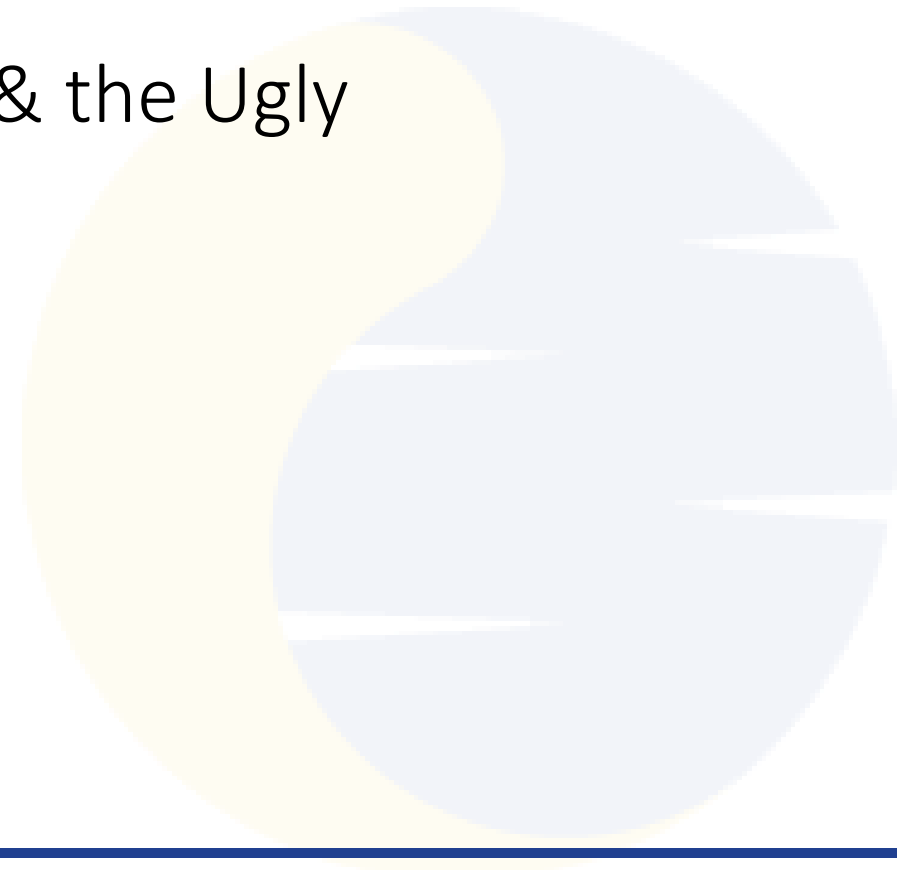


Session 2: The Energy Mix: the Good, the Bad & the Ugly

September 2019

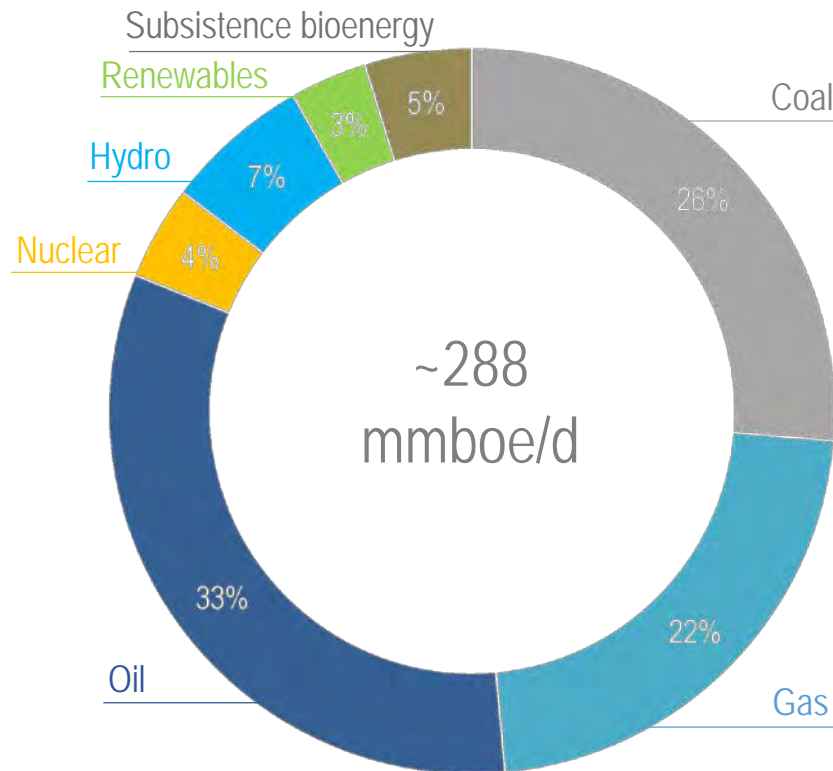
Badr Jafar – President, Crescent Petroleum



