



Nuclear power in a clean energy system

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Low carbon electricity is a key component of the energy transition

Replacing direct fossil fuel use with low carbon electricity is a promising alternative in several sectors

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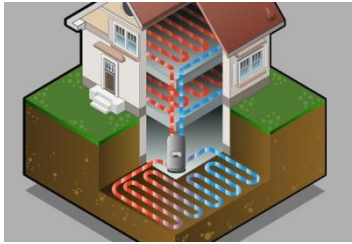
Electrification of cars replacing oil

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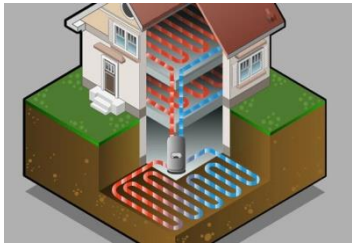
Heat pumps replacing gas in buildings

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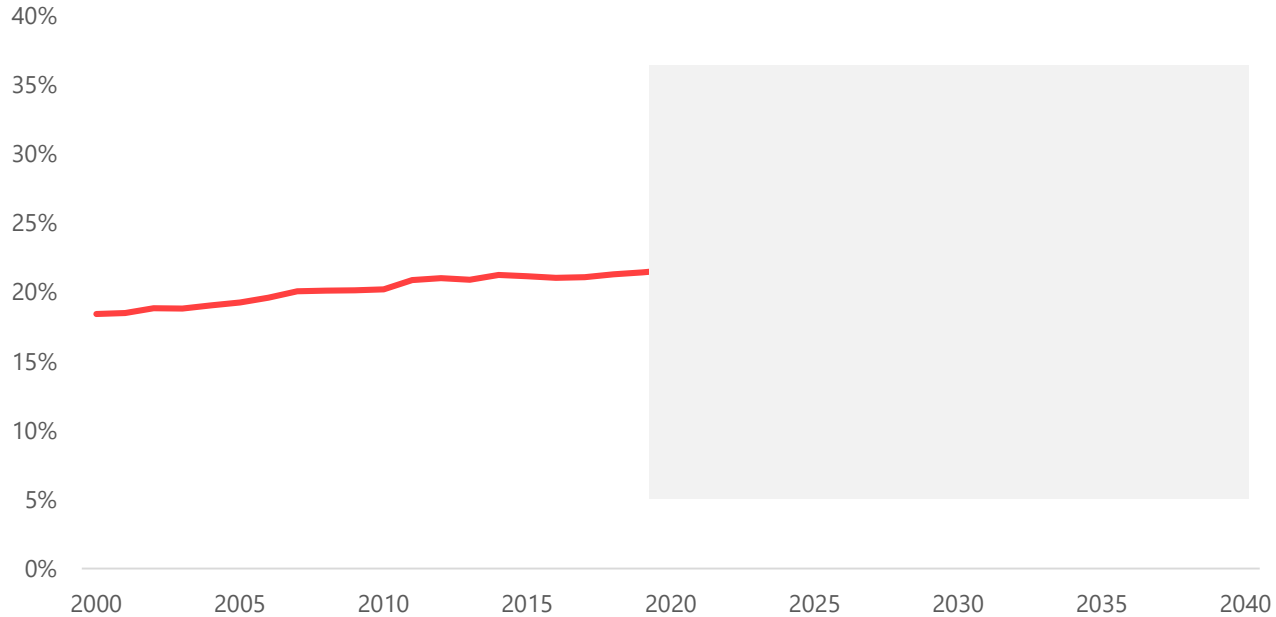


Hydrogen for industrial processes

Replacing direct fossil fuel use with low carbon electricity is a promising alternative in several sectors

An increasingly electrified EU energy system

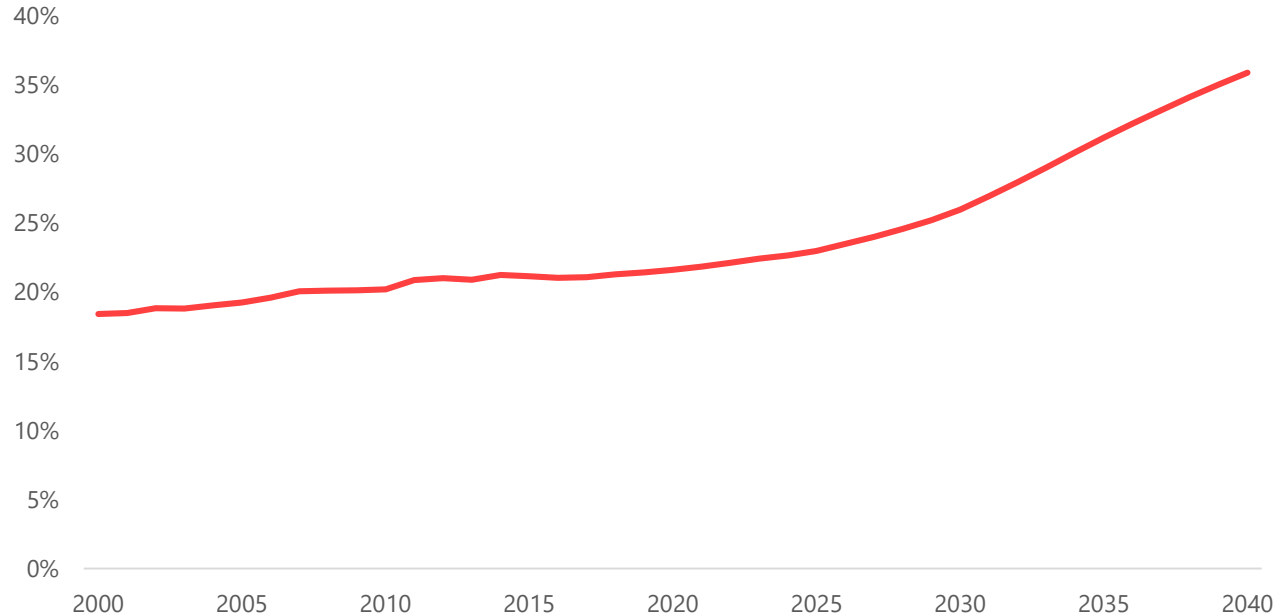
Share of electricity in EU energy consumption in the Sustainable Development Scenario



The growth of the share of electricity accelerates due to electric cars and heat pumps

