

De Groene Waterstofeconomie

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Third wave renewable energy

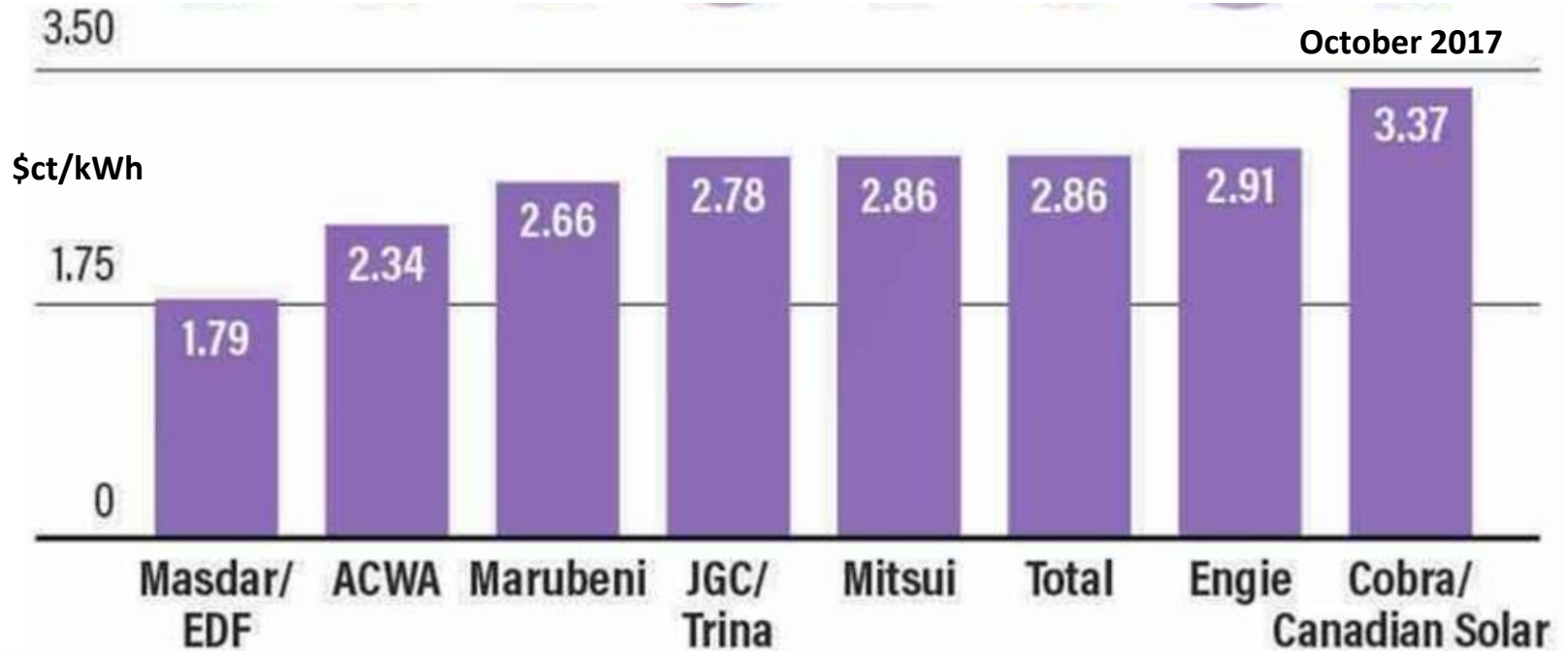
World wide, large scale
cheap renewables