Access to affordable energy has driven huge advances in human prosperity

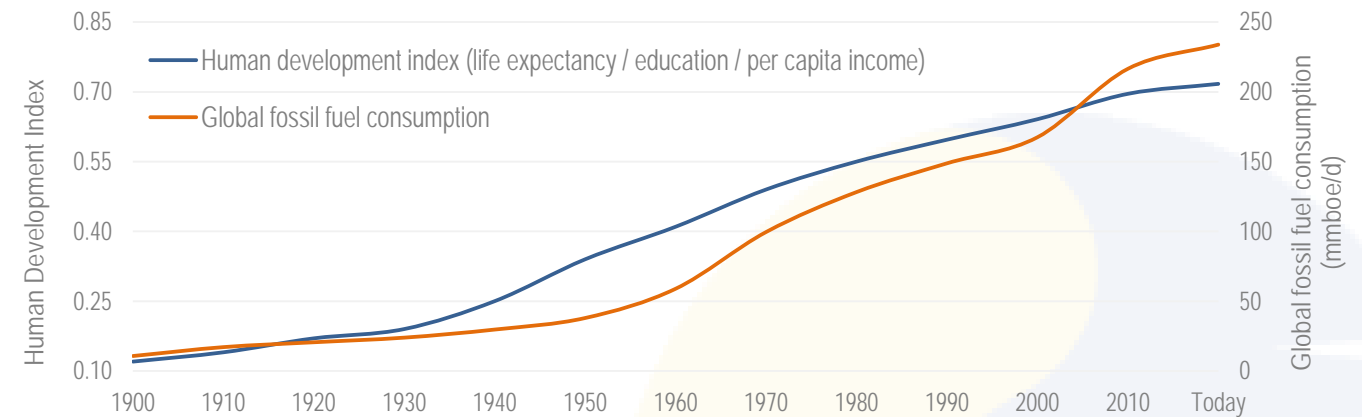
Hydrocarbons supply >80% of energy needs

2018 global primary energy demand by fuel



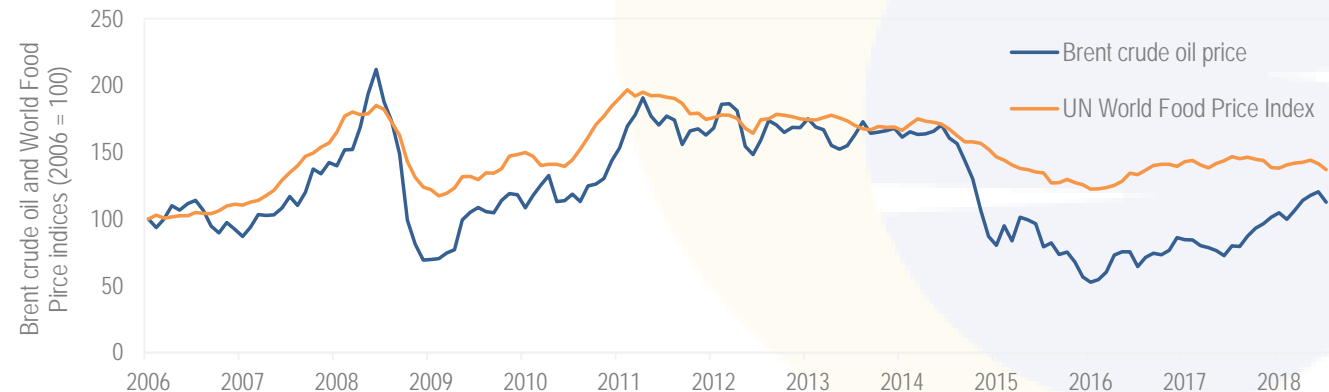
Abundant affordable energy has underpinned progress in the human condition

Global Human Development Index vs fossil fuel consumption



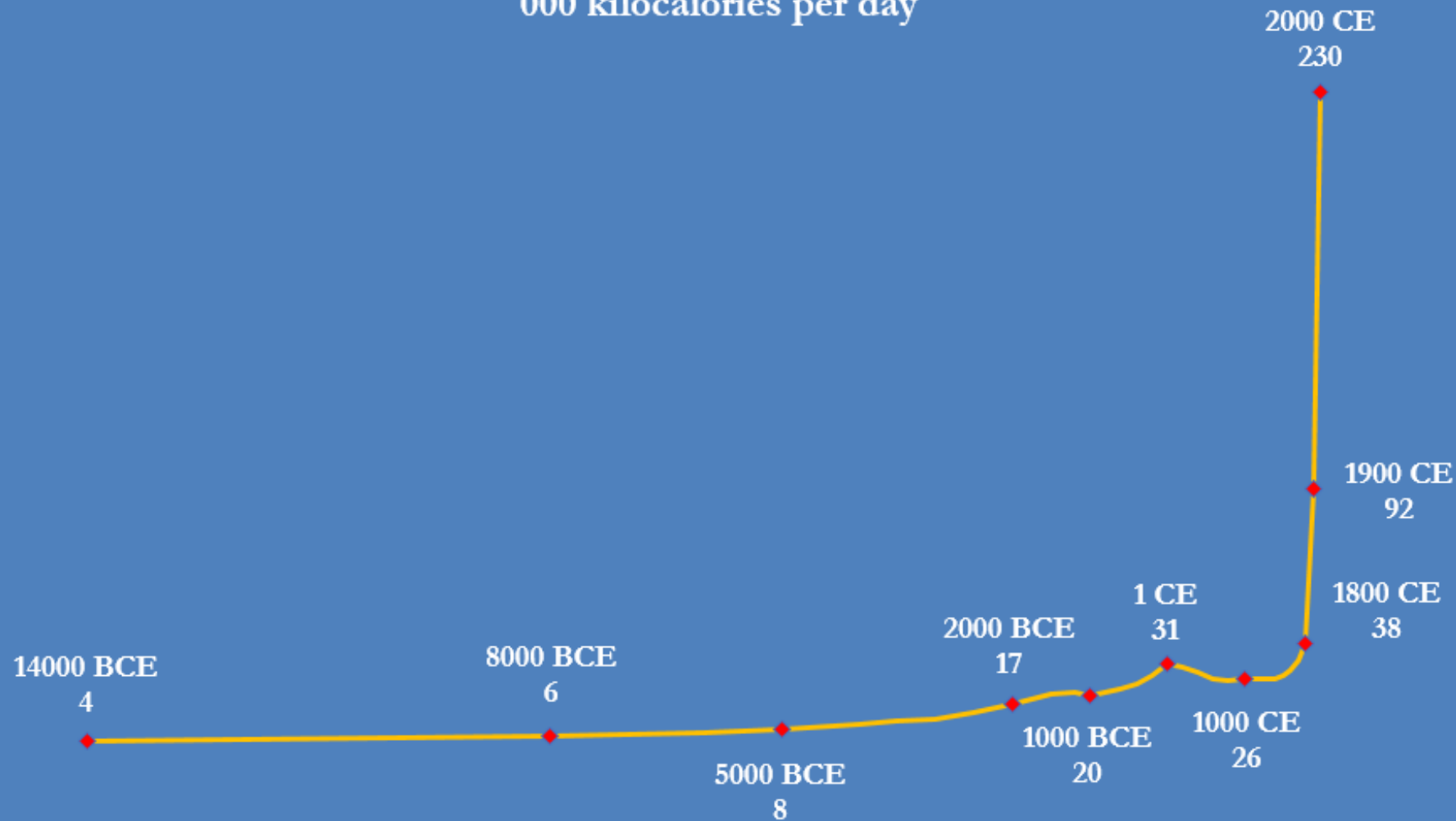
Affordable energy is especially important due to its inextricable link to food prices