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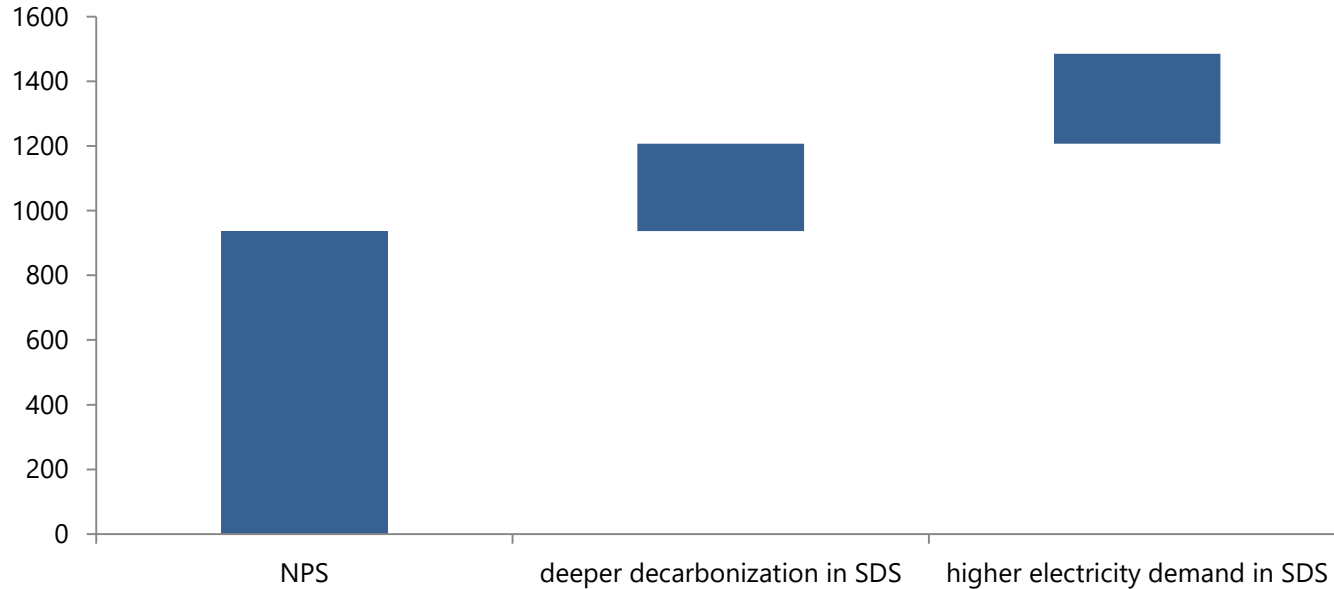
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A rapid scale up of low carbon generation is needed

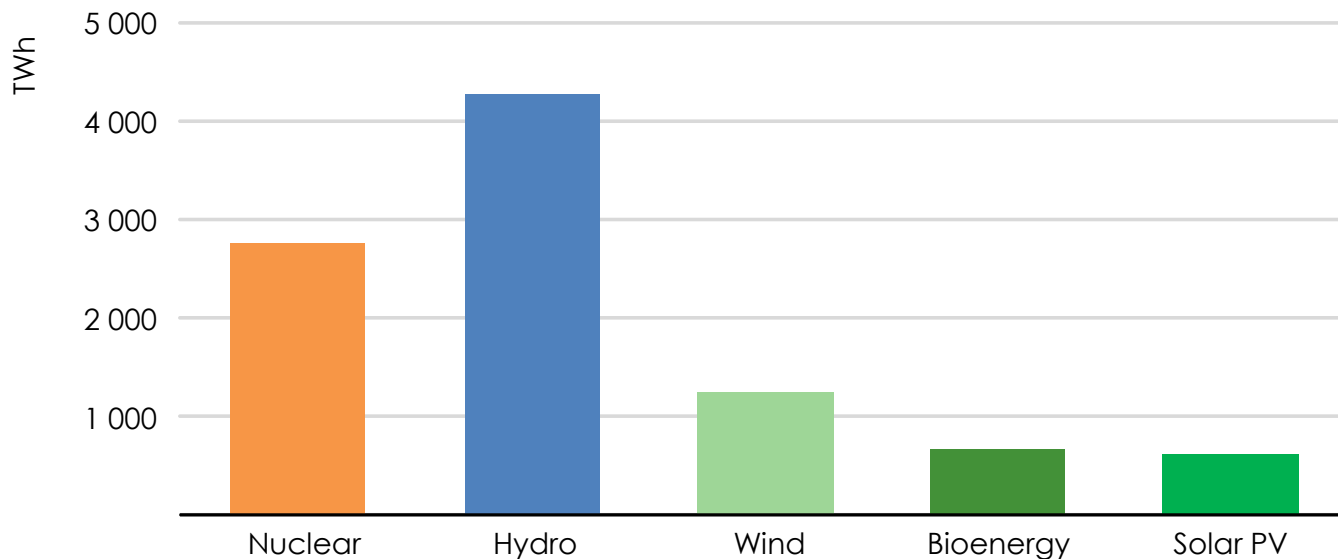
Growth of low carbon generation 2017-2040



In Europe electrification overcompensates the efficiency improvements in conventional uses

Nuclear is a leading source of clean electricity today

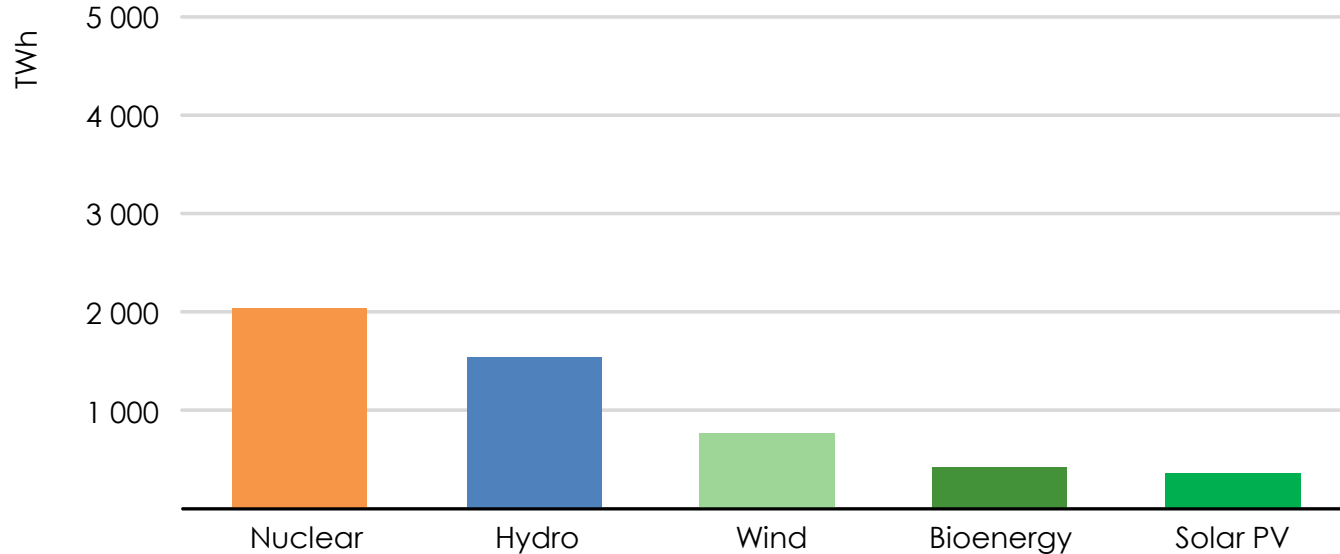
Low-carbon electricity generation in advanced economies by source, 2018



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.

