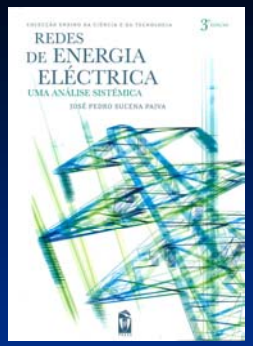
TÉCNICO LISBOA

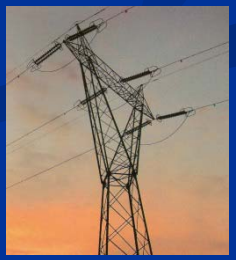


PUBLIC POLICIES FOR ENERGY

THE SEARCH FOR SECURE AND SUSTAINABLE ENERGY

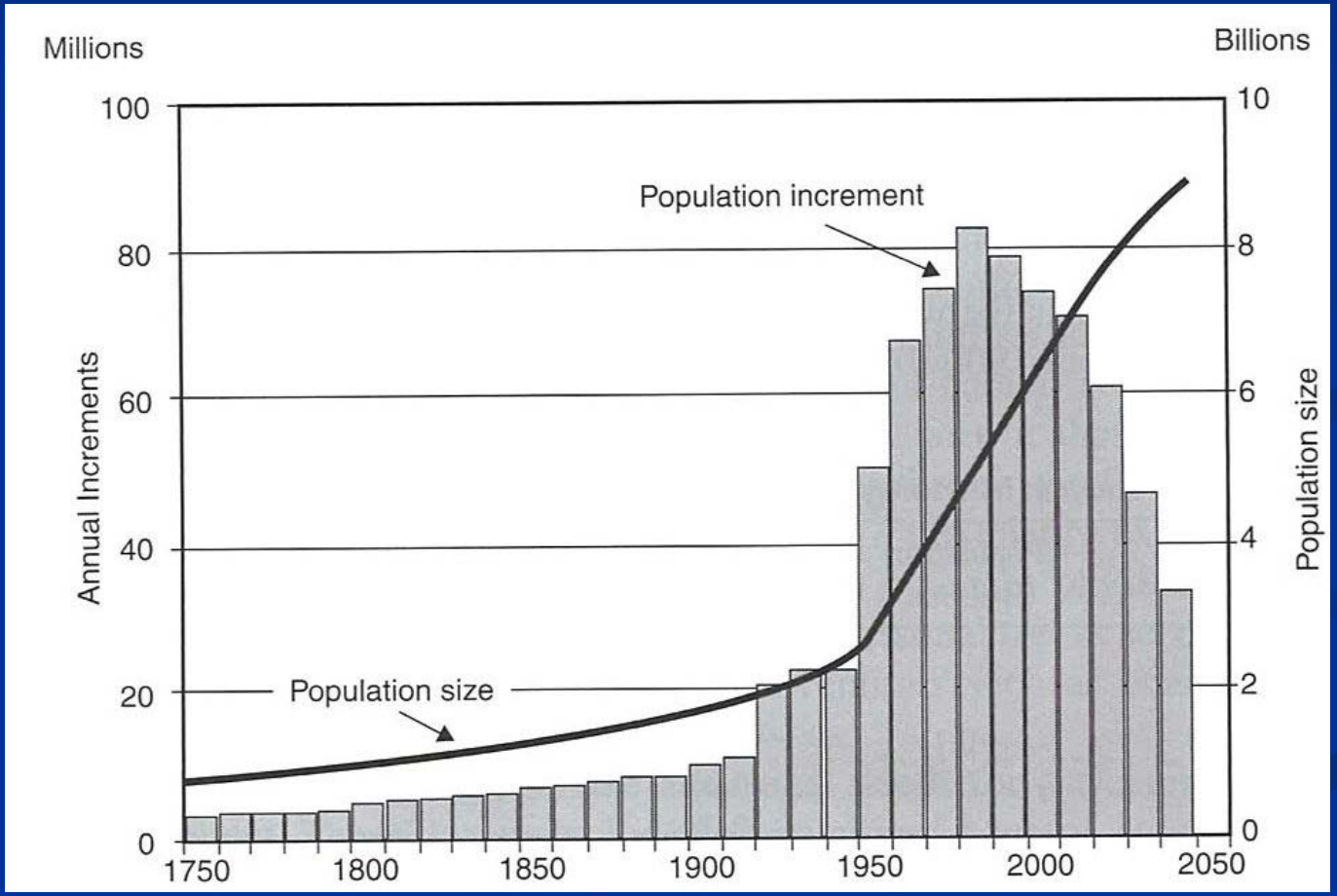
José P. Sucena Paiva

Prof. Emeritus IST



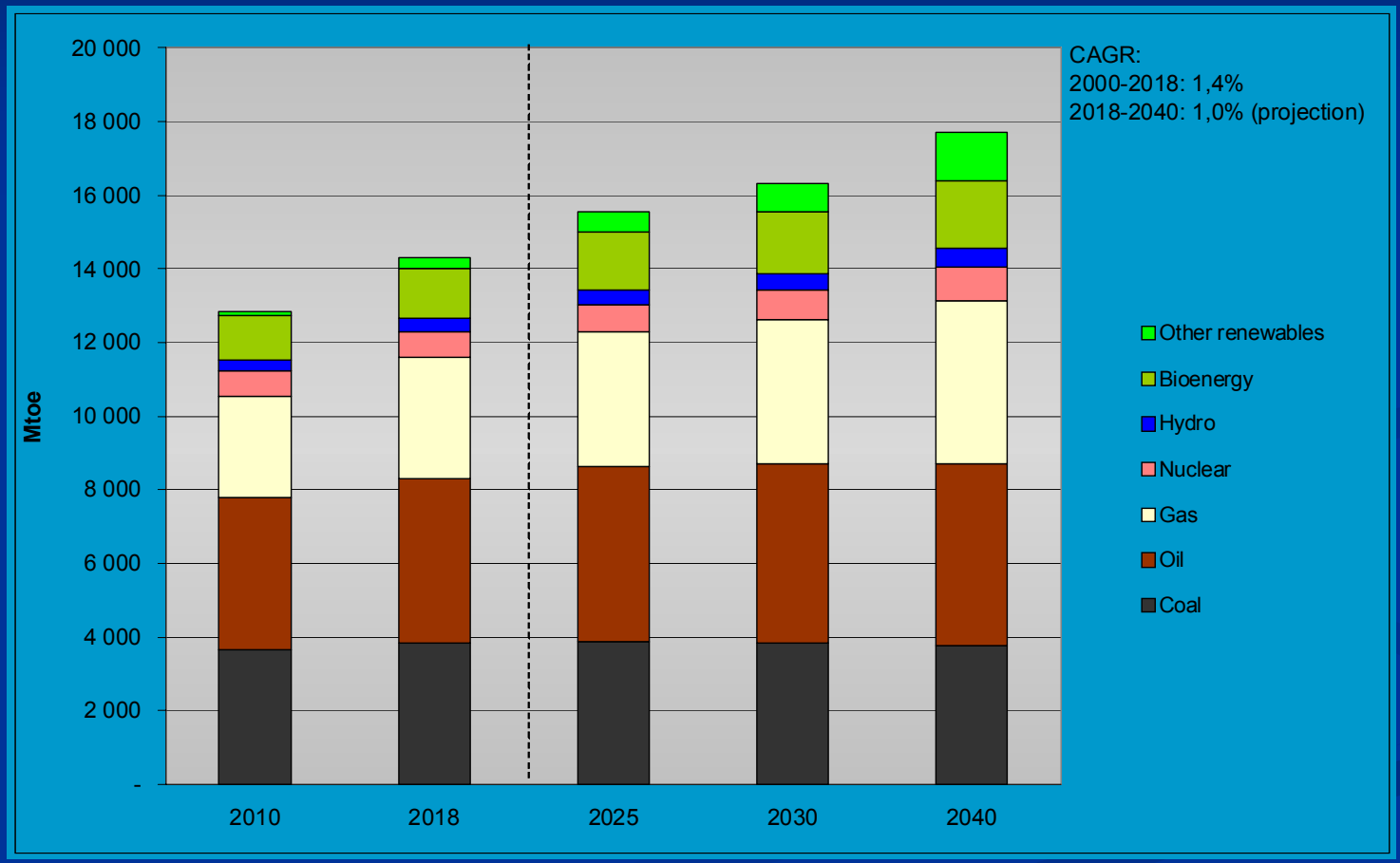
WORLD POPULATION GROWTH FROM 1750, PROJECTED TO 2050

[Source: Paul Kruger, Alternative Energy Resources]



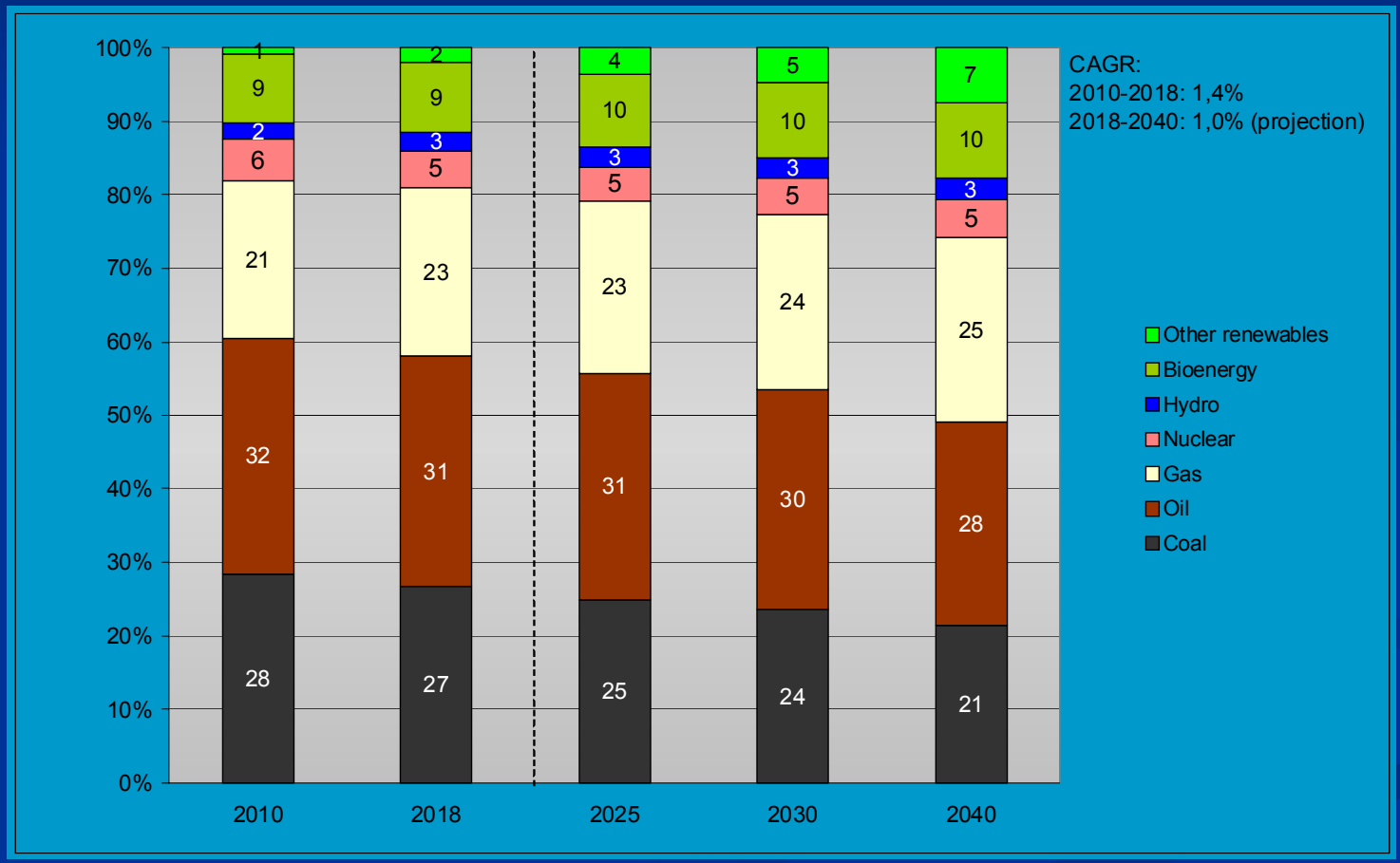
WORLD PRIMARY ENERGY DEMAND STATED POLICIES SCENARIO, 2010-2040 (Mtoe)

[Source: IEA World Energy Outlook 2019]



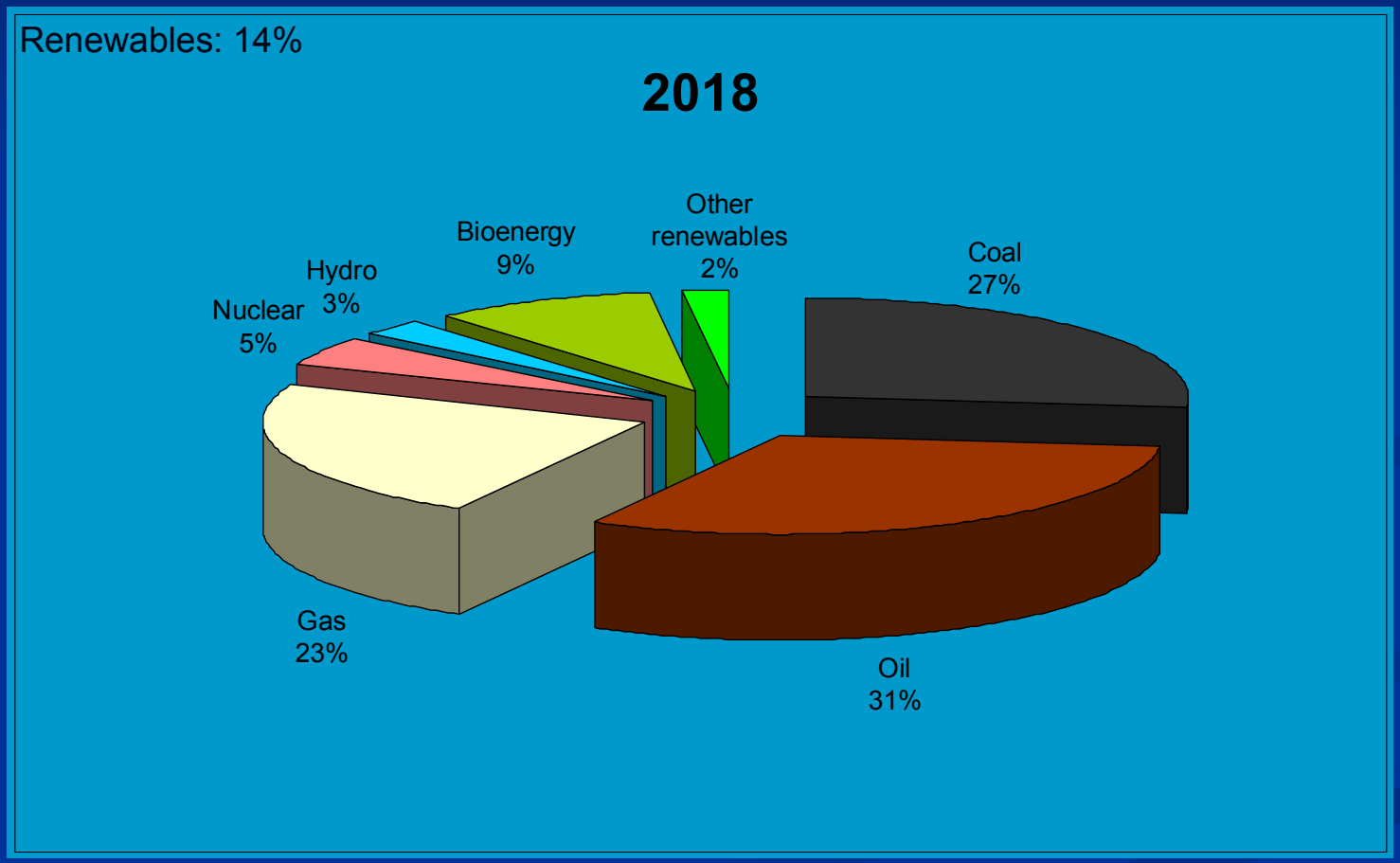
WORLD PRIMARY ENERGY DEMAND STATED POLICIES SCENARIO, 2010-2040 (%)

[Source: IEA World Energy Outlook 2019]



WORLD PRIMARY ENERGY DEMAND STATED POLICIES SCENARIO, 2018

[Source: IEA World Energy Outlook 2019]

