Decarbonisation Beyond the Electric Sector

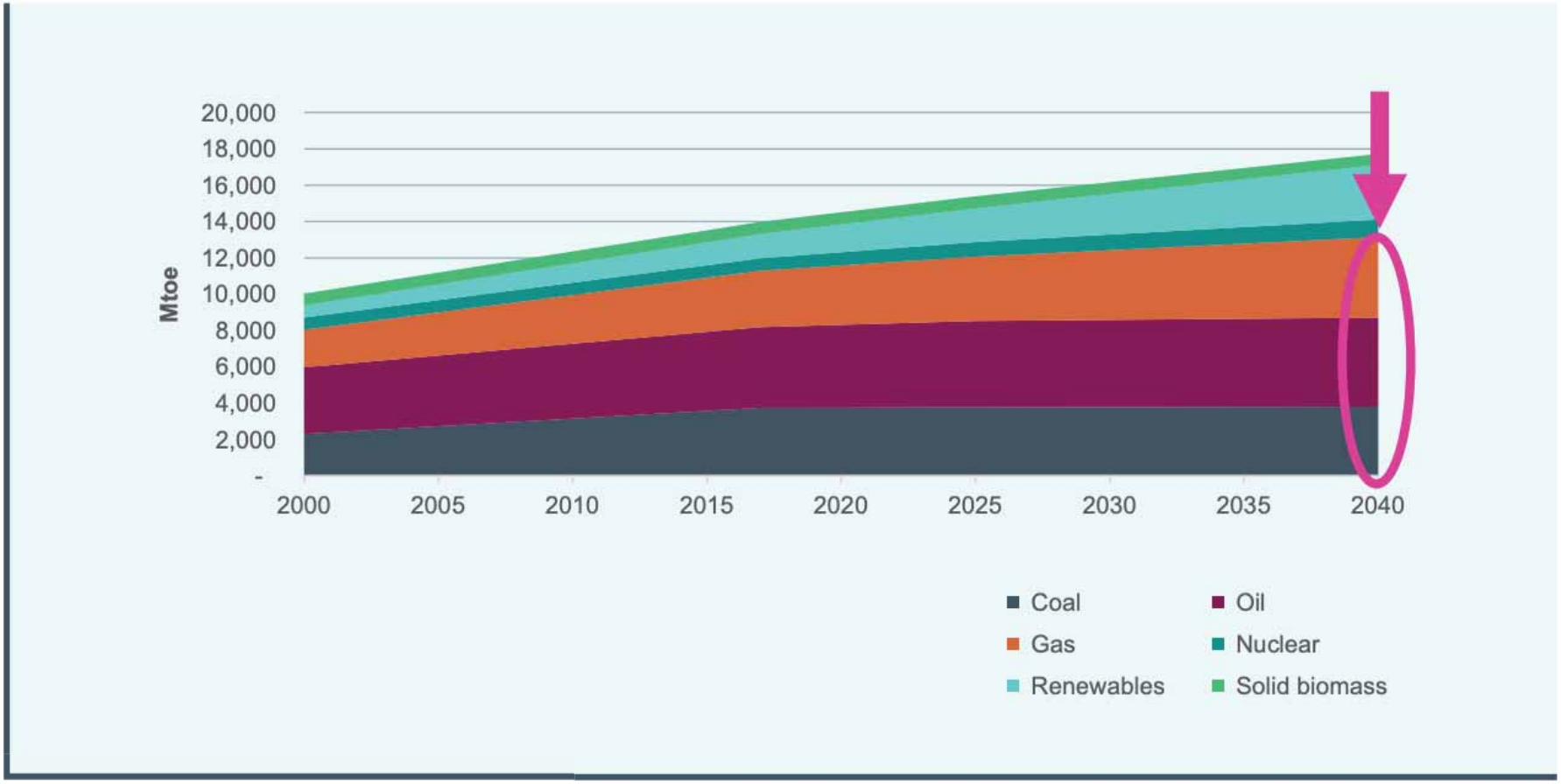
Applications and Business Models

Eric Ingersoll

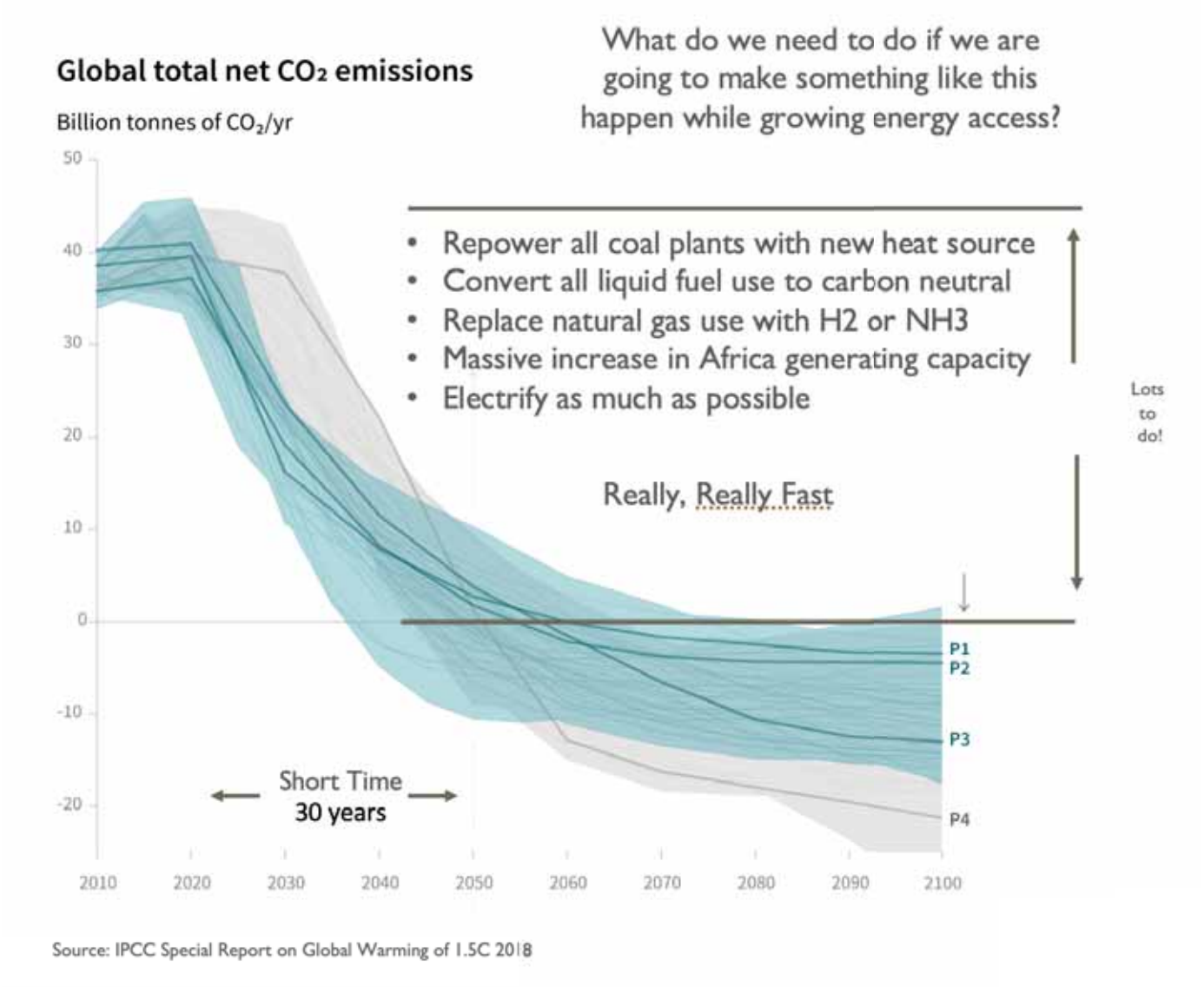
LUCID CATALYST

29 years to 2050

Stated Policies Scenario:
World Energy by Source (IEA 2018)



