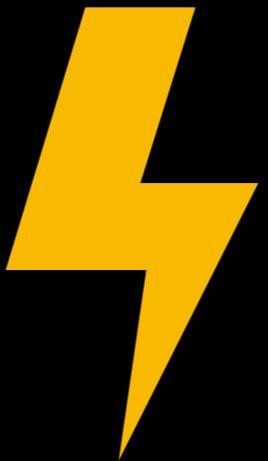


# Renewable Energy

What's next and why we need it

Akshiv Bansal

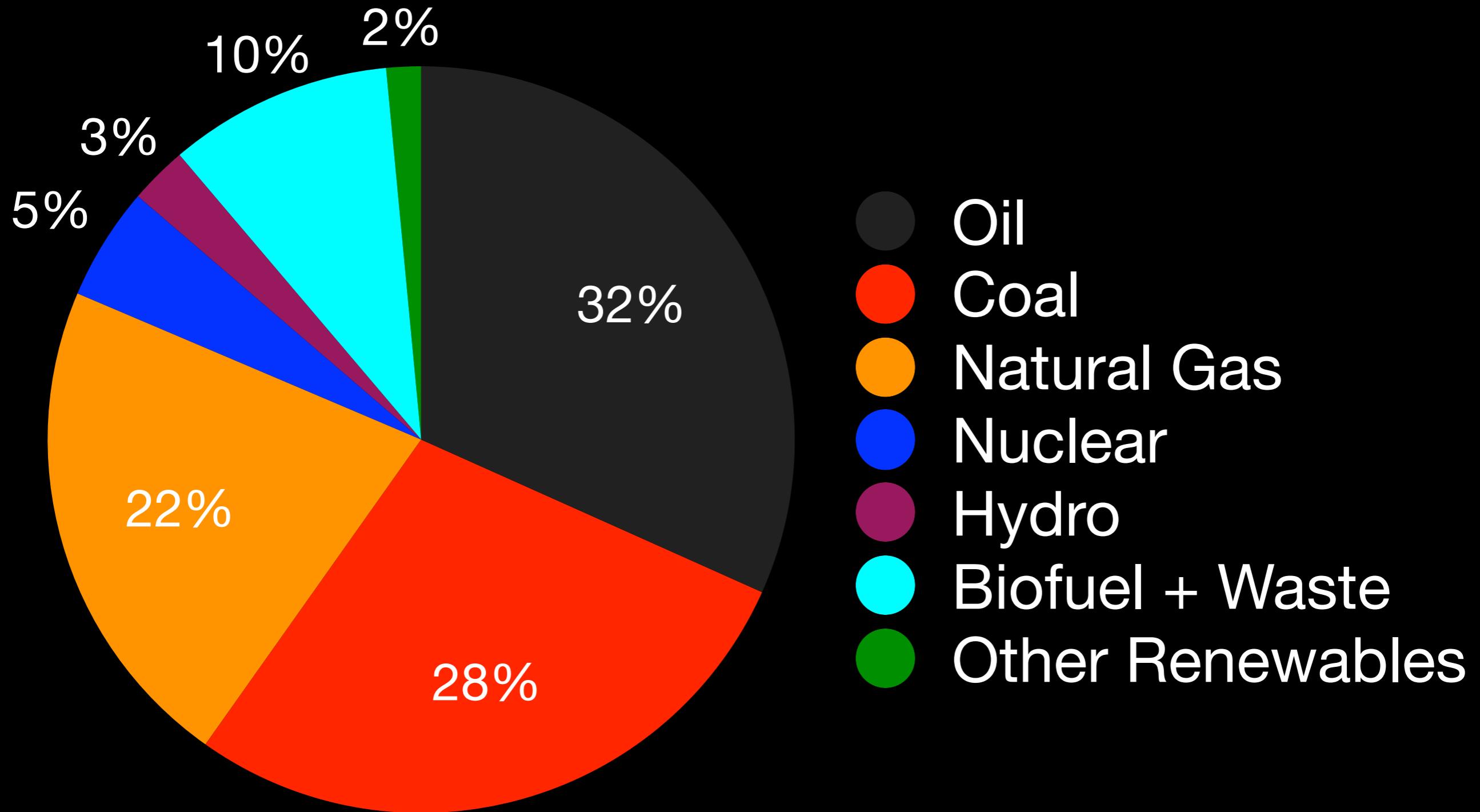
# 1) Generation



# 2) Storage and Distribution

# 1) The Generation Problem

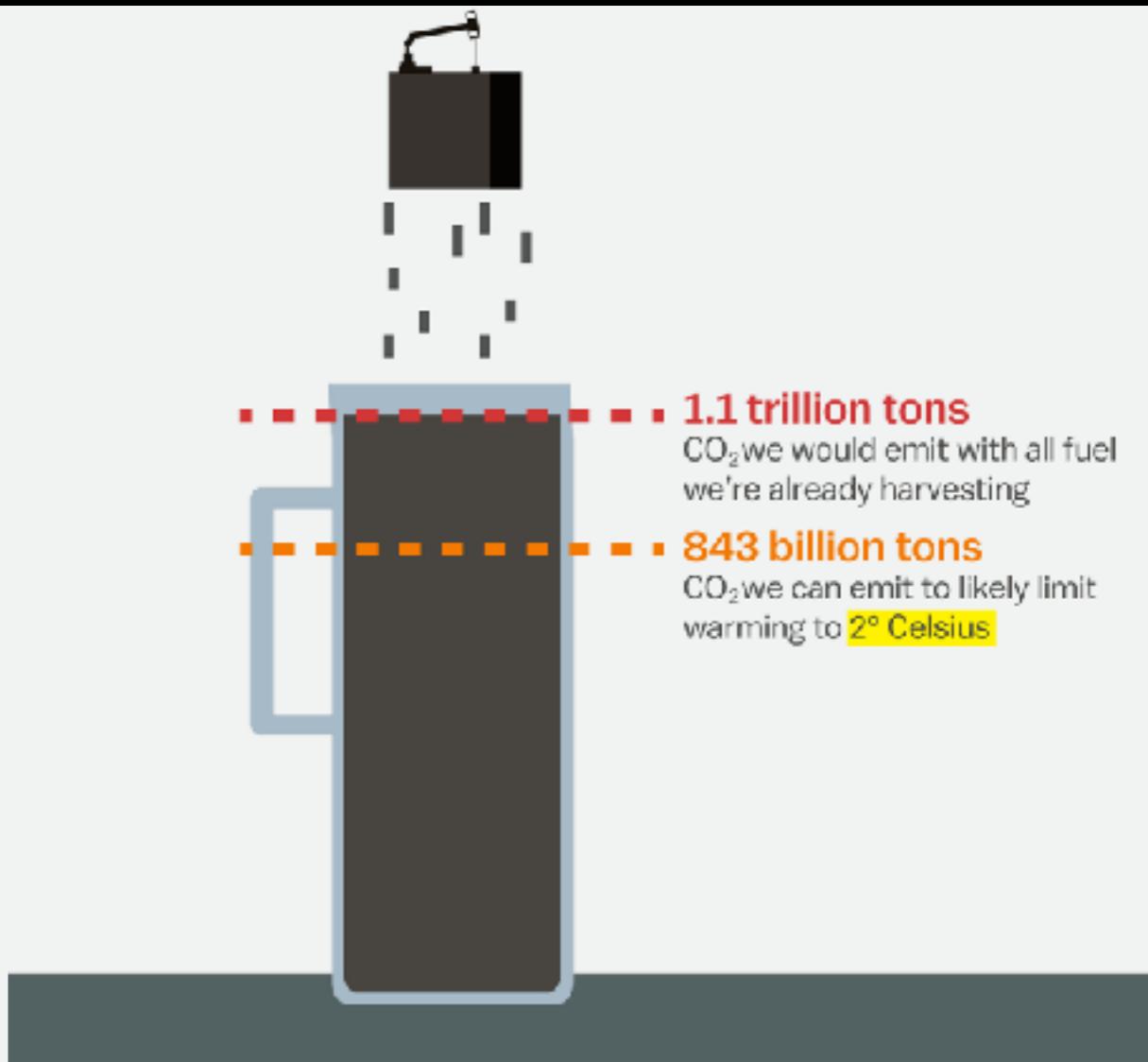
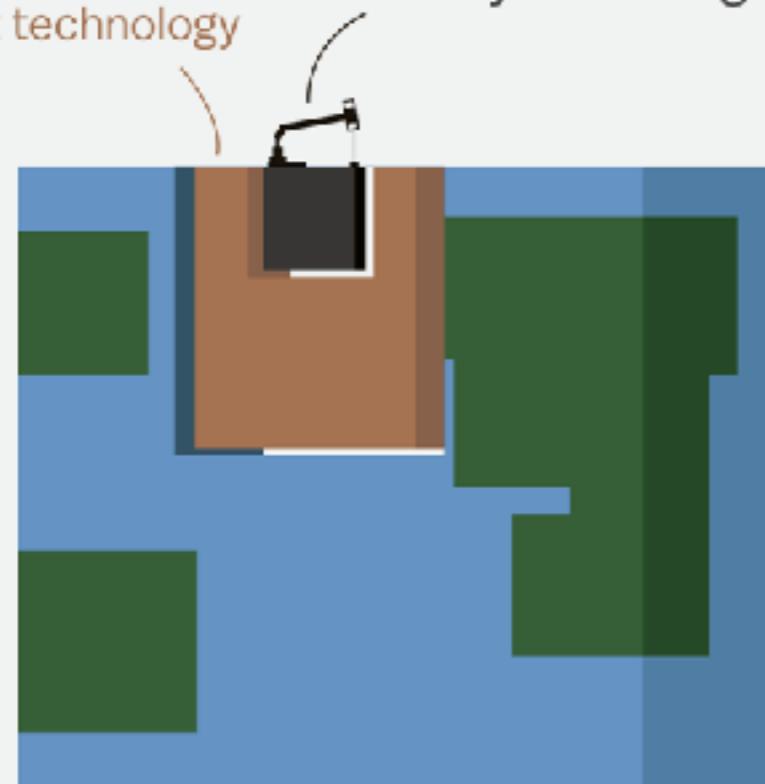
# State of the World



