



GREEN ENERGY TRANSITION- Technology Know-how from Germany

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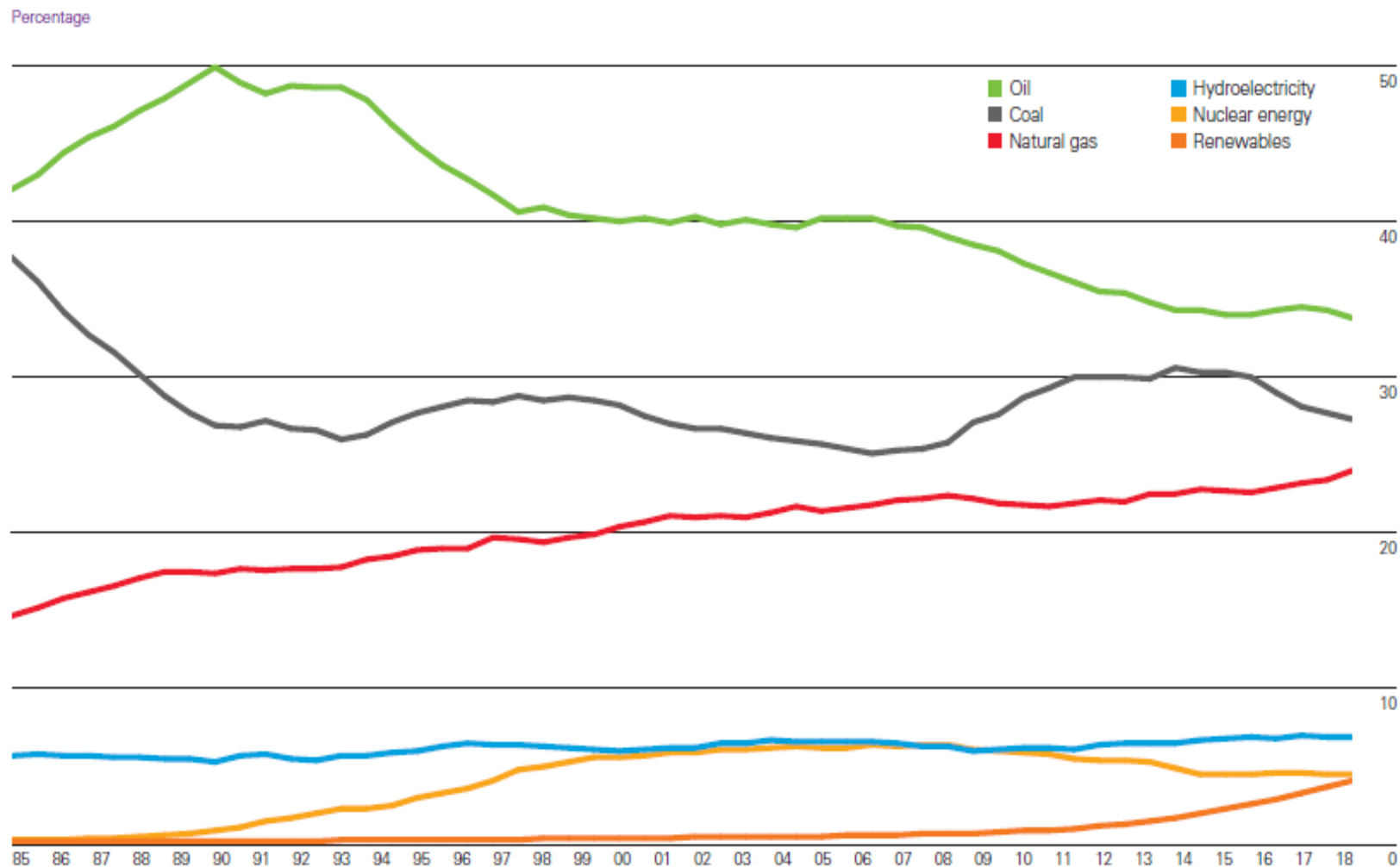
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WORLD ENERGY SCENARIO

Share of Global Primary Energy Consumption- by fuel



Oil remains the most used fuel in the energy mix. Coal is the second largest fuel but lost share in 2018 to account for 27%, its lowest level in 15 years. The share of natural gas increased to 24% such that the gap between coal and gas has narrowed to three percentage points. The contribution of hydro and nuclear remained relatively flat in 2018 at 7% and 4%, respectively. Strong growth pushed up renewables share to 4%, just behind nuclear.