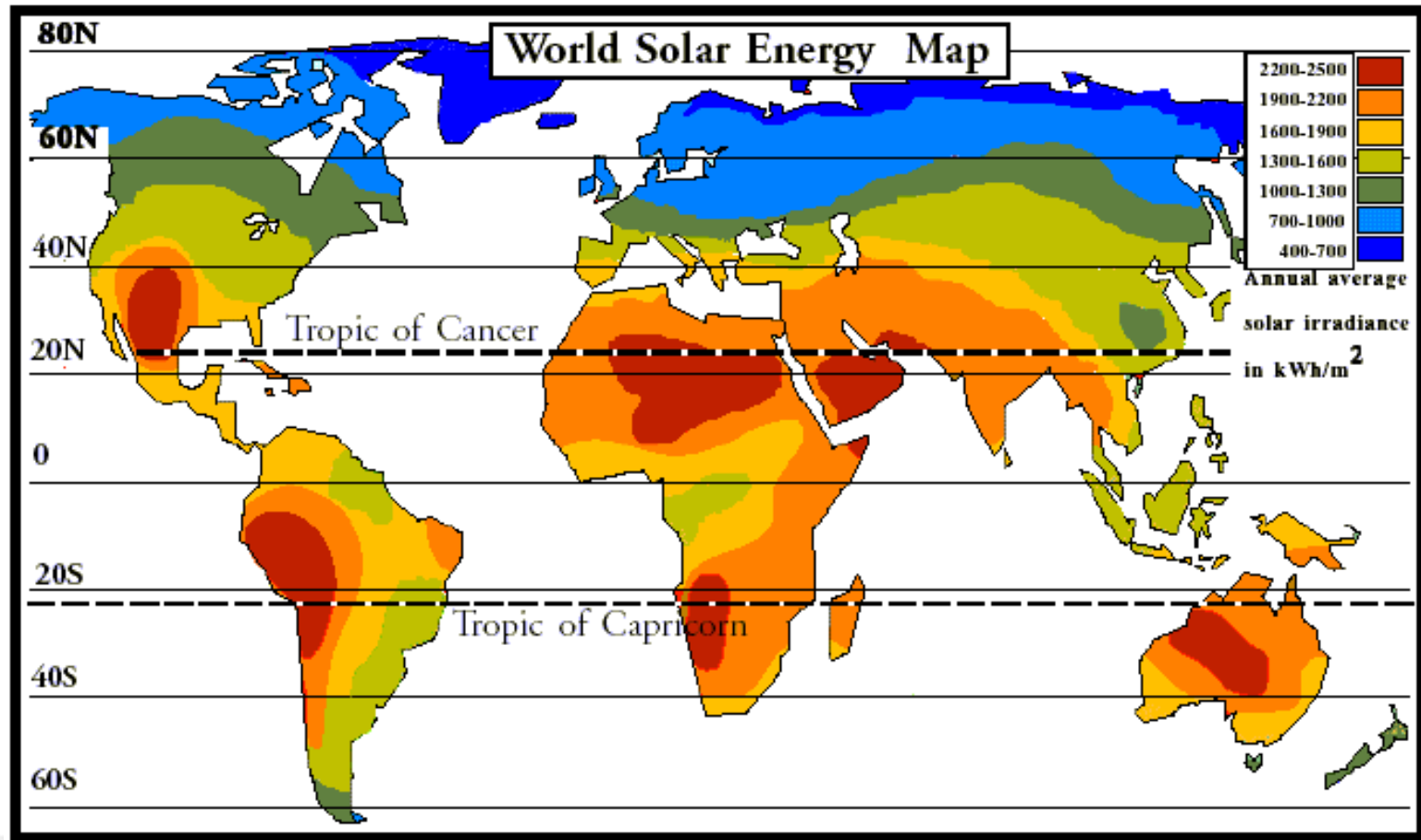
Local, renewable
energy in fossil
energy system