# What's the problem?

All the fossil fuel we've identified and can recover with current technology

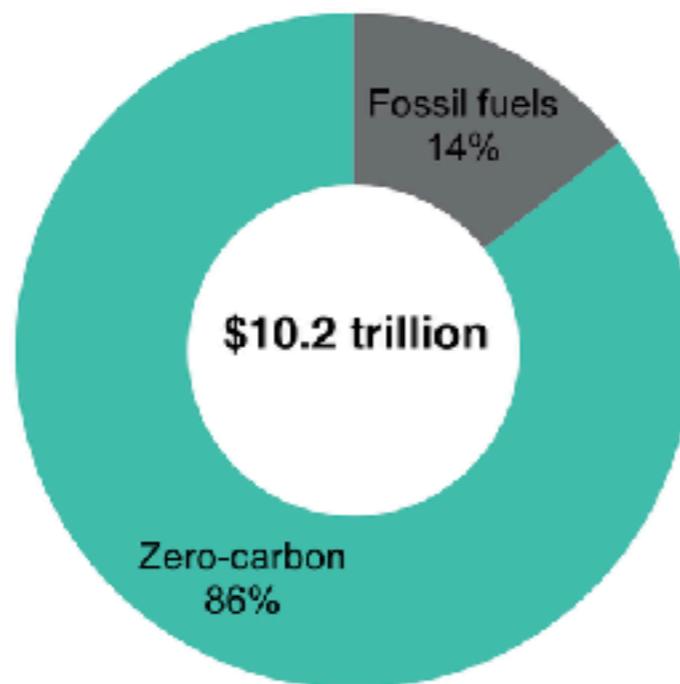
The portion we are currently harvesting



# Future?

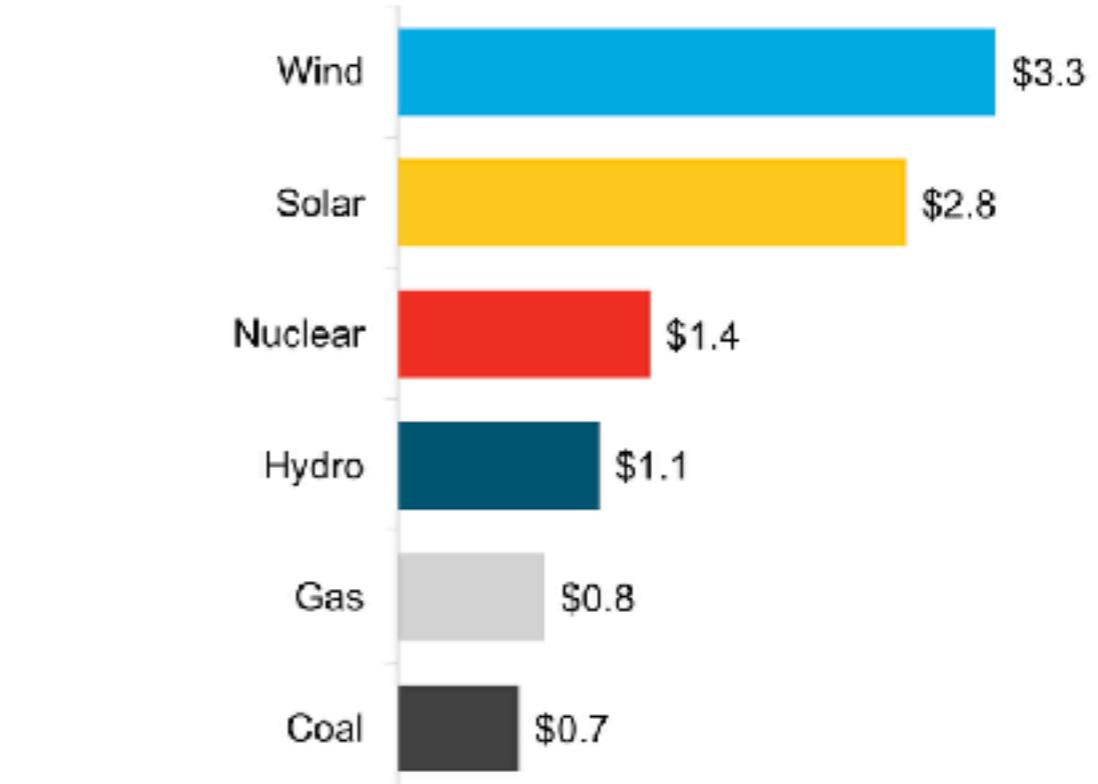
**Solar and wind attract 73% of new investment in power generating capacity**

Investment, by technology, 2017-2040



Investment, by technology, 2017-2040

(\$ trillion - 2016 real)