Source: BP Statistical Review of World Energy 2019

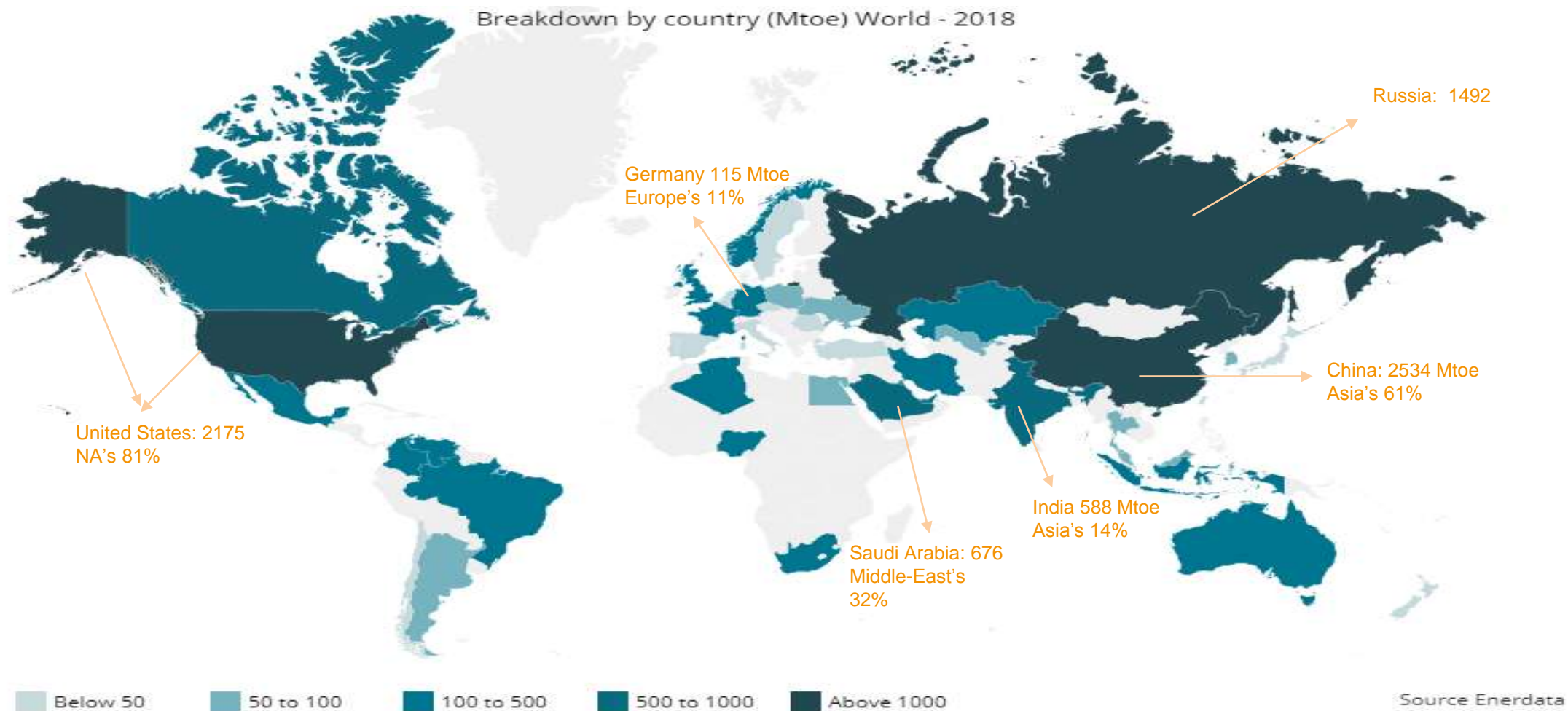
Key Takeaways - 2018

- » Global energy consumption grew at a rate of 2.9% last year, almost double its 10-year average of 1.5% per year, and the fastest since 2010
- » Renewable power grew by 14.5%, slightly below its historical average.
- » Solar generation grew by 30 mtoe, just below the increase in wind (32 mtoe), and provided more than 40% of renewables growth.
- » Hydroelectric generation increased by an above-average 3.1%.
- » The improvement in energy efficiency was significantly lower in 2018 than some years earlier – the energy intensity of the global economy only improved by 0.8%.
- » Carbon emissions grew by 2.0%, the fastest growth for seven years



- » Global oil production rose by 2.2 million b/d. Oil consumption grew by an above-average 1.4 million barrels per day (b/d), or 1.5%.
- » Coal consumption grew by 1.4%. Coal's share in primary energy fell to 27.2%, its lowest in fifteen years. Global coal production rose by 162 mtoe, or 4.3%.