Technology
Development



Bids for Saudi Arabia's 300 MW Solar Plant

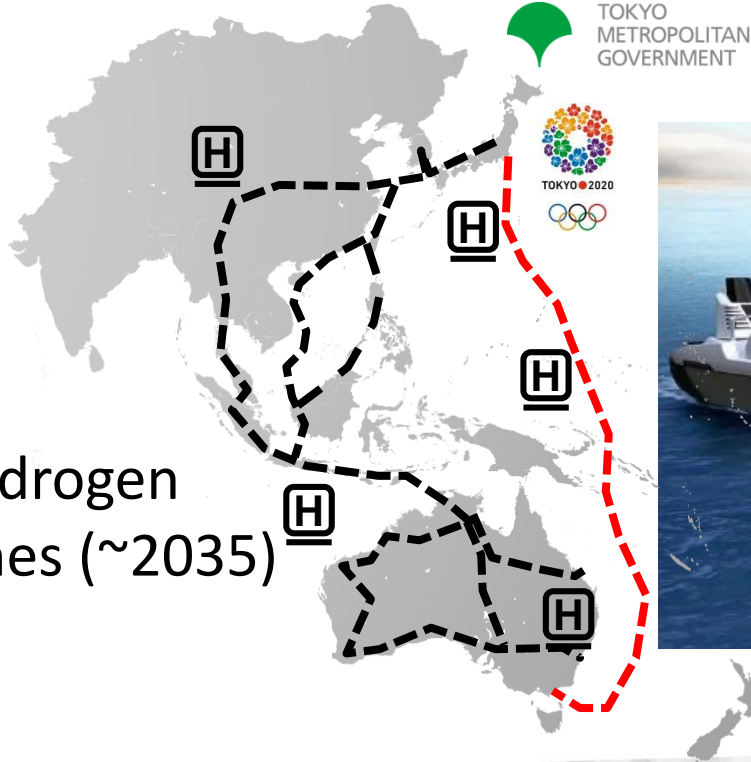




Tokyo Olympic Games 2020



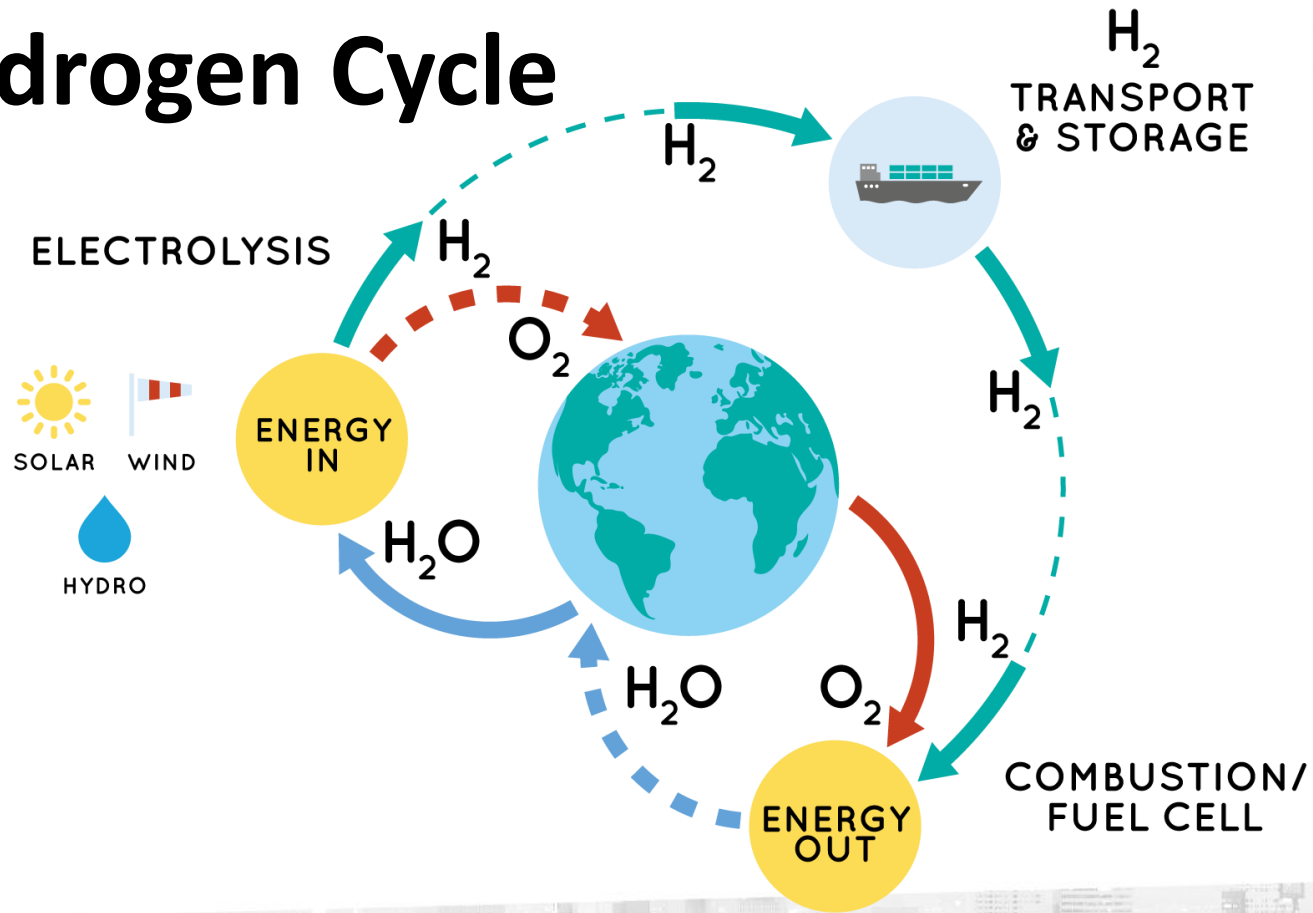
Hydrogen
Pipelines (~2035)