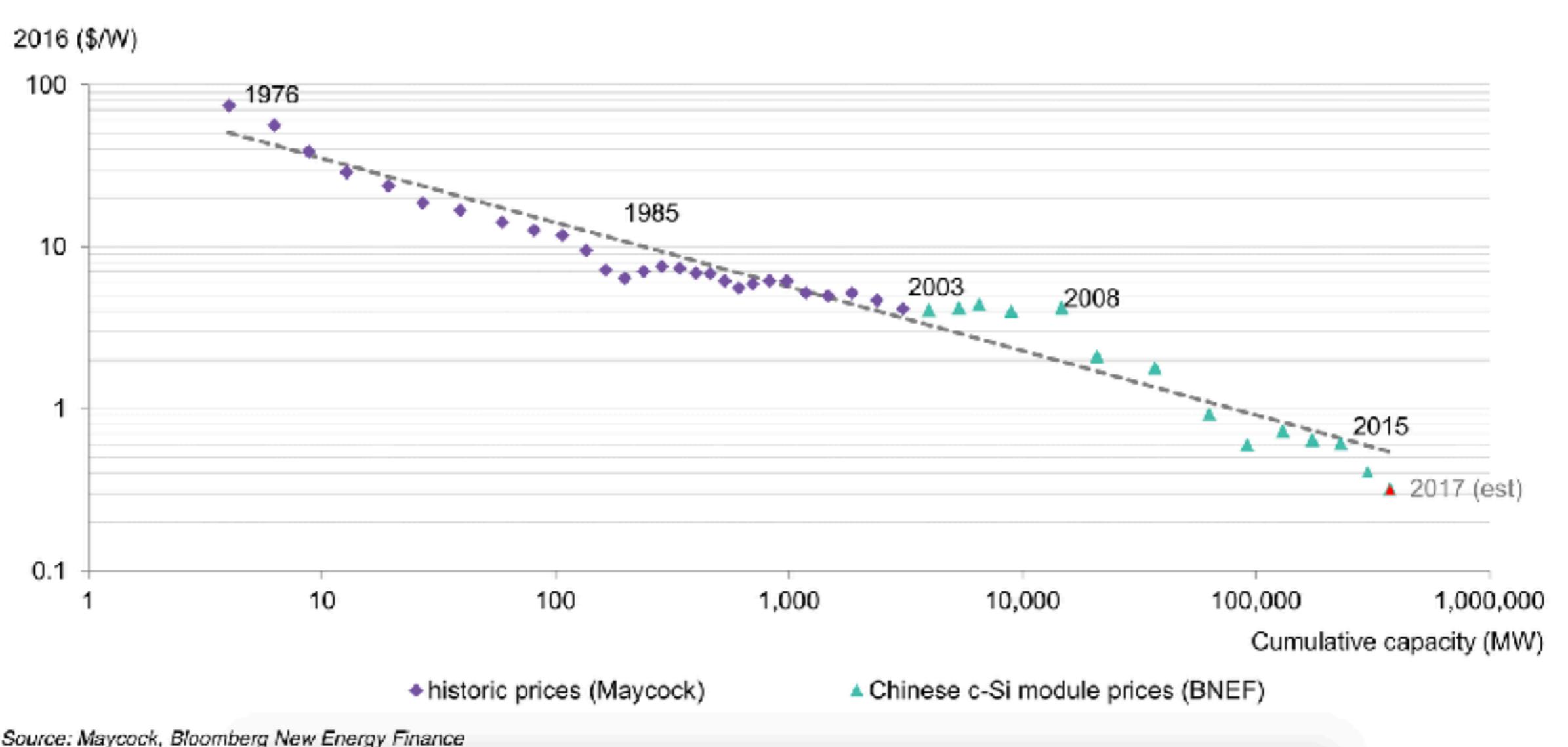


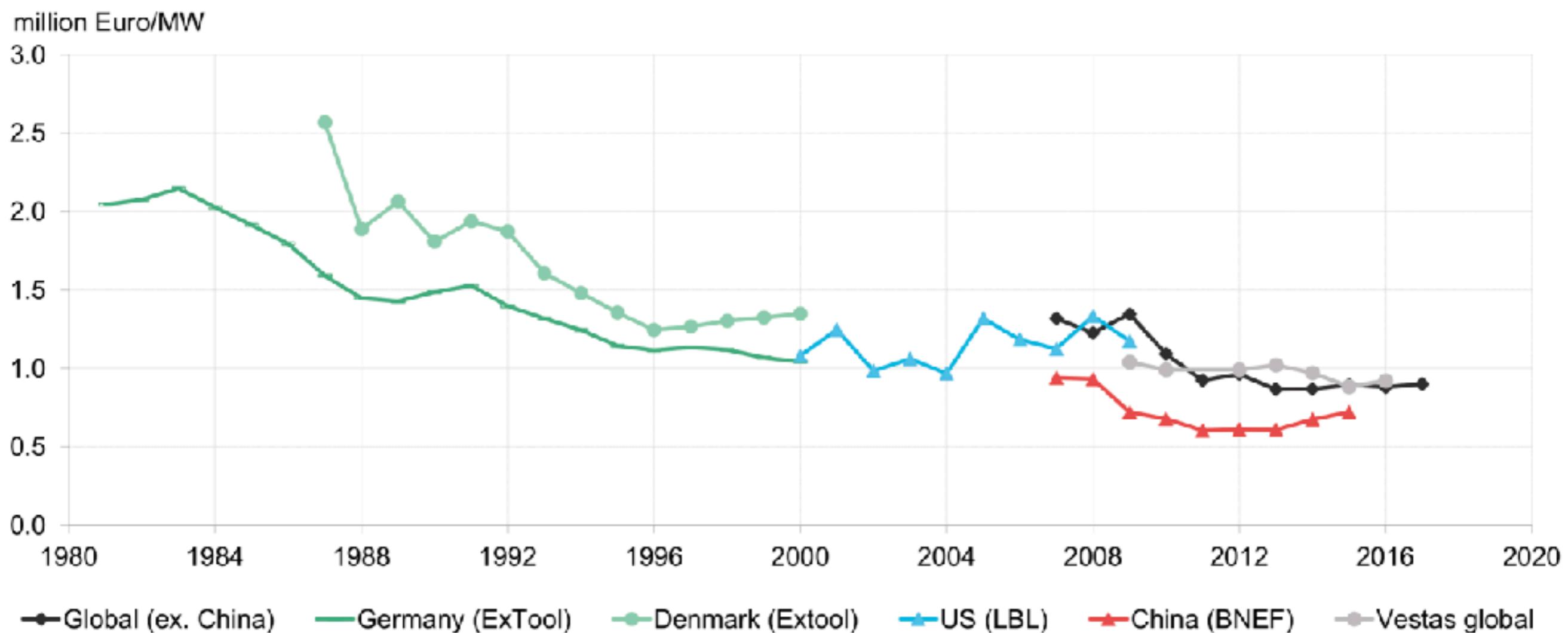
Source: Bloomberg New Energy Finance

Source: Bloomberg New Energy Finance

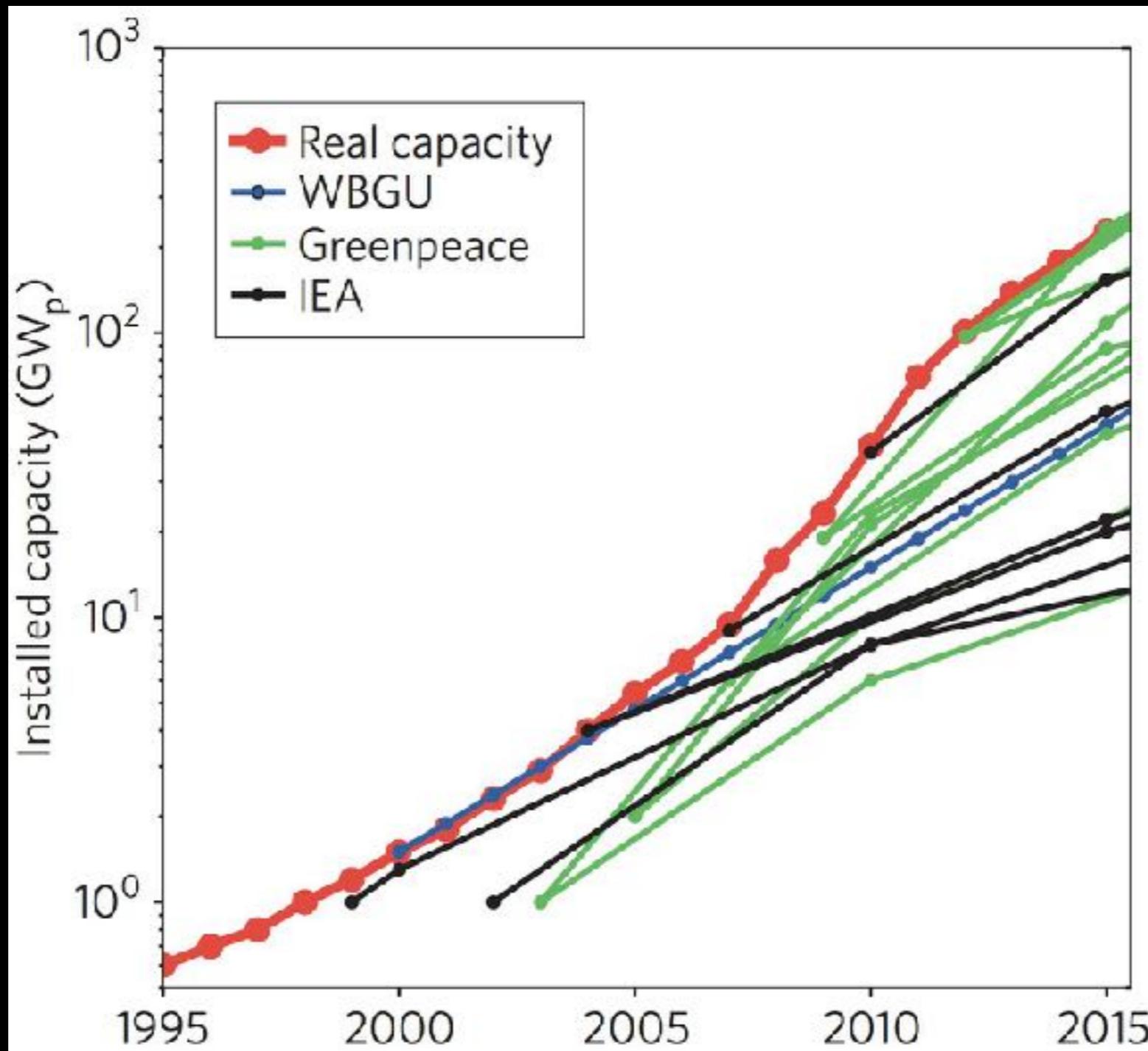
# Why bet on renewables?