The Brent crude oil price vs the UN World Food Index



Energy capture per person in the western core

000 kilocalories per day



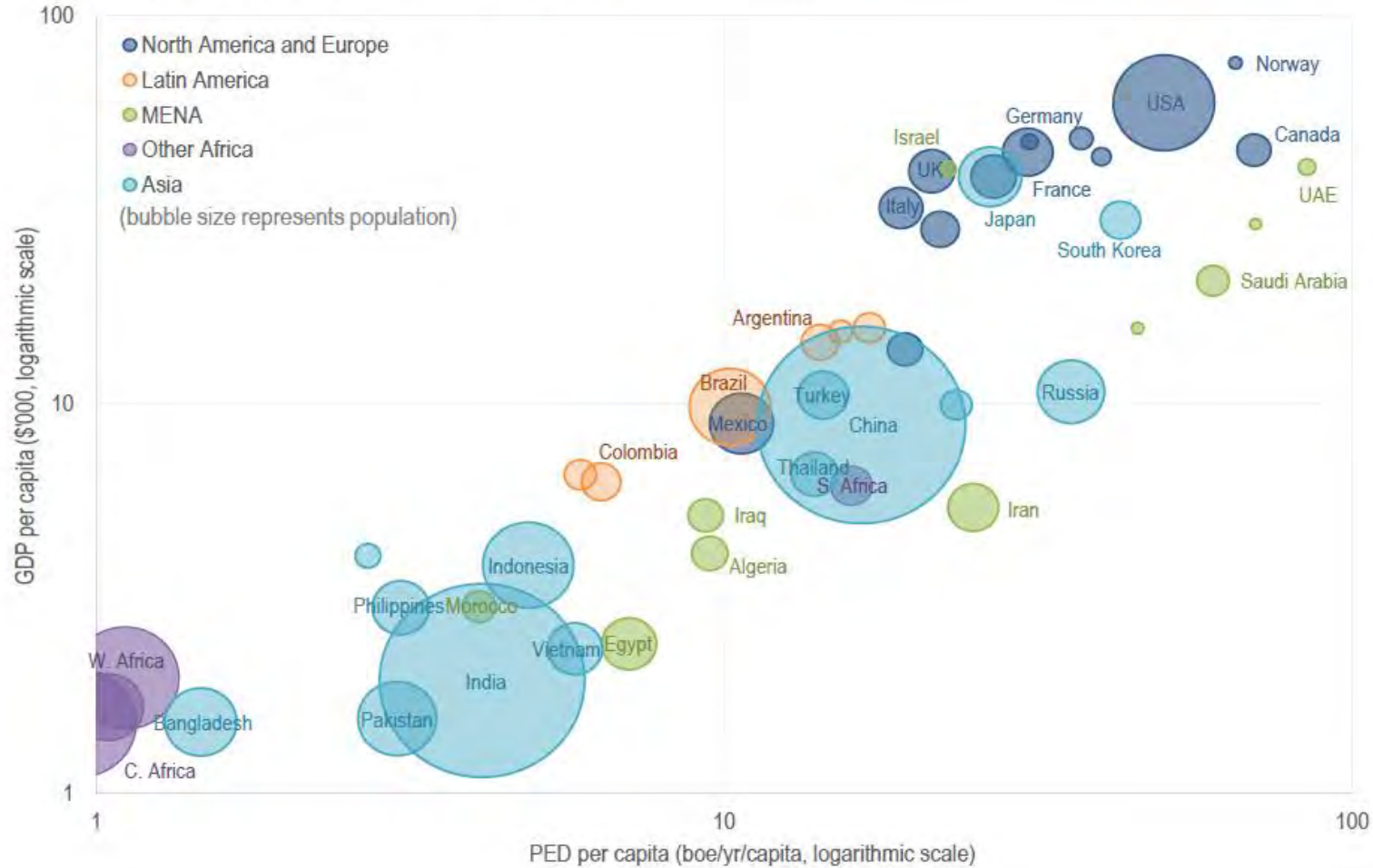
Energy capture includes energy used for food, animal feed, in the home, commerce, agriculture, industry and transport. Humans need a minimum of around 2,000 kcal per day just to survive