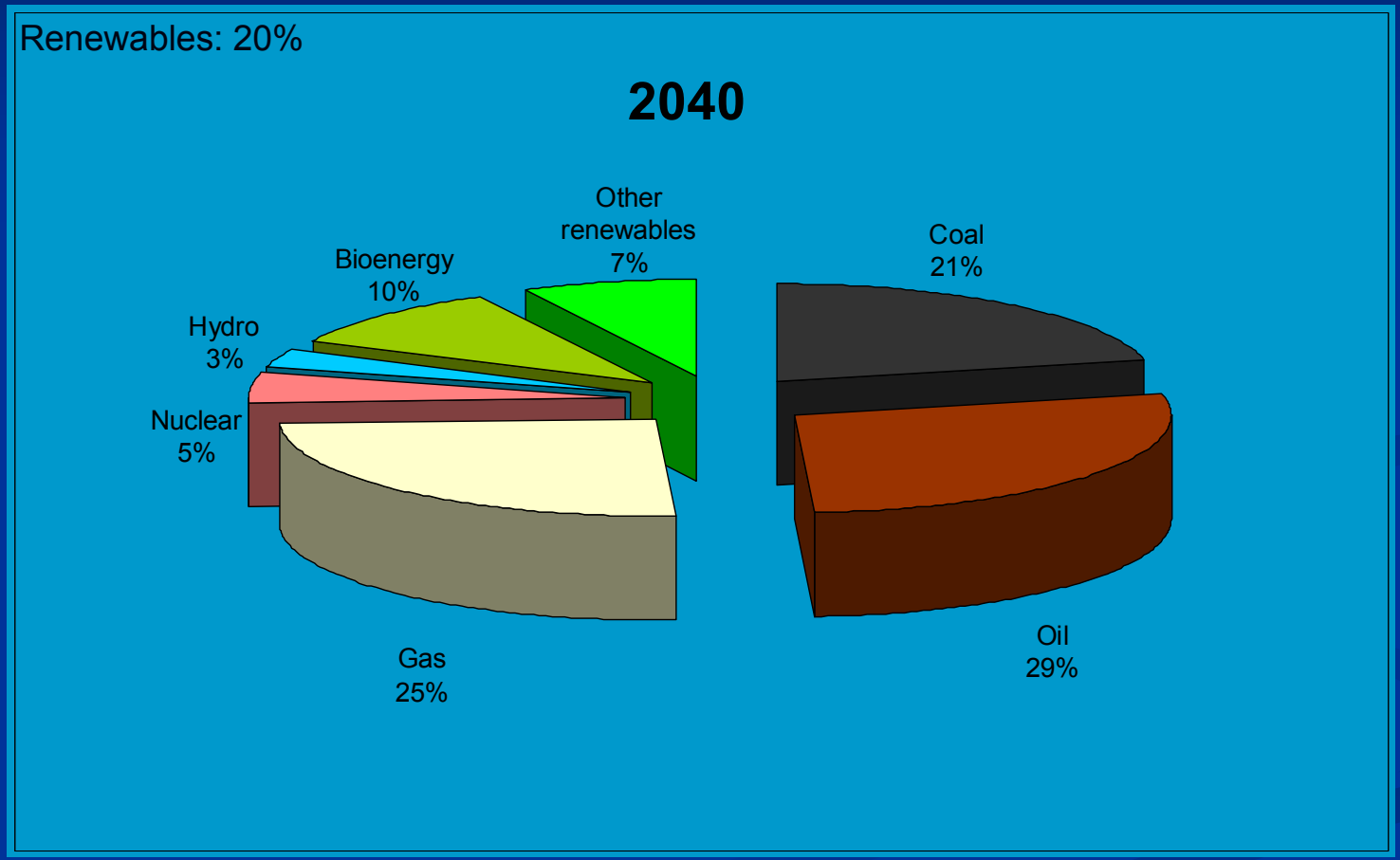


Average power 2018: 19 TW

Average power per capita: 2,5 kW

WORLD PRIMARY ENERGY DEMAND STATED POLICIES SCENARIO, 2040

[Source: IEA World Energy Outlook 2019]

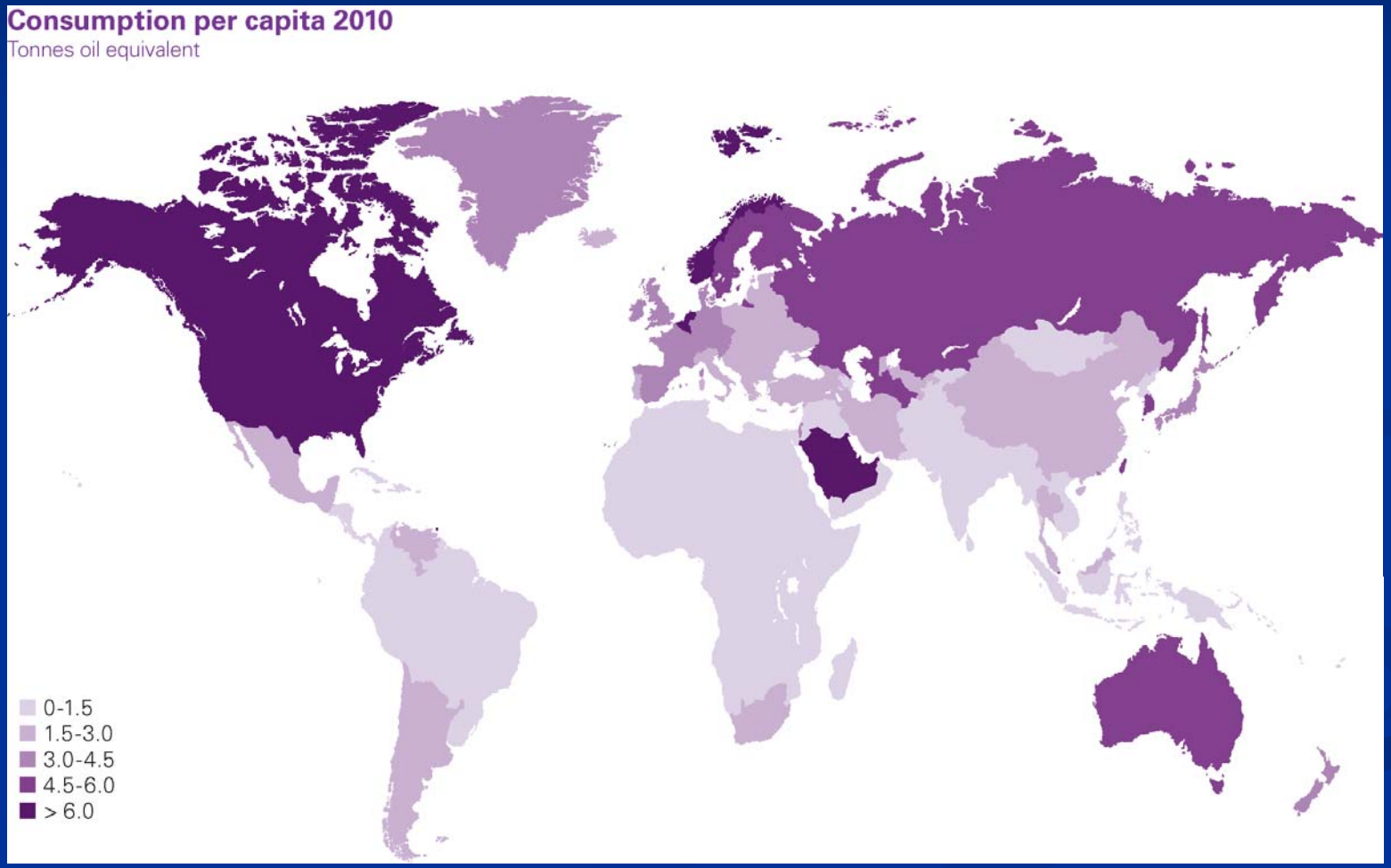


Average power 2040: 24 TW

Average power per capita: 2,8 kW

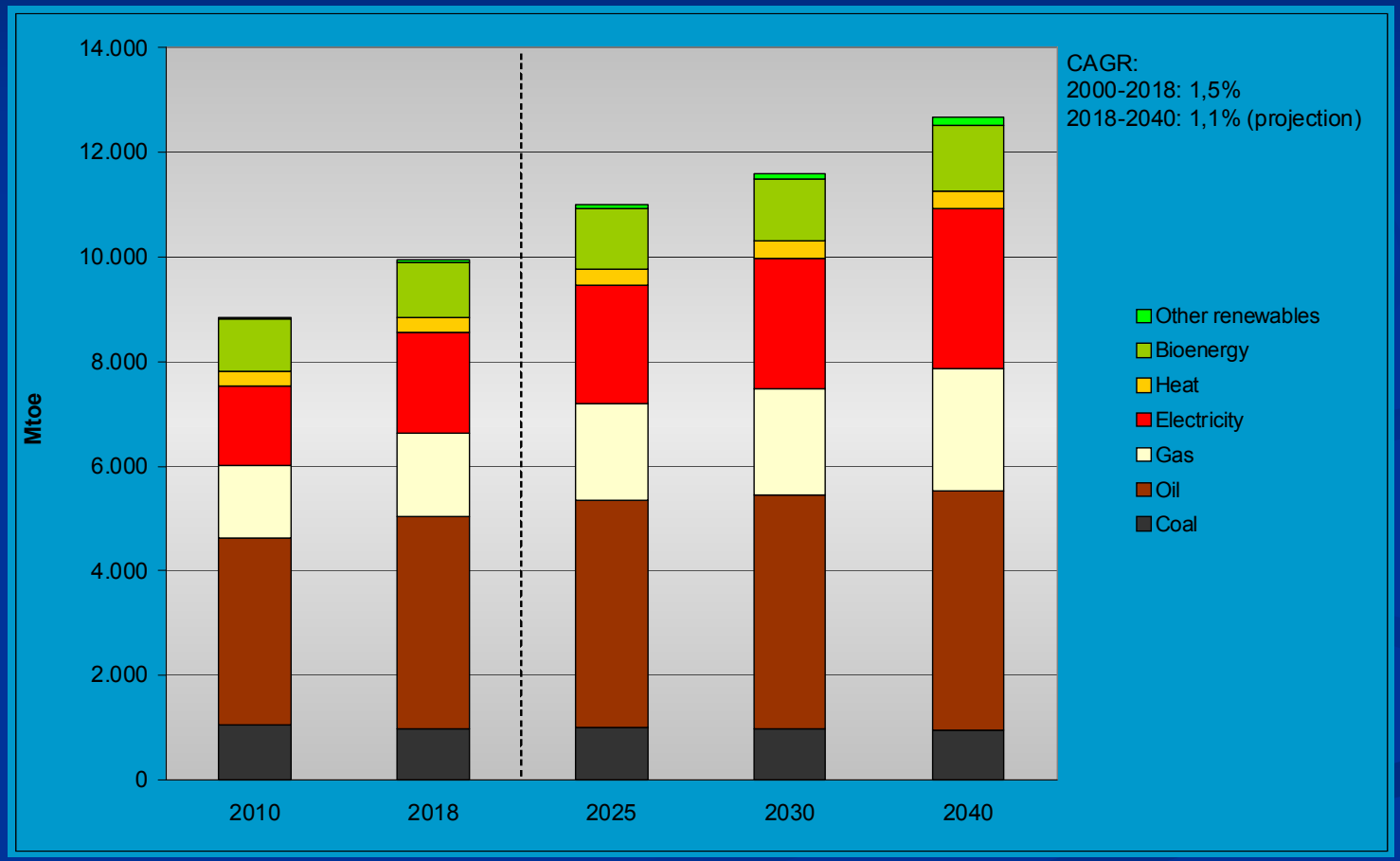
PRIMARY ENERGY CONSUMPTION PER CAPITA, WORLD, 2010

[Source: BP Statistical Review, 2011]



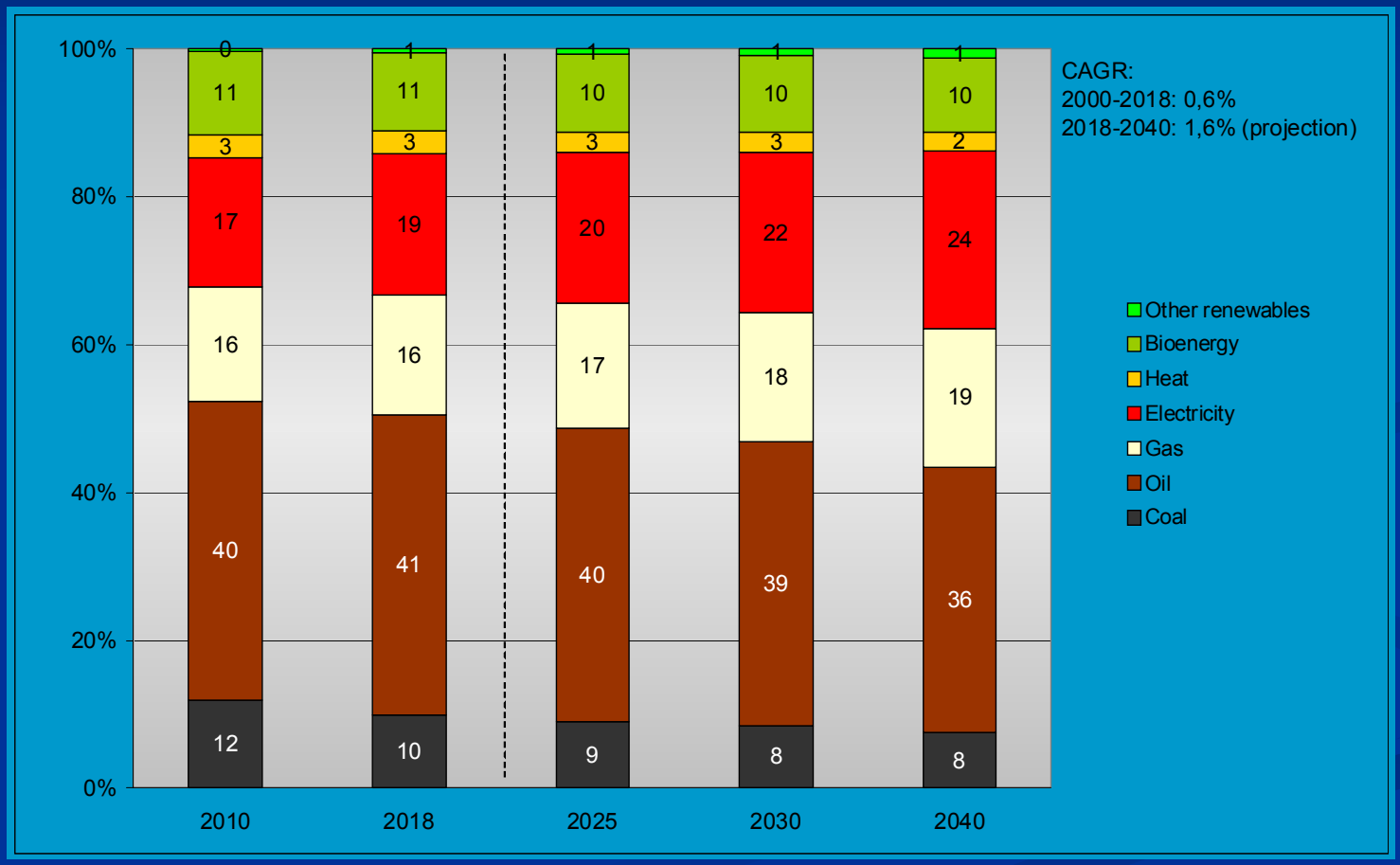
WORLD TOTAL FINAL CONSUMPTION, STATED POLICIES SCENARIO, 2000-2040 (Mtoe)

[Source: IEA World Energy Outlook 2019]



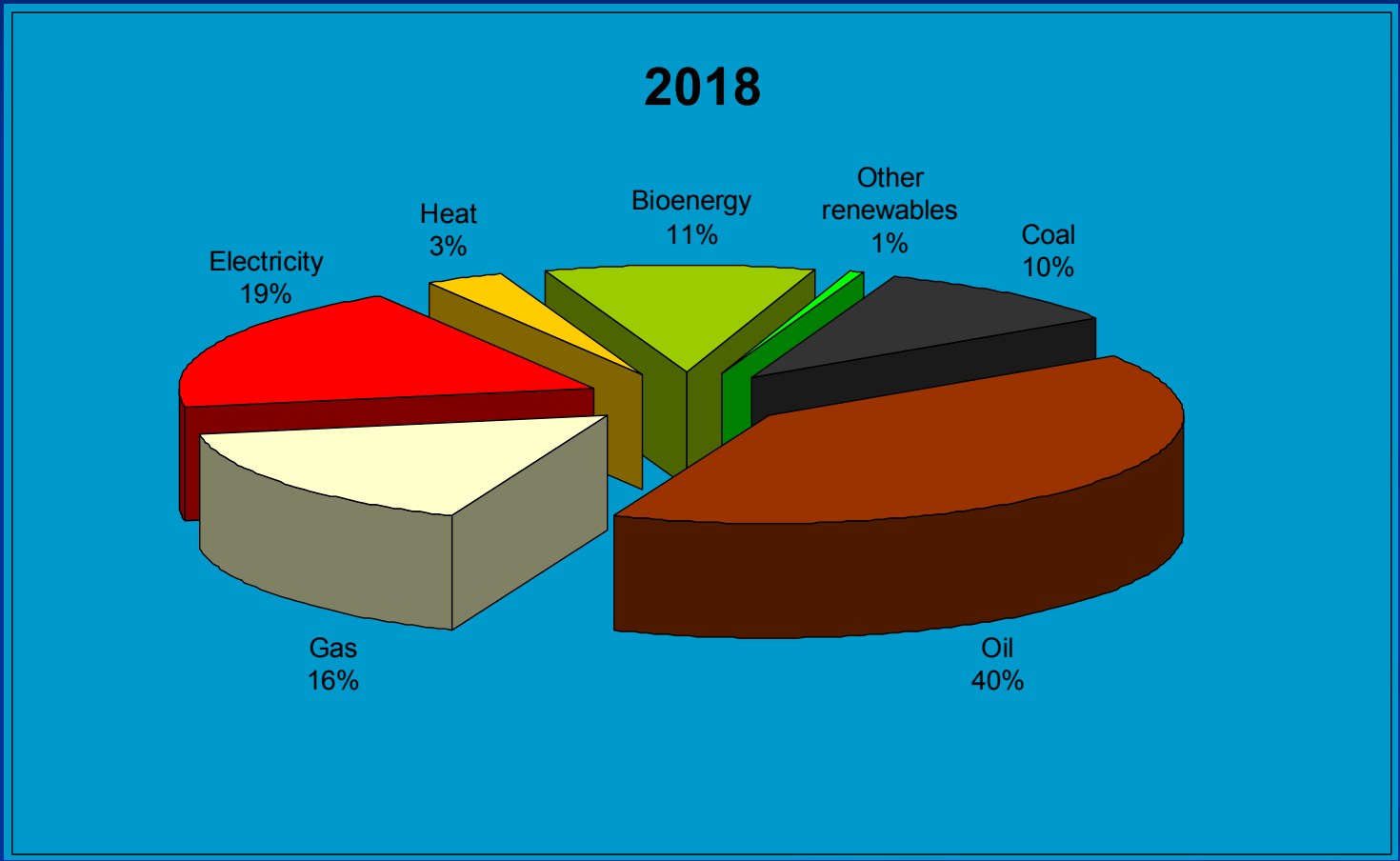
WORLD TOTAL FINAL CONSUMPTION, STATED POLICIES SCENARIO, 2000-2040 (%)

