



economics<sub>for</sub>  
energy

# Where is the energy sector heading? Looking at the future

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## Why look at the future?

*...for strictly logical reasons, it is impossible for us to predict the future course of history.*

*Sir Karl R. Popper*

*We don't predict the future, we prepare for it*  
*Pericles (or somebody)*

# Many possible futures



# Many possible futures



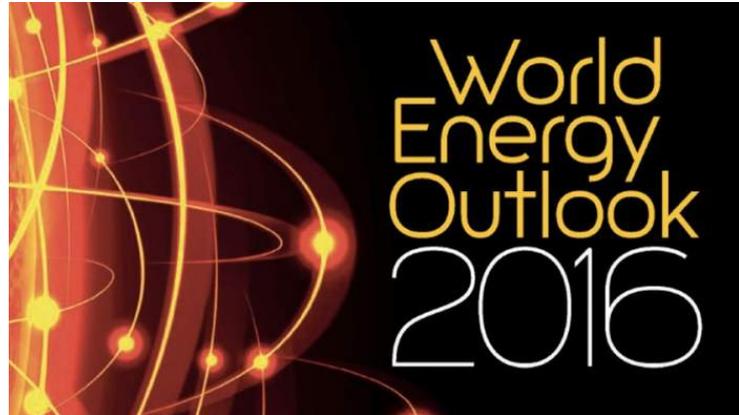
# Many possible futures



# Many possible futures



Many studies



CERA

GREENPEACE

Bloomberg New Energy Finance

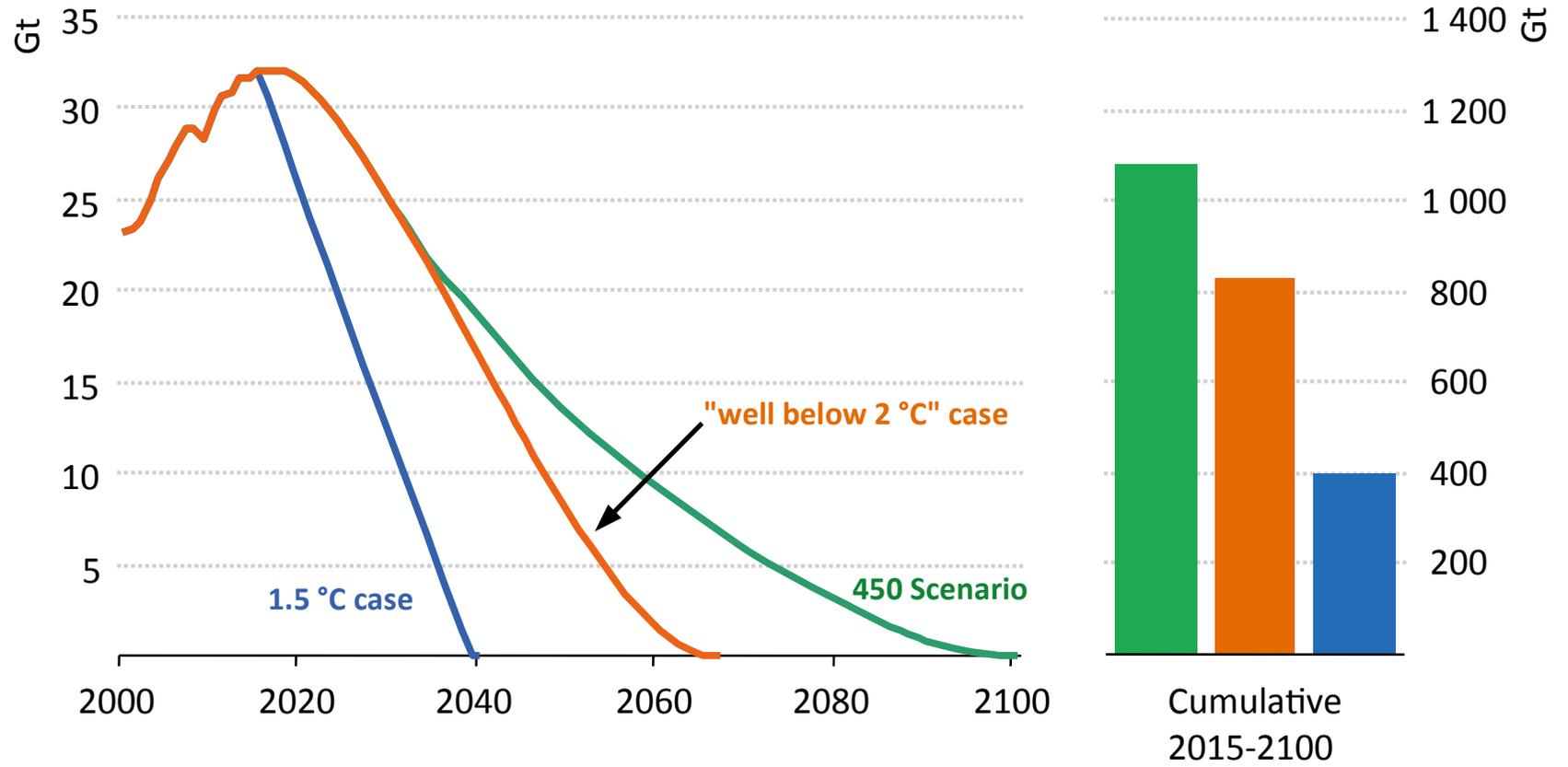




## Normative vs Positive

- Where is the energy sector going?
- Where do we want it to go?

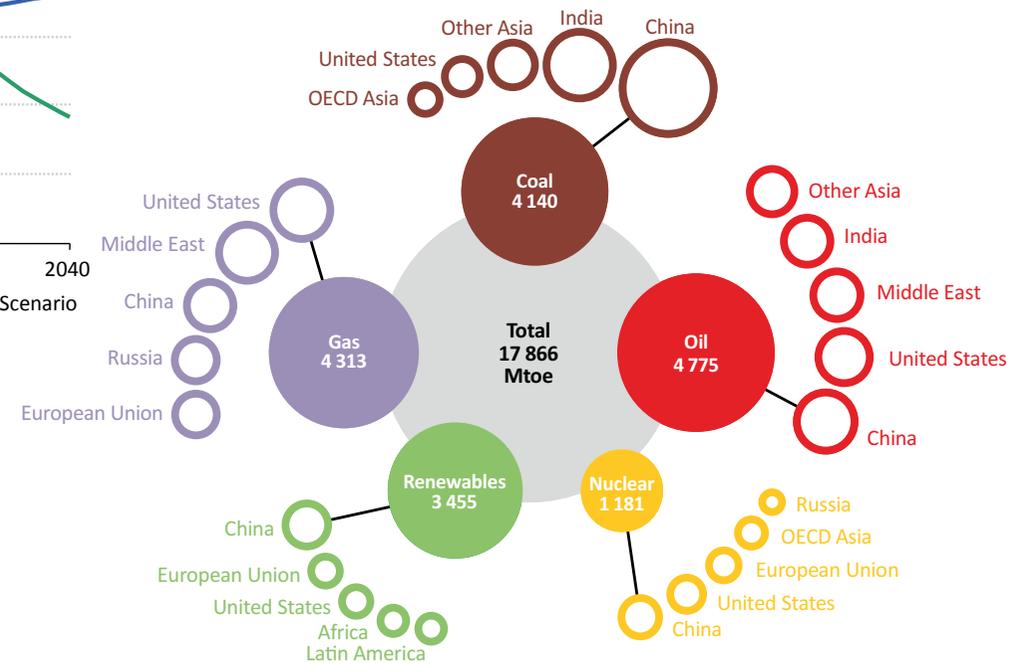
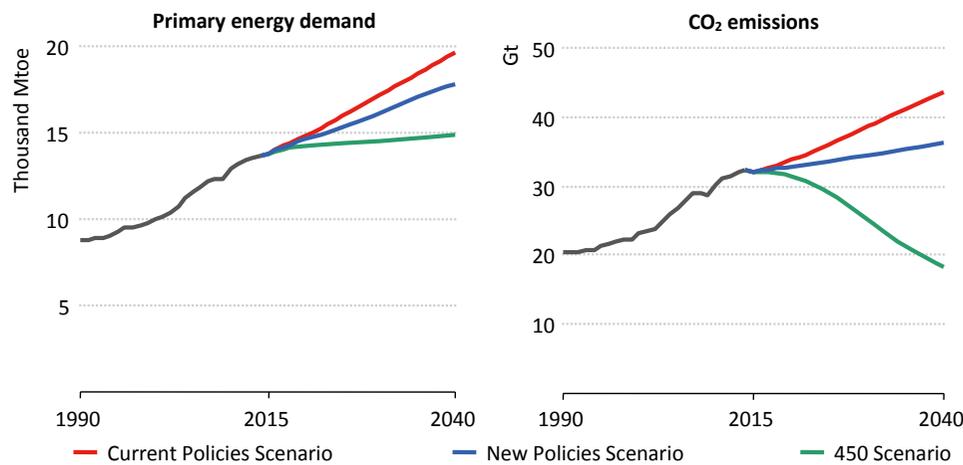
# Deep decarbonization