Global total net CO_2 emissions

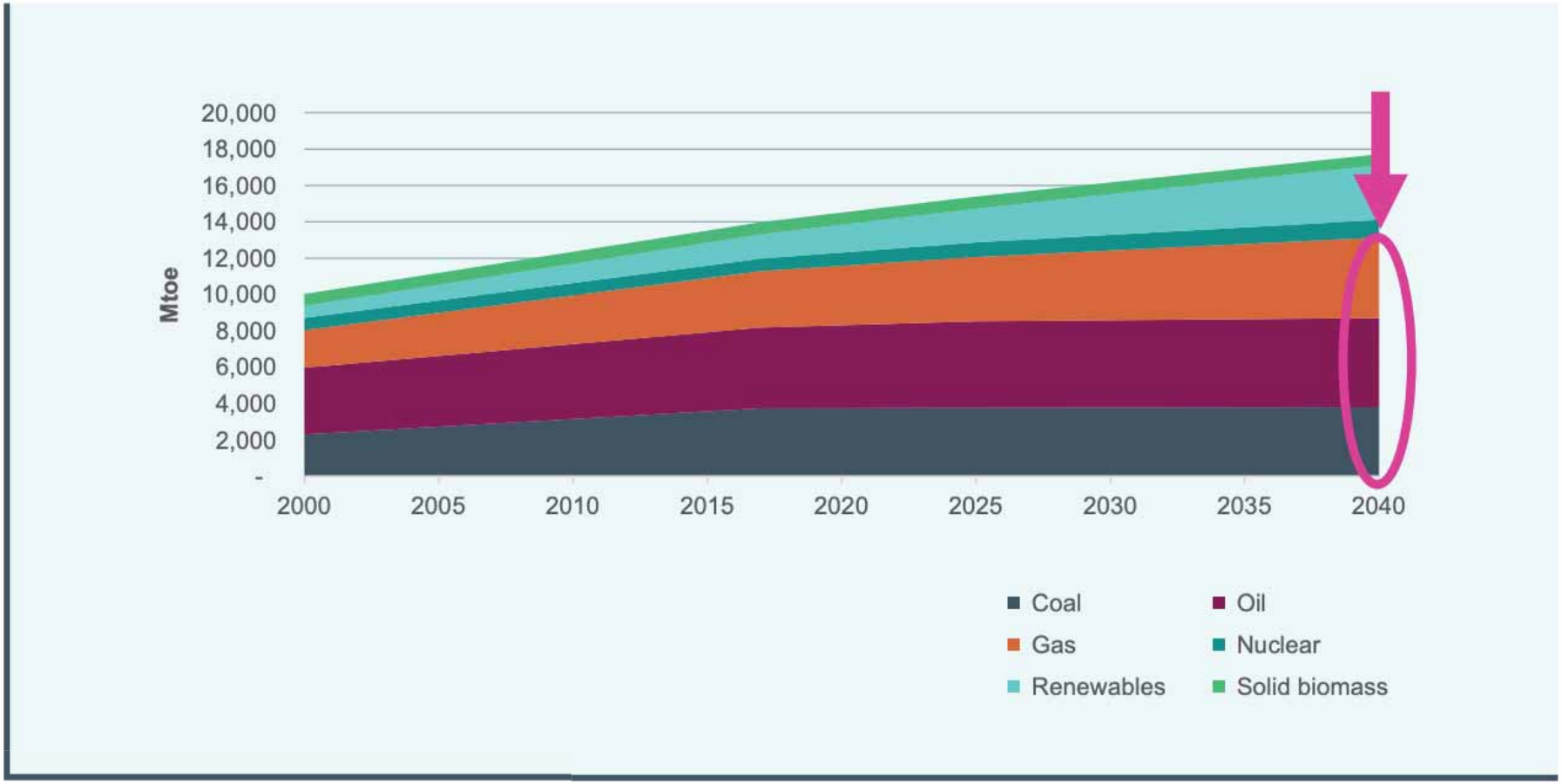


Source: IPCC Special Report on Global Warming of 1.5C 2018

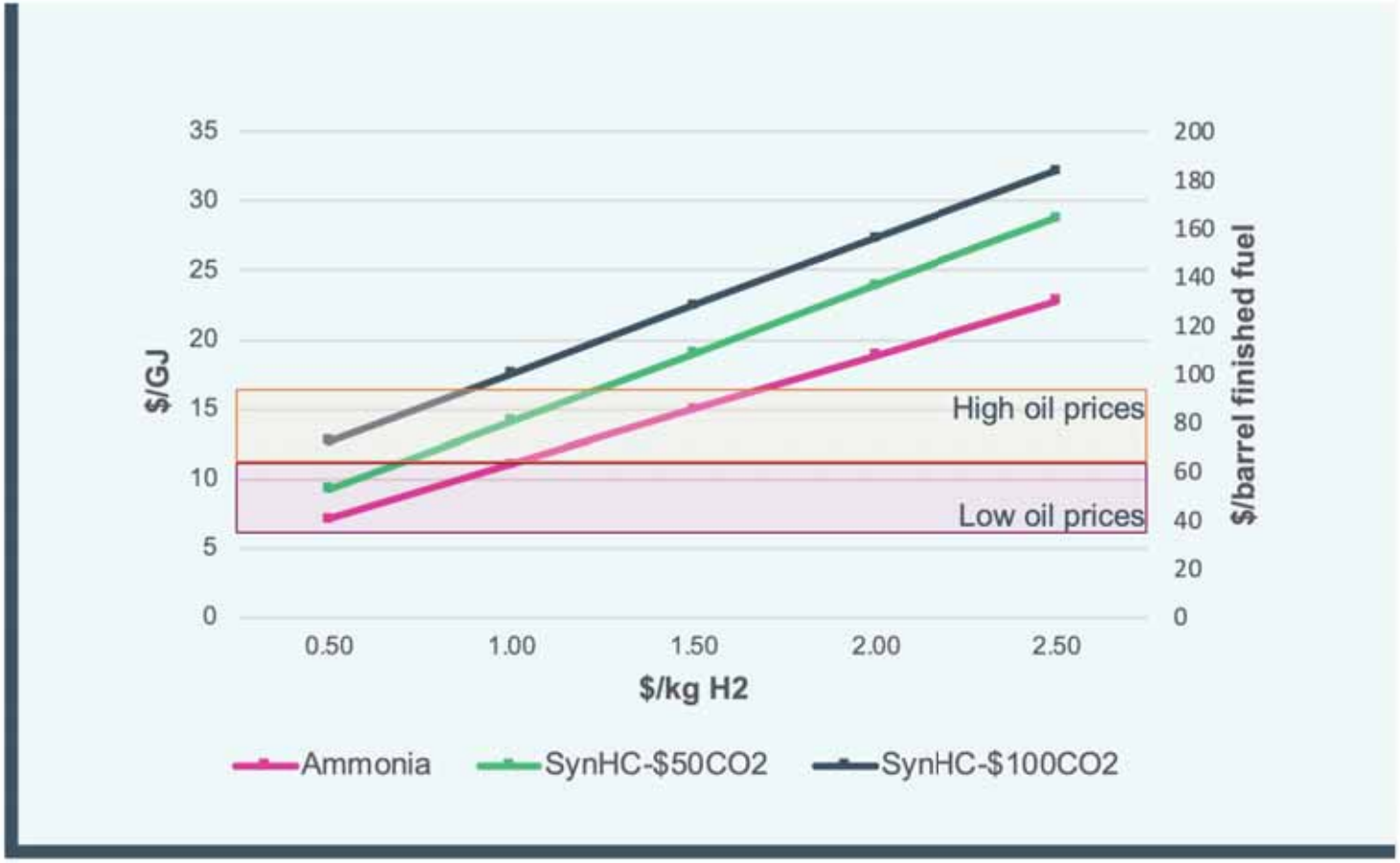
Our Climate Solutions need to be Impossible Burgers