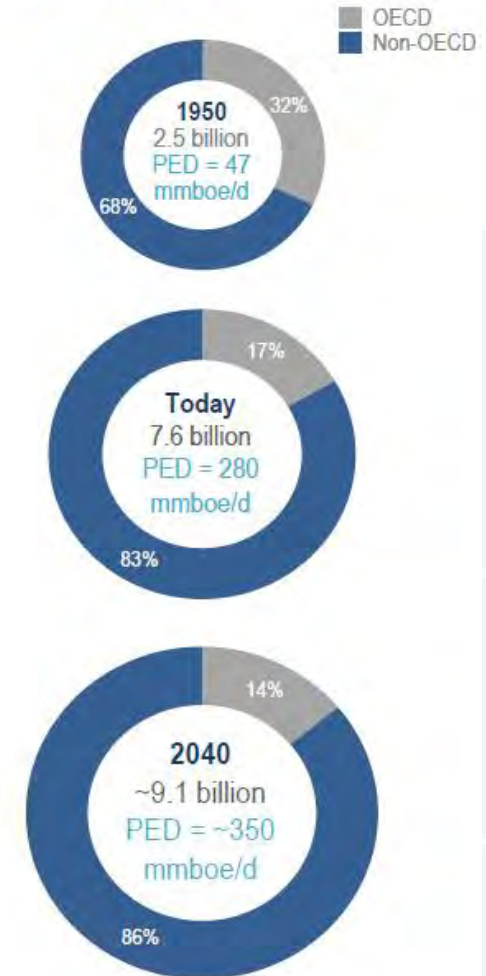
By some estimates, the world will demand 30% more energy by 2040 than it does today as developing economies with large populations become increasingly prosperous. Meeting the growing energy needs of billions seeking a better quality of life in non-OECD countries will be a giant challenge for the energy industry in the coming decades.

As people become wealthier, they consume more energy

Primary energy demand per capita vs GDP per capita of selected countries



Global population



However, our current energy mix is failing us with GHG emissions

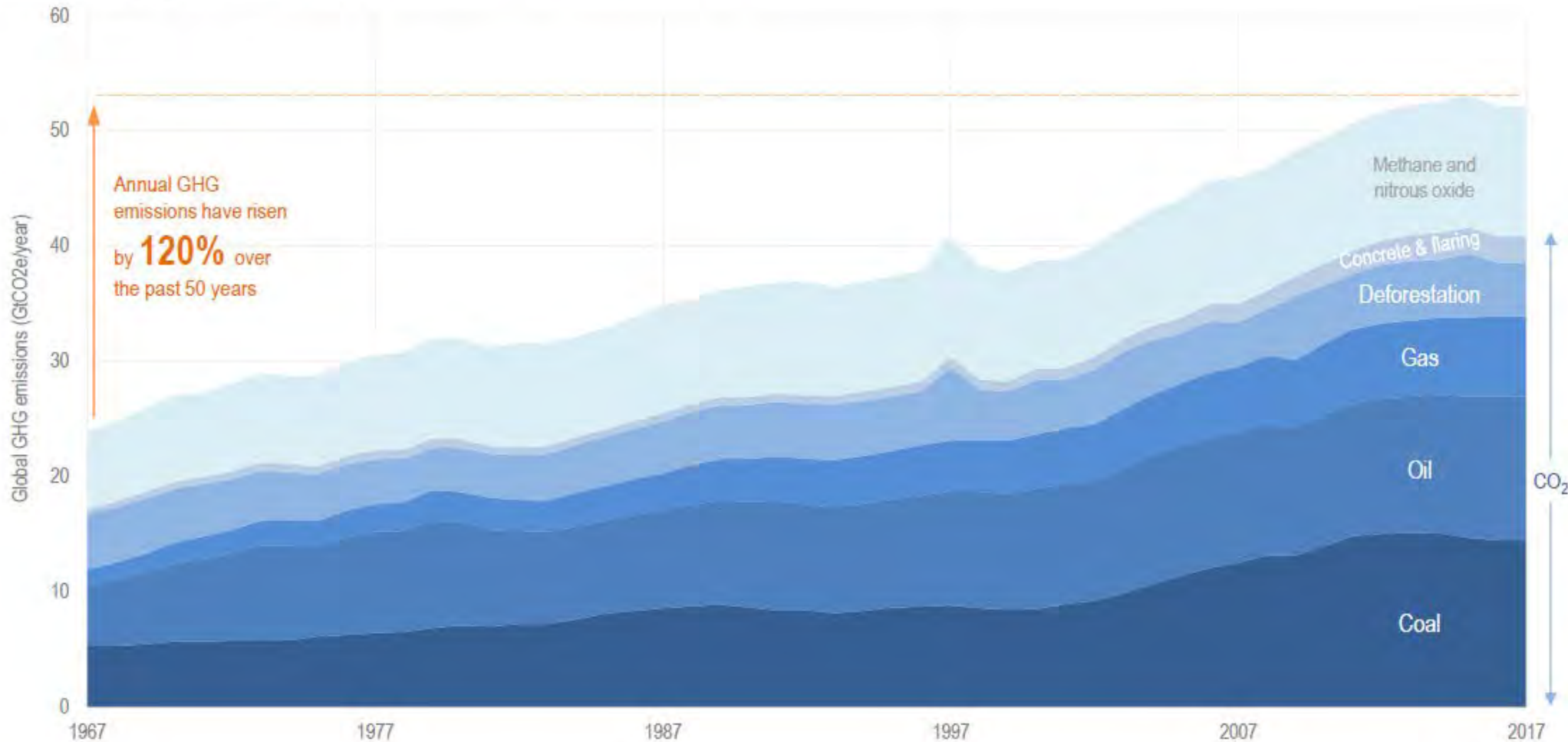


النسبة نفط الهلال
Crescent Petroleum

Global CO₂ emissions, the primary component of GHGs, have grown rapidly over the past 50 years, largely due to our surging demand for energy. The world has reached a critical juncture where immediate and effective action is required to reverse the trend of climbing emissions and the impact on global warming. Deforestation, as a major source of emissions, must also be rigorously addressed.

