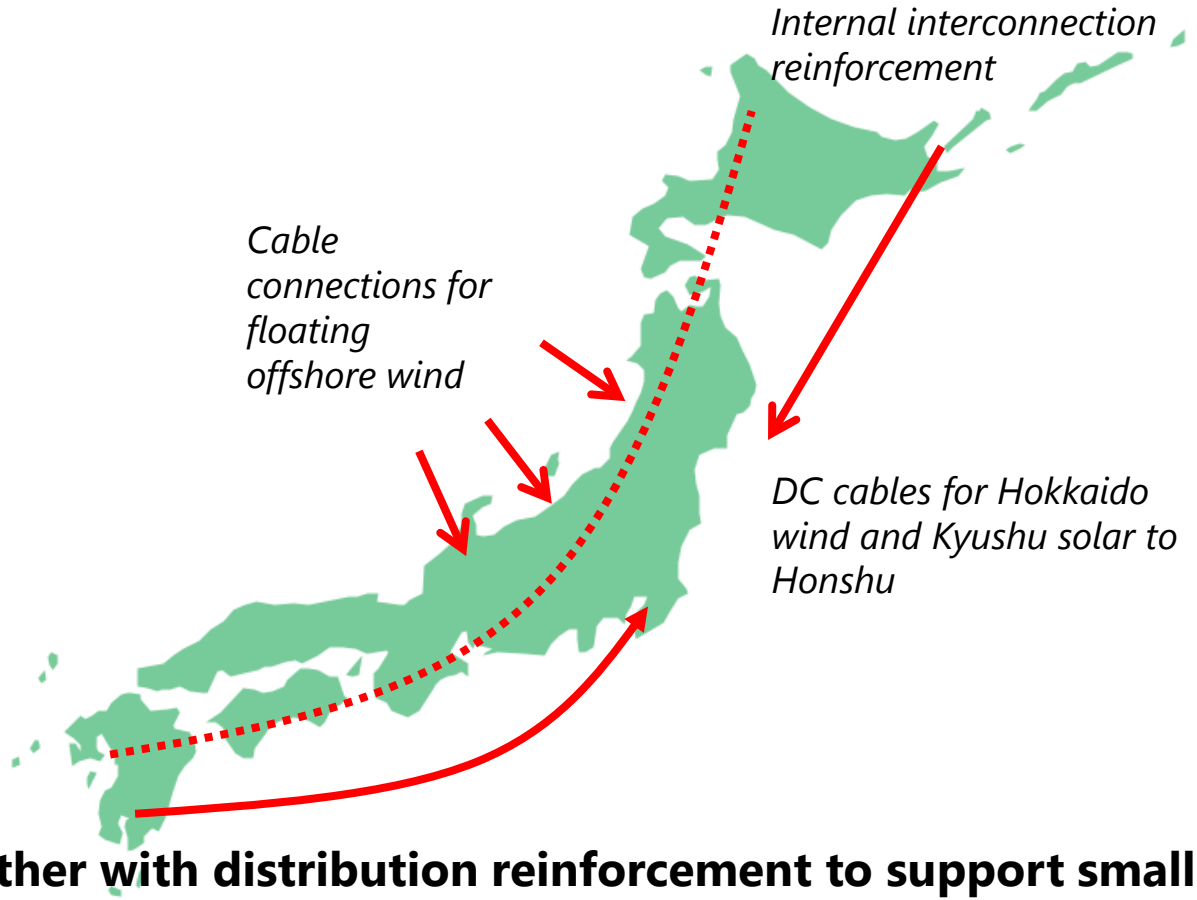
60 million tons/year of biomass burned for power