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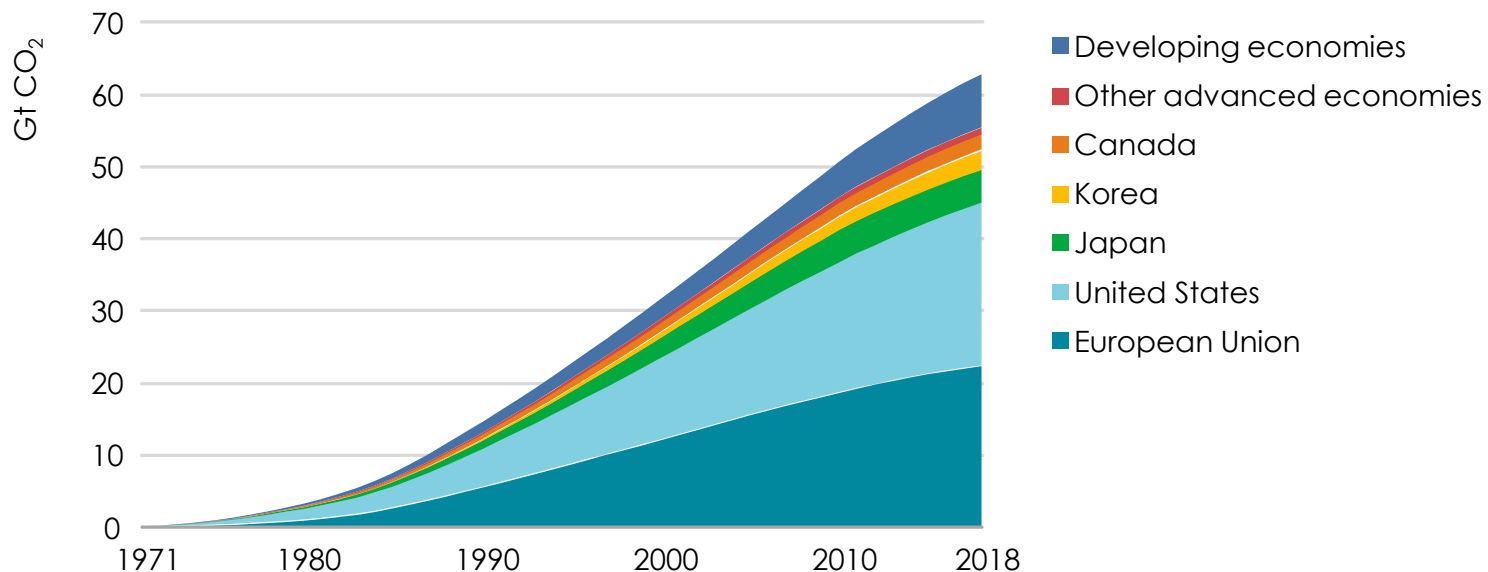
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Nuclear power has avoided CO₂ emissions for 50 years

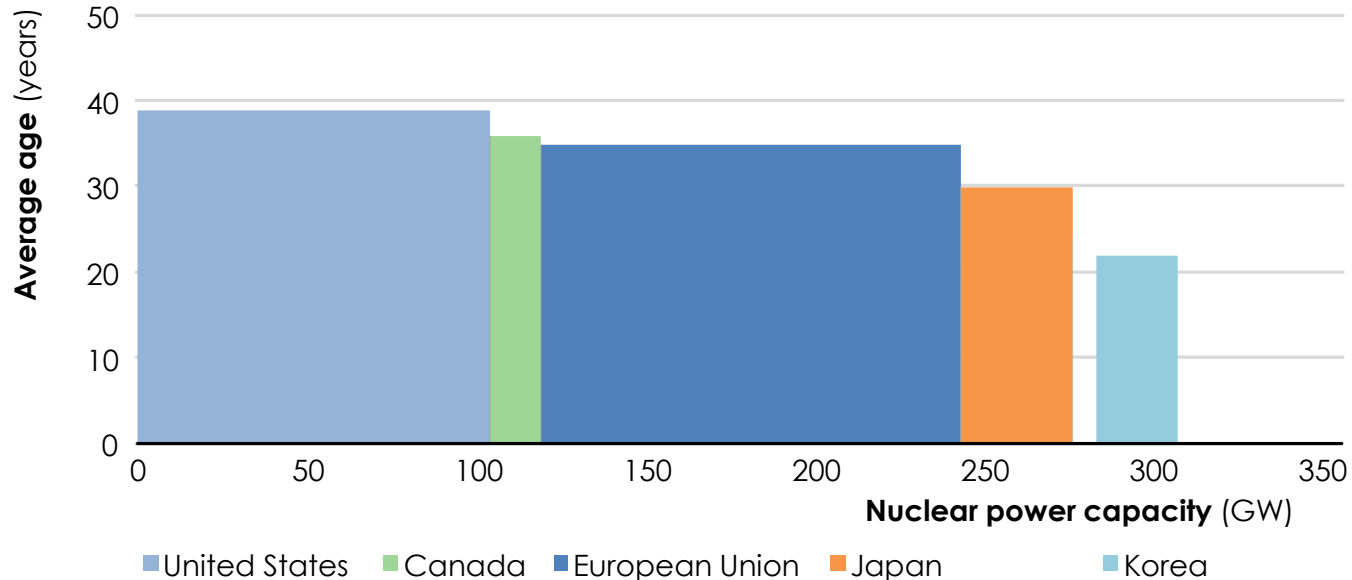
Cumulative CO₂ emissions avoided by nuclear power worldwide, 1971-2018



Without nuclear power, CO₂ emissions from electricity generation would have been almost 20% higher over the period.