- » Natural gas consumption rose by 195 billion cubic metres (bcm), or 5.3%, one of the fastest rates of growth since 1984. Global natural gas production increased by 190 bcm, or 5.2%.
- » Nuclear generation rose by 2.4%.
- » Electricity generation rose by an above-average 3.7% and the share of renewables in power generation increased from 8.4% to 9.3%. Coal still accounted for the largest share of power generation at 38%.

Global Primary Energy Production- by region in 2018



Source: Enerdata, Global Energy Statistical Yearbook 2019

Global Primary Energy Demand-by fuel

World primary energy demand by fuel type, 2018–2040

	Levels <i>mboe/d</i>				Growth <i>mboe/d</i>	Growth <i>% p.a.</i>	Share of global energy demand <i>%</i>			
	2018	2020	2030	2040			2018–2040	2018–2040	2018	2020
Oil	90.1	92.1	98.6	100.7	10.6	0.5	31.5	31.4	30.0	28.2
Coal	75.9	76.2	77.3	76.8	0.9	0.1	26.6	26.0	23.5	21.5
Gas	65.5	67.4	79.7	90.3	24.7	1.5	22.9	23.0	24.2	25.2
Nuclear	14.3	15.1	18.5	21.8	7.5	1.9	5.0	5.2	5.6	6.1
Hydro	7.3	7.5	8.9	10.2	3.0	1.6	2.5	2.6	2.7	2.9
Biomass	27.5	28.3	31.7	34.5	7.0	1.0	9.6	9.7	9.7	9.6
Other renewables	5.3	6.6	14.1	23.2	17.9	6.9	1.9	2.3	4.3	6.5
Total	285.8	293.3	328.8	357.5	71.7	1.0	100.0	100.0	100.0	100.0