**Without net-negative emissions, energy sector CO<sub>2</sub> emissions fall to zero by 2040 for a 50% chance of 1.5 °C and around 2060 for a 66% chance of 2 °C**

# IEA WEO

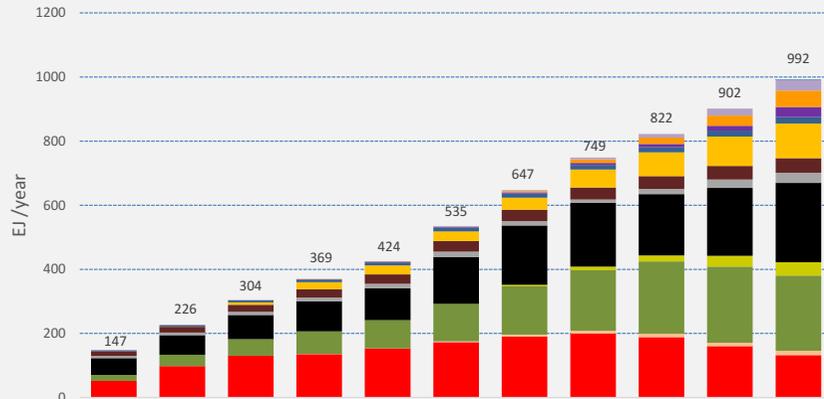
- Large investment needs to keep supply flowing, even more to decarbonize
- The Paris goal (1.5°C) is almost unachievable



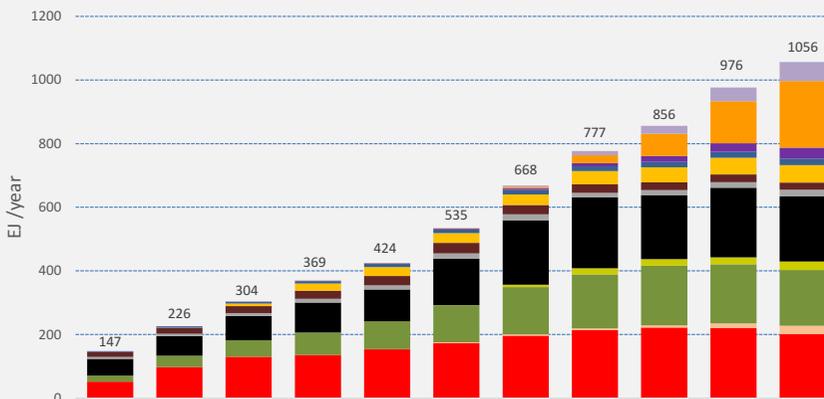


# Shell

Mountains - Total Primary Energy By Source

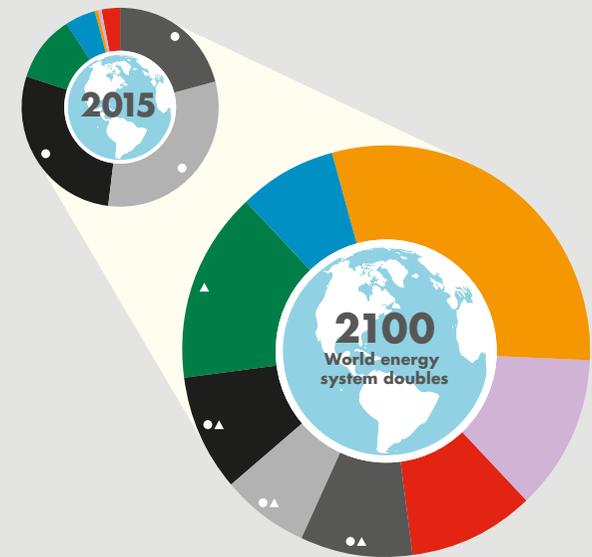


Oceans - Total Primary Energy By Source



- Oil
- Biomass/Waste Solids
- Biomass Traditional
- Biomass Gasified
- Coal
- Biofuels
- Nuclear
- Hydro-electricity
- Geothermal
- Natural gas
- Solar
- Wind
- Other renewables