The nuclear fleet is ageing

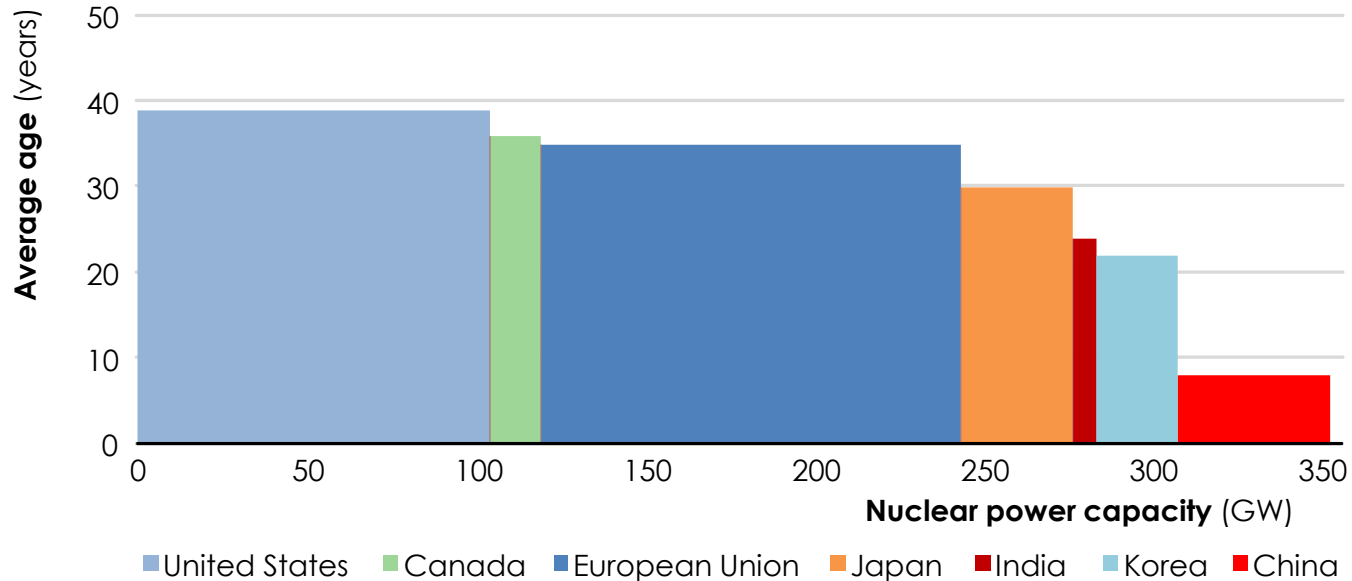
Age profile of nuclear power capacity in selected regions



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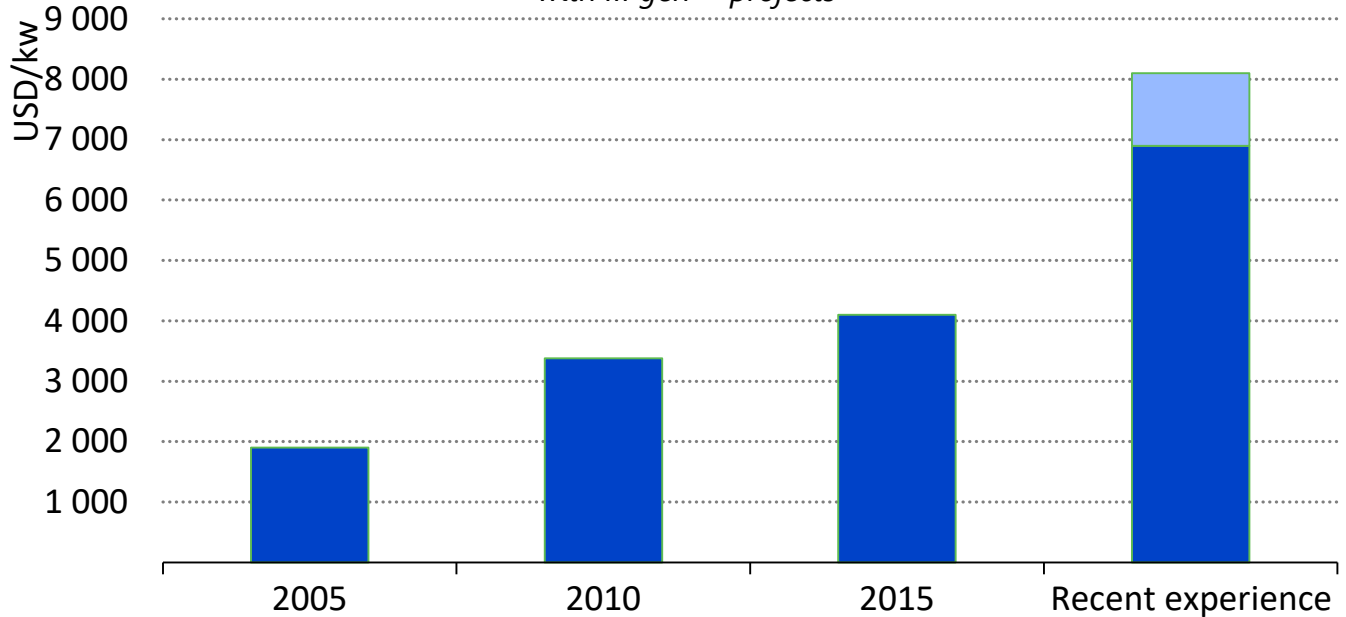
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Unfavorable new construction experience both in the US and Europe

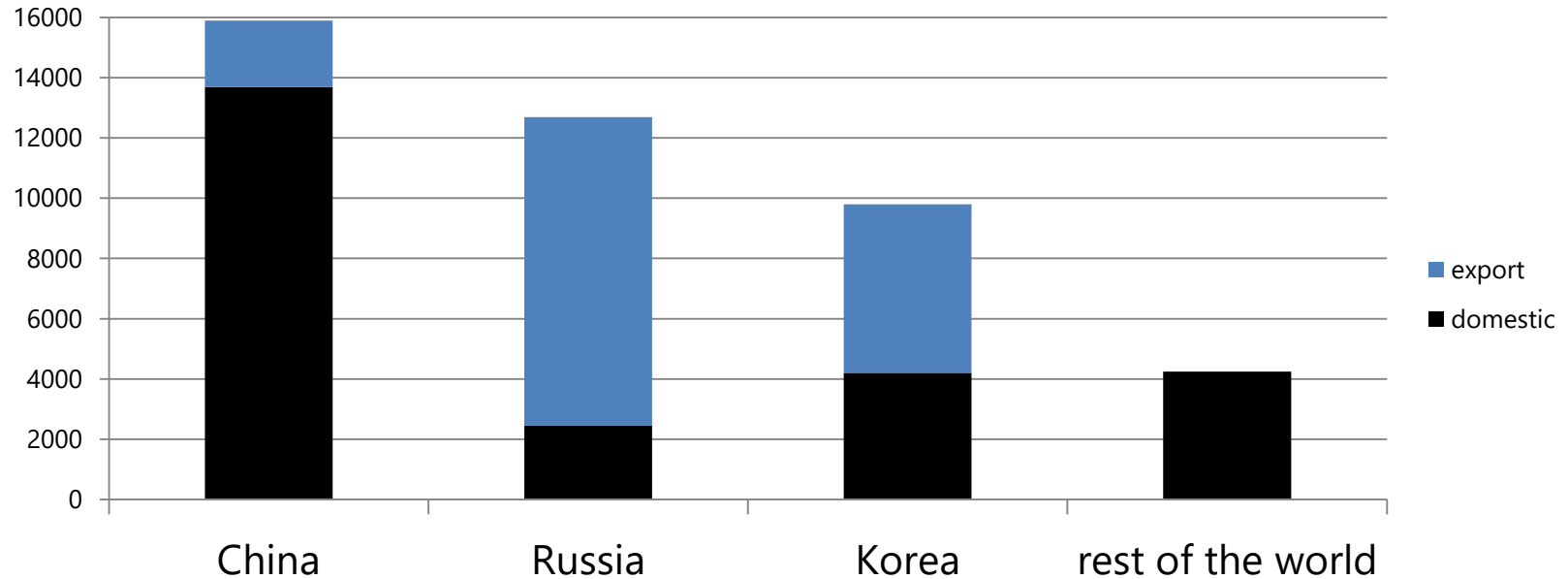
Nuclear investment costs from the 2005 - 2015 editions of Projected Cost of Power Generation and recent US/EU experience with III gen + projects