The Fuels Decarbonization Challenge

Scale: Oil use alone is >100 million barrels per day



Cost: Oil Price "Guardrails' of the Hydrogen Economy ($0.50-$1.50/kg)



Re-Deploying Oil and Gas Capability for Clean Hydrogen/Synfuels Production

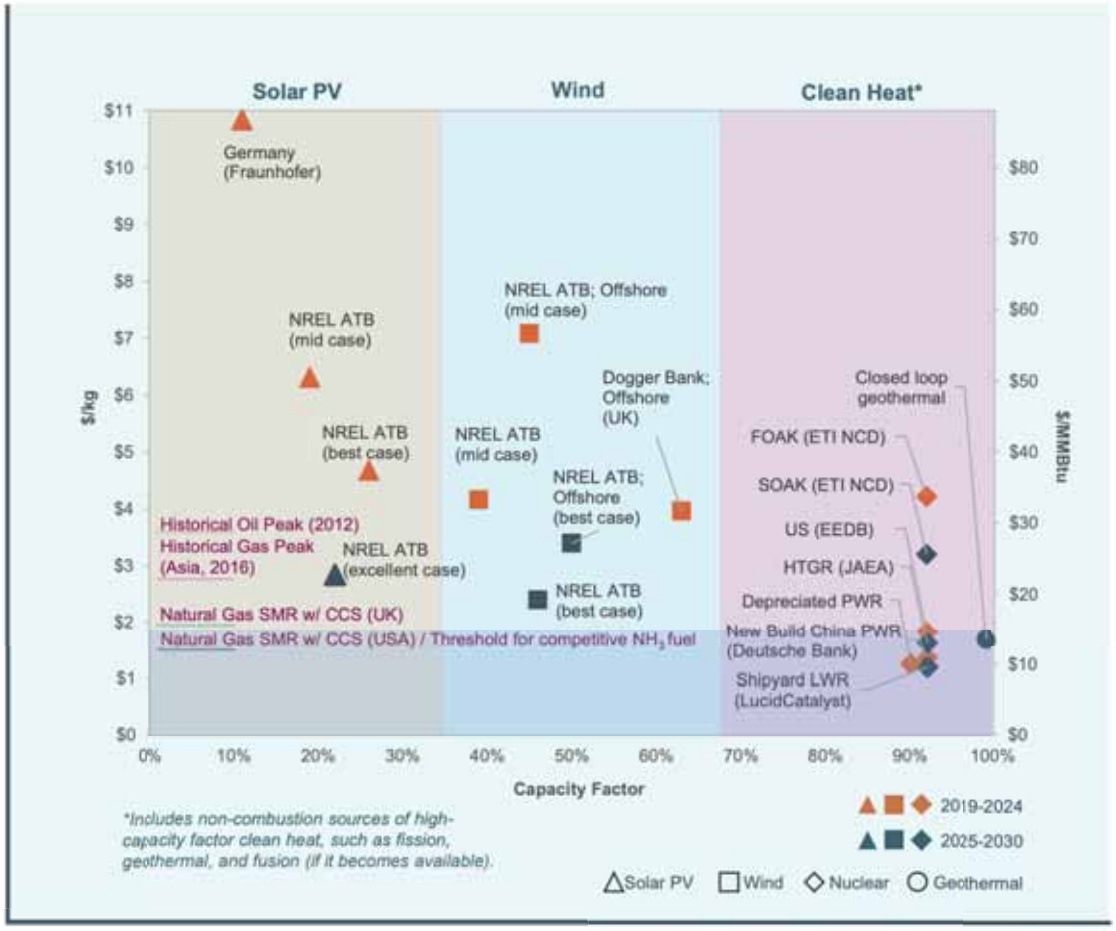
Refinery-Scale Hydrogen/Synfuel Gigafactory

Shipyard Construction of Floating Production Platform (FPSO)

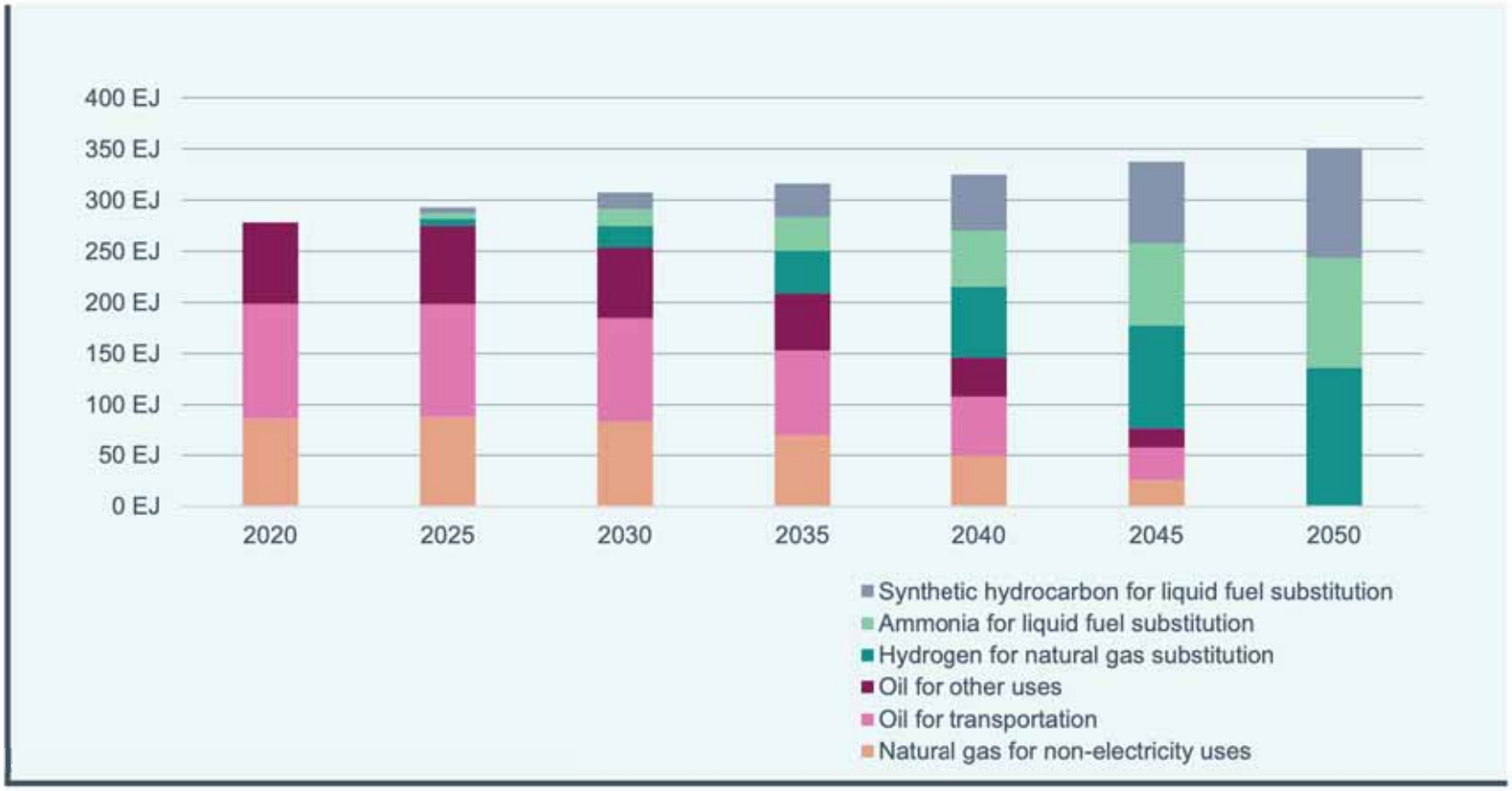
Modular blocks are added to an FPSO under construction in a dry dock.