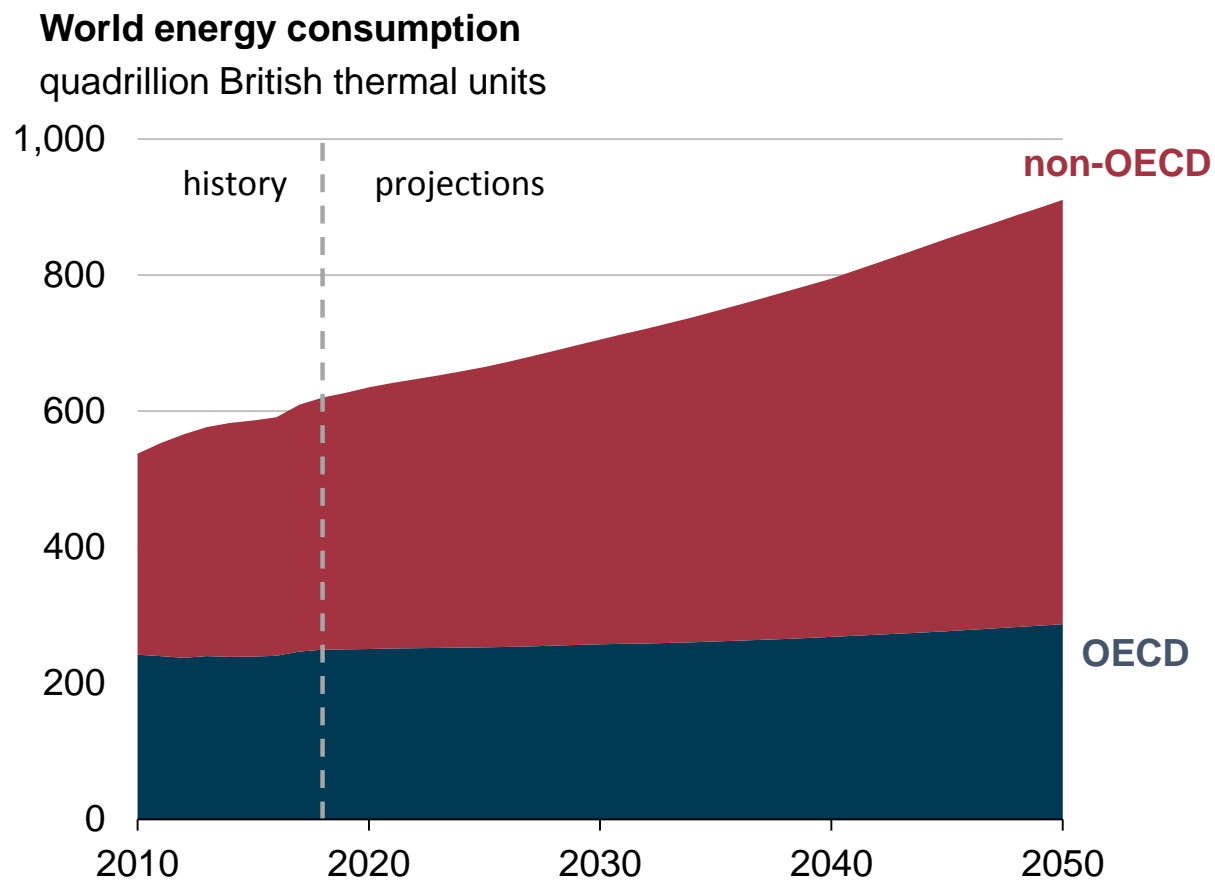
Source: OPEC.

Global primary energy demand is forecast to increase by 72 mboe/d in the period to 2040.

Oil and Coal are expected to lose 3 and 5 pp of their market share respectively by 2040. The share of gas is anticipated to rise by less than 2.5 pp and other renewables by 4.5 pp. Nonetheless, oil is forecasted to remain the dominant fuel source.