[Source: IEA World Energy Outlook 2019]



WORLD TOTAL FINAL CONSUMPTION STATED POLICIES SCENARIO, 2018

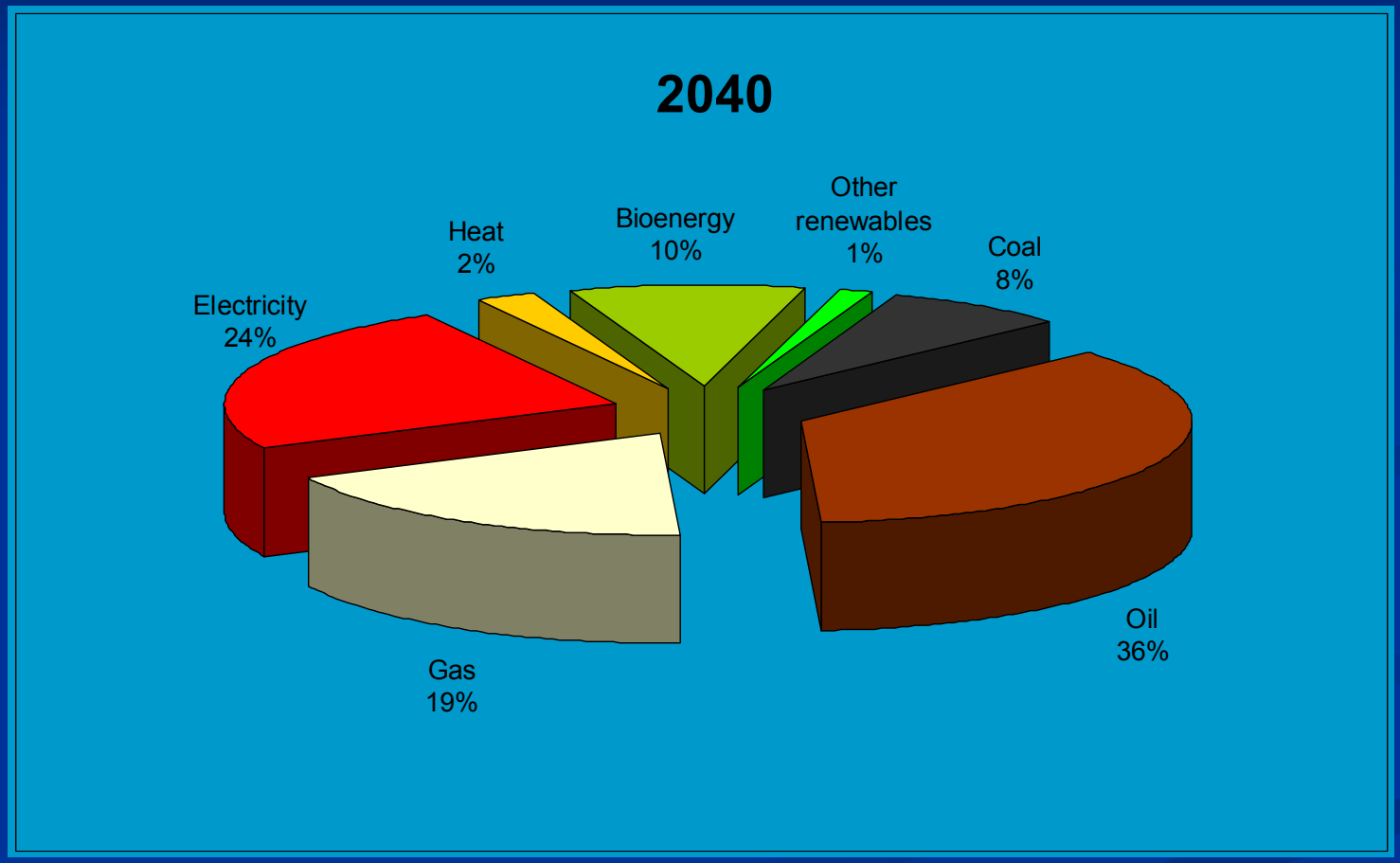
[Source: IEA World Energy Outlook 2019]



Average power 2018: 13 TW
Average power per capita: 1,9 kW

WORLD TOTAL FINAL CONSUMPTION STATED POLICIES SCENARIO, 2040

[Source: IEA World Energy Outlook 2019]

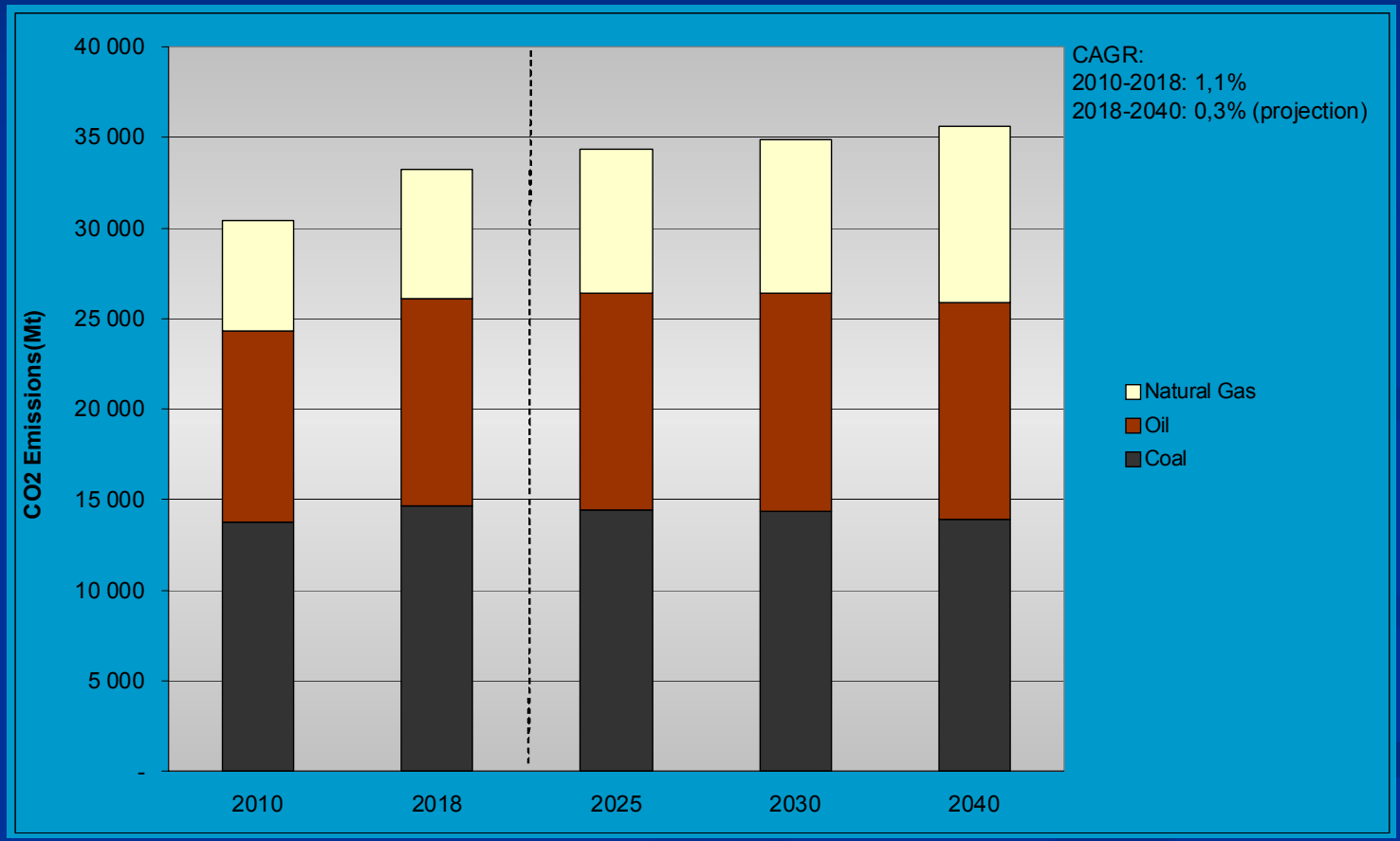


Average power 2018: 17 TW

Average power per capita: 2,4 kW

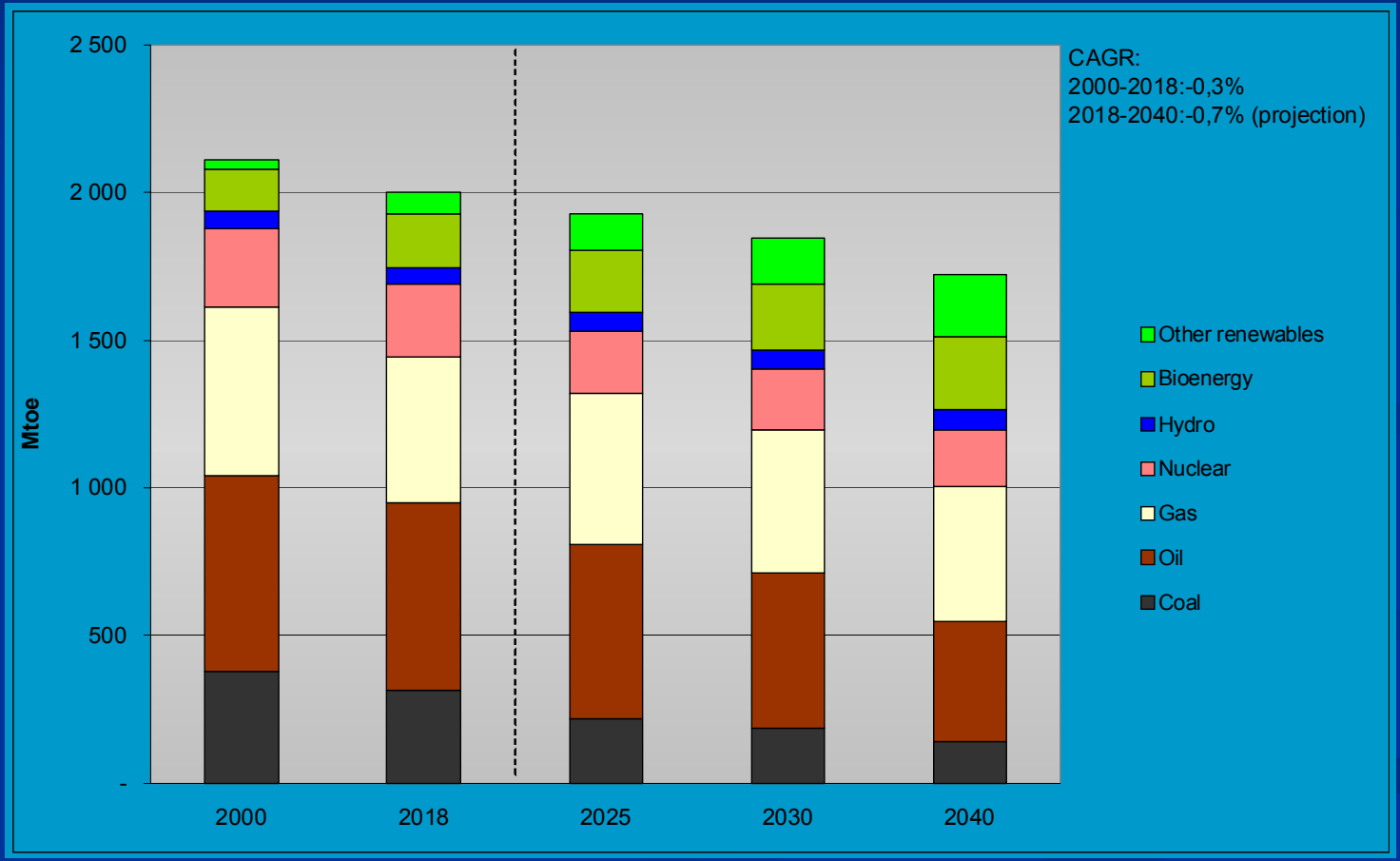
WORLD ANNUAL CO_2 EMISSIONS (Mt) STATED POLICIES SCENARIO, 2010-2040

[Source: IEA World Energy Outlook 2019]



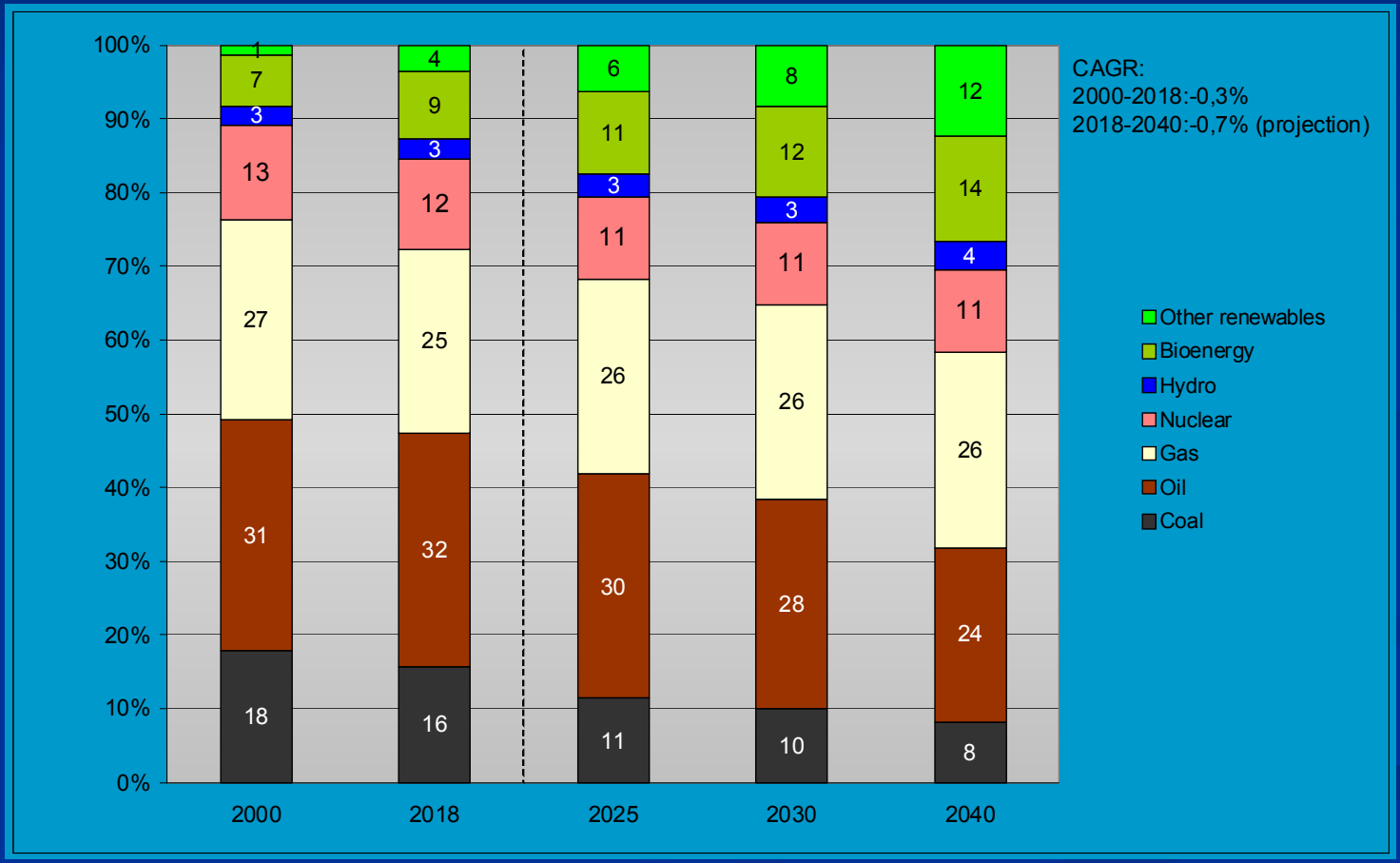
EU PRIMARY ENERGY DEMAND (Mtoe) STATED POLICIES SCENARIO, 2000-2040

[Source : IEA, World Energy Outlook 2019]