## Solar technology is getting cheaper, faster

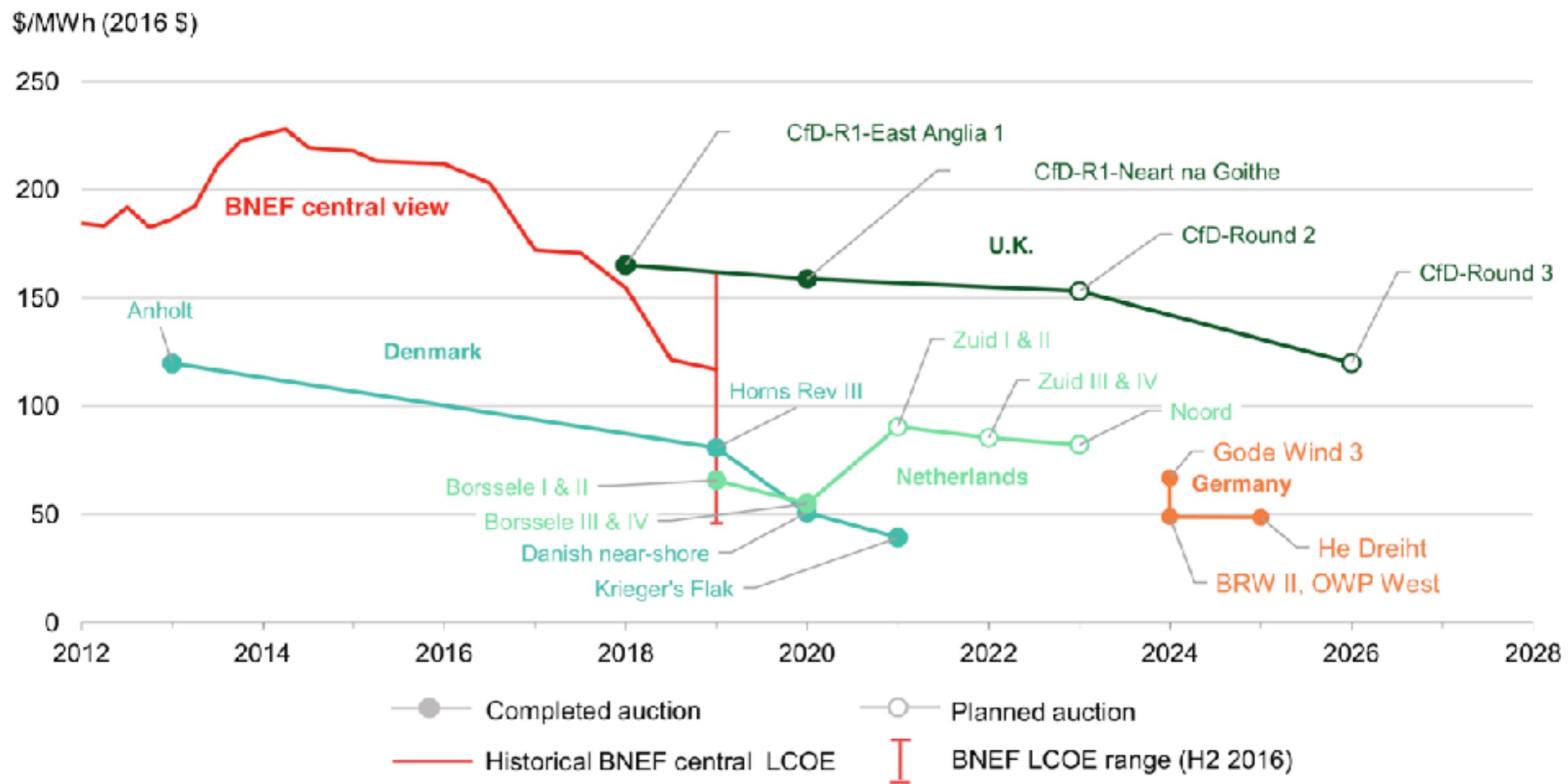


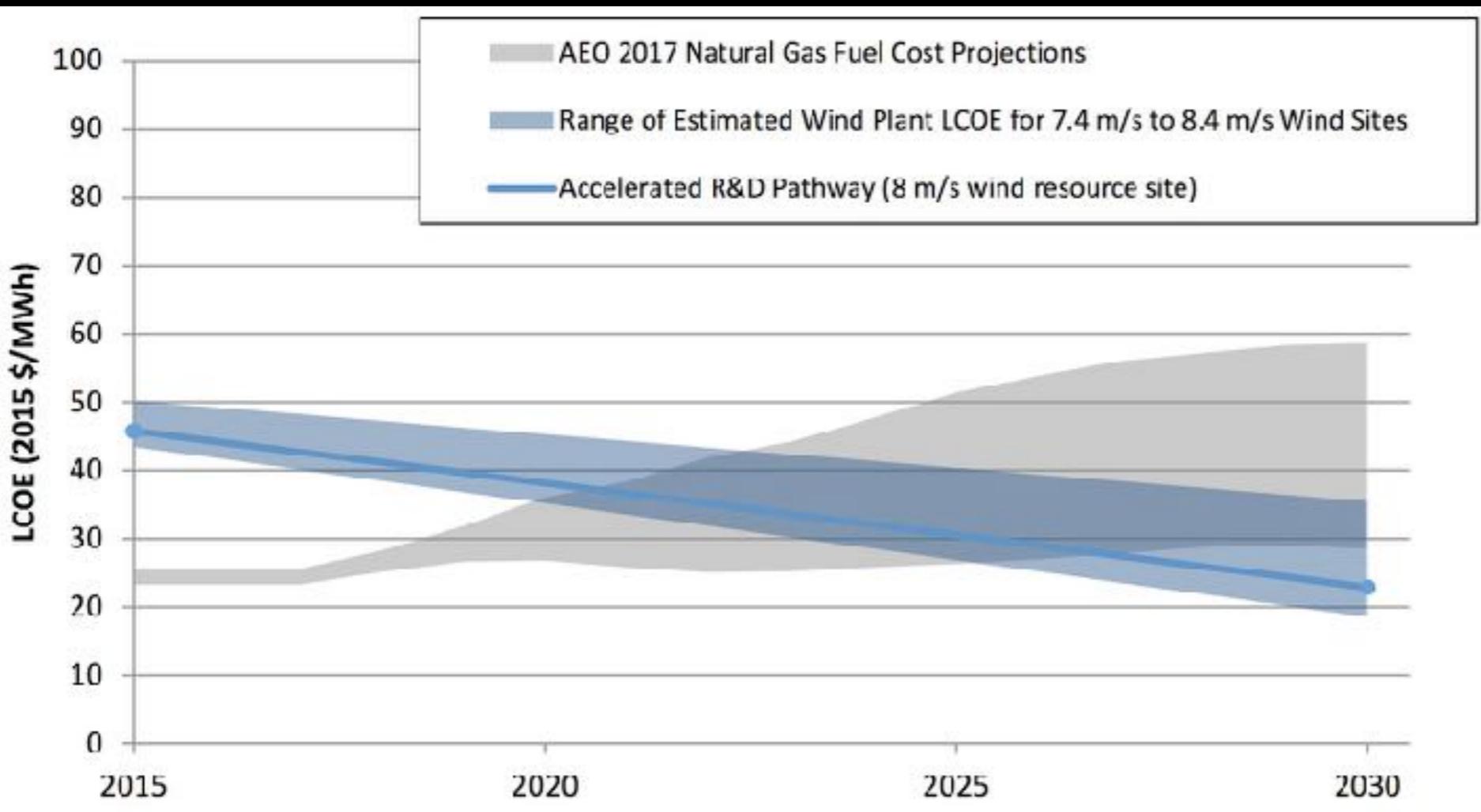


# We have consistently been wrong



# Installed Wind Capacity

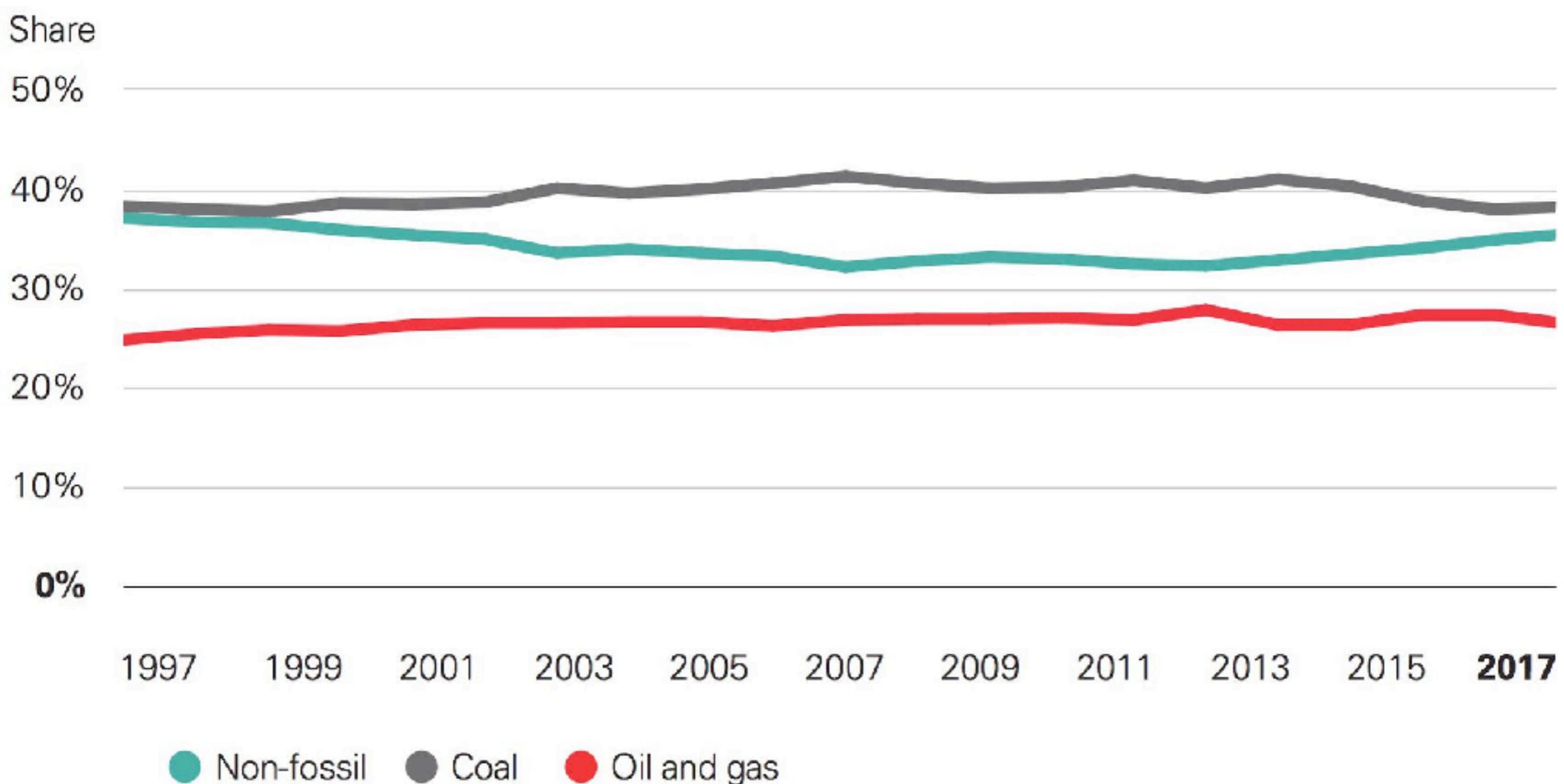