Rendering of ammonia bunker offloading ammonia from a production platform

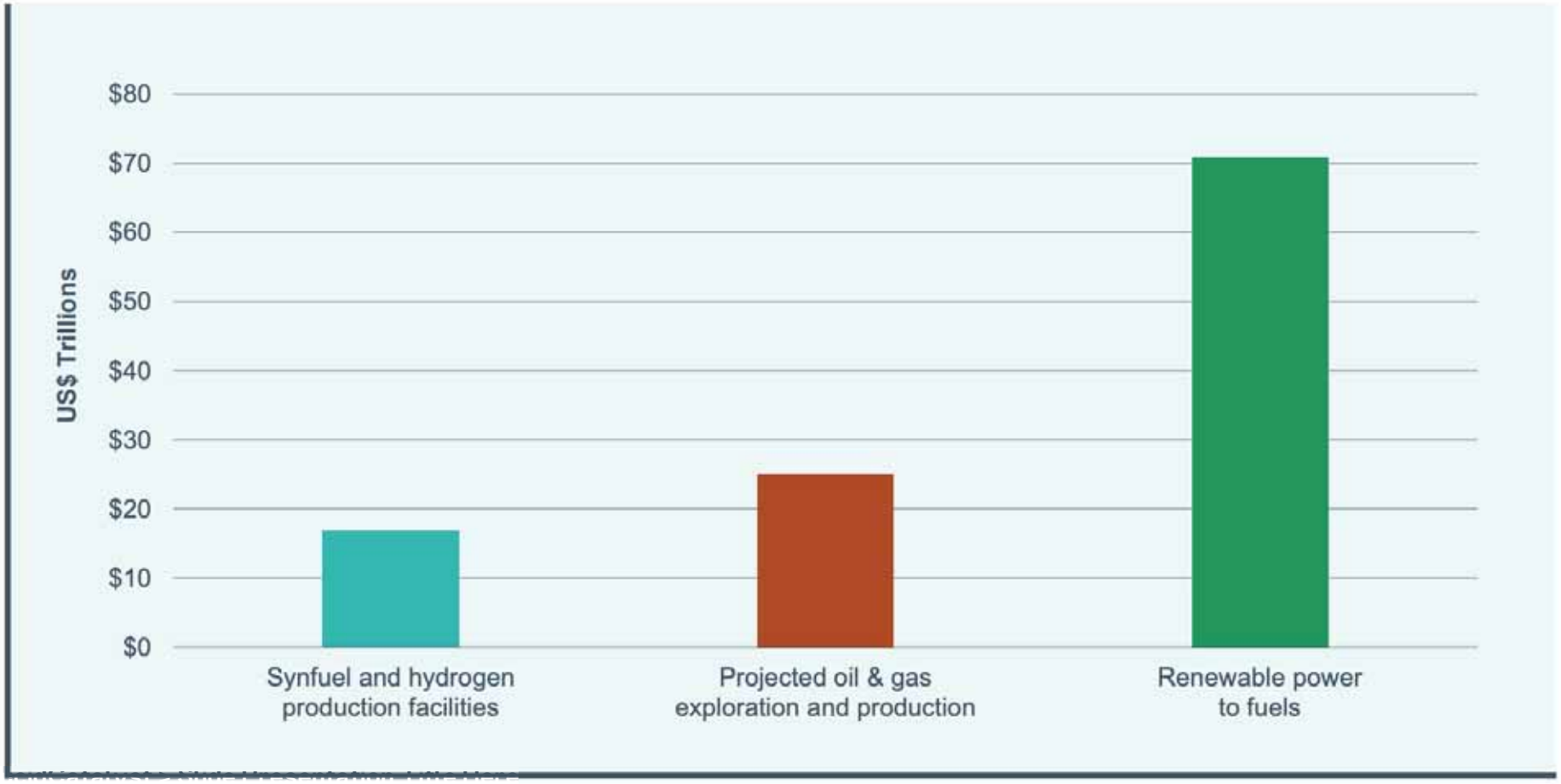
2018 – 2030 Hydrogen Production Costs



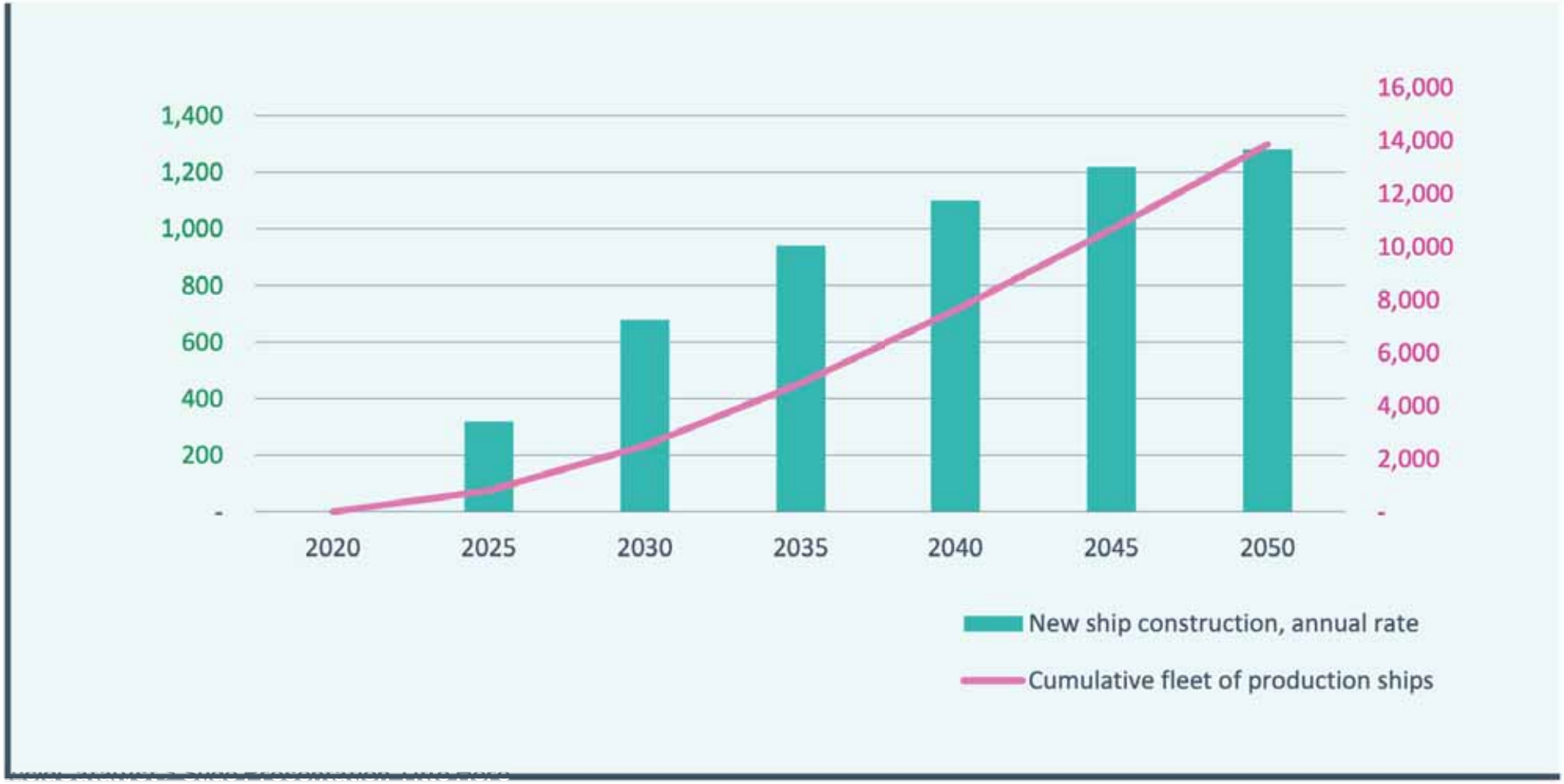
Fuel substitution in difficult to decarbonize sectors from ultra-cheap hydrogen generated by advanced heat sources 2020-2050