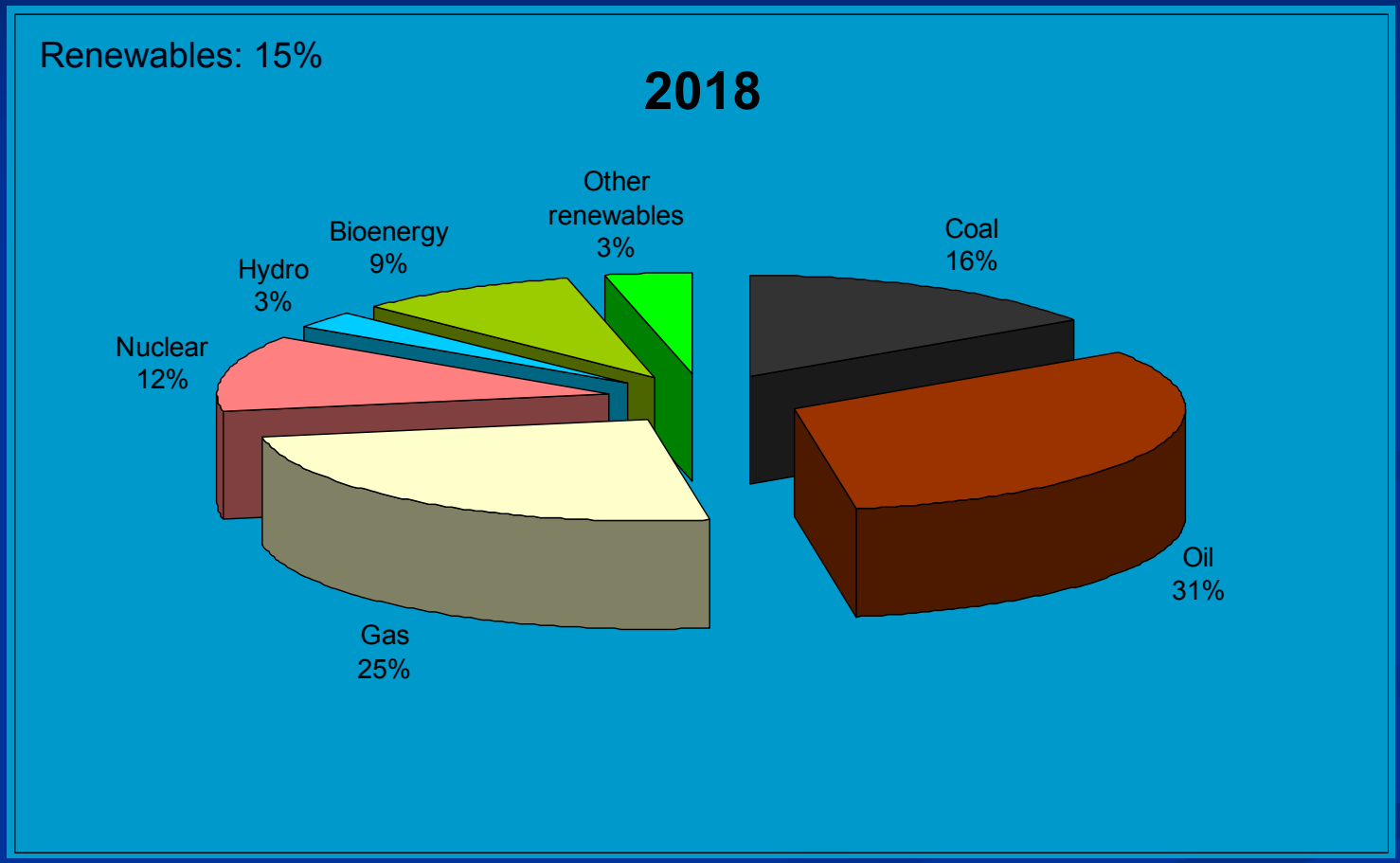
EU PRIMARY ENERGY DEMAND (%) STATED POLICIES SCENARIO, 2000-2040

[Source : IEA, World Energy Outlook 2019]



EU PRIMARY ENERGY DEMAND STATED POLICIES SCENARIO, 2018

[Source : IEA, World Energy Outlook 2019]

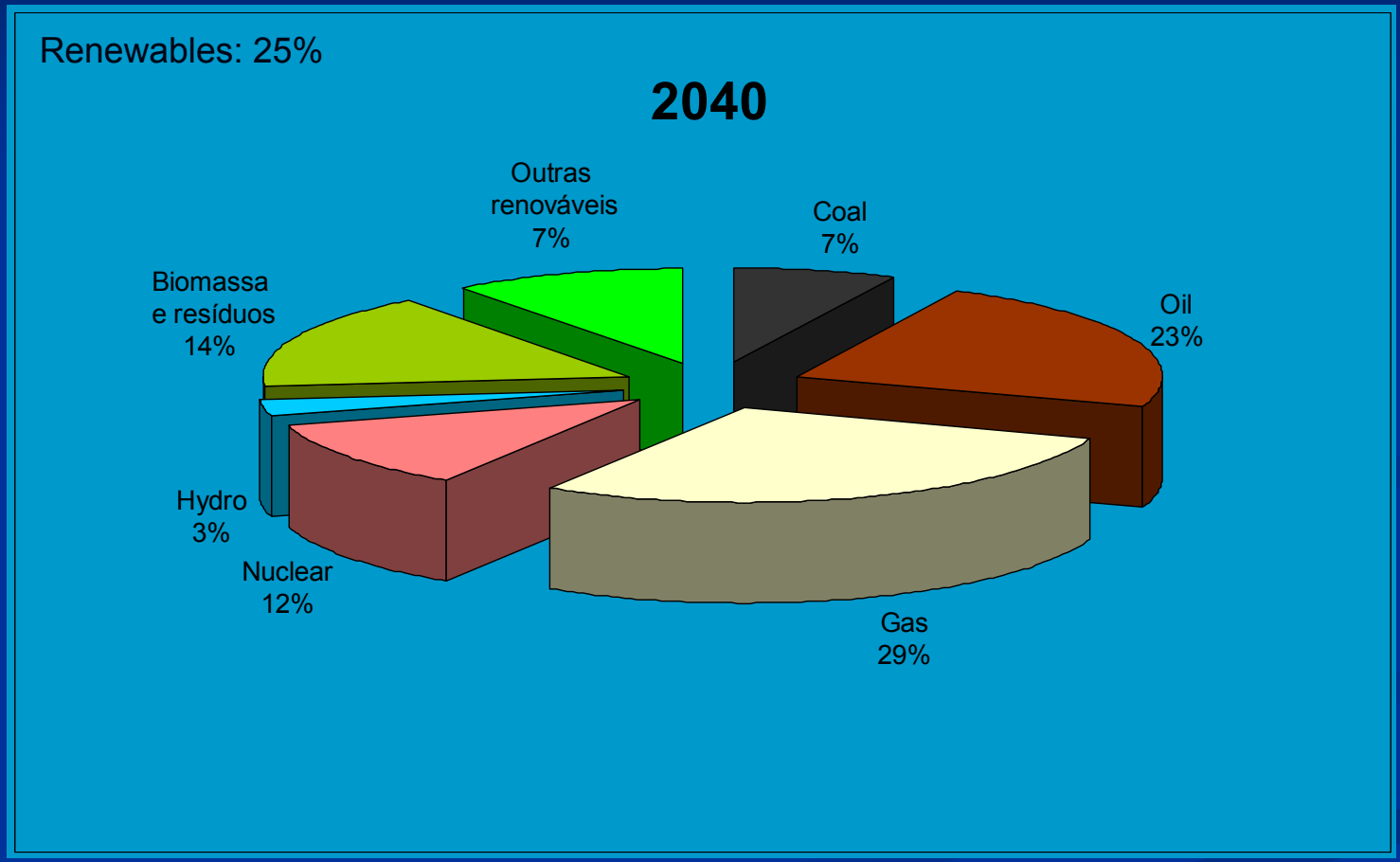


Average power 2018: 2,7 TW

Average power per capita: 5,3 kW

EU PRIMARY ENERGY DEMAND STATED POLICIES SCENARIO, 2040

[Source : IEA, World Energy Outlook 2019]

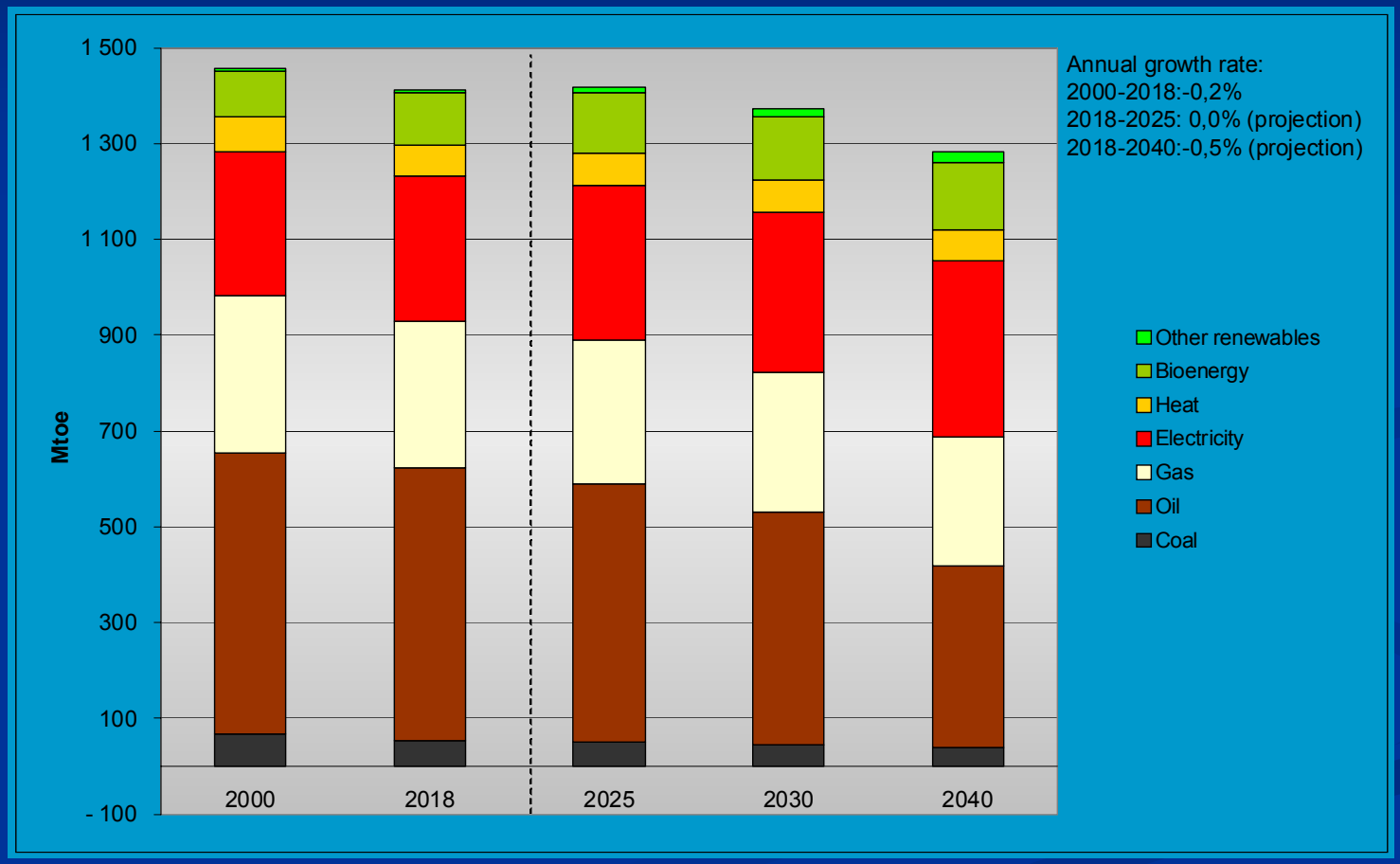


Average power 2040: 2,3 TW

Average power per capita: 4,6 kW

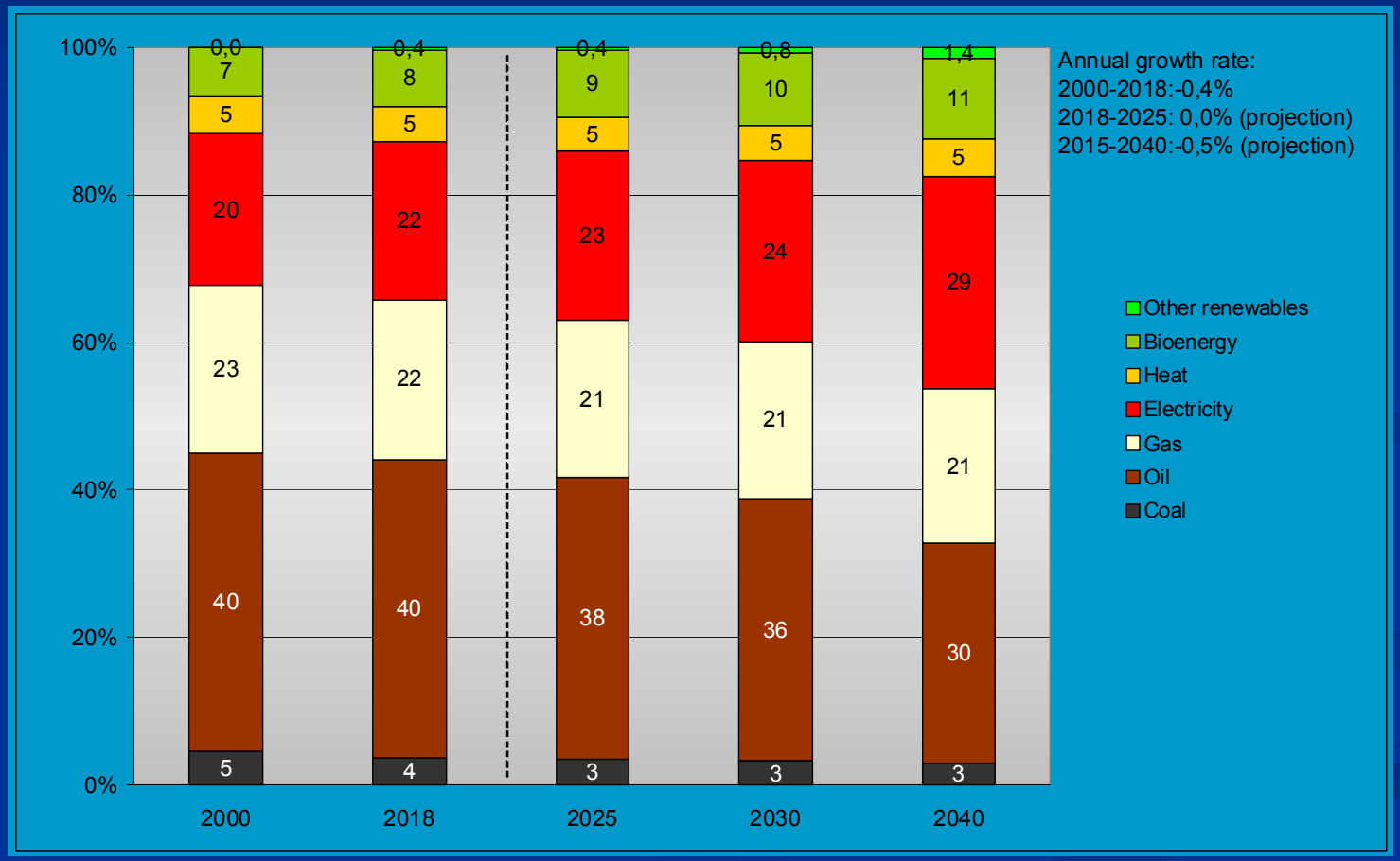
EU FINAL ENERGY DEMAND (Mtoe) STATED POLICIES SCENARIO, 2000-2040

[Source : IEA, World Energy Outlook 2019]