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

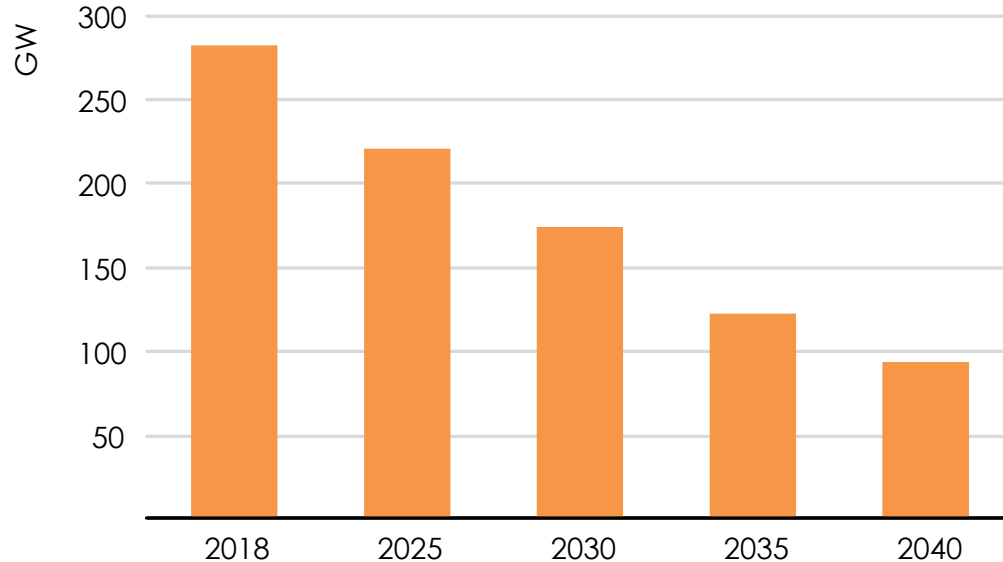
Nuclear could face a steep decline in advanced economies

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.**

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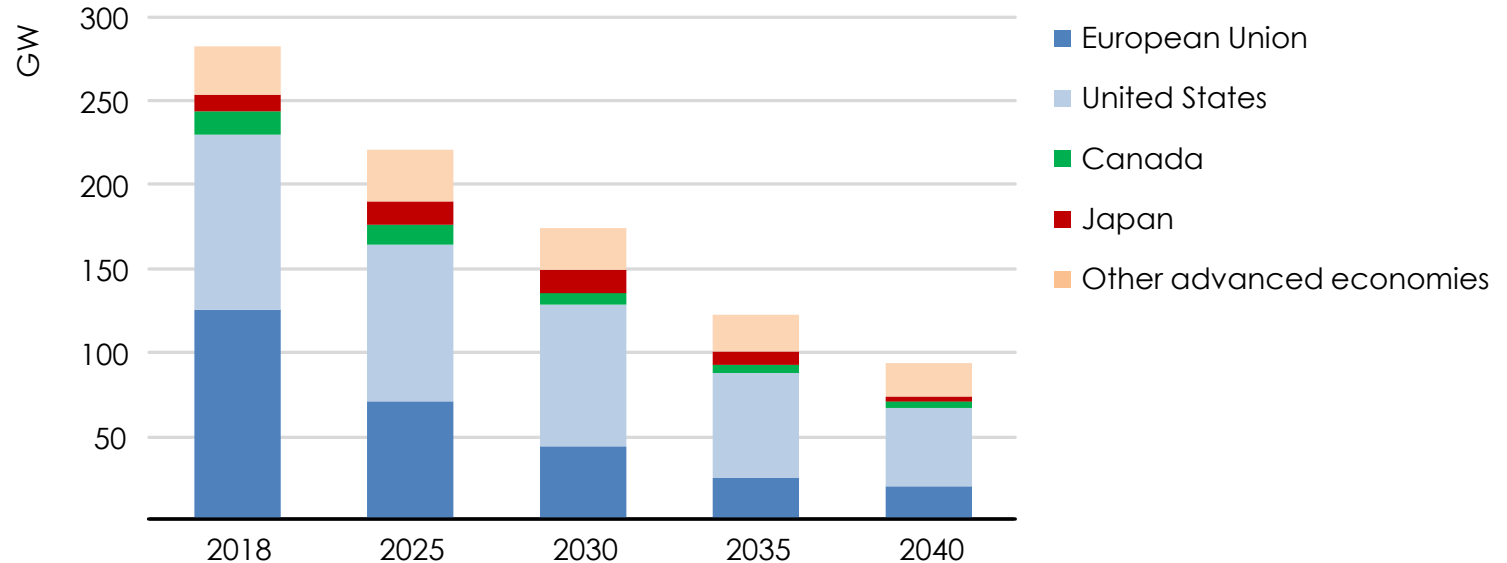
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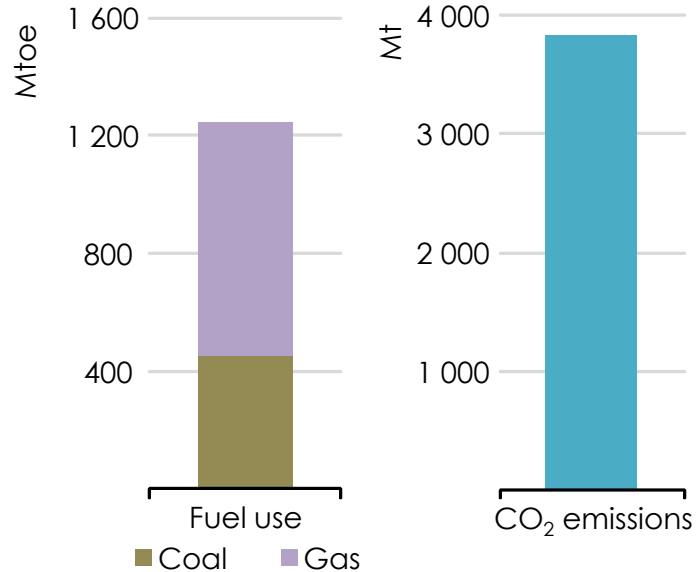
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Lower nuclear raises CO₂ emissions and supply costs