36 GW new hydro and battery storage

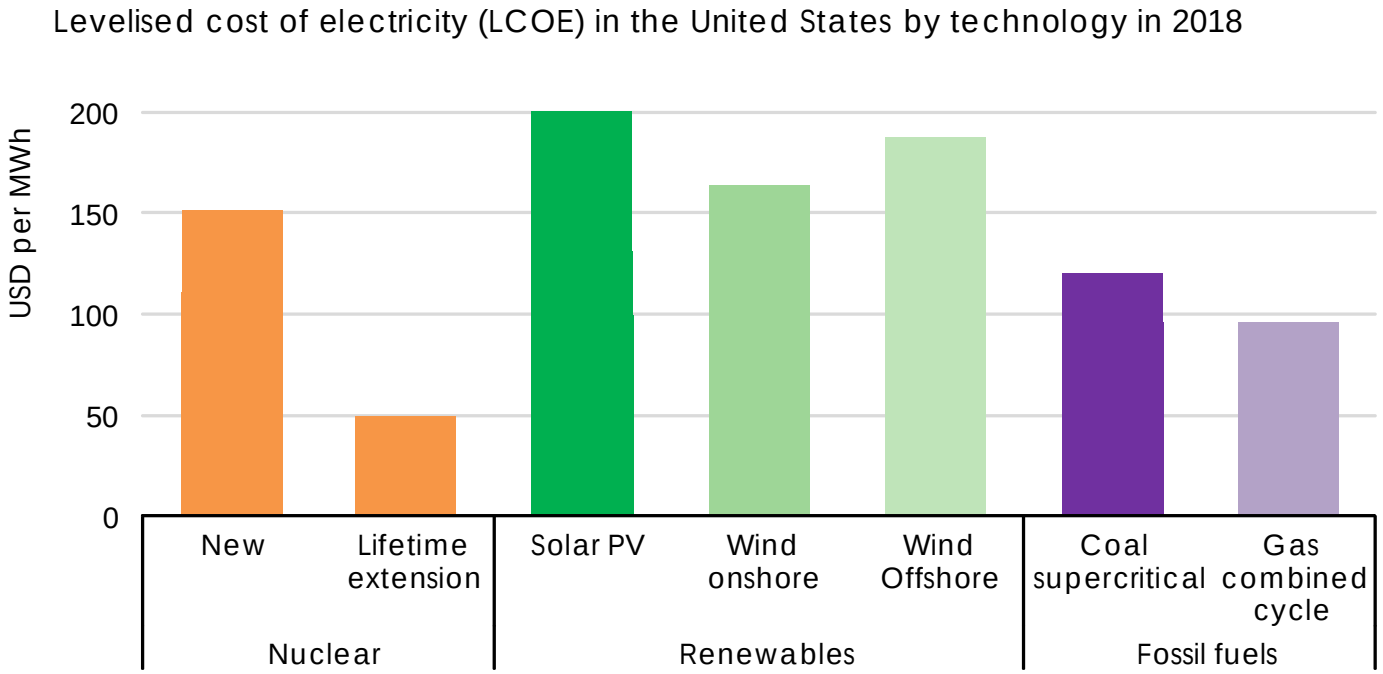
Maintaining electricity security in a low carbon – low nuclear Japanese system would require massive and socially contentious investments in dispatchable low carbon capacities

+ 20 years of network investment at 4 times the current level



Together with distribution reinforcement to support small scale solar network investment needs reach 0.6% of GDP

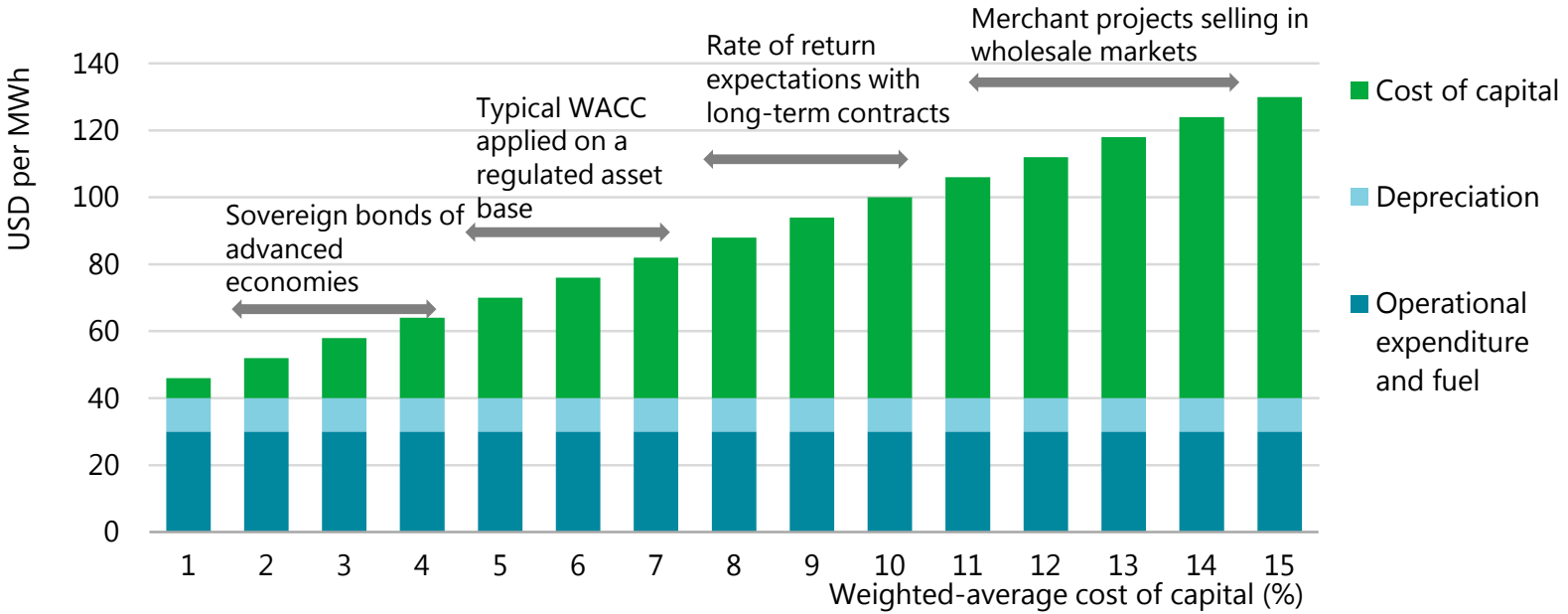
Nuclear lifetime extensions provide cheap clean electricity