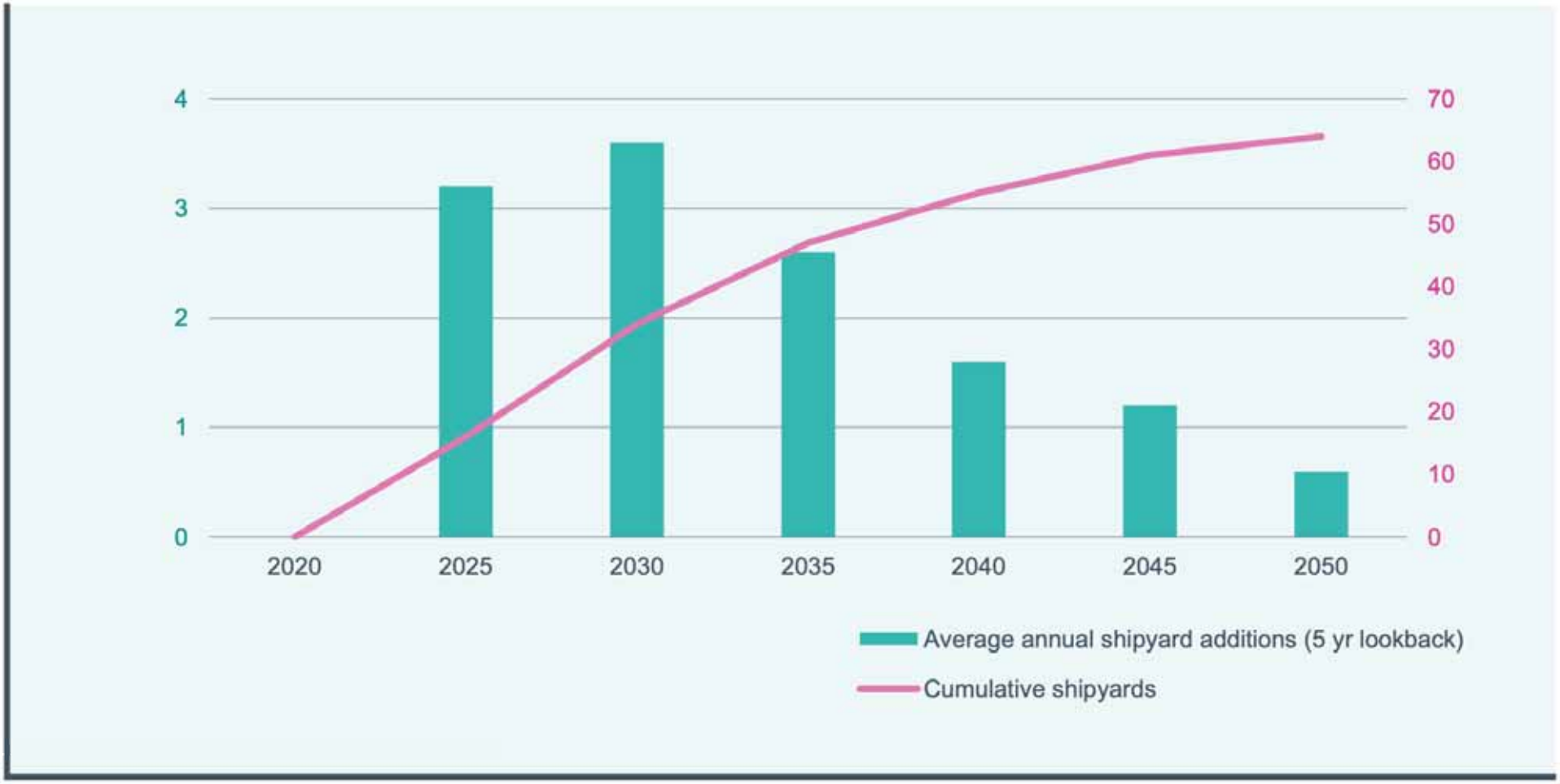
Comparative investment for fuel substitution by 2050



Additions and cumulative production facilities

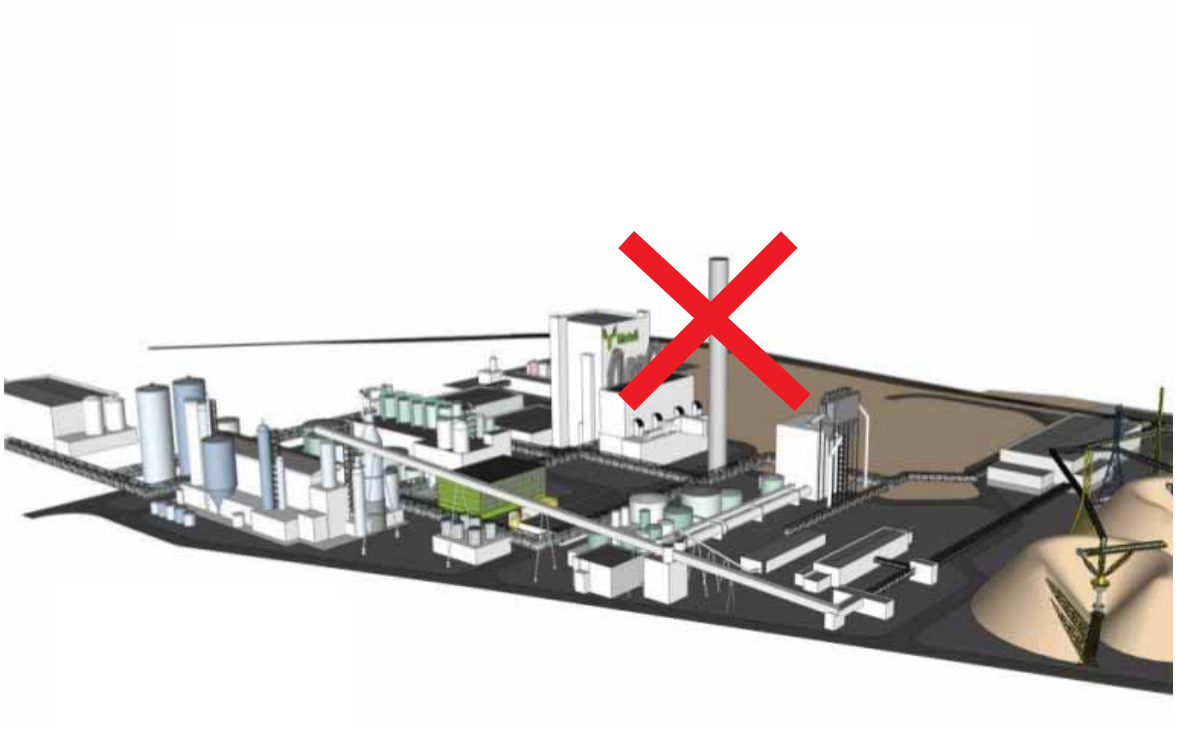


Shipyard starts and cumulative operating shipyards



Where do we get the biocarbon for large scale synthetic drop in hydrocarbons?

Stop Burning It!



Provide heat with SMR

Convert excess biomass to liquid fuel

Nuclear + Biomass

Nuclear enabled biomass gasification increases carbon efficiency by getting the heat and hydrogen required from a nuclear source.

This can produce up to 3x the fuel compared with traditional biomass to liquids

Enables large new markets outside the less profitable paper sector

Combines two industrial sectors where Sweden is very strong

Addresses a critical global need for decarbonization

Conclusion

Given the scale and urgency of the required clean transition combined with growth of the global energy system, all zero-carbon hydrogen production options should be pursued.

The potential of advanced heat sources to power the production of large-scale, very low-cost hydrogen and hydrogen-based fuels could transform global prospects for near-term decarbonization and prosperity.

Our report: *Missing Link to a Livable Climate* sets out a pathway to decarbonize a substantial portion of the global energy system, for which there is currently no viable alternative.

LucidCatalyst delivers strategic thought leadership to enable rapid decarbonization and prosperity for all.