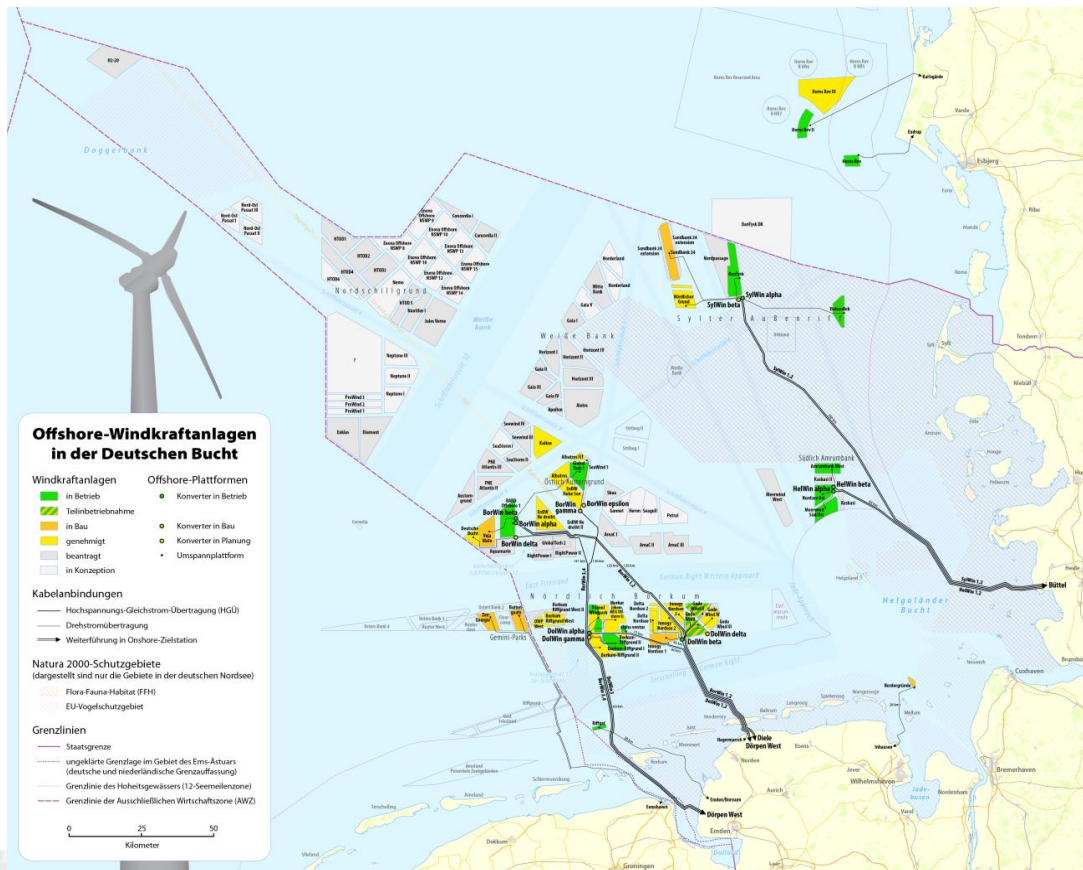
Hydrogen Shipping
(~2025)



The Hydrogen Cycle



Offshore Wind Development Germany



Eemshaven; The Energy Harbor



Norned Cable 700 MW

Cobra Cable 700 MW (2019)

Gemini Offshore Wind Farm 600 MW

Onshore Wind Farms > 275 MW

Nuon Magnum power plant 1,320 MW

RWE Coal fired power plant 1,560 MW

Engie Gas fired power plant 2,450 MW

Cable Inland 4,000 MW

Expansion to 5,610 MW

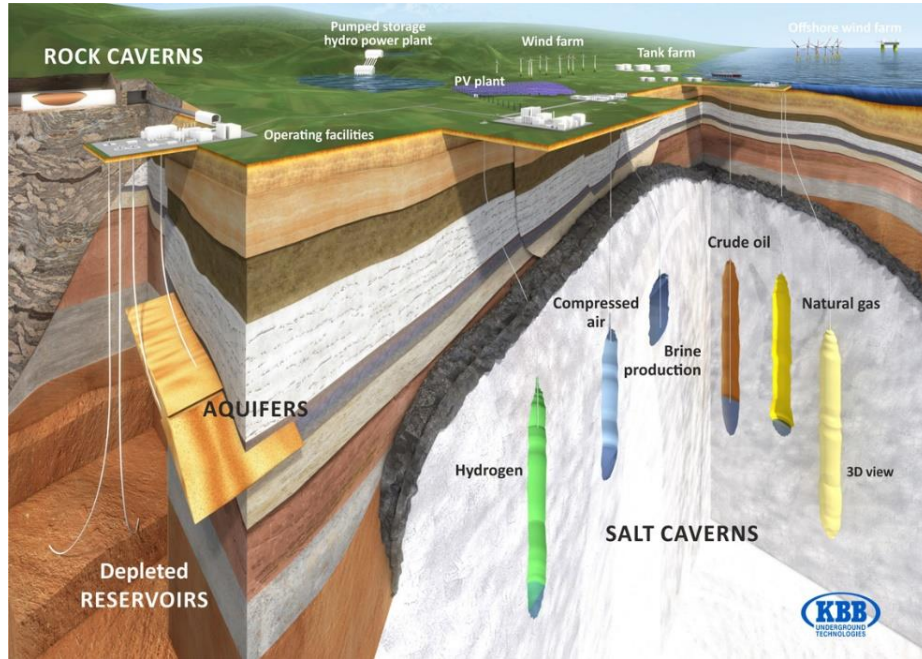
Electricity and Gas Transport Grid



Doggersbank Energy Island



Hydrogen storage in Salt Caverns



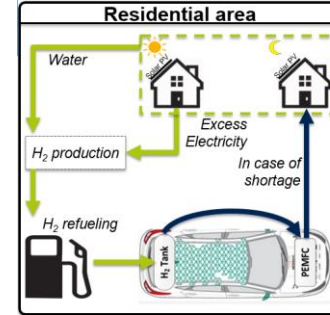
1 salt cavern can contain 6,000 ton hydrogen
Equivalent of 17 million Tesla Power walls