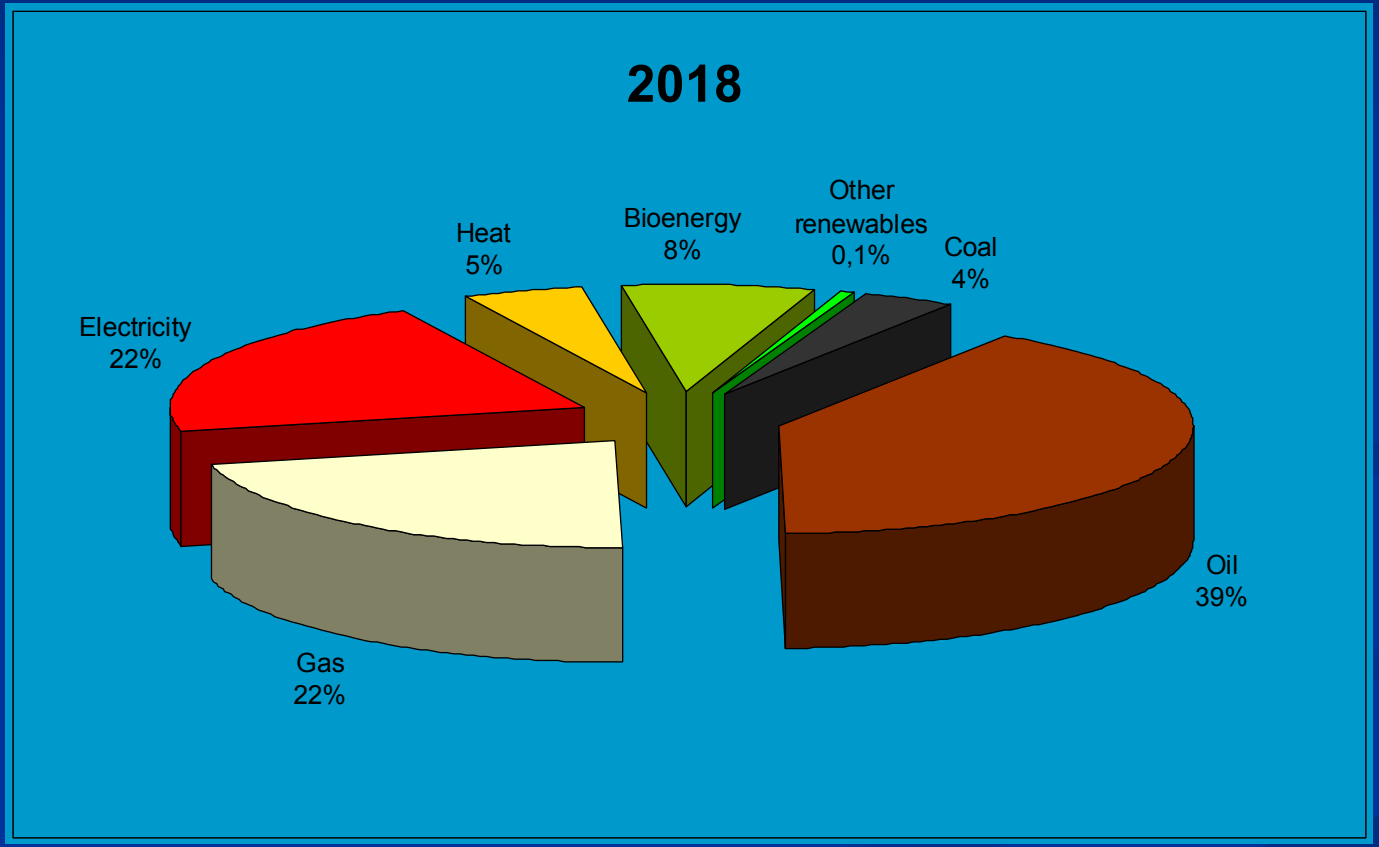
EU FINAL ENERGY DEMAND (%) STATED POLICIES SCENARIO, 2000-2040

[Source : IEA, World Energy Outlook 2019]



EU FINAL ENERGY DEMAND STATED POLICIES SCENARIO, 2018

[Source : IEA, World Energy Outlook 2019]

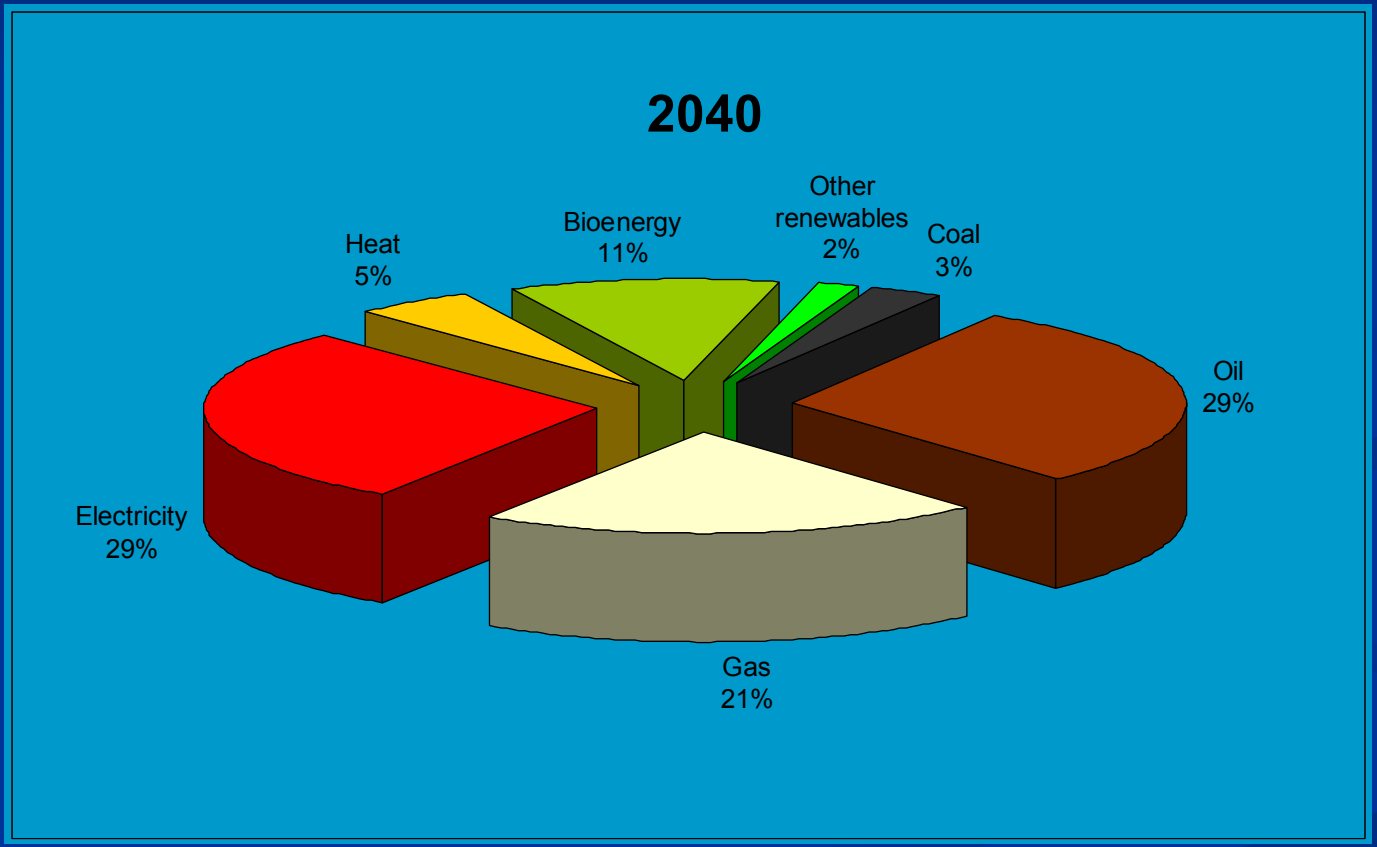


Average power 2018: 1,9 TW

Average power per capita: 3,7 kW

EU FINAL ENERGY DEMAND STATED POLICIES SCENARIO, 2040

[Source : IEA, World Energy Outlook 2019]

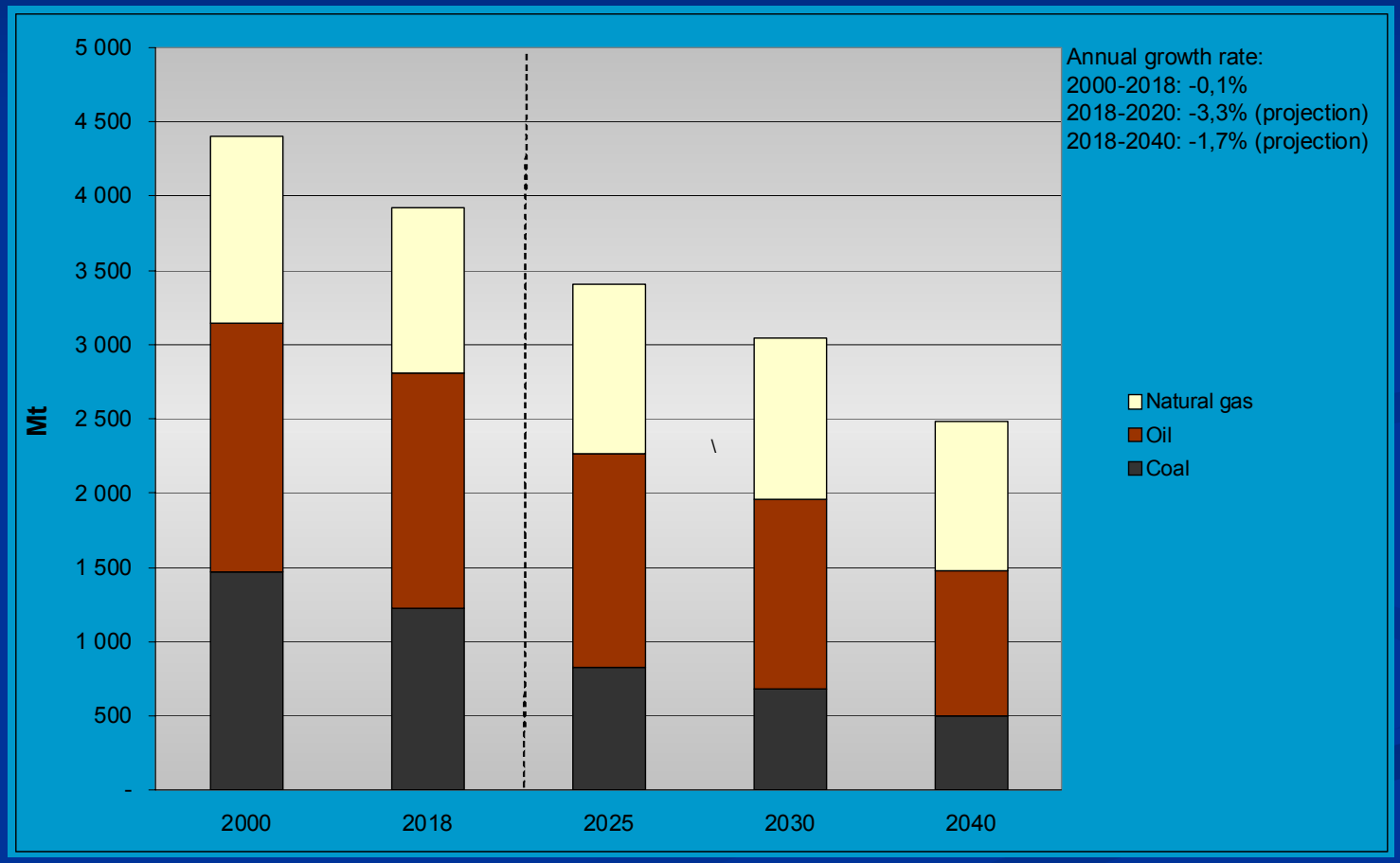


Average power 2040: 1,7 TW

Average power per capita: 3,4 kW

EU ANNUAL CO_2 EMISSIONS (Mt) STATED POLICIES SCENARIO, 2000-2040

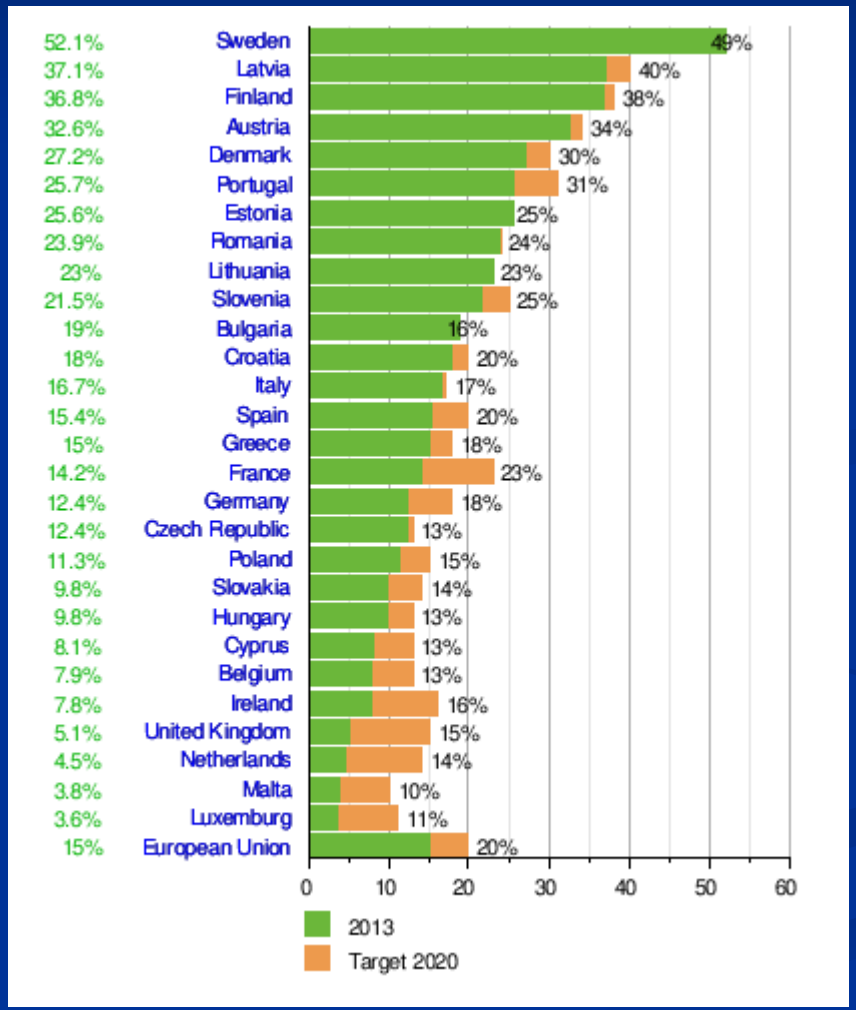
[Source : IEA, World Energy Outlook 2019]]



SHARE OF RENEWABLES IN GROSS FINAL ENERGY CONSUMPTION IN THE EU

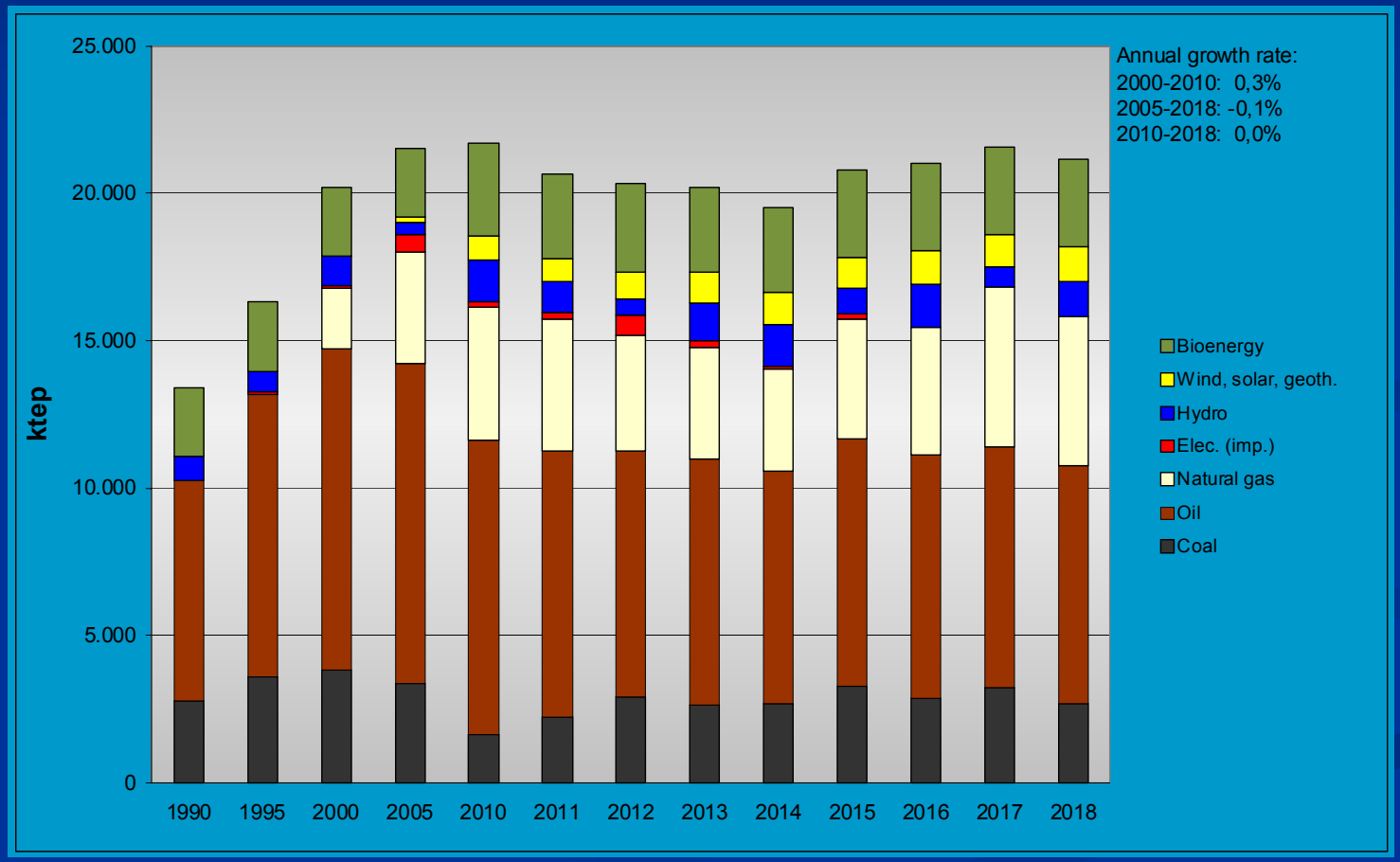
(excluding hydro)

[Source: Eurostat Energy Statistics]