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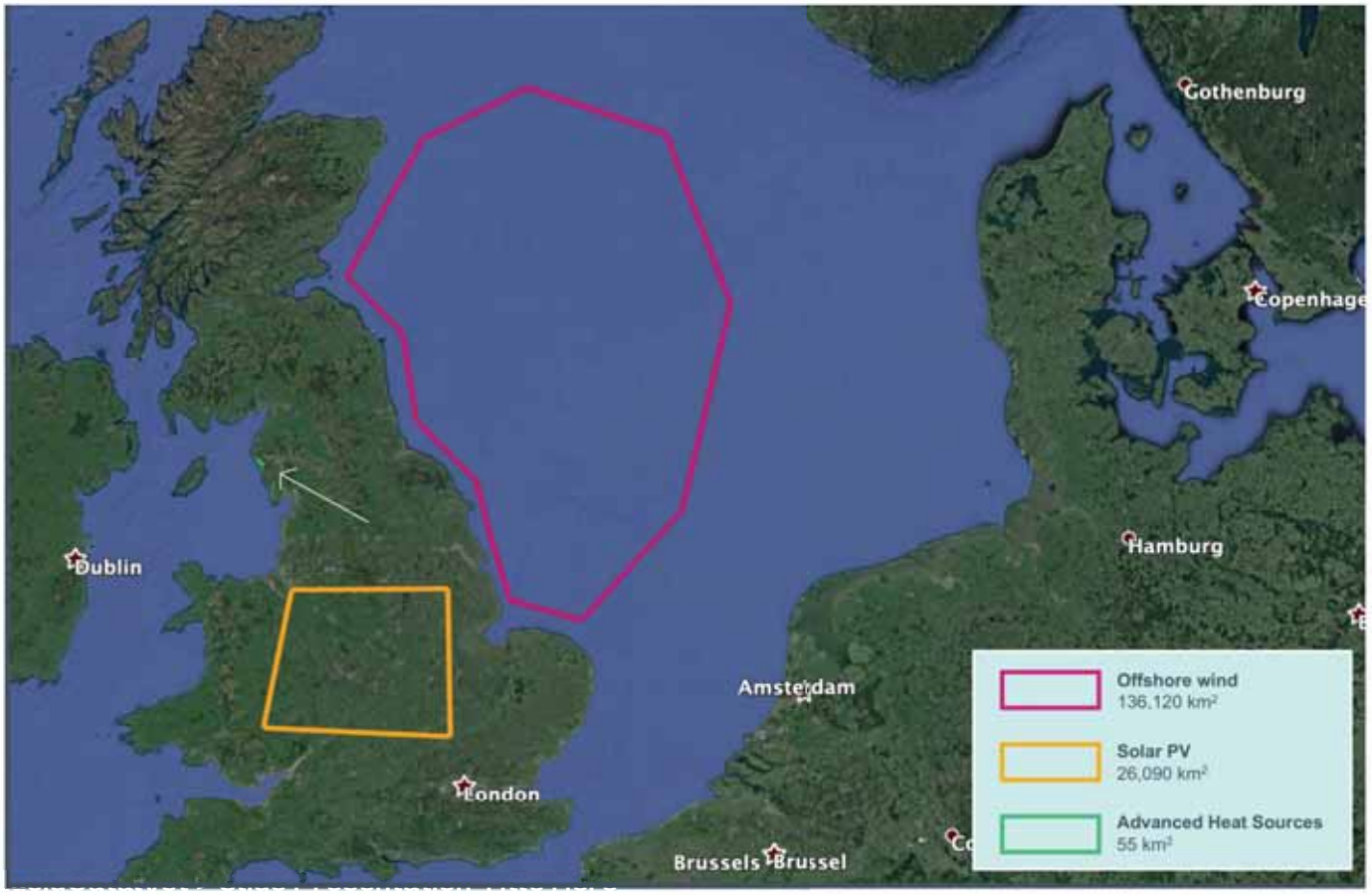
Physical Space Constraints:

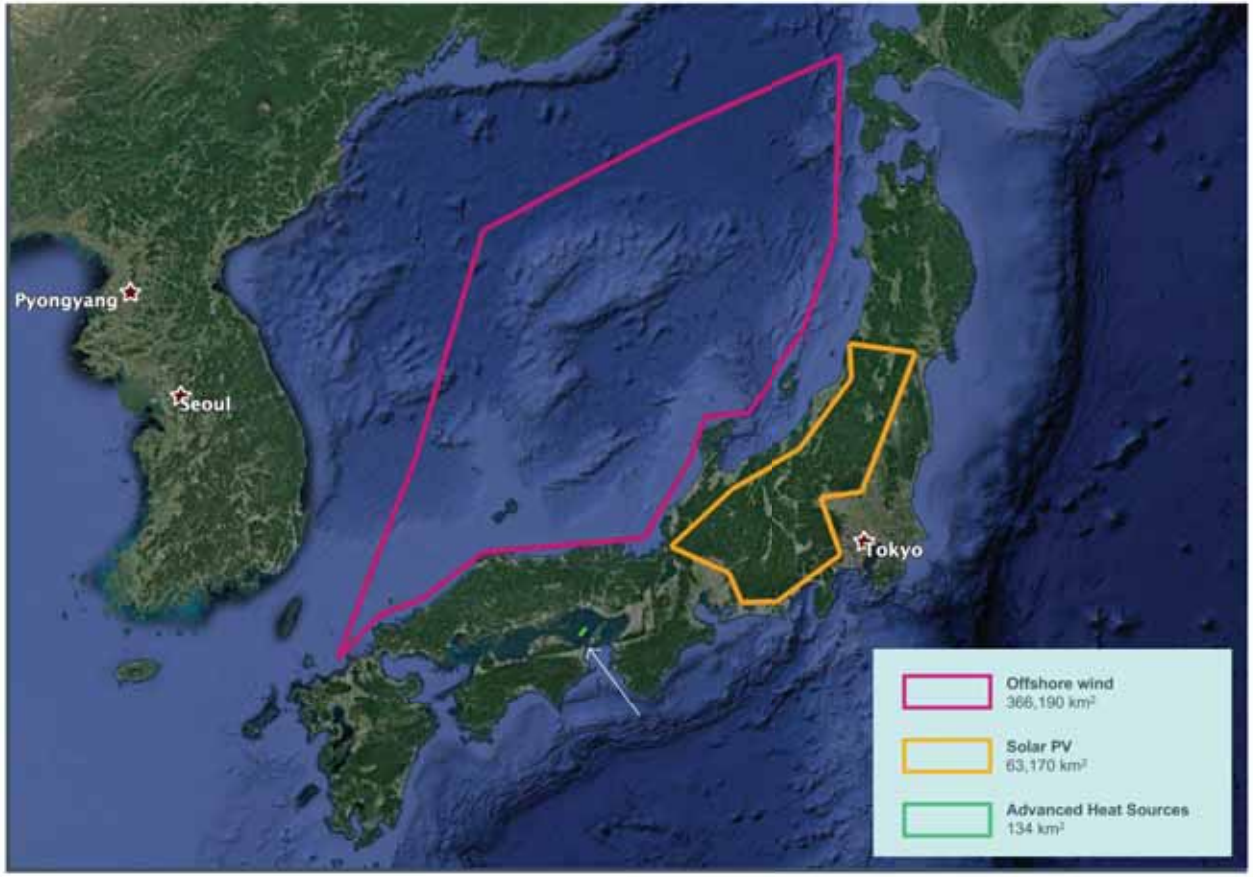
A Reality Check

Comparing area required to replace the UK's current oil consumption with hydrogen generated from either wind, solar, or advanced heat sources