**Figure 8. Projected costs for the SMART wind power plant at a range of different wind resource sites using the accelerated R&D pathway relative to future natural gas prices**

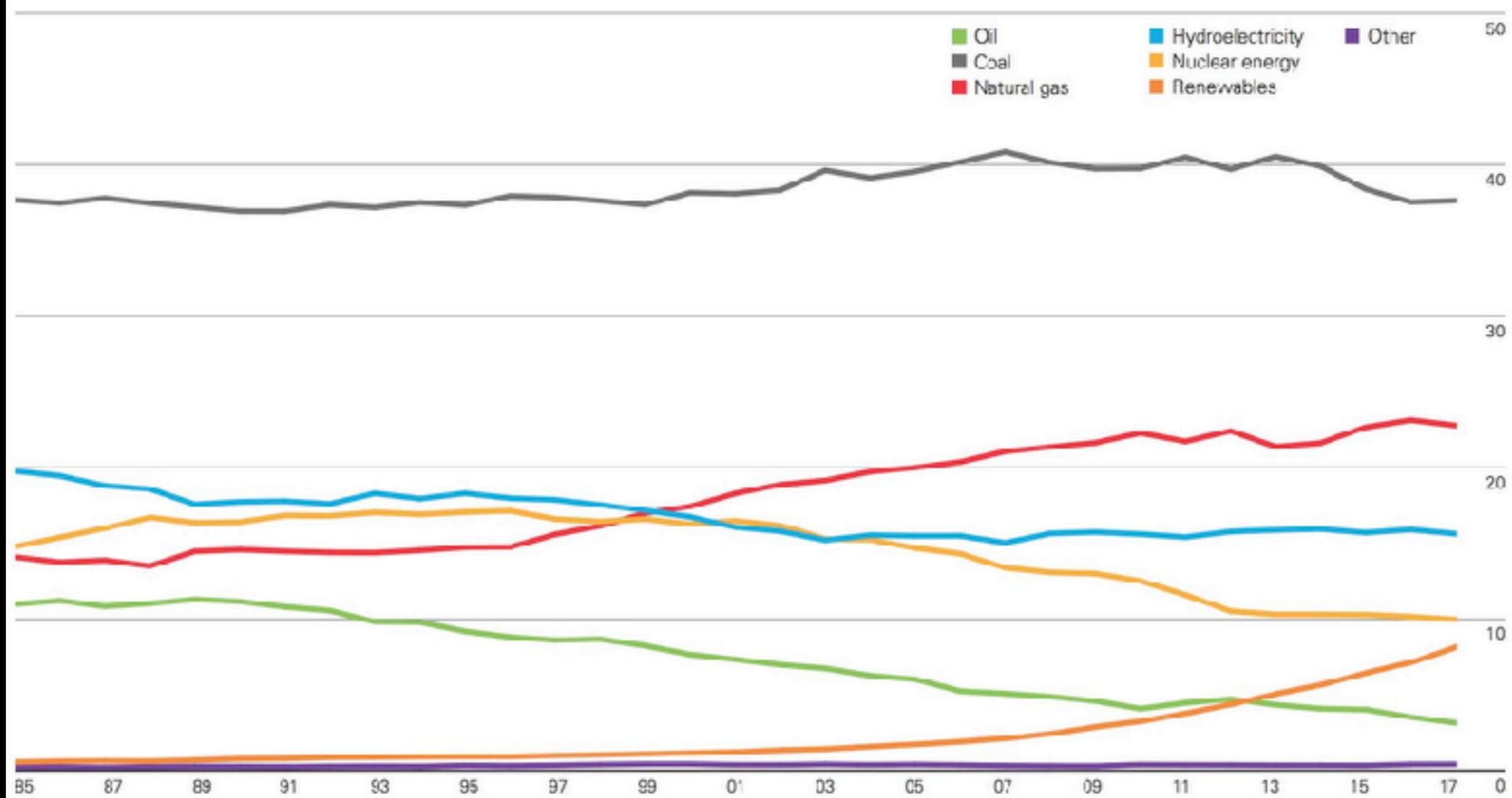
Learning  
Policy Support  
Bullish on  
Other Renewable