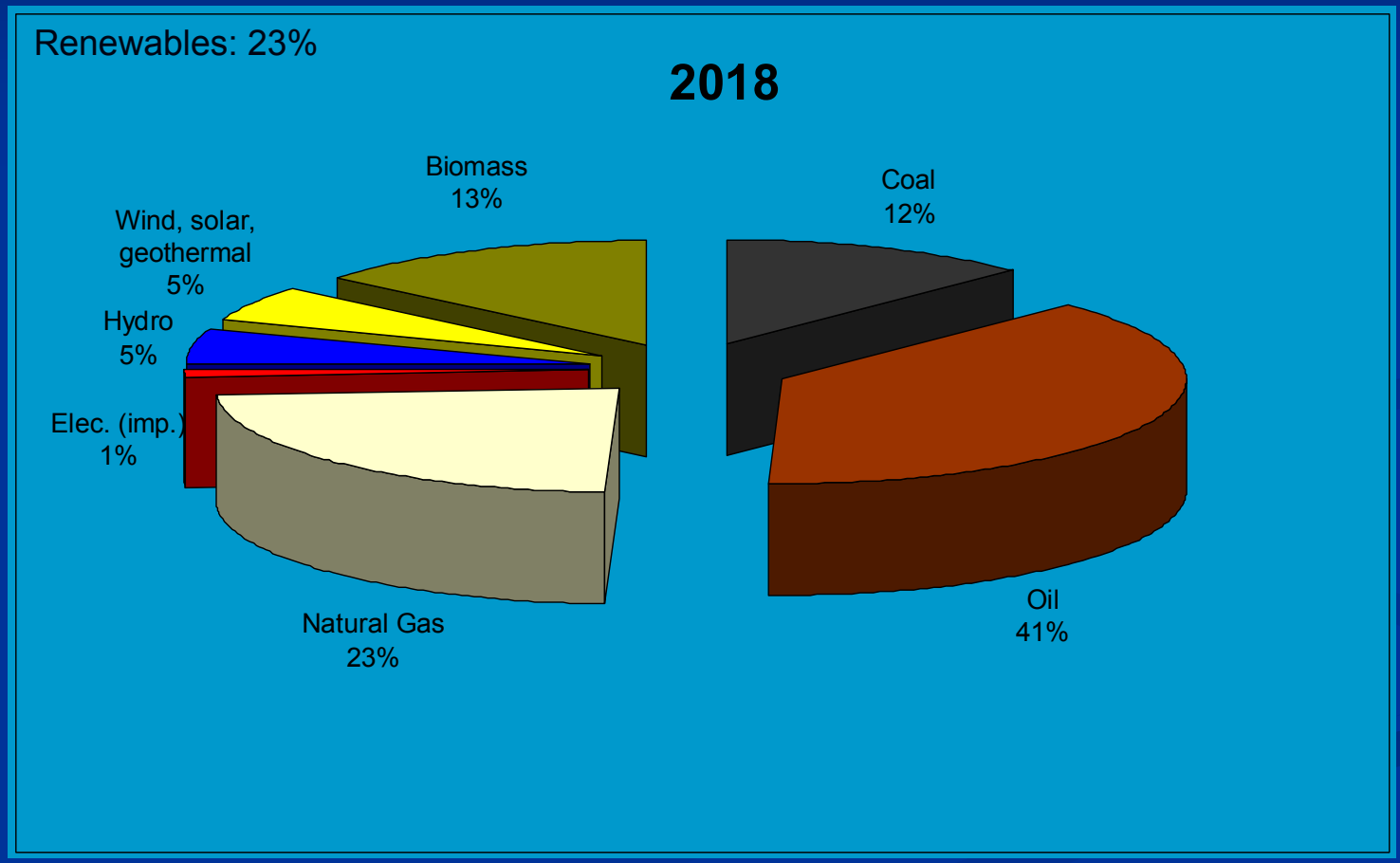
PRIMARY ENERGY CONSUMPTION PORTUGAL, 2000-2018

[Source : Direcção-Geral de Energia e Geologia]



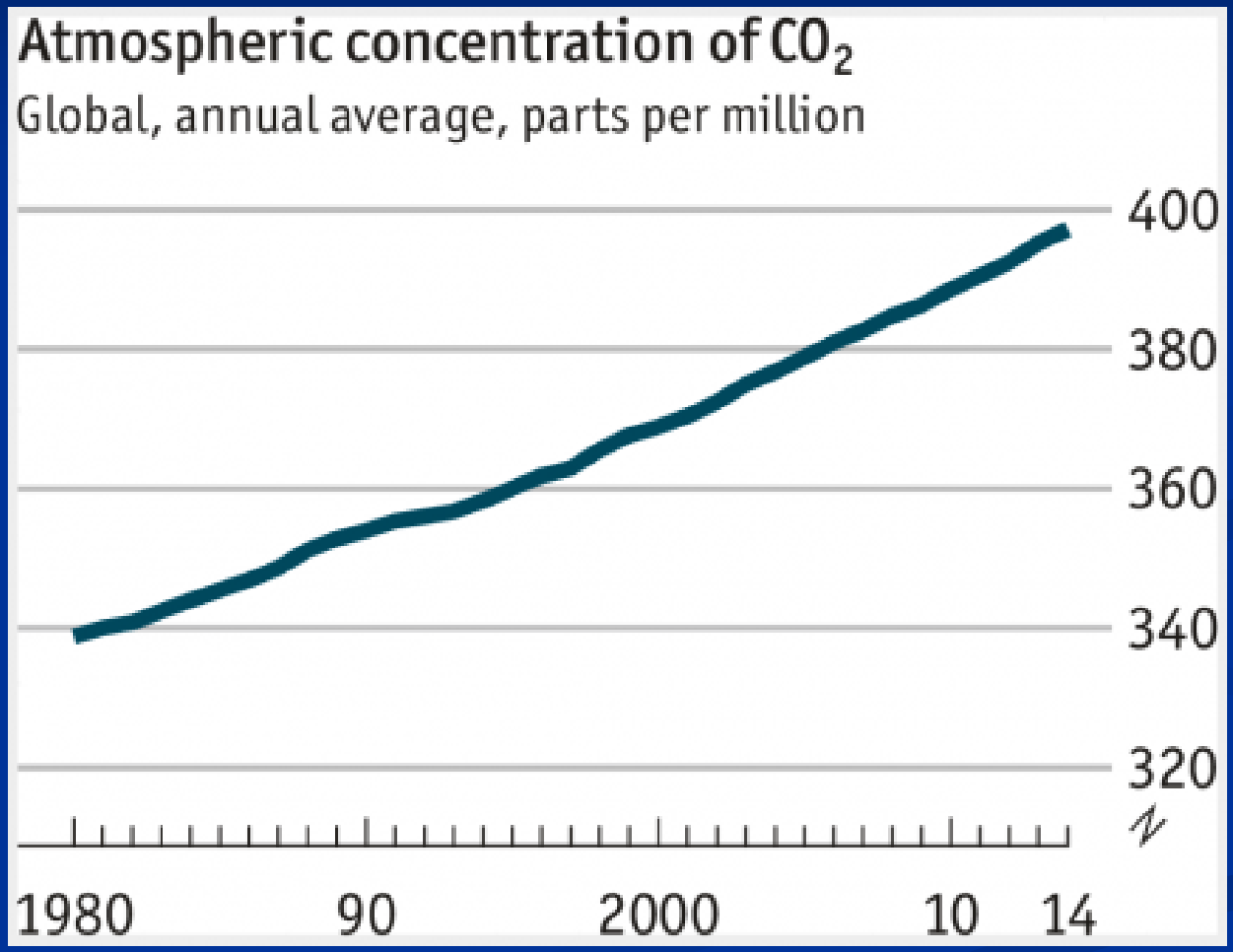
PRIMARY ENERGY CONSUMPTION PORTUGAL, 2018

[Source: Direcção-Geral de Energia e Geologia]



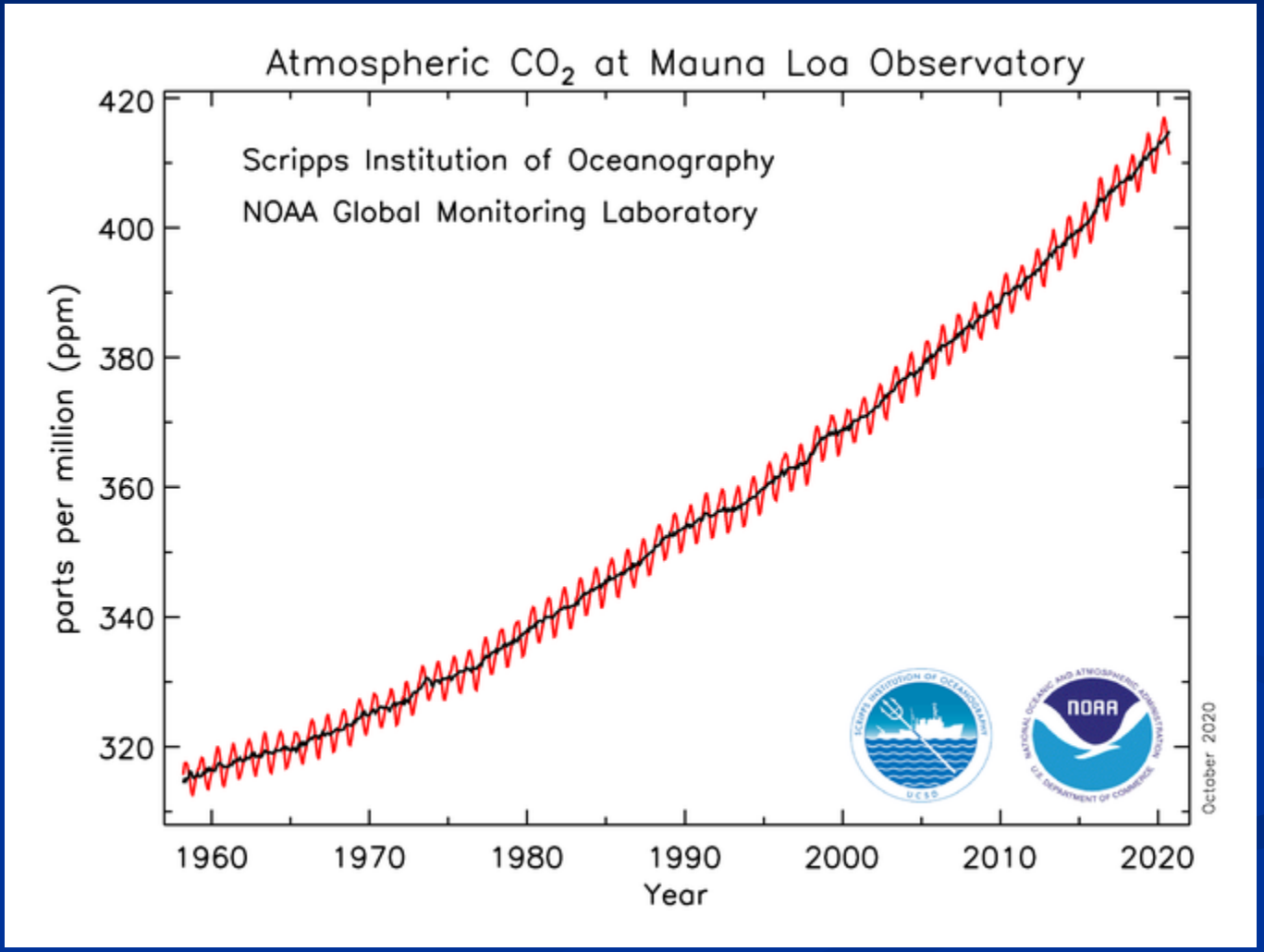
ATMOSPHERIC CONCENTRATION OF CO_2

[Source : NOAA]



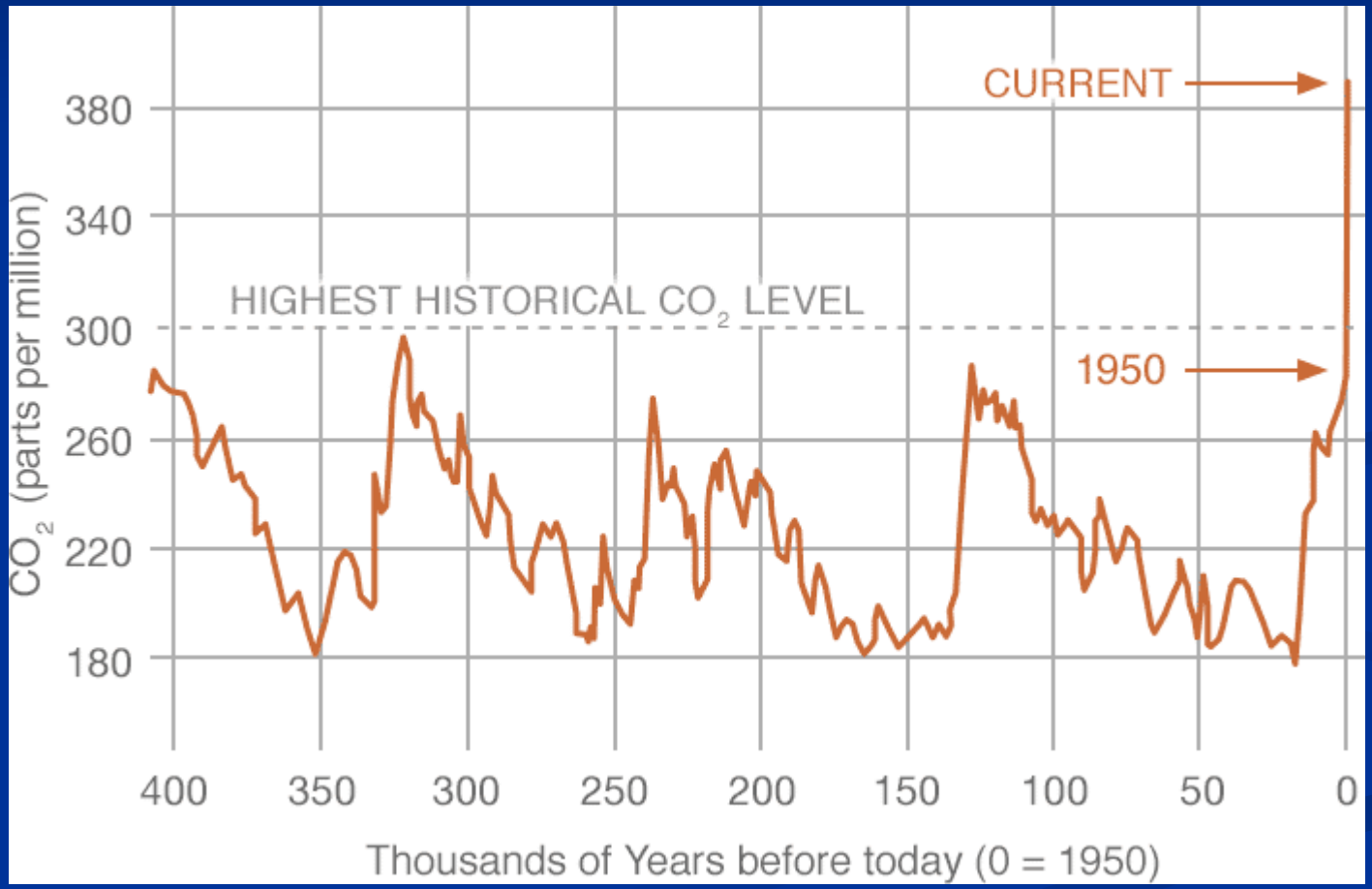
ATMOSPHERIC CONCENTRATION OF CO_2

[Source : NOAA]



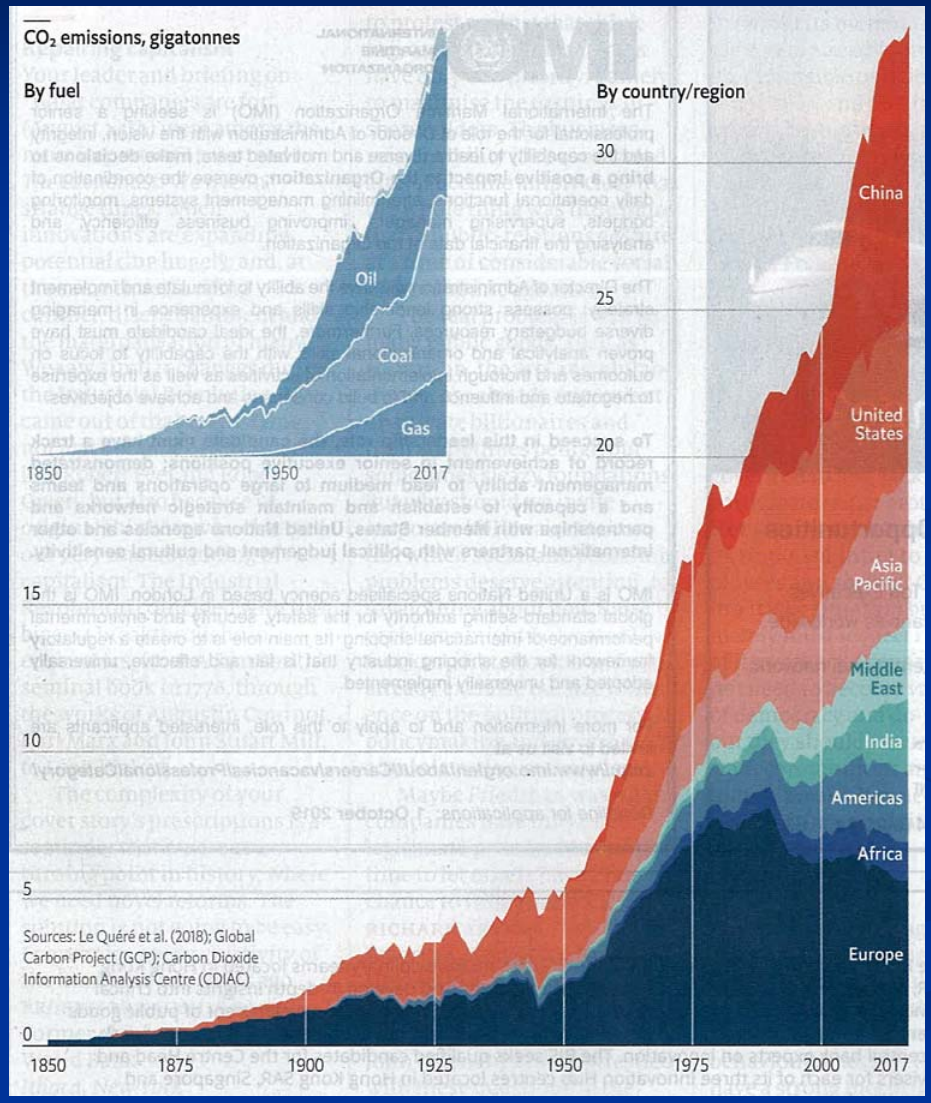
CO_2 CONCENTRATION (ppm)