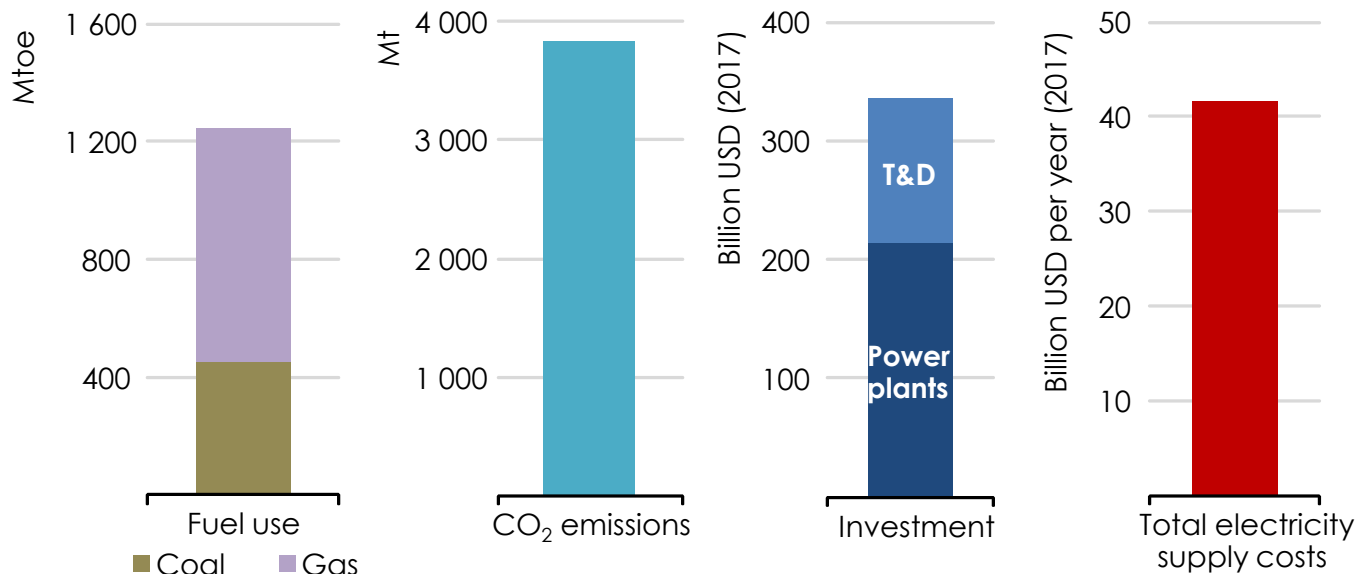
Change in key indicator in advanced economies in the *Nuclear Fade Case* under current policies, 2019-2040



Lower nuclear raises fossil fuel use and power sector CO₂ emissions by 5% to 2040, raising investment needs by close to \$600 billion to 2040 and supply costs to consumers.

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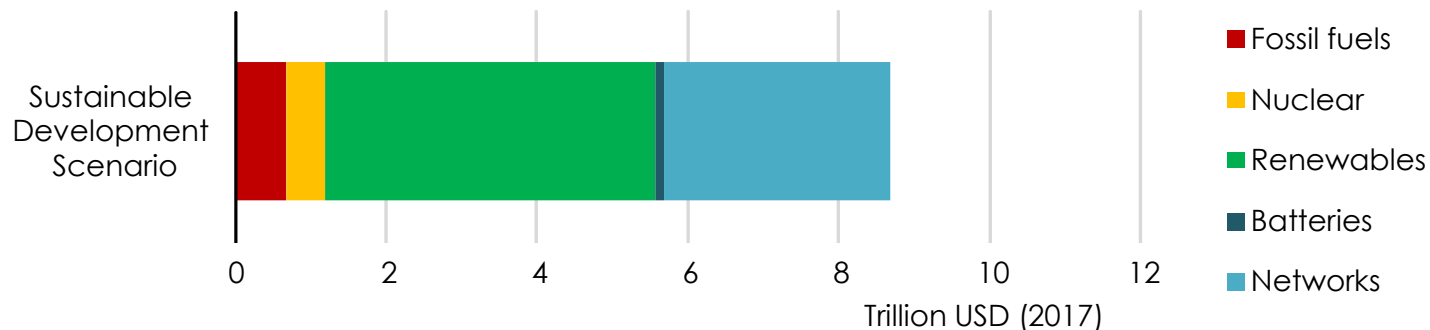
Nuclear power is part of a cost-effective clean energy transition

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.

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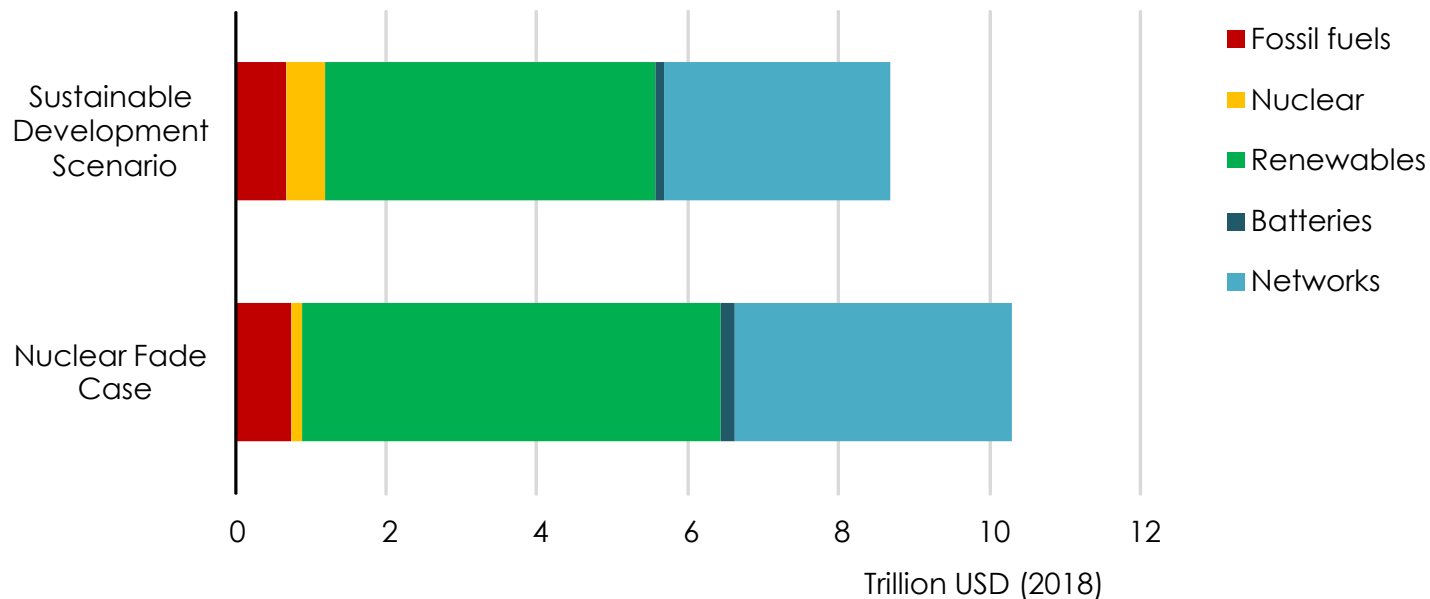
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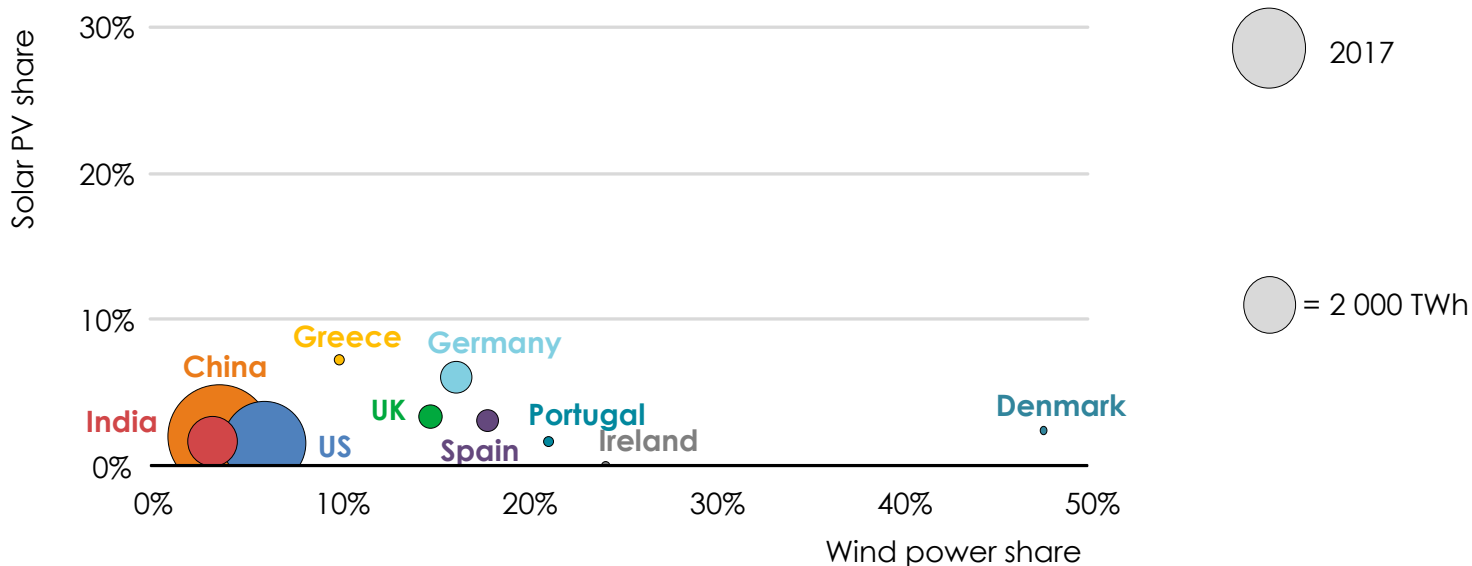
Further emphasis on solar and wind raises integration challenges