## Fuel shares in power generation



## Share of global electricity generation by fuel

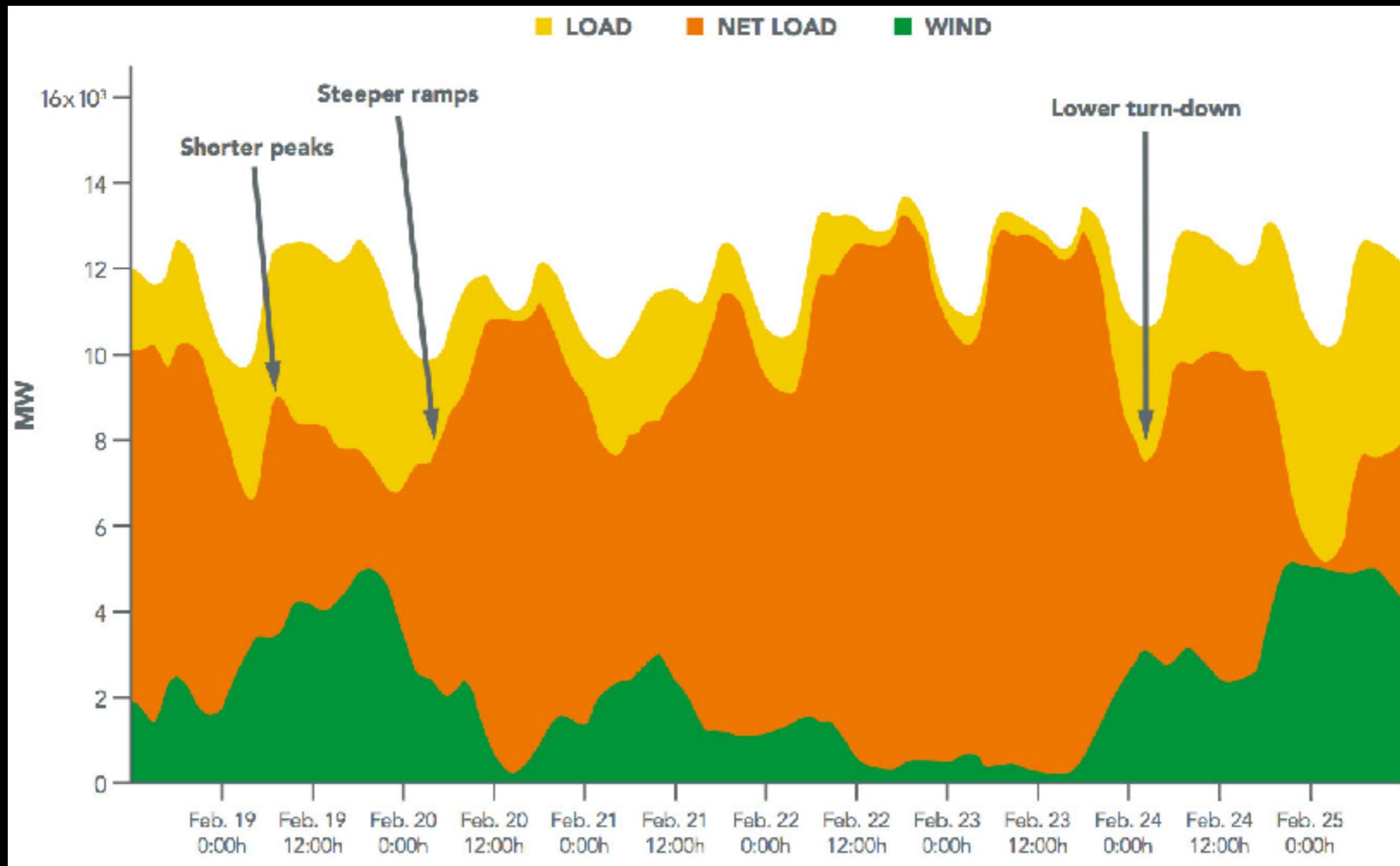
Percentage



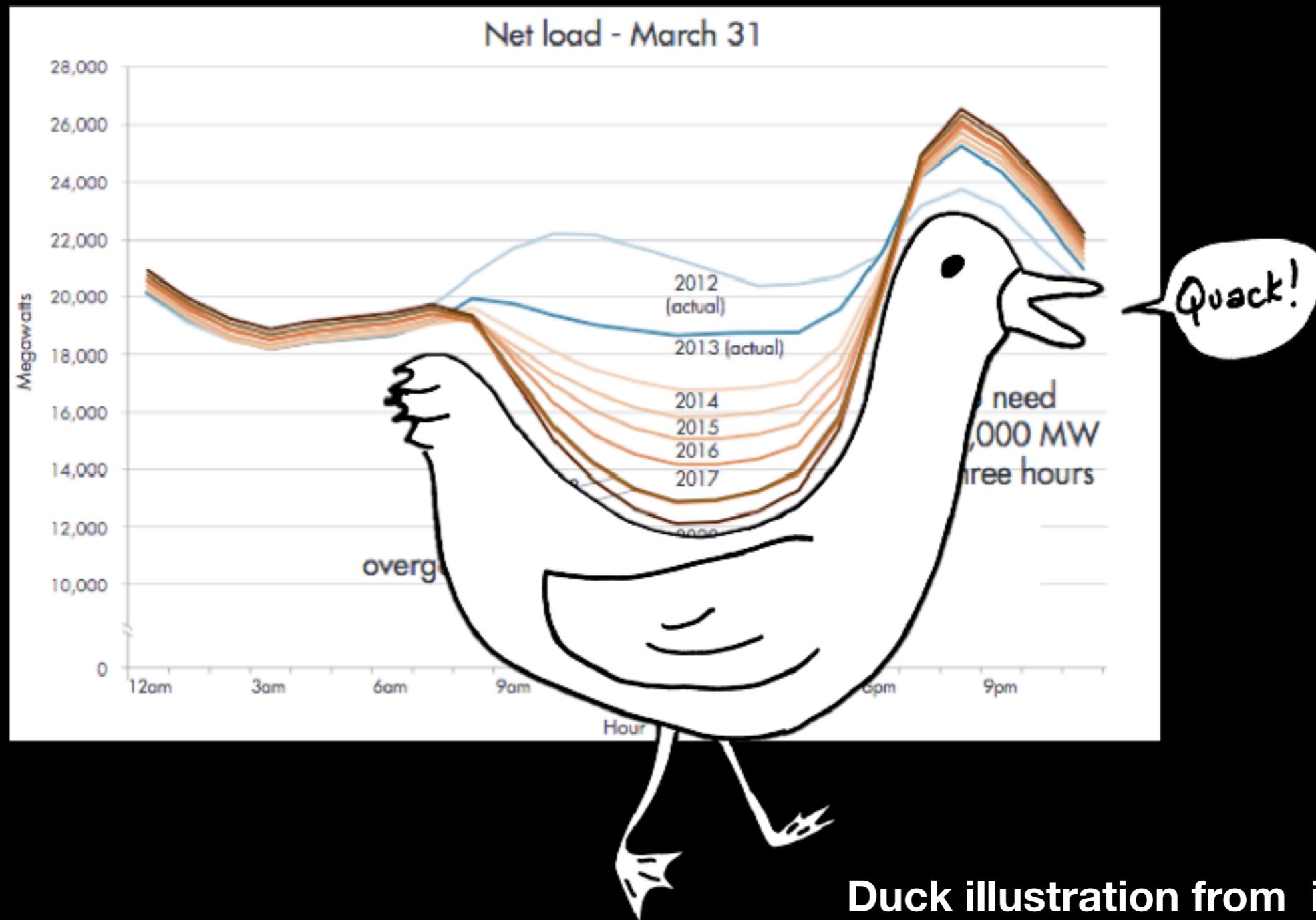


## 2) The Storage Problem

# Variability

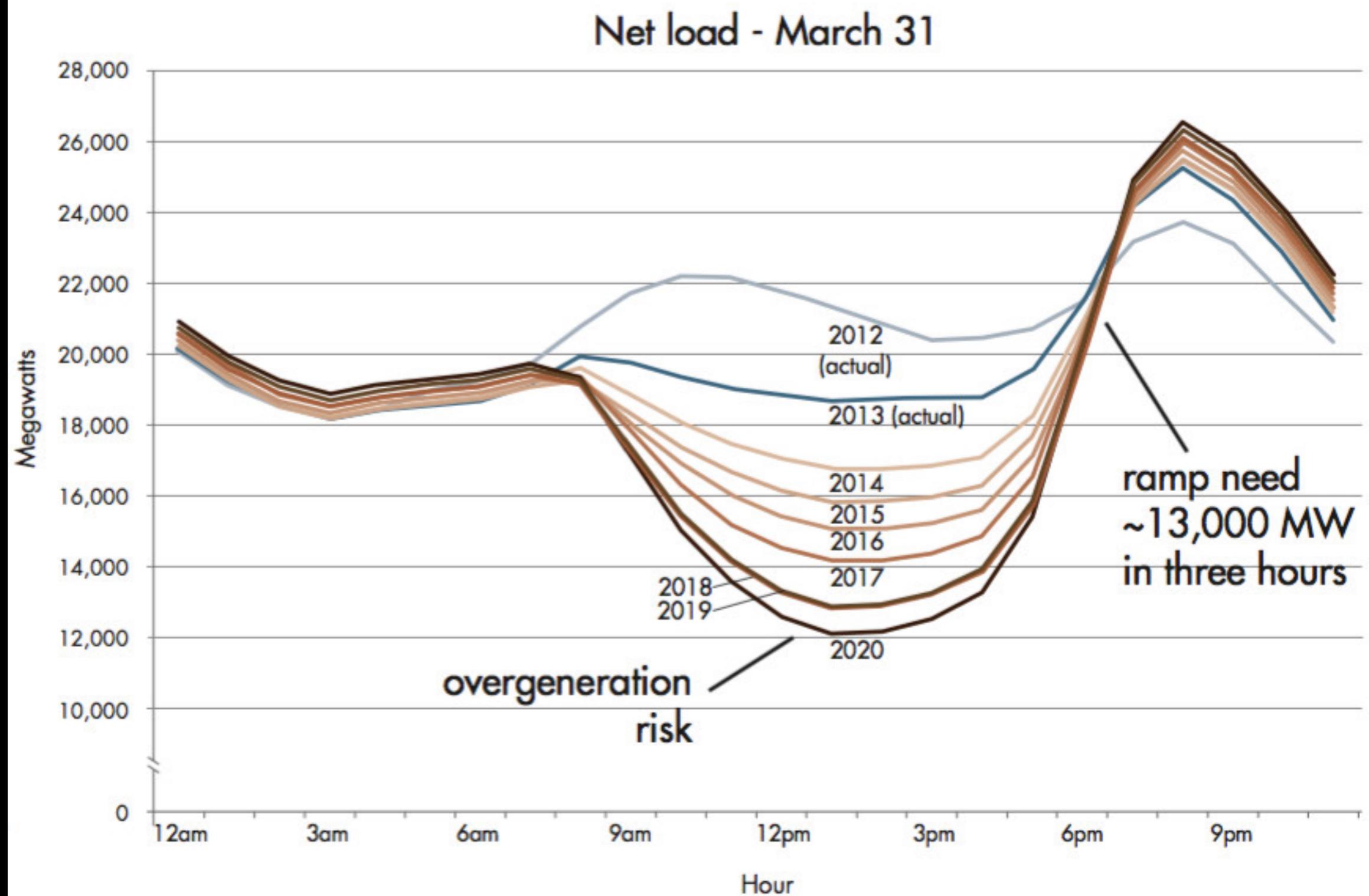