Green Hydrogen Markets

Chemical Feedstock



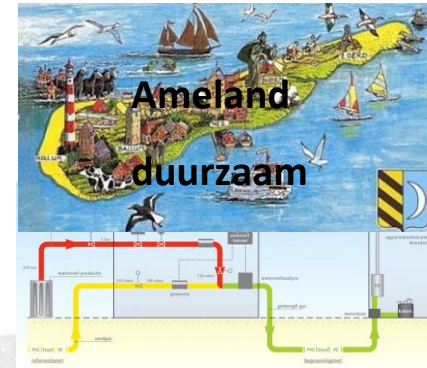
Electricity Balancing



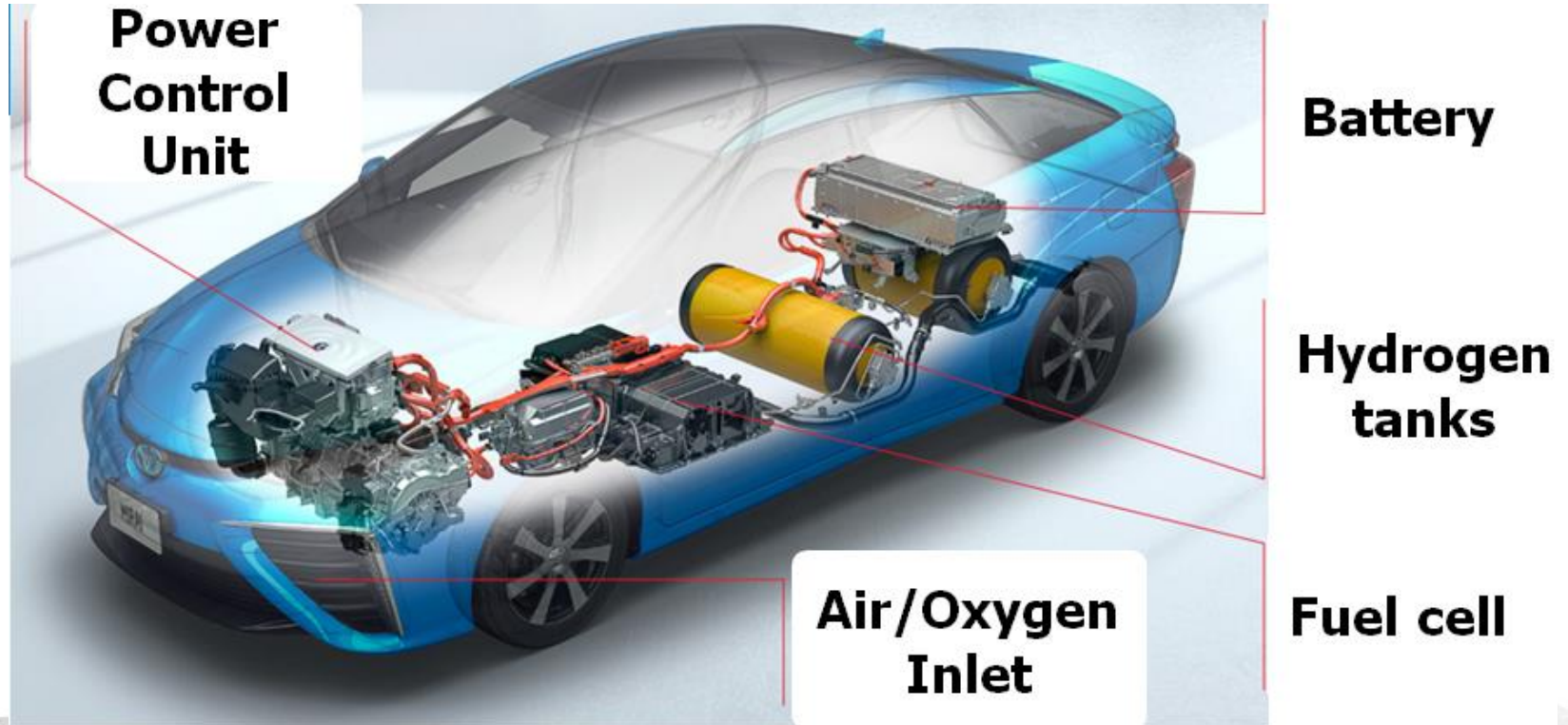
Transport



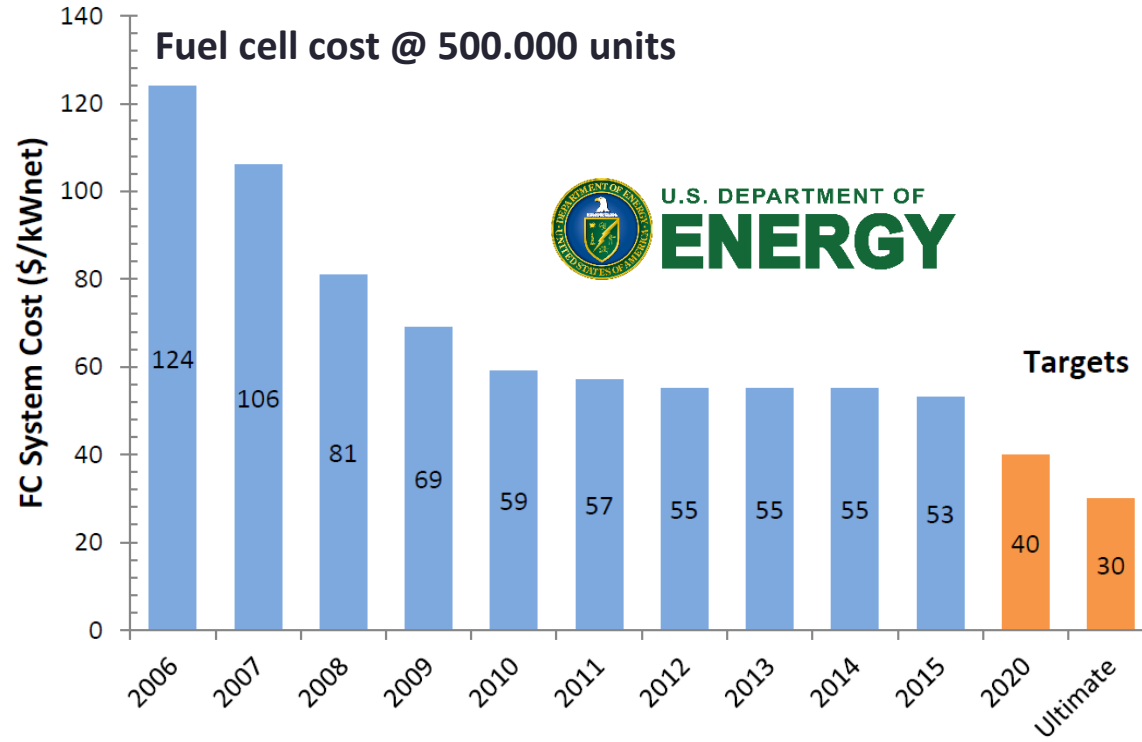