Nuclear lifetime extensions are cost-competitive with new solar and wind, and provide a dispatchable source of clean electricity.

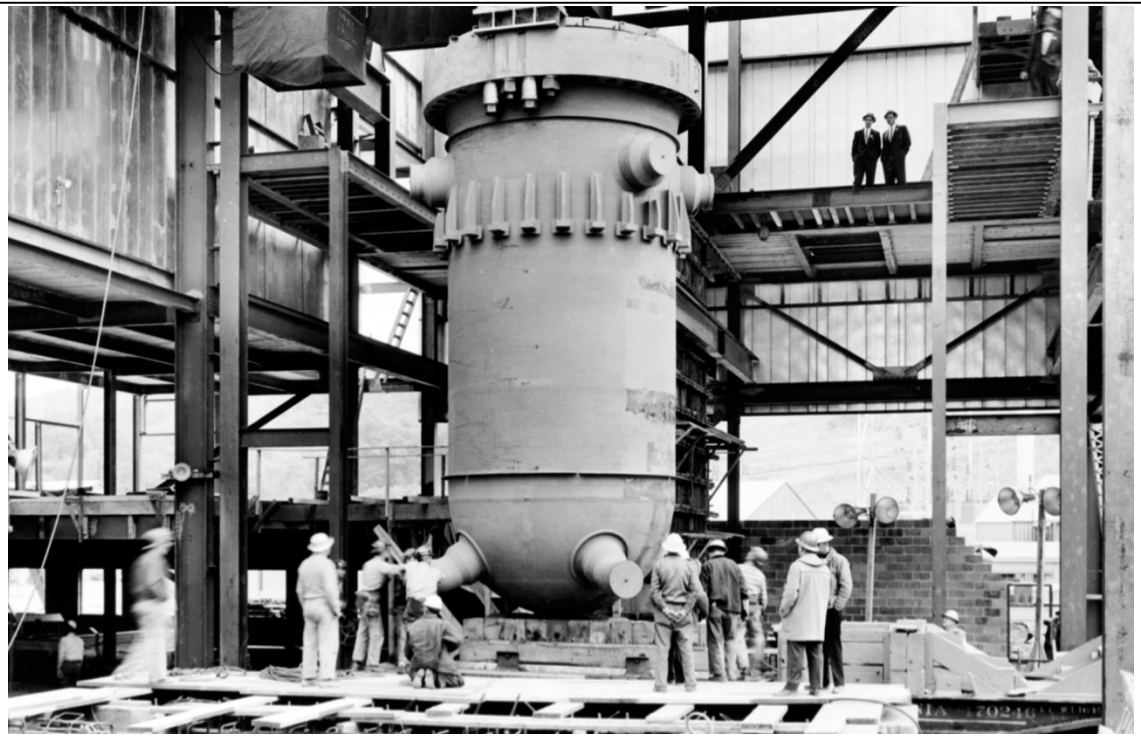
Financing is a key issue to enable new nuclear construction

LCOE of a 4 billion USD/GW nuclear project depending on the cost of capital



Given long lead times and long lifetimes, the cost of capital is a dominant driver of the competitiveness of nuclear investment

Small modular reactors, this time for real?



Nuclear innovation and early deployment of advanced technologies needs to accelerate for nuclear to play meaningful role in the low carbon system

Policy recommendations for countries pursuing nuclear power

Ensure a sound framework for lifetime extensions:

- Value the clean nature of nuclear power and contributions to electricity security
- Clarify safety requirements for longer life and more flexible operations

Support new construction:

- Establish appropriate frameworks to reduce financial risks
- Maintain technical competencies related to nuclear power
- Pursue research & development of new technologies (e.g. small modular reactors)

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