[Source : NOAA]



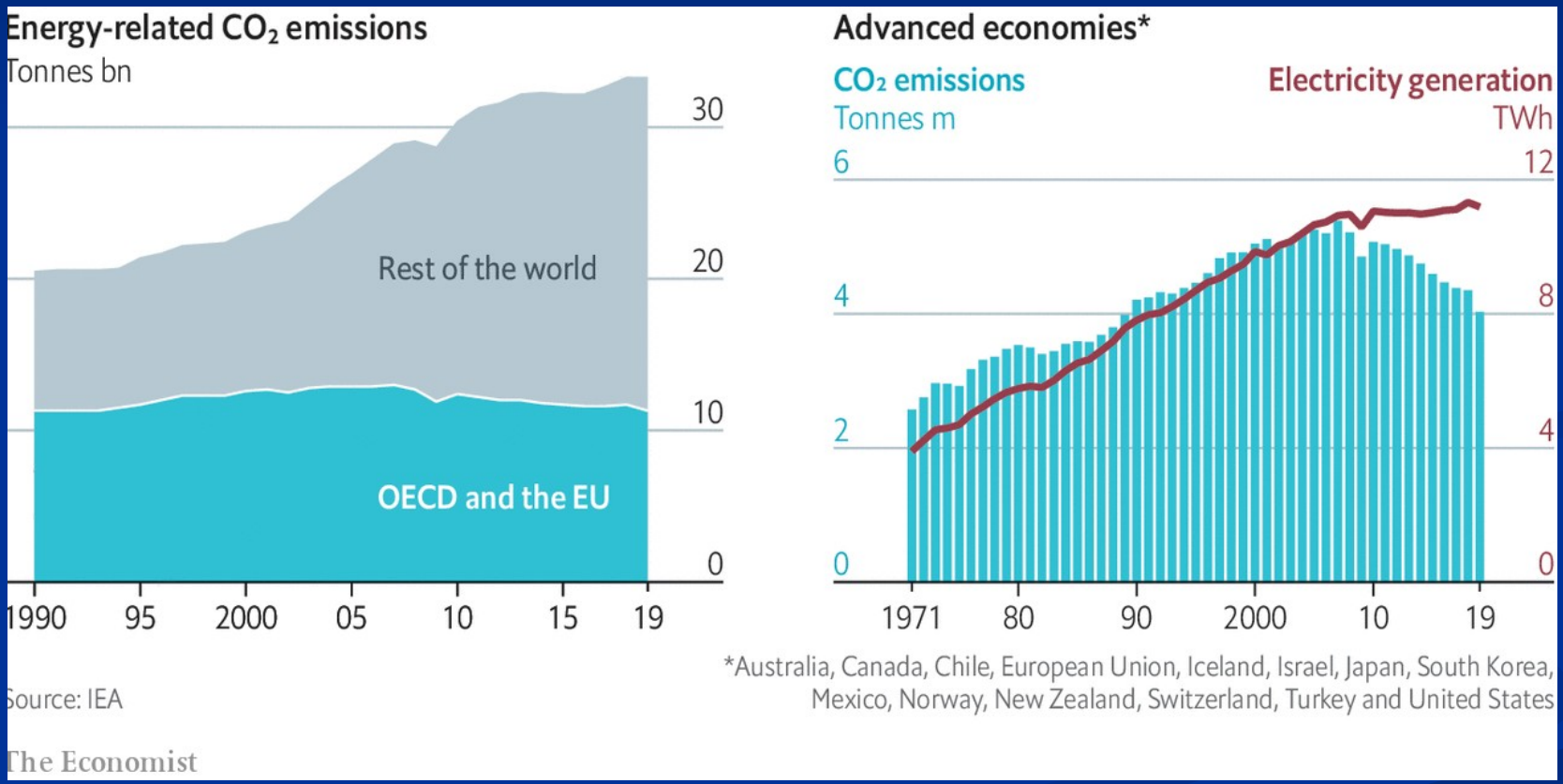
CO_2 EMISSIONS (Gton)

[Source : The Economist]



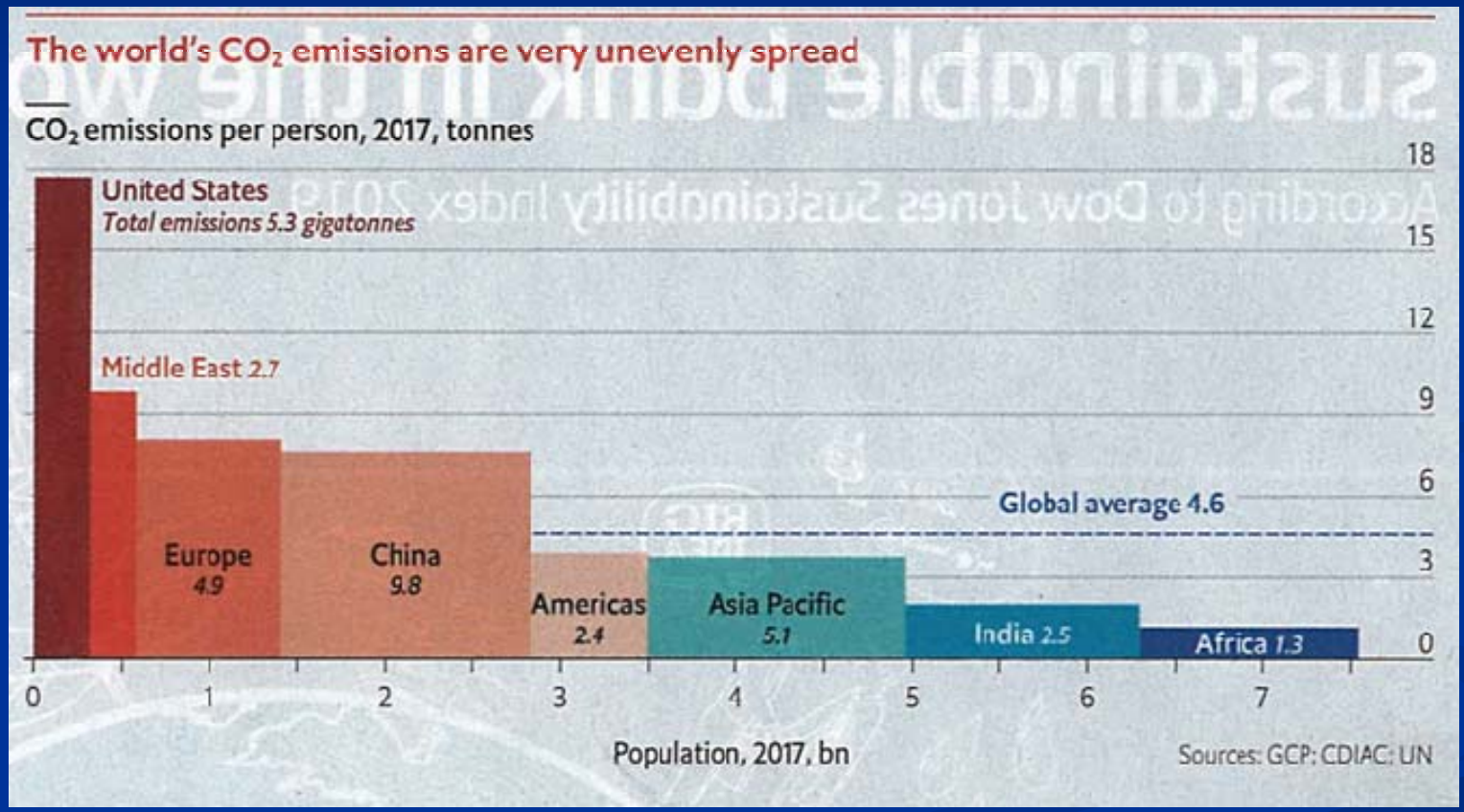
ENERGY-RELATED CO_2 EMISSIONS

[Source : The Economist]



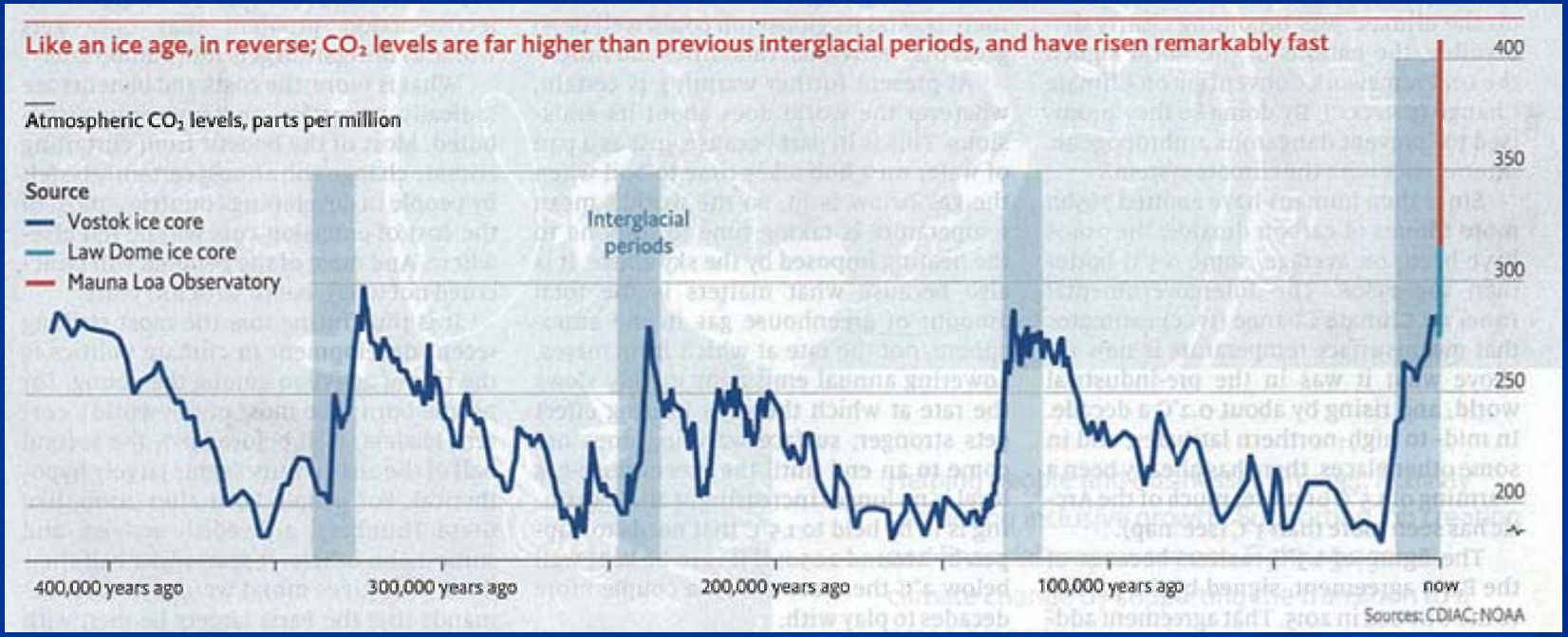
CO_2 EMISSIONS PER PERSON, 2017 (ton)

[Source : The Economist]



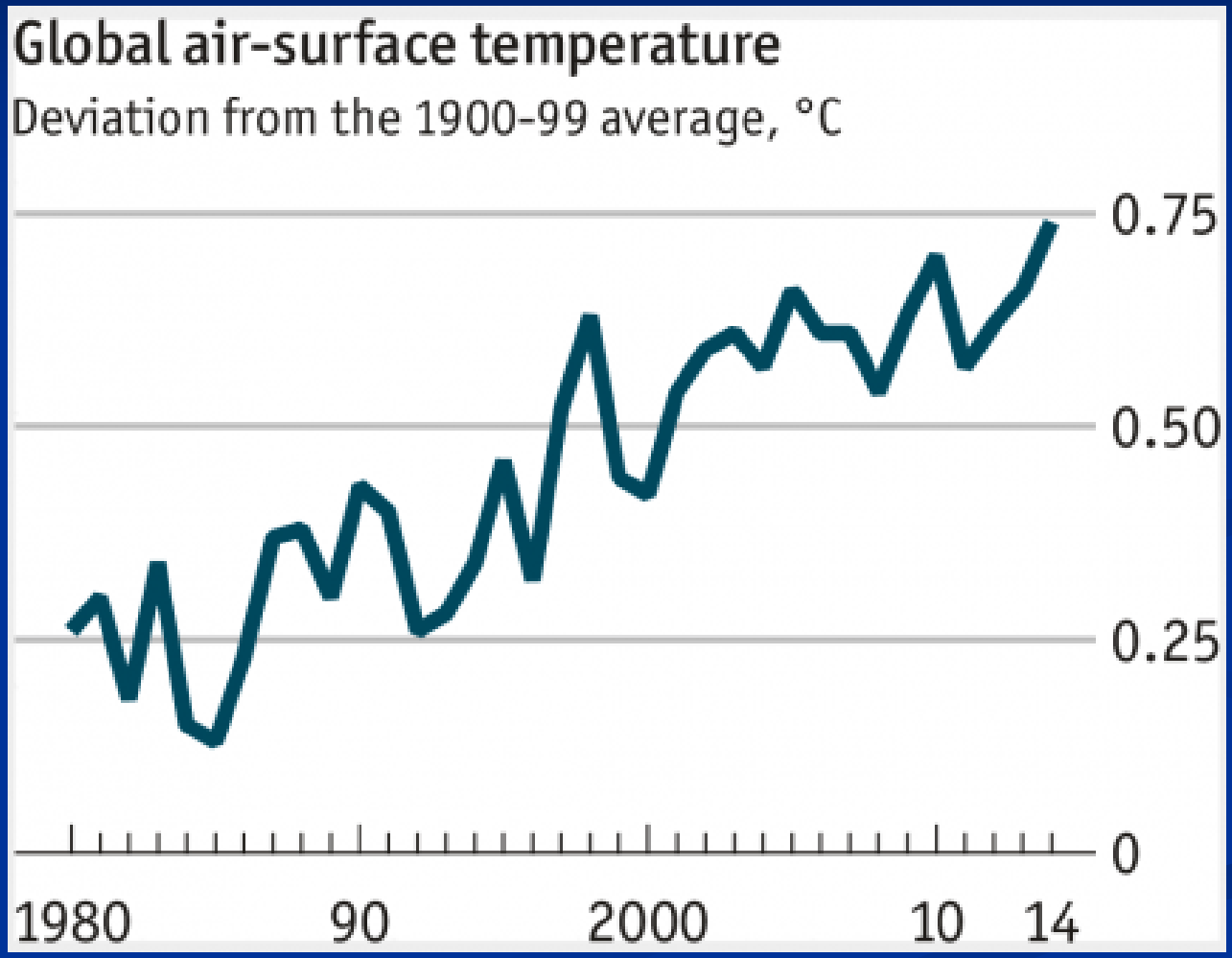
ATMOSPHERIC CO_2 LEVELS (ppm)

[Source : The Economist]