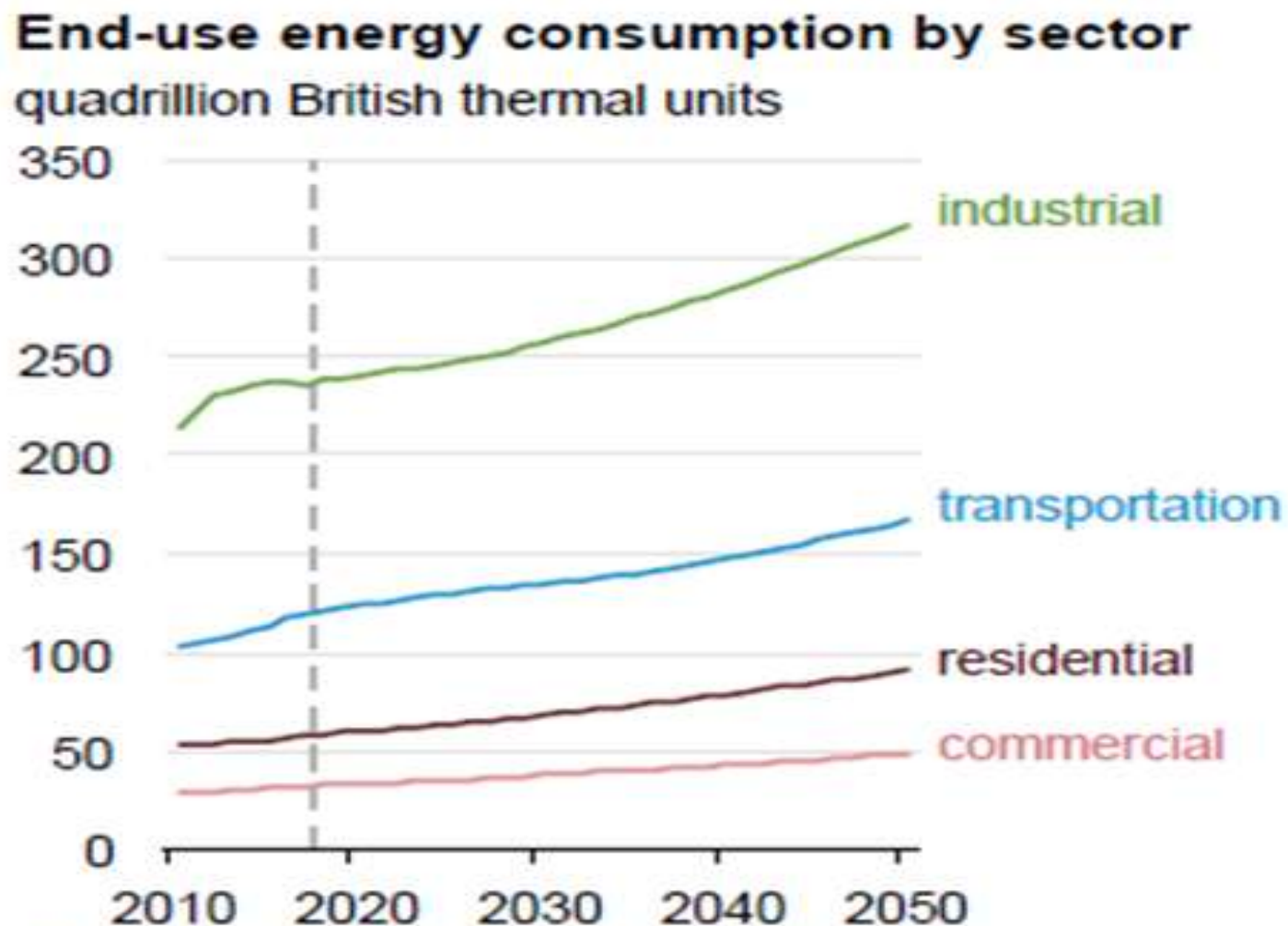
A gradual shift away from coal and oil toward renewables and gas is being driven by policies and initiatives focused on increasing the share of cleaner fuels in the energy mix, particularly in power generation.

Future Projections (2018-2050)—(1/2)



- » World energy consumption is to rise nearly 50% between 2018 & 2050 with 70% of the increase from non-OECD countries
- » The industrial sector is the largest consumer of energy— and constitutes more than half of global energy consumption.
- » Renewable energy becomes the leading source of primary energy consumption by 2050 in the Reference case— although consumption increases for all primary energy sources.
- » **The Dual Challenge:** As energy is essential for human development, society faces a dual challenge: to provide reliable and affordable energy to a growing population, while reducing environmental impacts, including the risks of climate change.