Heating



Toyota Mirai; Fuel cell car



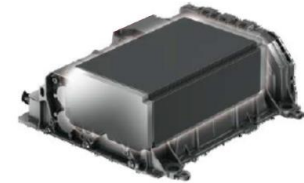
Fuel cell cost



2008 FUEL CELL STACK



Weight **-48%** Volume **-43%** Power **+26%**

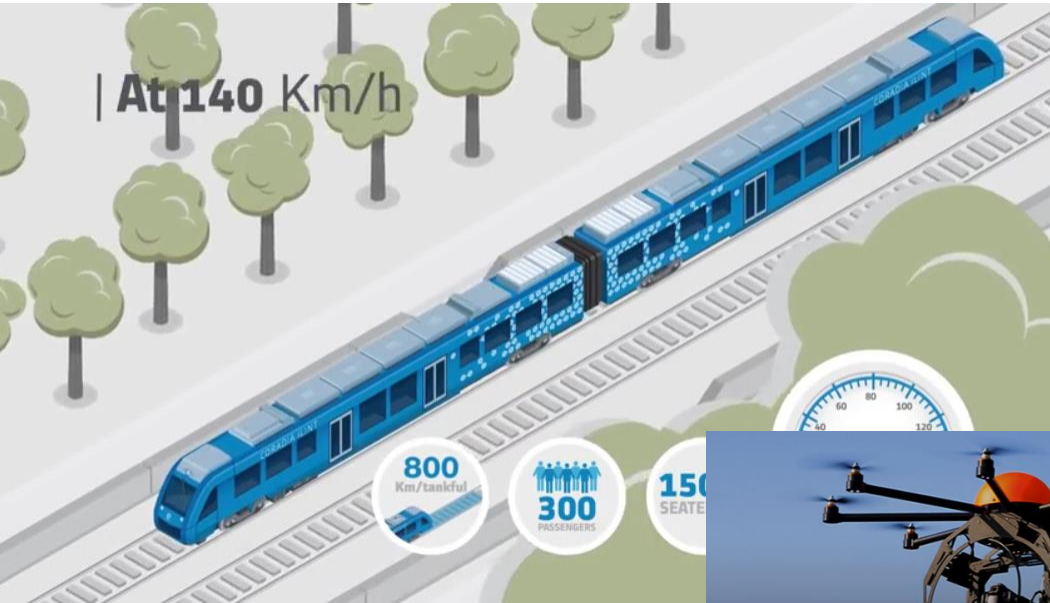