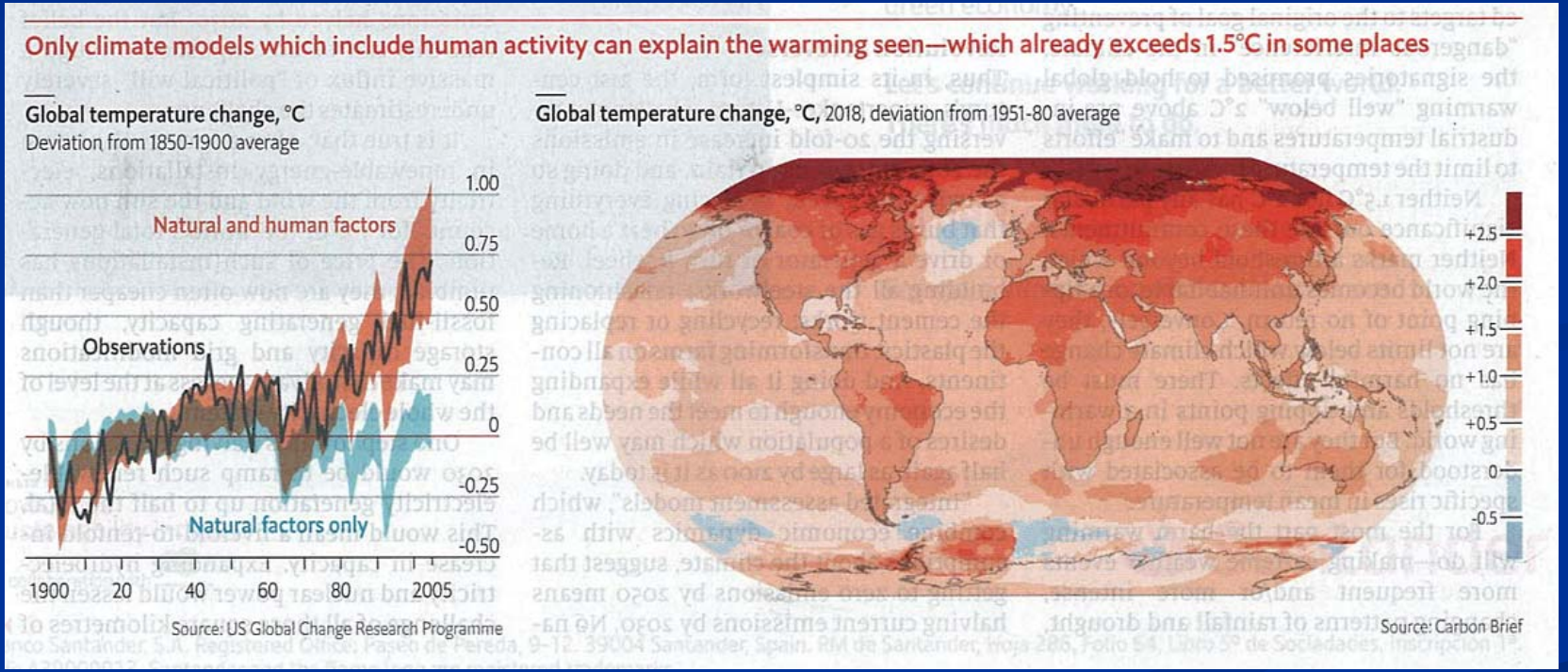
GLOBAL AIR-SURFACE TEMPERATURE

[Source : NOAA]



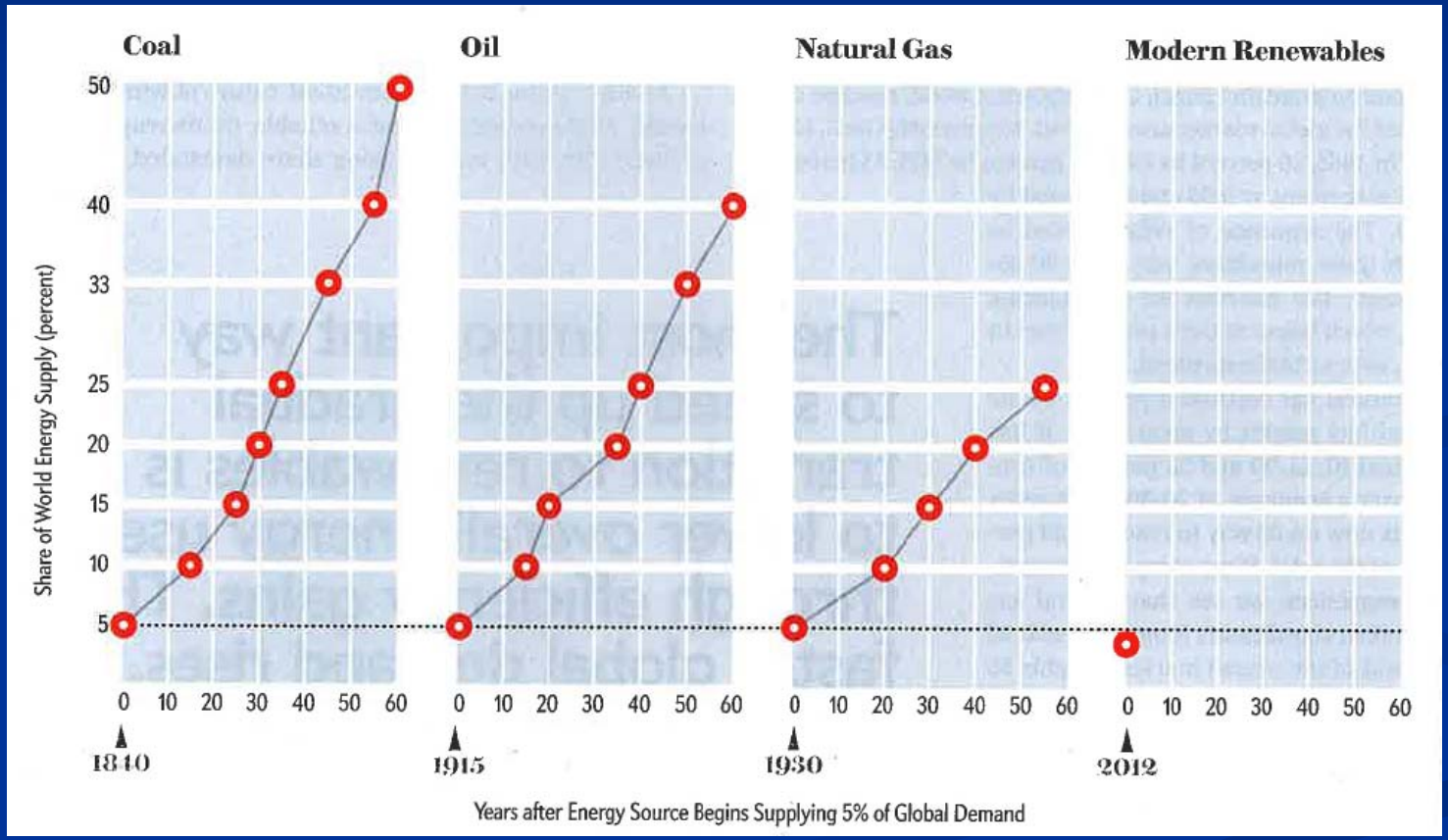
GLOBAL TEMPERATURE CHANGE (ºC)

[Source : The Economist]



SHARE OF WORLD ENERGY SUPPLY

[Source: Scientific American]



GRAPHIC SCIENCE

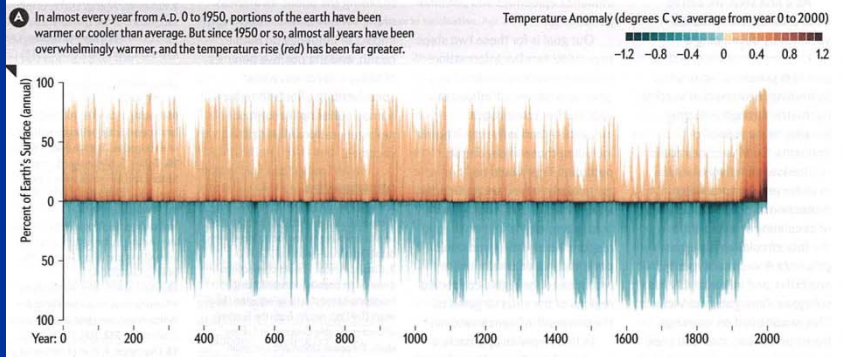
Text by Mark Fischetti | Graphic by Pitch Interactive

Climate Clincher

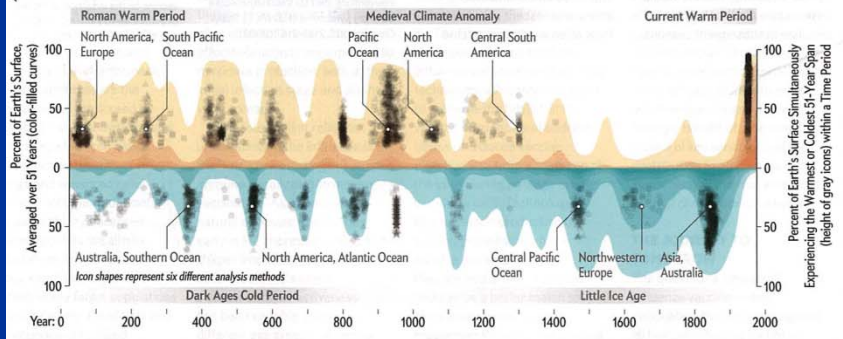
The argument that global warming is part of a natural cycle is dead

People who dismiss climate change often claim that the earth's warm-up is simply part of "natural climate variability." A paper published in July in *Nature* puts that argument to rest. The authors show that warm and cold years were regularly interspersed during the past 2,000 years (A) and that even the warmest and coldest periods were experienced only by isolated regions at a given time—never across the entire globe simultaneously (B). For example, the so-called Little Ice Age occurred in the 1400s across the central Pacific Ocean, in the 1600s across northwestern Europe and in the mid-1800s in other places. The warm Medieval Climate Anomaly occurred in the Pacific in the 900s, in North America in the 1000s and in central South America in the 1200s. But the current warm-up has taken place across 98 percent of the globe at the same time, from about 1900 through today. "It's completely different," states lead researcher Raphael Neukom of the University of Bern in Switzerland. All regions have heated up relentlessly, in unison.

(A) In almost every year from A.D. 0 to 1950, portions of the earth have been warmer or cooler than average. But since 1950 or so, almost all years have been overwhelmingly warmer, and the temperature rise (*red*) has been far greater.



(B) Six hundred analyses of 210 data sets from corals, glacier ice, lake sediments and other temperature markers worldwide are shown by icons. Only some coalesce during any time period from A.D. 0 to 1950; at most, 70 percent of the earth warmed or cooled. Since 1950, however, all 600 reconstructions have lined up; 98 percent of the planet has warmed at once—an unnatural variation.



Environment

Paris climate pact aims fading, warns IEA

Spending on renewables slips while investment in coal mining increases

ANJLI RAVAL AND LESLIE HOOK
LONDON

The world is moving in the opposite direction to the Paris climate pact goals, with investment in renewable energy falling for the second consecutive year in 2018 and spending on fossil fuel extraction rising, the world's energy watchdog has warned.

Spending on renewable power such as wind, solar and biomass projects slipped 1 per cent in real terms to $304bn in 2018, the lowest level since 2014, according to an International Energy Agency report yesterday.

Investment in coal mining rose by 2.6 per cent compared with the previous year, the first uptick since 2012, to $80bn, while capital expenditure in oil and gas extraction saw a 5.7 per cent increase to $477bn.

Under the Paris accord, nearly 200 countries pledged to limit global temperature rises to less than 2°C above pre-industrial levels.

"Compared to 2015 when the Paris climate agreement was signed, the appetite to push low carbon investments and policies is slowly fading," Fatih Birol, IEA executive director, said.

Last year, carbon dioxide emissions from human activities reached a record owing to increased fossil fuel consumption. Two-thirds of the world's capital investment in energy, which stood at $1.85tn last year, was spent on hydrocarbons, with the remaining third spent on low-carbon efforts such as renewables, nuclear and energy efficiency.

"If there was a bigger political will, we would have seen the numbers go the other way," Mr Birol said.

"I would put the responsibility of investment flows and which direction they go on the governments of the world."

The generation capacity of new renewable power projects was flat last year compared with the previous year, making 2018 the first year with no growth in new renewable installations since 2001.

This marks a big shift from previous years, which saw renewable power capacity increase even as investment levels were stagnant, owing to falling costs.

Between 2010 and 2018, the cost of new solar fell by 75 per cent and that of onshore wind turbines by 20 per cent, prompting a surge in renewable installations. However, that growth came to a halt last year, as China slashed solar subsidies and new renewables capacity fell in India and the EU.

Higher crude prices and rising appetite for investments in US shale production drove a jump in oil and gas spending. In an uncertain energy transition, big energy companies such as Royal Dutch Shell and ExxonMobil have been drawn to shale projects that require modest cash injections and less time to start up compared with the capital-intensive mega-projects of the past.

China remained the largest market for total energy spending and accounted for more than half the investment in coal mining, followed by India and Australia.

However, the IEA said its spending almost all went on sustaining production levels rather than opening new mines.


The Economist
The 90% economy, revisited
African pop culture goes global
In praise of citizens' assemblies
TikTok and the rise of Frankenfirms
21st century power
How clean energy will remake geopolitics

The Economist 19/09/2020

Power in the 21st century

Efforts to rein in climate change will up-end the geopolitics of energy

Oil fuelled the 20th century—its cars, its wars, its economy and its geopolitics. Now the world is in the midst of an energy shock that is speeding up the shift to a new order. As covid-19 struck the global economy earlier this year, demand for oil dropped by more than a fifth and prices collapsed. Since then there has been a jittery recovery, but a return to the old world is unlikely. Fossil-fuel producers are being forced to confront their vulnerabilities. ExxonMobil has been ejected from the Dow Jones Industrial Average, having been a member since 1928. Petrostates such as Saudi Arabia need an oil price of $70-80 a barrel to balance their budgets. Today it is scraping along at just $40.

There have been oil slumps before, but this one is different. As the public, governments and investors wake up to climate change, the clean-energy industry is gaining momentum. Capital markets have shifted: clean-power stocks are up by 45% this year. With interest rates near zero, politicians are backing green-infrastructure plans. America's Democratic presidential contender, Joe Biden, wants to spend $2trn decarbonising America's economy. The European Union has earmarked 30% of its $880bn covid-19 recovery plan for climate measures, and its president, Ursula von der Leyen, used her state-of-the-union address this week to confirm that she wants the EU to cut greenhouse-gas emissions by 55% over 1990 levels in the next decade.

The 21st-century energy system promises to be better than the oil age—better for human health, more politically stable and less economically volatile. The shift involves big risks. If disorderly, it could add to political and economic instability in petrostates and concentrate control of the green-supply chain in China. Even more dangerous, it could happen too slowly.

Today fossil fuels are the ultimate source of 85% of energy. But this system is dirty. Energy accounts for two-thirds of greenhouse-gas emissions; the pollution from burning fossil fuels kills over 4m people a year, mostly in the emerging world's mega-cities. Oil has also created political instability. For decades petrostates such as Venezuela and Saudi Arabia, with little incentive to develop their economies, have been mired in the politics of handouts and cronyism. In an effort to ensure secure supplies, the world's big powers have vied to influence these states, not least in the Middle East, where America has roughly 60,000 troops. Fossil fuels cause economic volatility, too. Oil markets are buffeted by an erratic cartel. Concentration of the world's oil reserves makes supply vulnerable to geopolitical shocks. Little wonder that the price has swung by over 30% in a sixth-month period 62 times since 1970.

A picture of the new energy system is emerging. With bold action, renewable electricity such as solar and wind power could rise from 5% of supply today to 25% in 2035, and nearly 50% by 2050. Oil and coal use will drop, although cleaner natural gas will remain central. This architecture will ultimately bring huge benefits. Most important, decarbonising energy will avoid the chaos of unchecked climate change, including devastating droughts, famine, floods and mass dislocation. Once mature, it should be more politically stable, too, because supply will be diversified, geographically and technologically. Petrostates will have to attempt to reform themselves and, as their governments start to depend on taxing their own citizens, some will become more representative. Consuming countries, which once sought energy security by meddling in the politics of the oil producers, will instead look to sensible regulation of their own power industry. The 21st-century system should also be less economically volatile. Electricity prices will be determined not by a few big actors but by competition and gradual efficiency gains.

Yet even as a better energy system emerges, the threat of a poorly managed transition looms. Two risks stand out. Autocratic China could temporarily gain clout over the global power system because of its dominance in making key components and developing new technologies. Today Chinese firms produce 72% of the world's solar modules, 69% of its lithium-ion batteries and 45% of its wind turbines. They also control much of the refining of minerals critical to clean energy, such as cobalt and lithium. Instead of a petrostate, the People's Republic may become an "electrostate". In the past six months it has announced investments in electric-car infrastructure and transmission, tested a nuclear plant in Pakistan and considered stockpiling cobalt.

China's leverage depends on how fast other economies move (see briefing). Europe is home to giant developers of wind and solar farms—Orsted, Enel and Iberdrola are building such projects around the world. European firms are leading the race to cut their own emissions, too. America's trajectory has been affected by the rise of shale oil and gas, which has made it the world's largest oil producer, and by Republican resistance to decarbonisation measures. If America were to act on climate change—with, say, a carbon tax and new infrastructure—its capital markets, national energy laboratories and universities would make it a formidable green power.

The other big risk is the transition of petrostates, which account for 8% of world GDP and nearly 900m citizens. As oil demand dwindles, they will face a vicious fight for market share which will be won by the countries with the cheapest and cleanest crude. Even as they grapple with the growing urgency of economic and political reform, the public resources to pay for it may dwindle. This year Saudi Arabia's government revenue fell by 49% in the second quarter. A perilous few decades lie ahead.

Faced with these dangers, the temptation will be to ease the adjustment, by taking the transition more slowly. However, that would bring about a different, even more destabilising set of climate-related consequences. Instead, as our special report in this issue explains, the investments being contemplated fall drastically short of what is needed to keep temperatures within 2°C of pre-industrial levels, let alone the 1.5°C required to limit the environmental, economic and political turmoil of climate change. For example, annual investment in wind and solar capacity needs to be about $750bn, triple recent levels. And if the shift towards fossil-fuel-free renewable energy accelerates, as it must, it will cause even more geopolitical turbulence. The move to a new energy order is vital, but it will be messy. ■