# Ducks?



California Independent Systems Operators

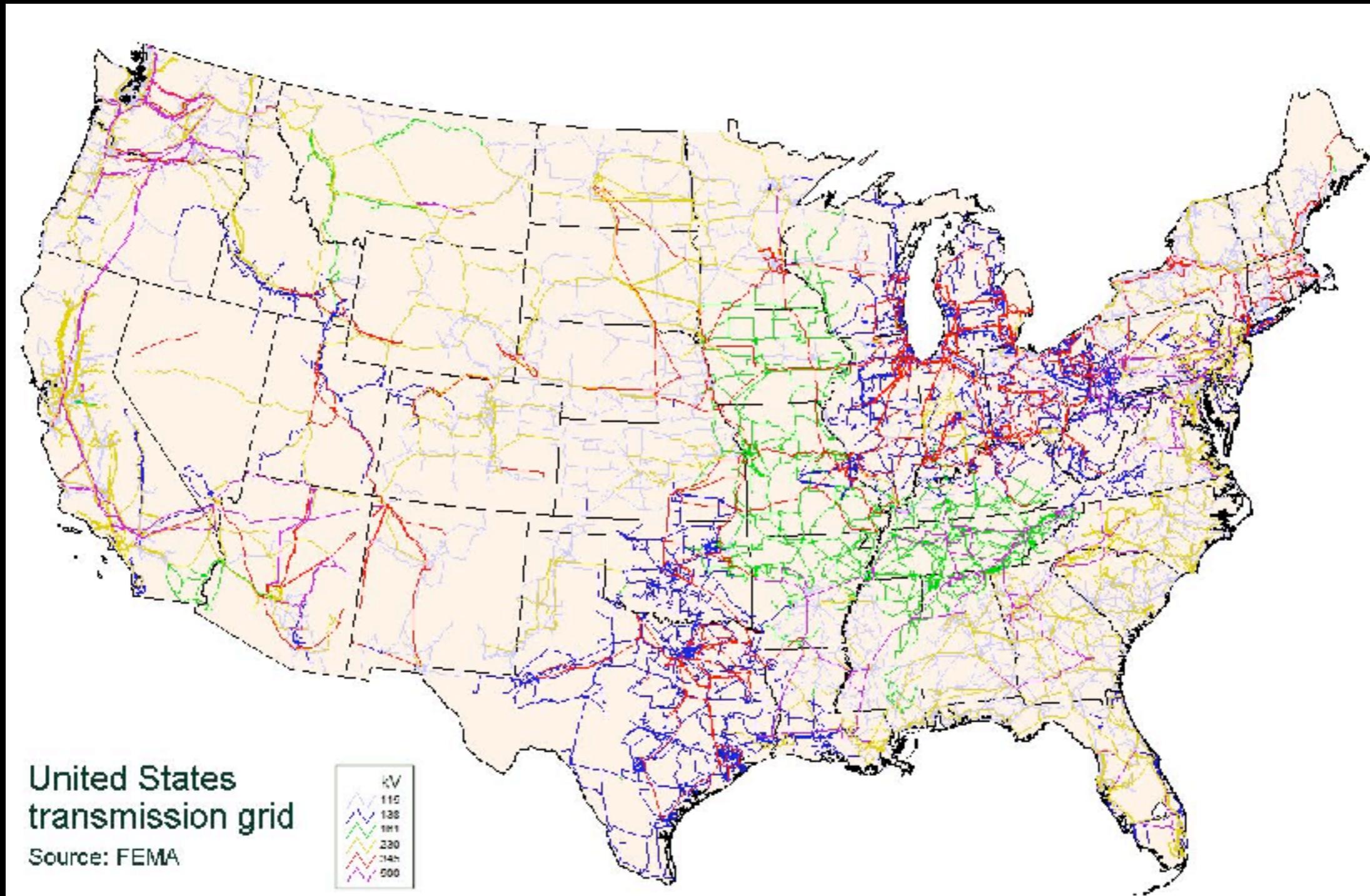
**Figure 2: The duck curve shows steep ramping needs and overgeneration risk**



# Other Issues

- Predictability
- Synchronous Generation
- Location, location, location
- Resistance to collaboration and flexibility