2016 FUEL CELL STACK

Toyota Fuel Cell Hydrogen Truck and Bus



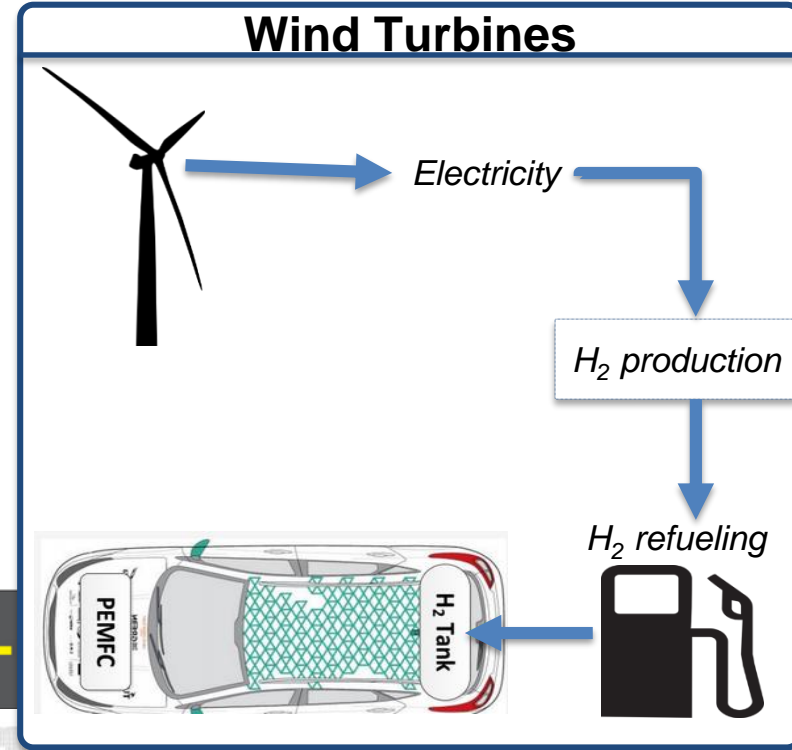
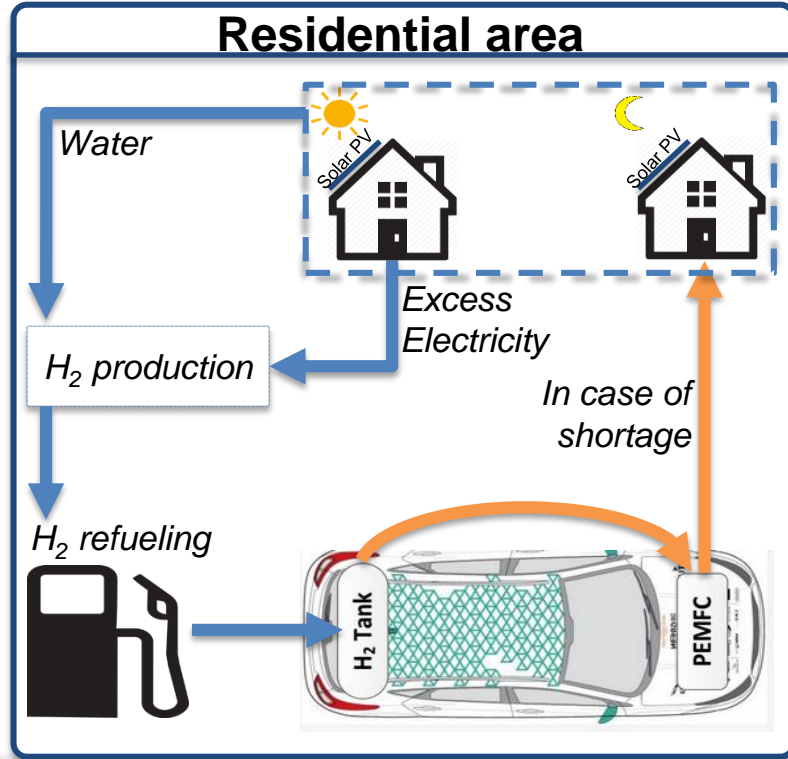
Fuel Cell Hydrogen Train, Ferry, Drone