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.

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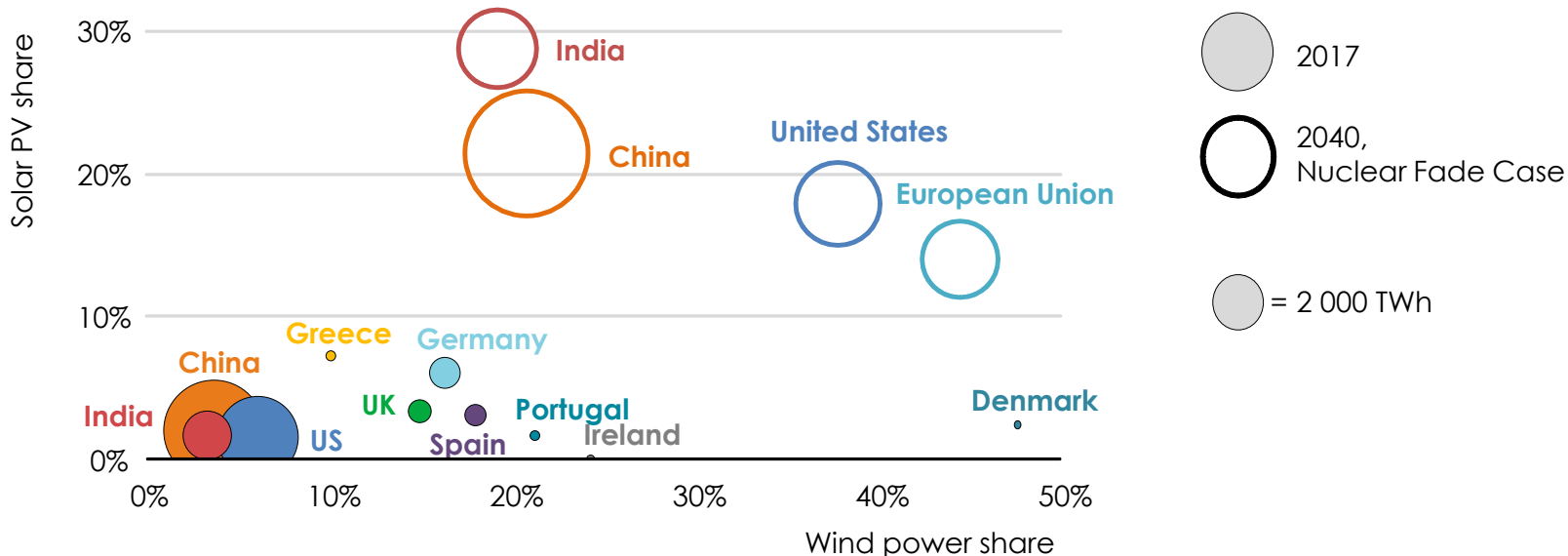
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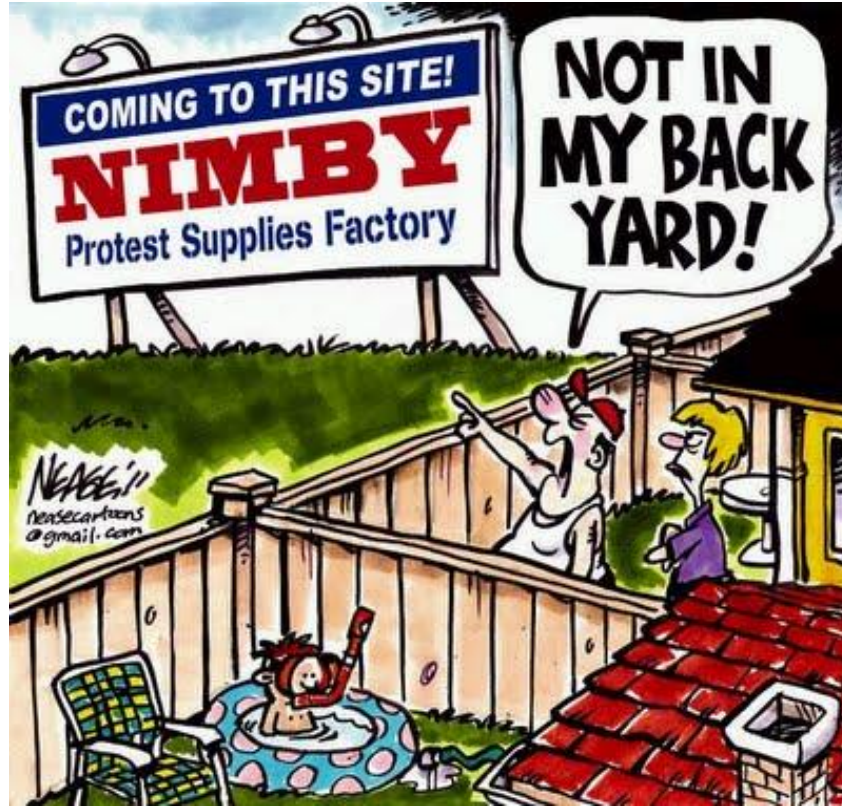
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Increasing network investment is not only a financial issue



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

What does it take to go for 100% renewables in Central Europe?