Fossil fuel use accounts for ~70% of global GHG emissions

Global greenhouse gas emissions (GtCO₂e)



GHG emissions reduction is a challenge for all industries and all consumers

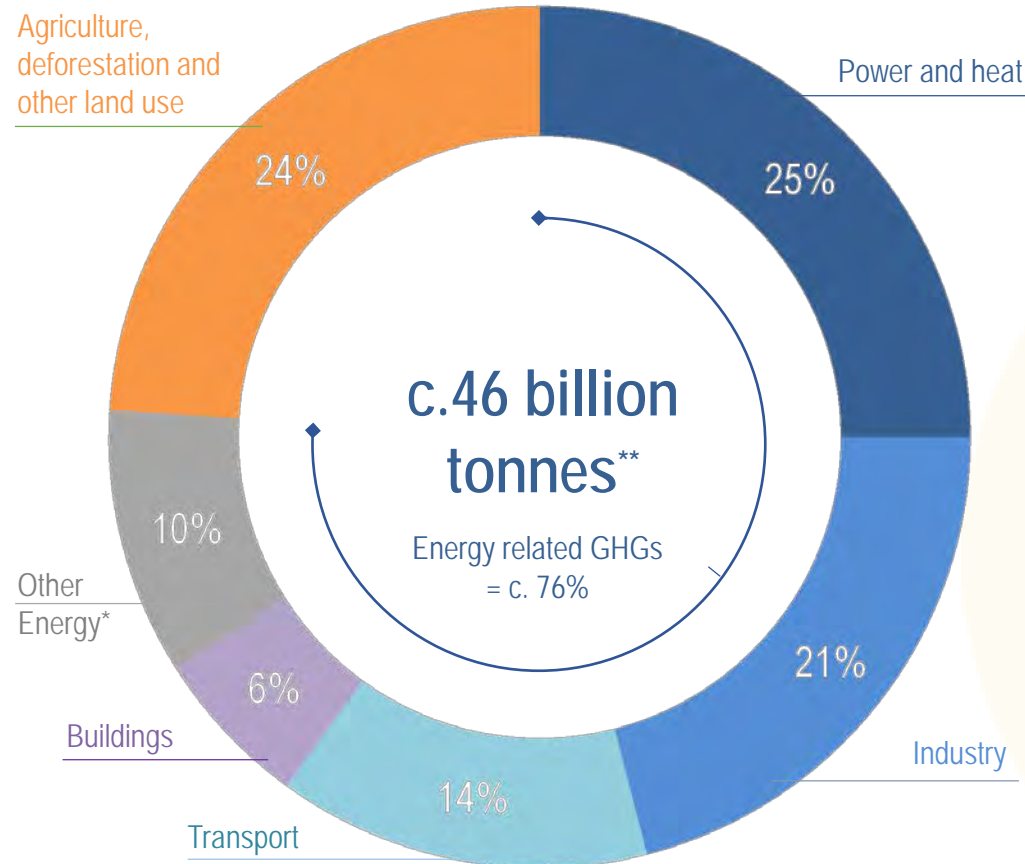
Global Greenhouse Gas emissions by sector (%)

Constrained by world hunger rising to **821 million** people in 2017
Increased by deforestation: World lost forest the area of Italy in 2017

World is expected to build **230 billion m2** in new construction by 2060 – this is the **equivalent of Paris every single week**

Global car fleet forecast to double from 900 million today to **1.8 billion by 2035** (EVs forecast to number just 60-250million then)

Agriculture, deforestation and other land use



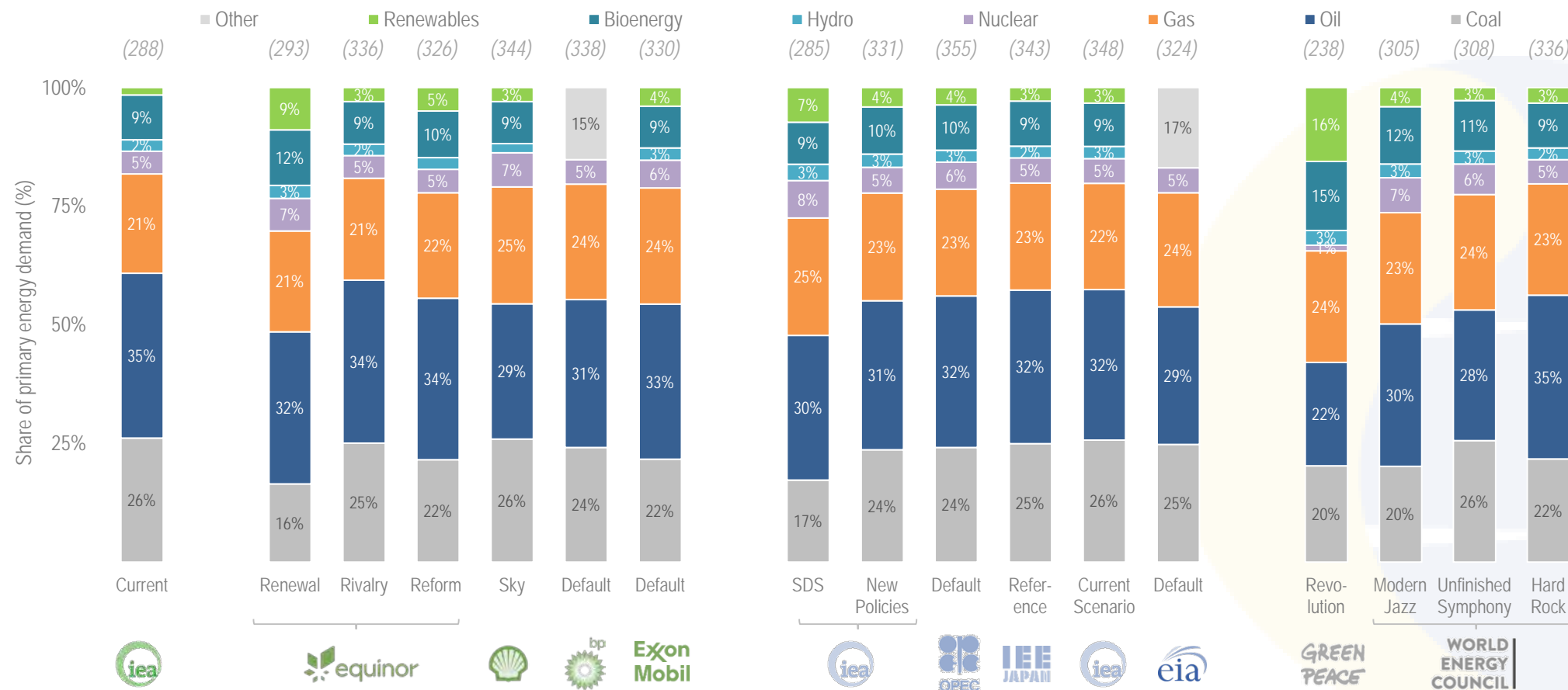
Although **97%** of the urban population worldwide has access to power, the access rate in rural areas is just **79%**