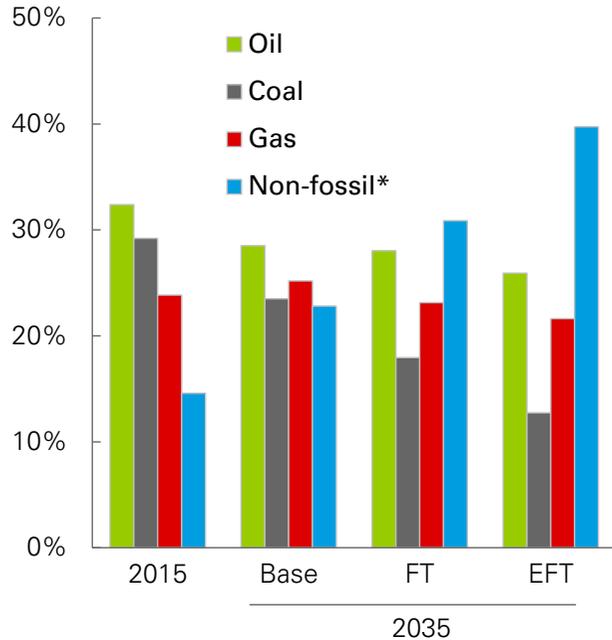
## Plausible energy mix in an emerging net-zero emissions world



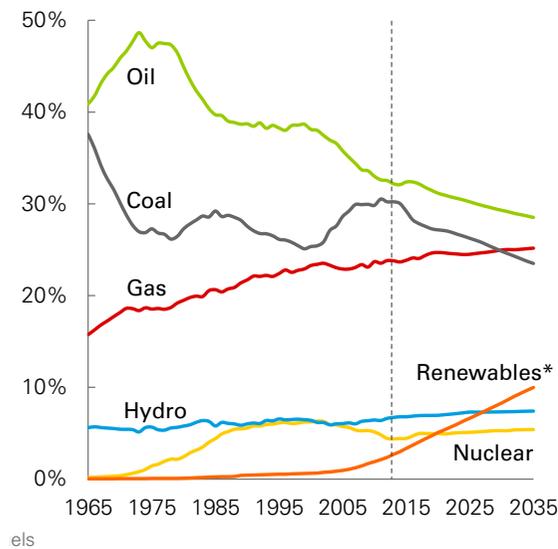
- Fossil
  - ▲ With CCS
  - Approximately 50–60% electrification of end use.
- |     |     |      |           |         |       |      |       |
|-----|-----|------|-----------|---------|-------|------|-------|
| GAS | OIL | COAL | BIOENERGY | NUCLEAR | SOLAR | WIND | OTHER |
|-----|-----|------|-----------|---------|-------|------|-------|

# BP Outlook

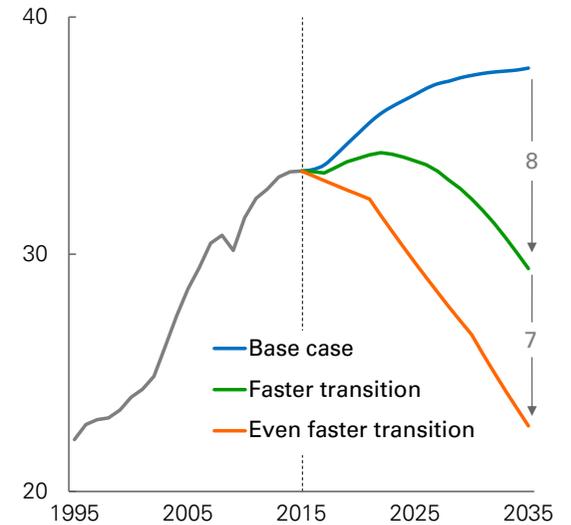
% of primary energy



Shares of primary energy



Billion tonnes CO<sub>2</sub>



- Global resource abundance
- Increased car ownership – but electric cars remain anecdotal
- Oil demand for cars keeps growing
- Resources are not the problem
- Demand revised down, RES revised up