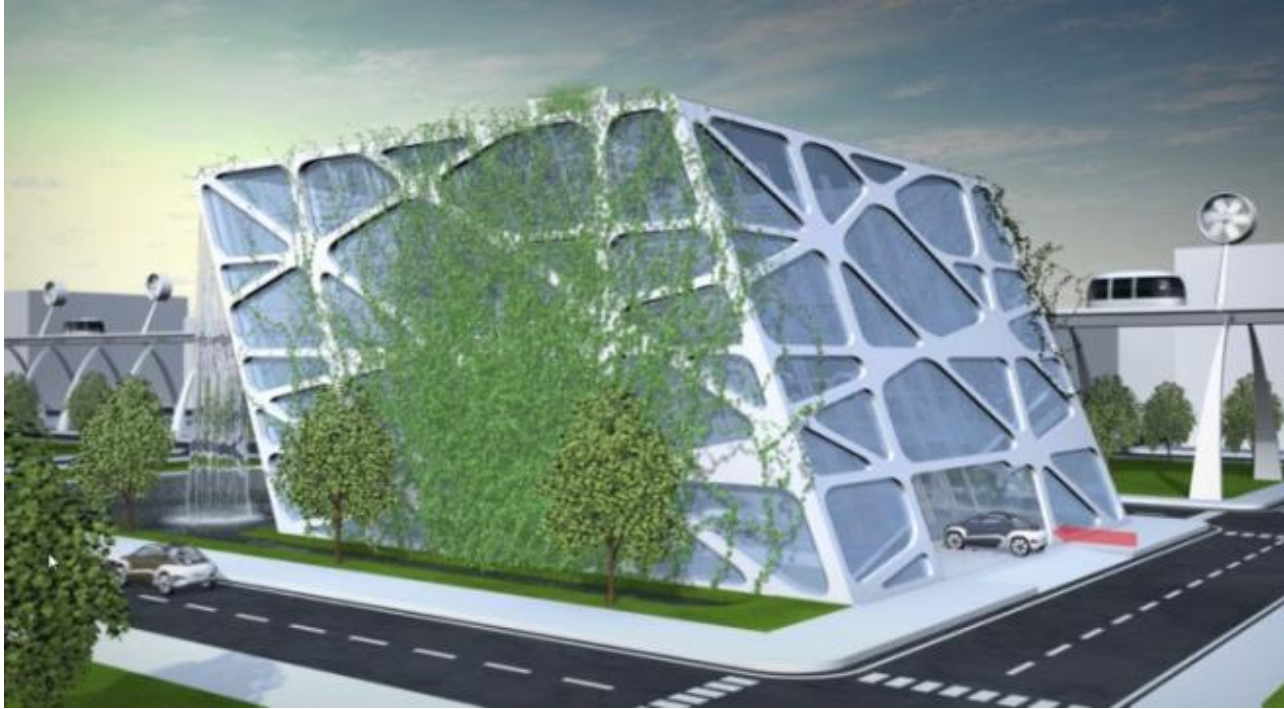
Toyota Mirai with Power Out



Car as home power plant



Car park power plant



Google Datacenter Eemshaven

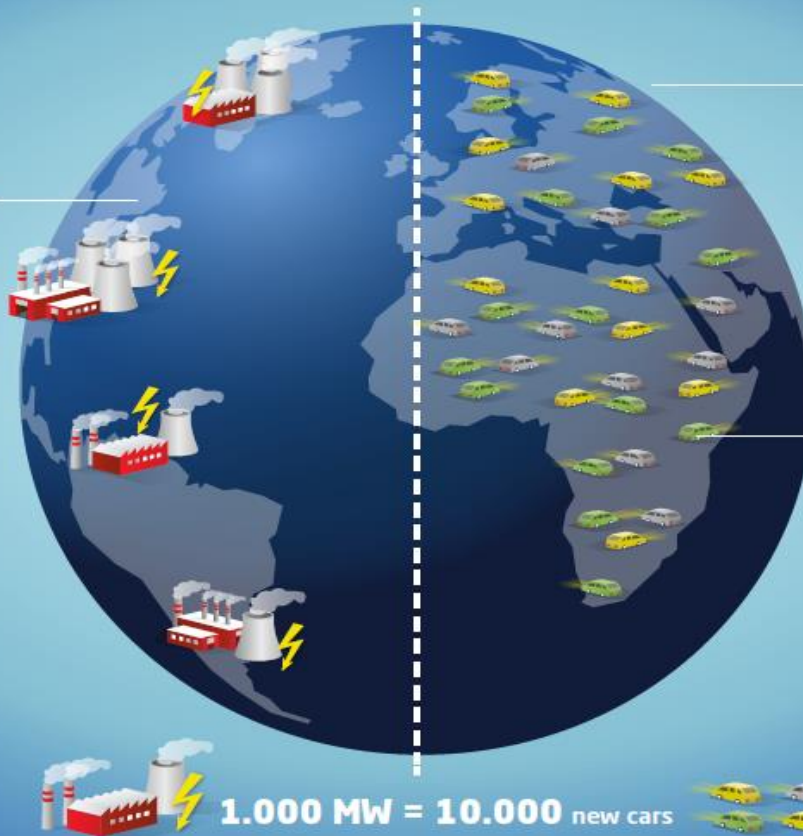


Our cars take over power plants

Power plants

Total installed
capacity (2010)

5.000 GW



Cars

1 car = **50 kW**

1.000 million cars (2010)

1.000 million x 50 kW =

50.000 GW

(5% of time in operation)

New cars

1 new car = **100 kW**

80 million new cars per year

80 million x 100 kW =

8.000 GW

per year

Defying Death Valley