Global industrial output has slowed since 2017, but at **0.17%** monthly growth 2019 is in line with the **0.18%** average since 2000

Global energy mix outlooks do not suggest any material change, why is this?

2030E primary energy demand forecasts by fuel

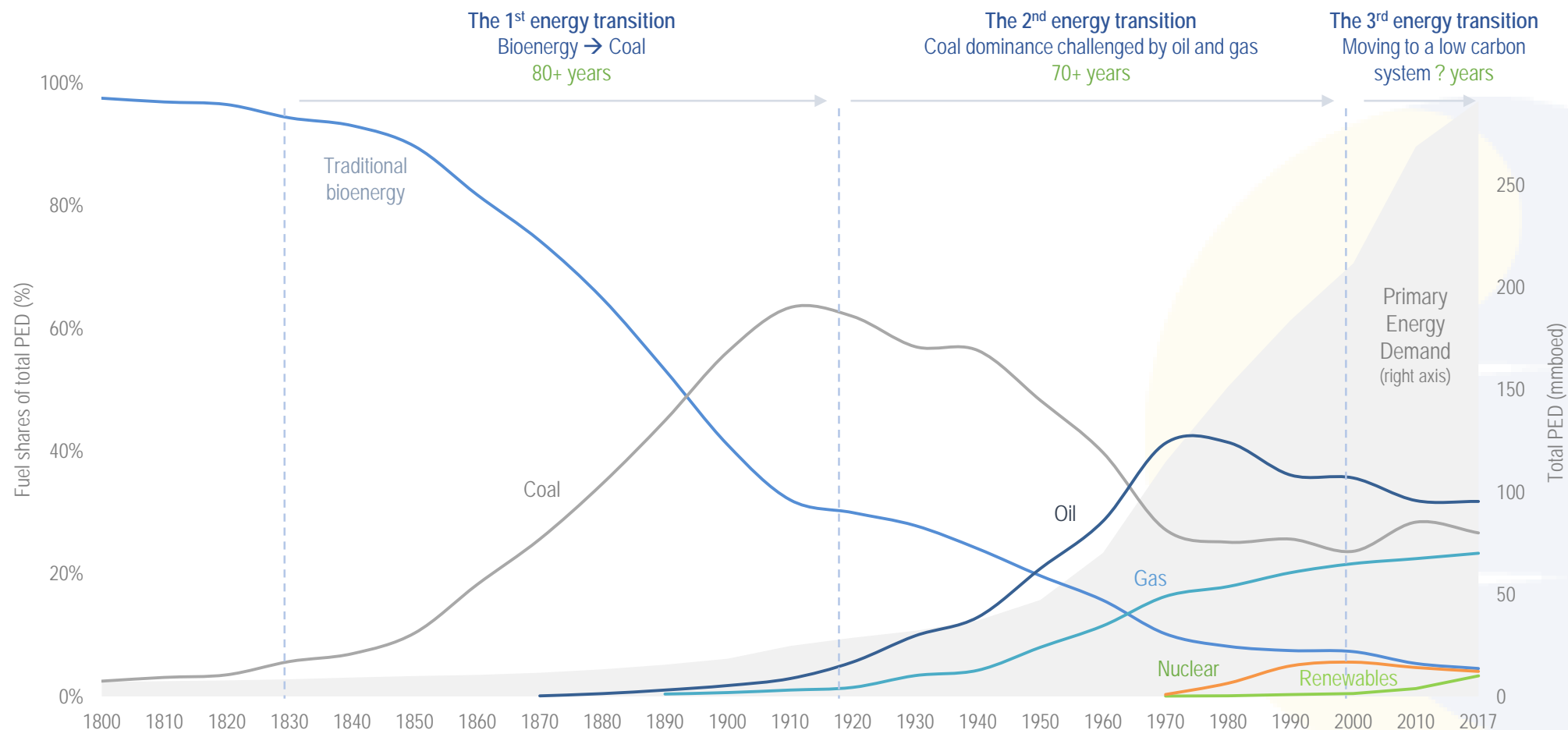
Including 2030E primary energy demand (brackets, mmbbl/d)