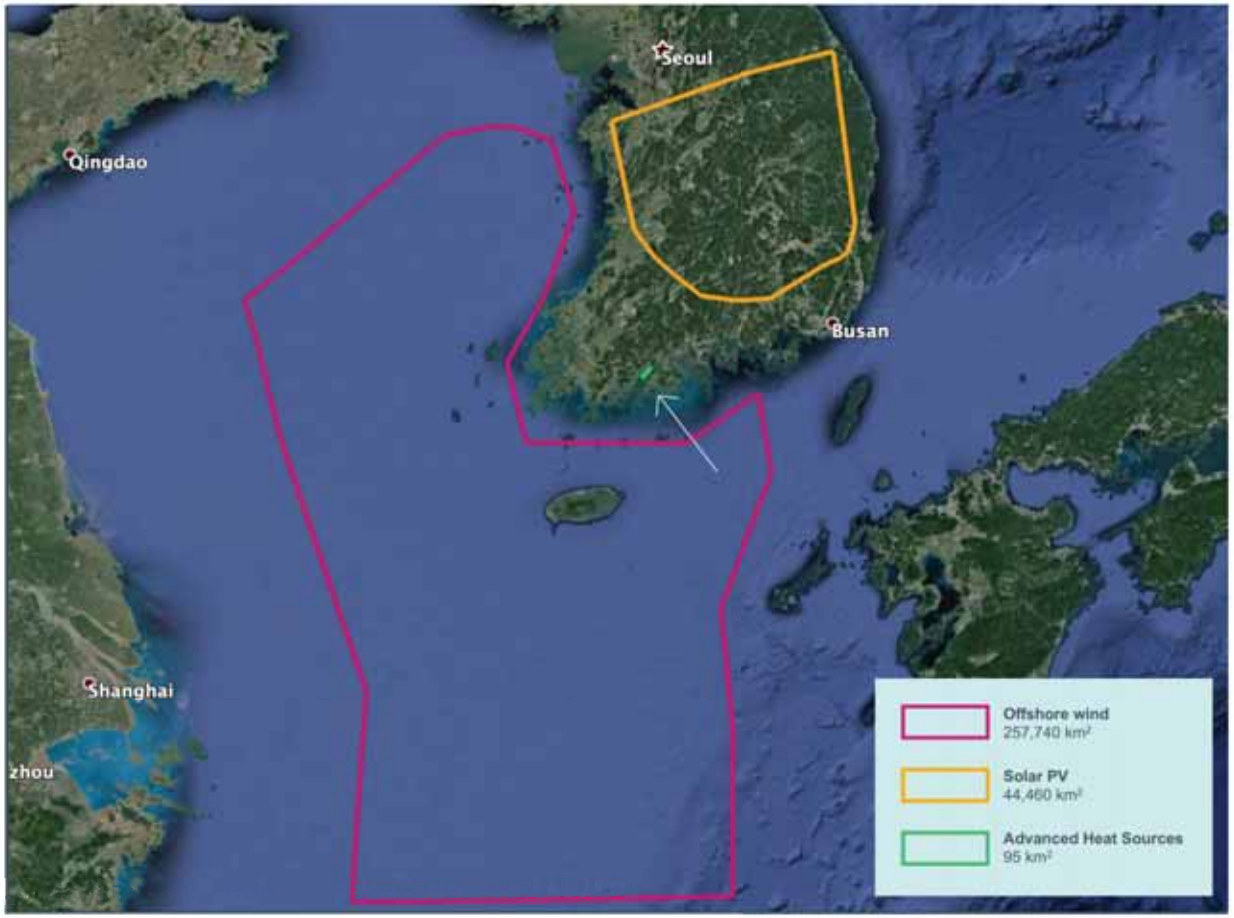
Each colored outline represents the total area that would be required for the siting of each type of resource if it were to be the only one used to generate enough hydrogen to replace current oil consumption in the UK.

Comparing area required to replace Japan's current oil consumption with hydrogen generated from either wind, solar, or advanced heat sources



Each colored outline represents the total area that would be required for the siting of each type of resource if it were to be the only one used to generate enough hydrogen to replace current oil consumption in Japan.

Comparing area required to replace South Korea's current oil consumption with hydrogen generated from either wind, solar, or advanced heat sources



Each colored outline represents the total area that would be required for the siting of each type of resource if it were to be the only one used to generate enough hydrogen to replace current oil consumption in South Korea.

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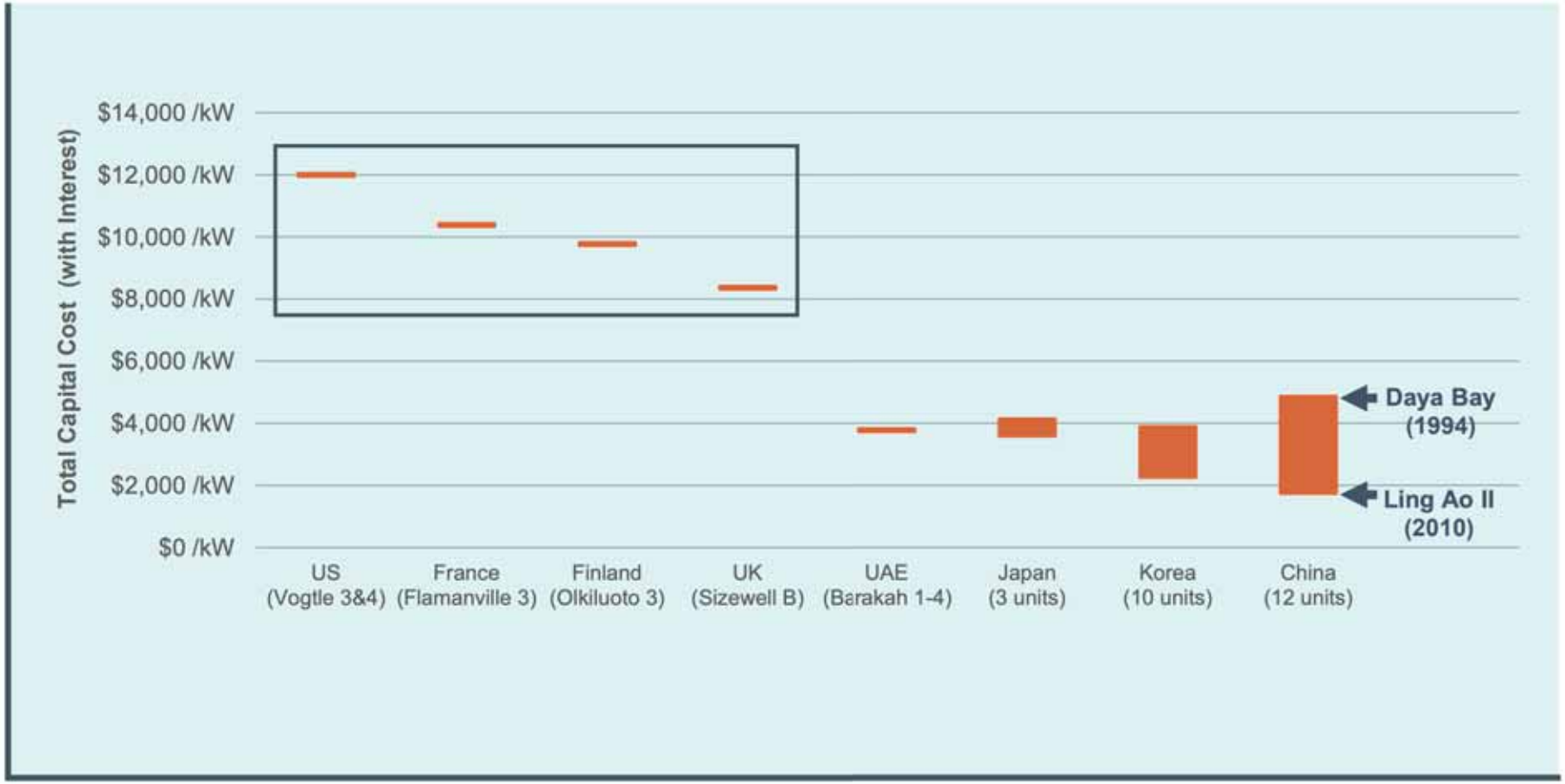
FPSO for Hydrogen, Power, Ammonia, Desalination