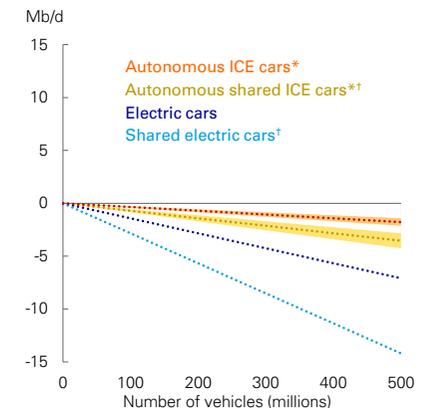
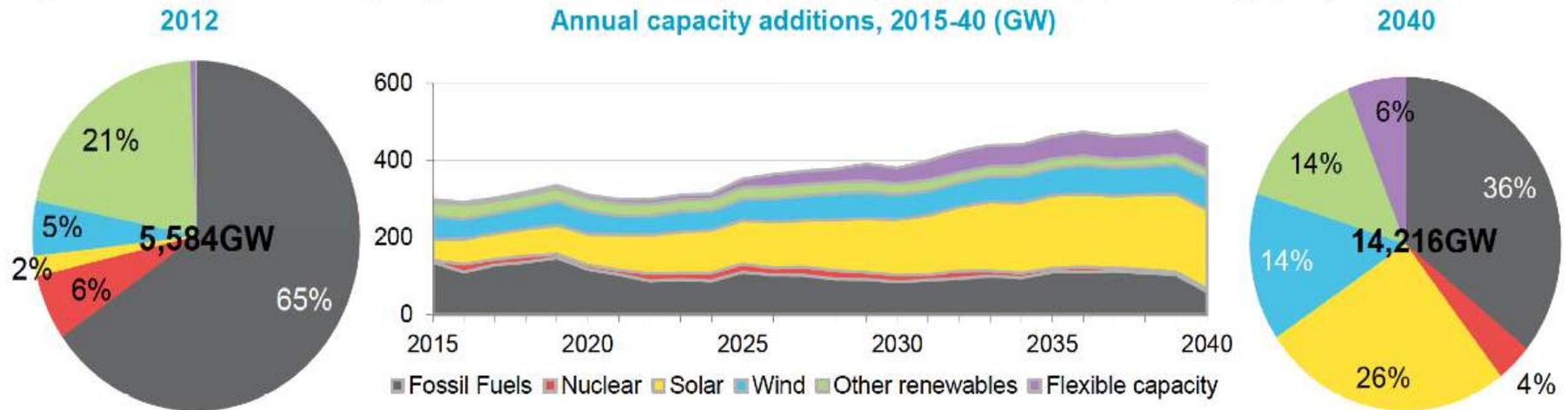


Figure 1: Global installed capacity in 2012 and 2040 and projected capacity additions, by technology (GW)



Source: Bloomberg New Energy Finance. Note: Flexible capacity includes power storage, demand response, and other potential resources.

- Renewables rule
- Thanks to technological development
- Decentralized in developed countries, centralized in developing ones

# Large differences in building blocks

	Faster transition	Even faster transition	IEA 450	MIT 2° Base	IHS Markit 'Solar Efficiency'	Greenpeace 'Revolution'
<b>CAGR (%)* 2015-2035</b>						
Carbon emissions	-0.7%	-2.0%	-2.0%	-2.0%	-2.8%	-3.2%
Total energy	0.9%	0.8%	0.4%	0.5%	-0.7%	-0.1%
Energy intensity	-2.4%	-2.5%	-3.0%	-2.9%	-4.0%	-3.5%
Carbon intensity	-1.5%	-2.7%	-2.3%	-2.5%	-2.1%	-3.5%
<b>Share of total energy, 2035</b>						
Oil & gas	51%	48%	48%	46%	51%	39%
Renewables†	16%	23%	17%	29%	19%	38%
<b>Share of abatement vs. 2015</b>						
Power sector	>100%	89%	77%	74%	58%	35%