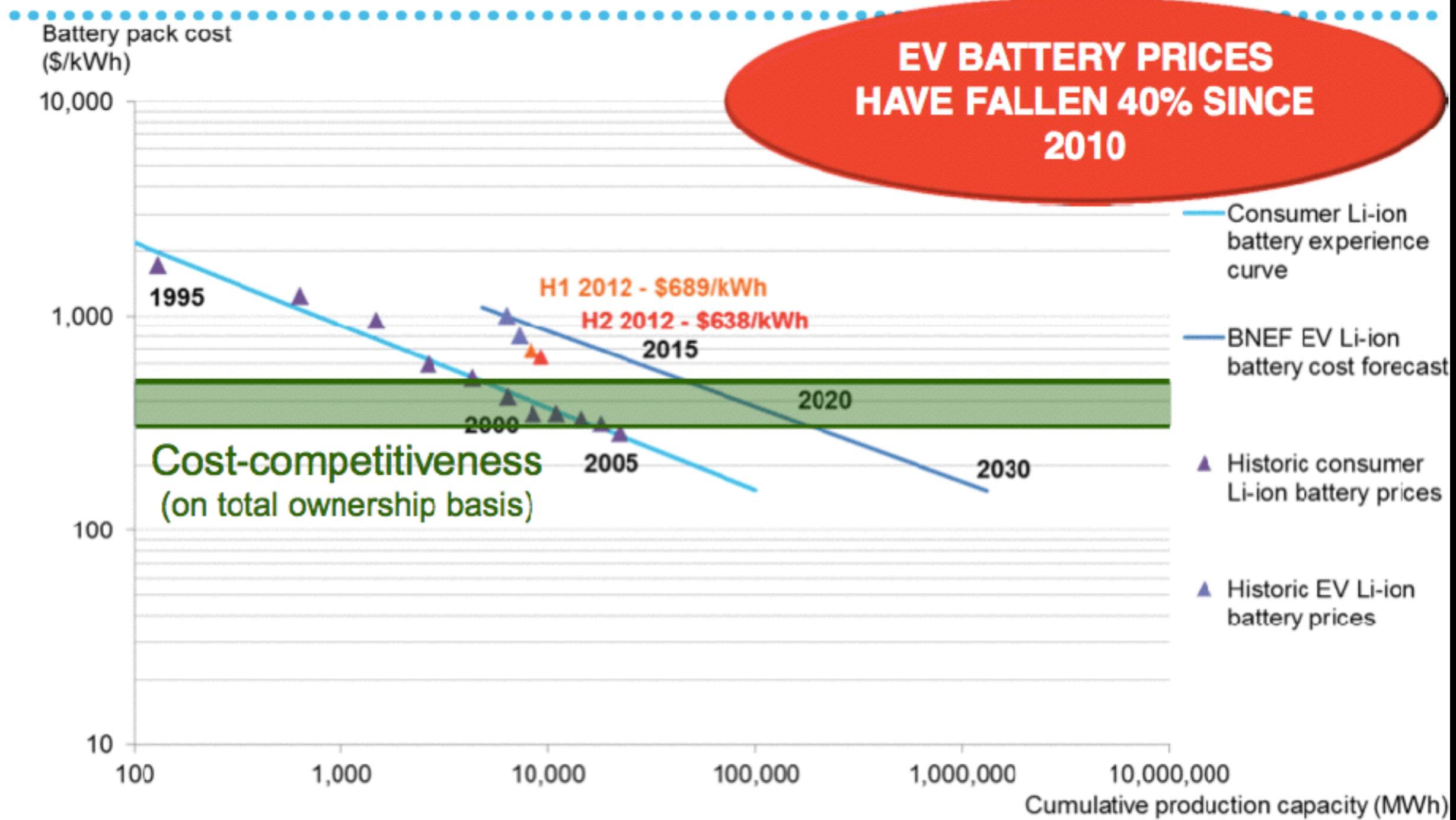


# PICK 2

# Batteries?

- Dense
- Cheap
- High Power Output
- Durability

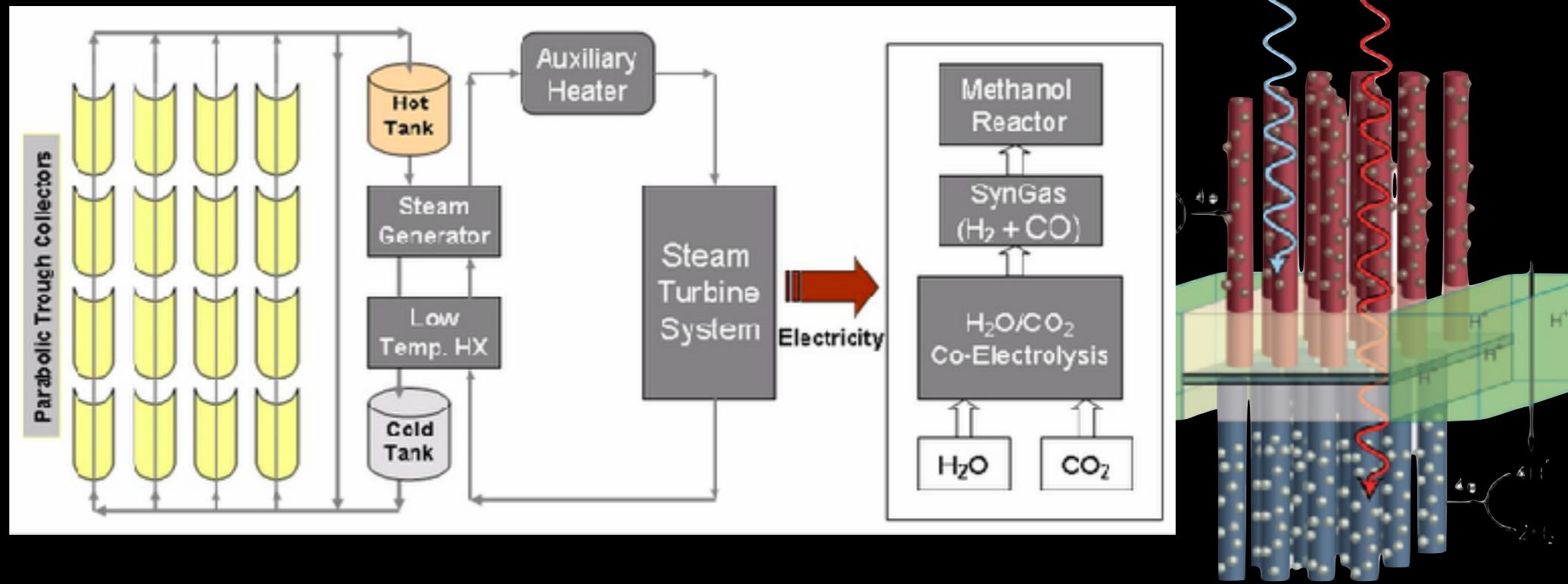
# LITHIUM-ION BATTERY EXPERIENCE CURVE



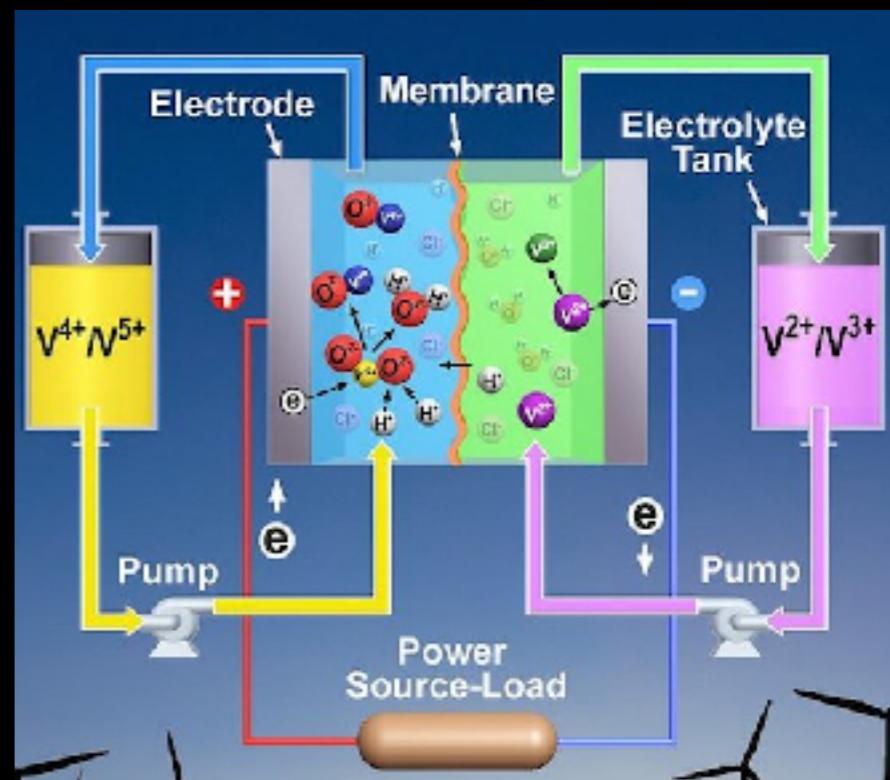
Source: Battery University, MIIT, IIT, Bloomberg New Energy Finance

# Other Ideas

## Solar Fuels



Artificial  
Photosynthesis



Flow Batteries



**Vanadium Flow Battery Juices Onion Plant**  
<http://www.powermag.com/vanadium-flow-battery-juices-onion-plant/>