Hydrogen Production Costs: 2050

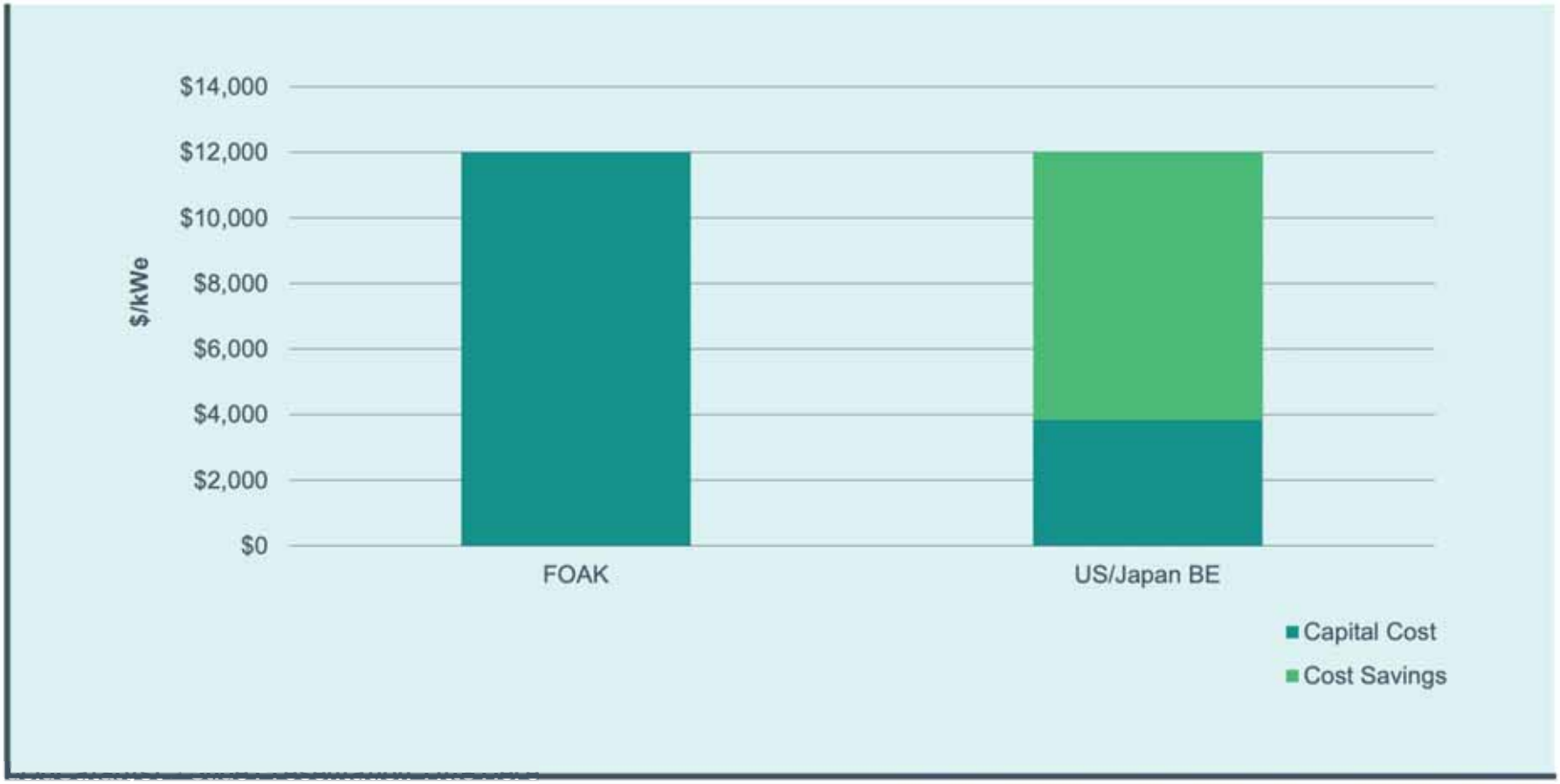
Cost Reduction from Shipyard Manufacturing

Costs of recent nuclear plants



Source: LucidCatalyst, Eric Ingersoll, Kirsty Gogan, et al., "The ETI Nuclear Cost Drivers Project: Full Technical Report," September 2020.

Cost reduction from first-of-a-kind (FOAK) to program build



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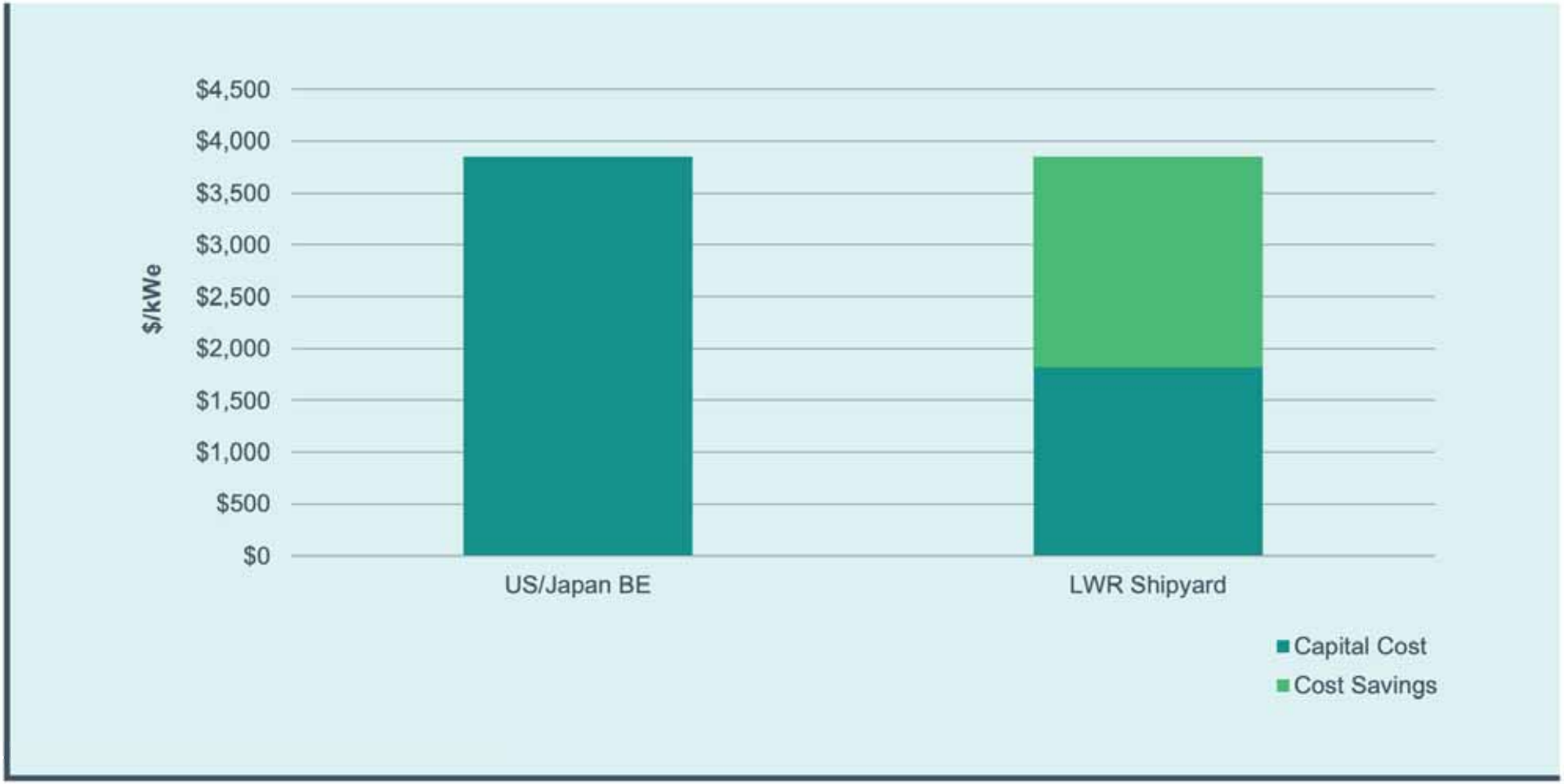

Evolution of cost reduction from first-of-a-kind construction projects to mass manufactured products