# Large differences among regions





## Common themes

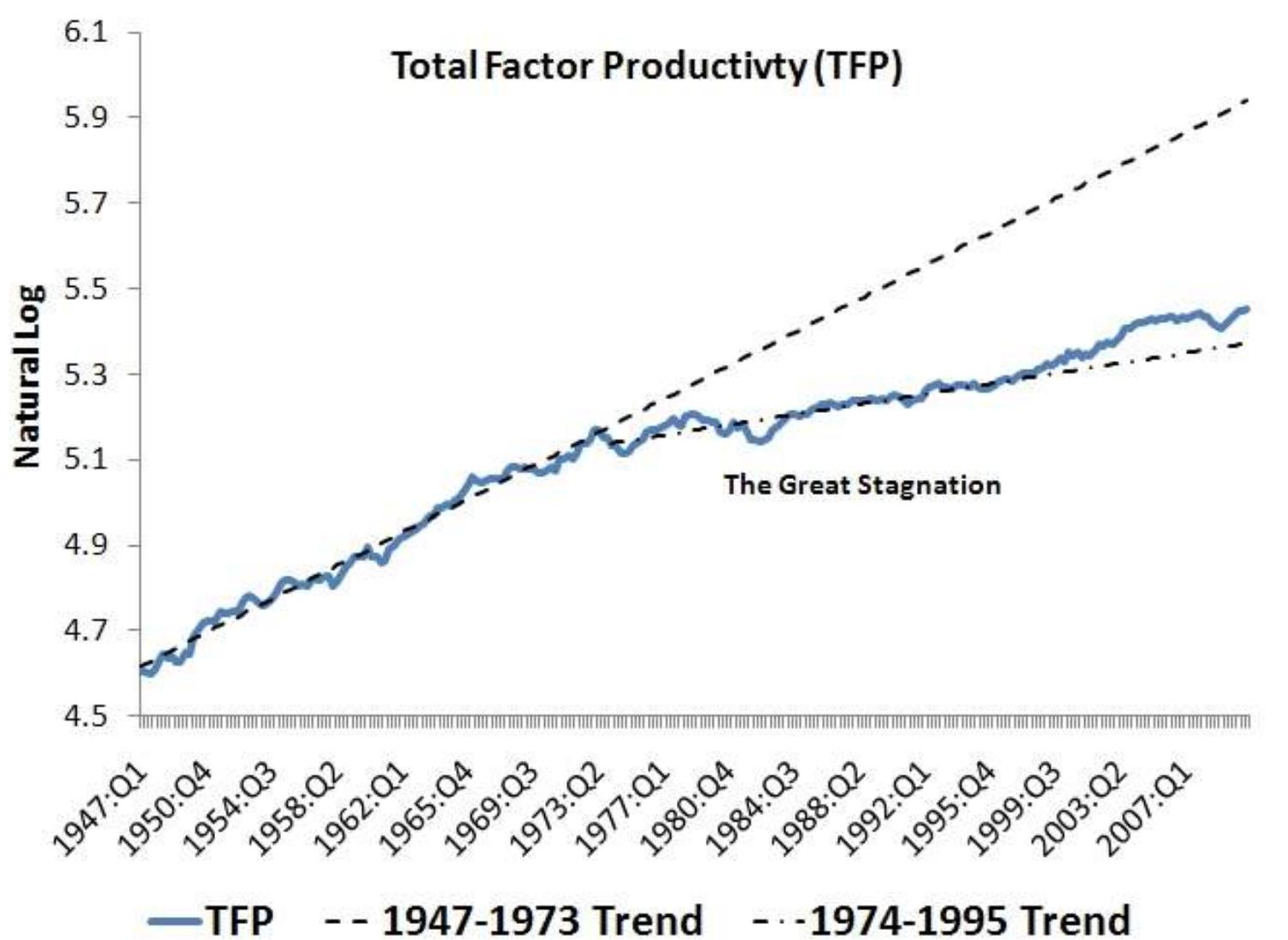
- The economy grows fast (3-4% pa)
- Energy demand continues growing (30-35% by 2040)
  - In non-OCDE countries
- Electricity grows faster
- Fossils maintain their rule
  - Decarbonization is not fast enough
  - Increasing role of gas and renewables
    - Renewables increase due to technological advances
  - But climate goals cannot be achieved
- Geopolitical changes



## Neglected (?) scenarios

- Secular stagnation
- Fossil abundance
- The impact of distributed generation

# Secular stagnation



# Fossil abundance



Not only Carbon Capture



BUT Storage

# Distributed generation





## Some points for discussion

- Many scenarios are plausible
  - But demand growth is critical
- Gas vs Coal: Leaks and atmospheric emissions
- Electrification seems the cheaper way
- The role of nuclear
- Transport: NatGas vs Biofuels vs Electricity
- Do we need more storage?



## And some additional questions

- How to deal with bridge technologies (and the associated infrastructure)?
- How to deal with networks (and their fixed costs)?
- Markets vs Regulation?

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Thanks for your attention

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