Any change in the world's energy system is likely to require a slow evolution

The global energy transitions since 1800 – the scale of today's challenge is vast

Selected fuels as a share of global Primary Energy Demand (LHS) and total global PED (RHS)



Germany's ineffective energy policy exemplifies the dangers of unpragmatic thinking

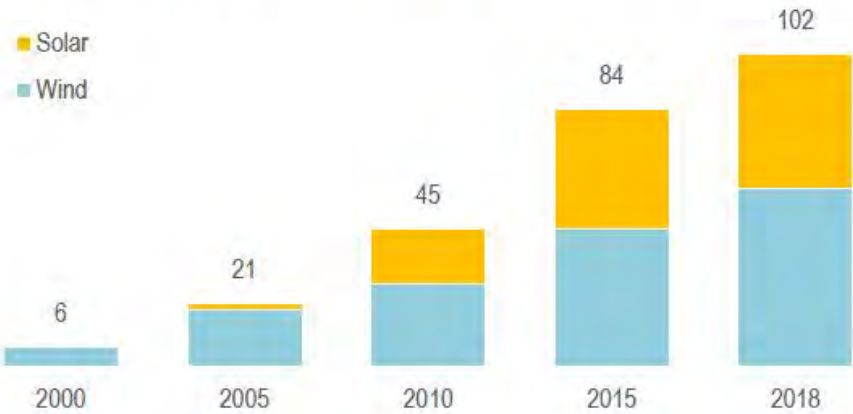


النسبة
Crescent Petroleum

Despite vast investment into renewables capacity in Germany - where solar conditions are extremely poor – GHG emissions have hardly fallen over the past ten years as the country has failed to materially reduce coal use. Electricity prices have soared to finance renewables subsidies and the intermittent nature of wind and solar has put severe strain on the country's power grid.

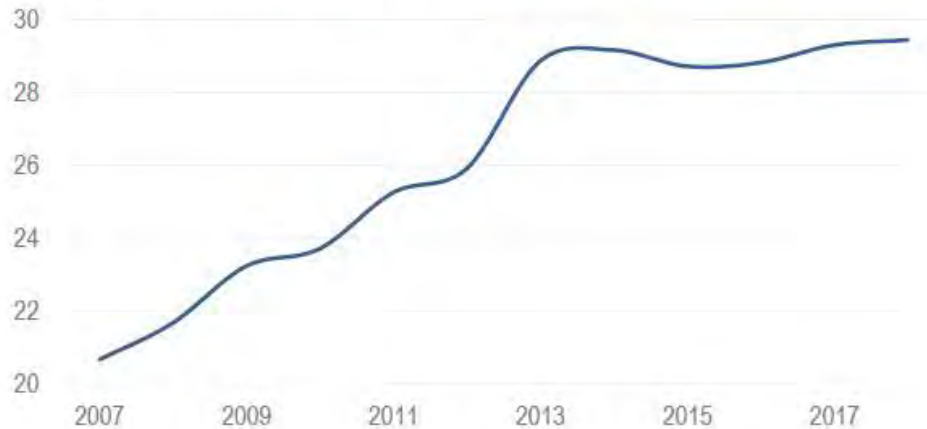
Germany has invested heavily into renewables capacity...

Solar and wind capacity (GW)



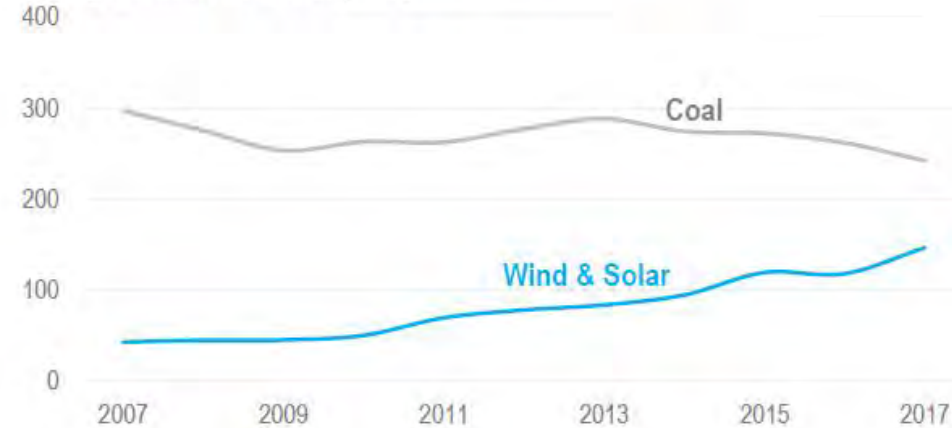
...power prices have risen to fund renewables subsidies...

Domestic power prices (ct/kwh)



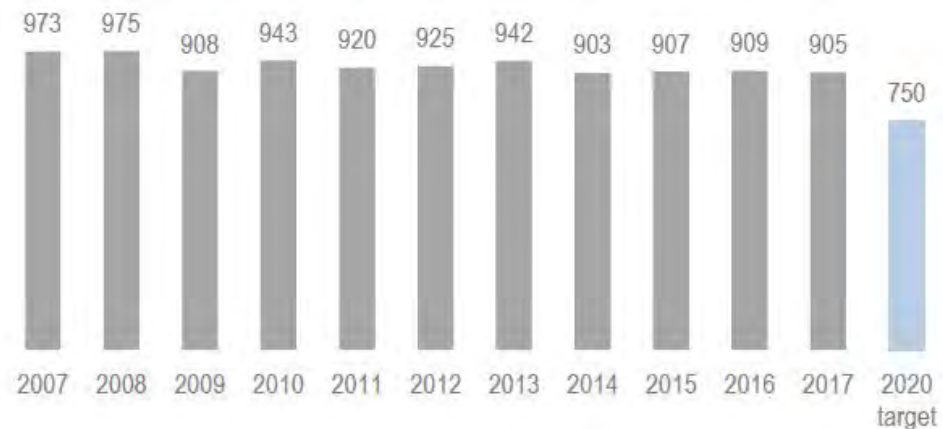
...but failed to materially reduce coal use...