10 – 10 twh from solar PV and wind



16000 football fields of solar panels



25000 football fields of wind farms

What does it take to go for 100% renewables in Central Europe?

10 – 10 twh from bio and geothermal



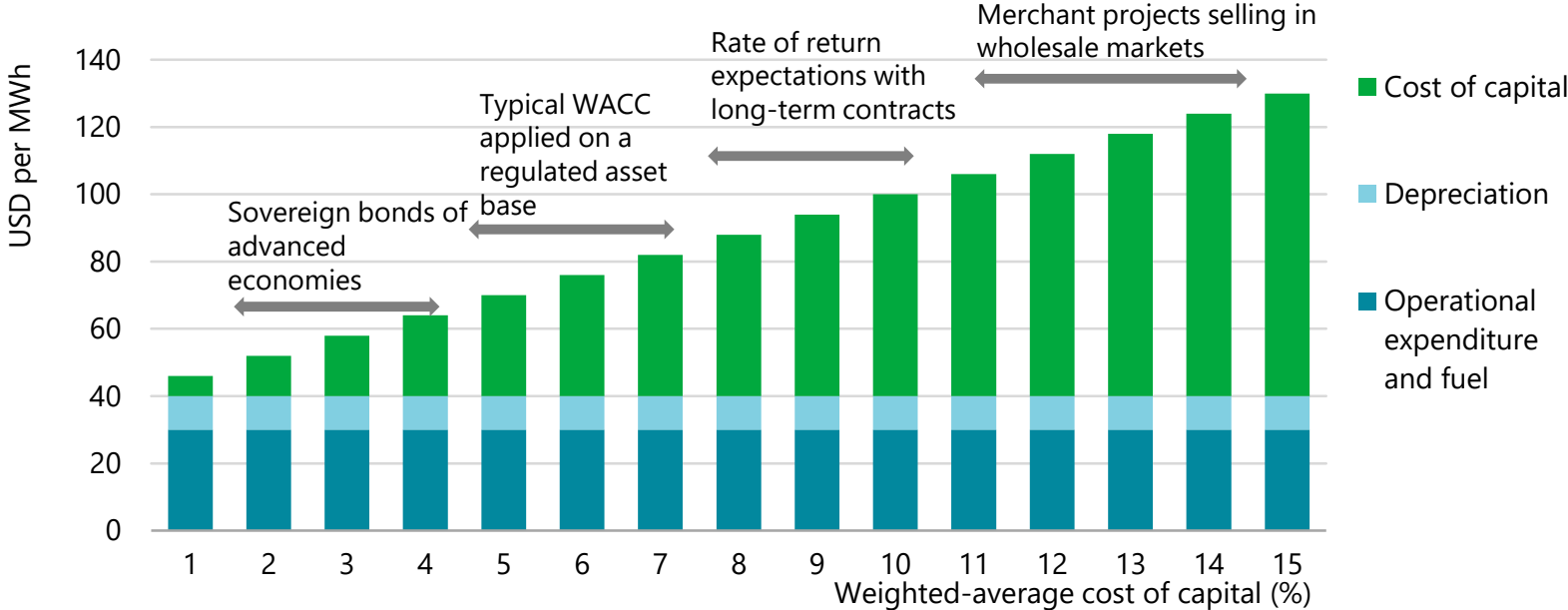
2.7 million hectares land dedicated to sustainable bioenergy production – half of the current agriculture



An olympic swimming pool of hot water in every 4 minutes

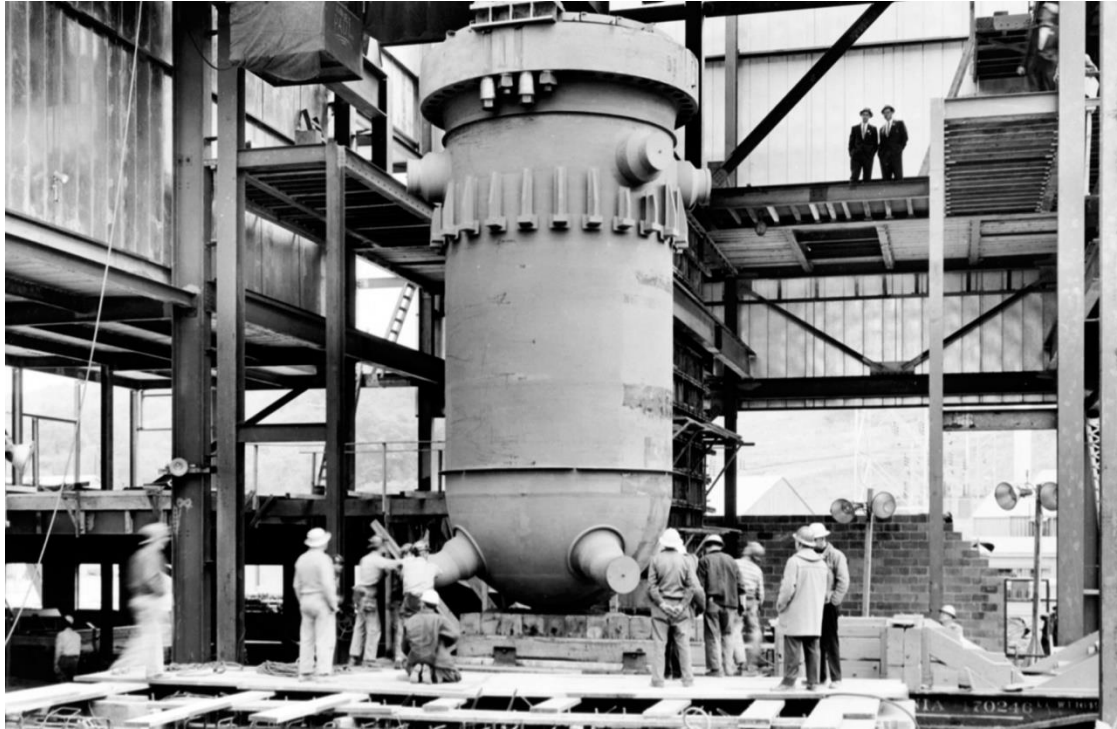
Financing is a key issue to enable new nuclear construction

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

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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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