Power generation from coal (TWh)



...and the impact on GHG emissions has been minimal

GHG emissions (m tonnes)



A dash for EVs before power mixes are cleaned up may increase CO₂ emissions

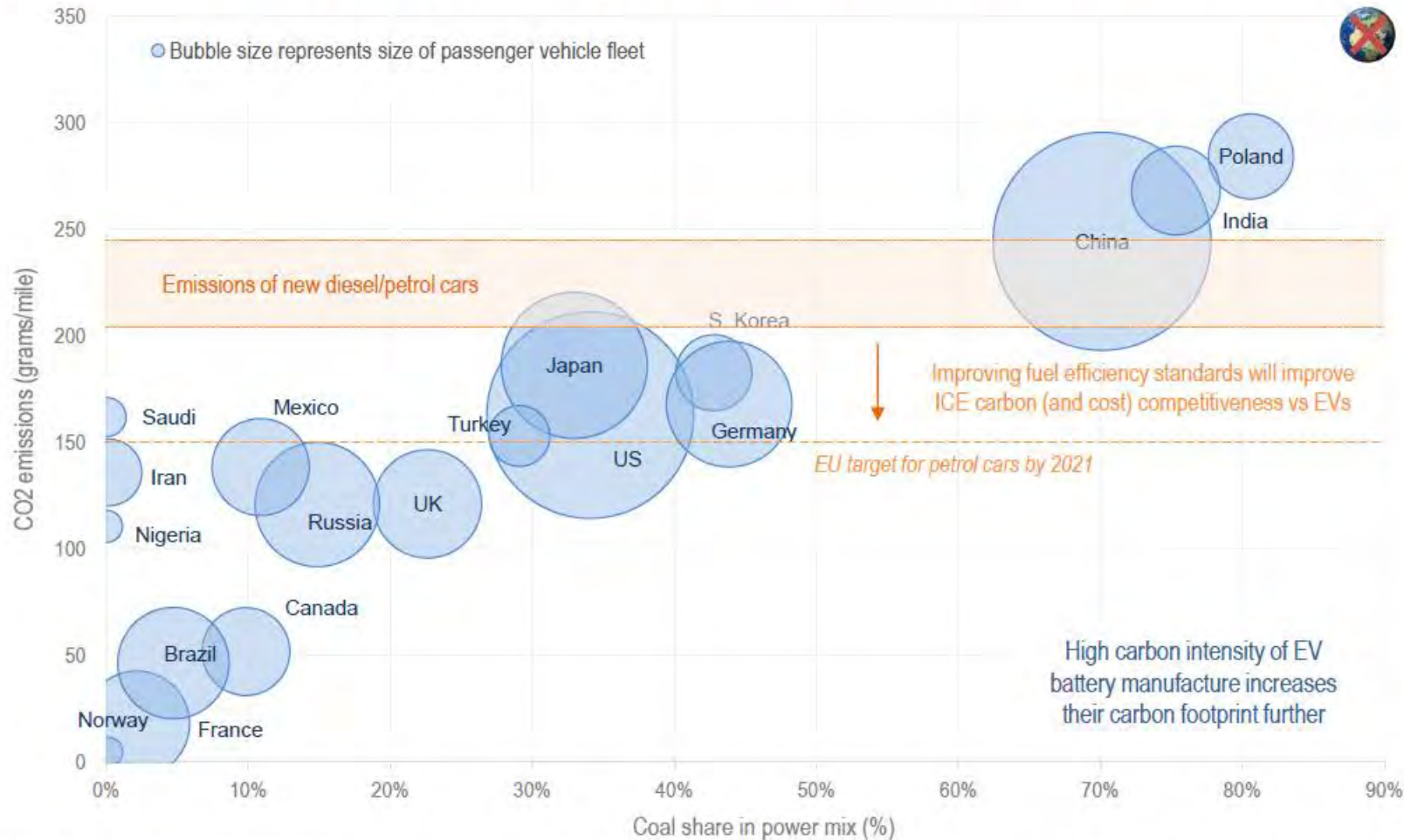


النسبة المئوية
Crescent Petroleum

China, the world's largest market for EVs, and where most EV batteries are likely to be made (a power intensive process) in the future, still relies on coal for ~70% of its power. EVs are effective at reducing urban smog but the CO₂ savings are contentious. Meanwhile, there are various other negative externalities of their use that should be considered by policy makers and consumers.

In coal-reliant countries such as China, EVs could result in more CO₂ than ICEs

CO₂ per mile of EVs in selected countries vs coal share in power mix



Other considerations for EV adoption

- Ethical sourcing of battery materials e.g. Cobalt from the DRC
- Regressive transfer of wealth from the taxpayer to affluent buyers via subsidies
- Loss of European automobile industry to battery manufacturing countries such as China
- Strain on power grids – will they be able to handle charging demand surges?
- Non-exhaust particulate emissions from EVs largely offset exhaust particulate savings

Note: CO₂ per mile does not include manufacturing emissions, power transmission and vampire losses, nor upstream and transmission carbon emissions for oil, gas and coal used in diesel/petrol and power generation