Future Projections—(2/2)



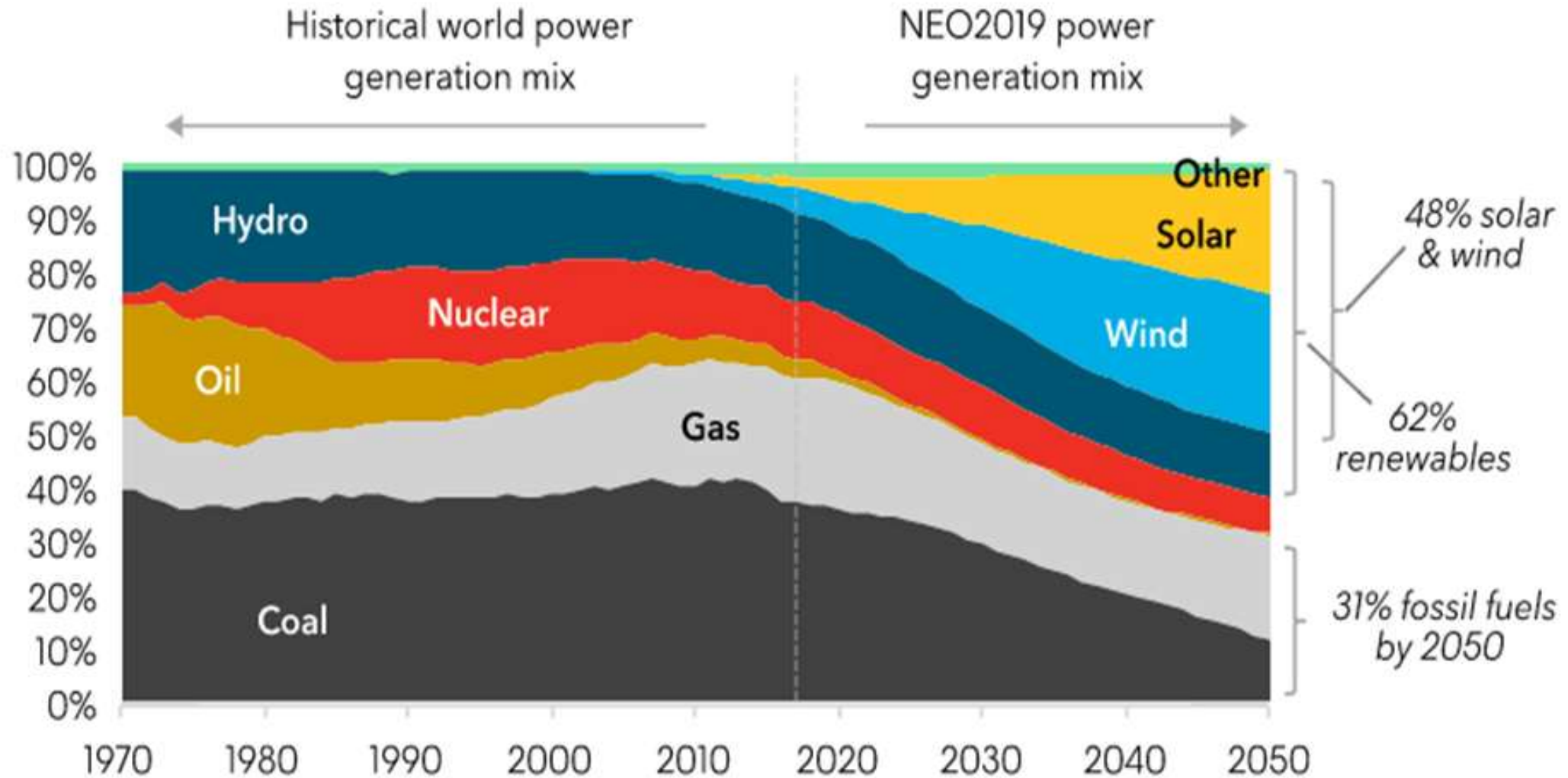
Source: U.S. Energy Information Administration, *International Energy Outlook 2019*

The industrial sector is the largest consumer of energy— and constitutes more than half of global energy consumption

The Dual Challenge

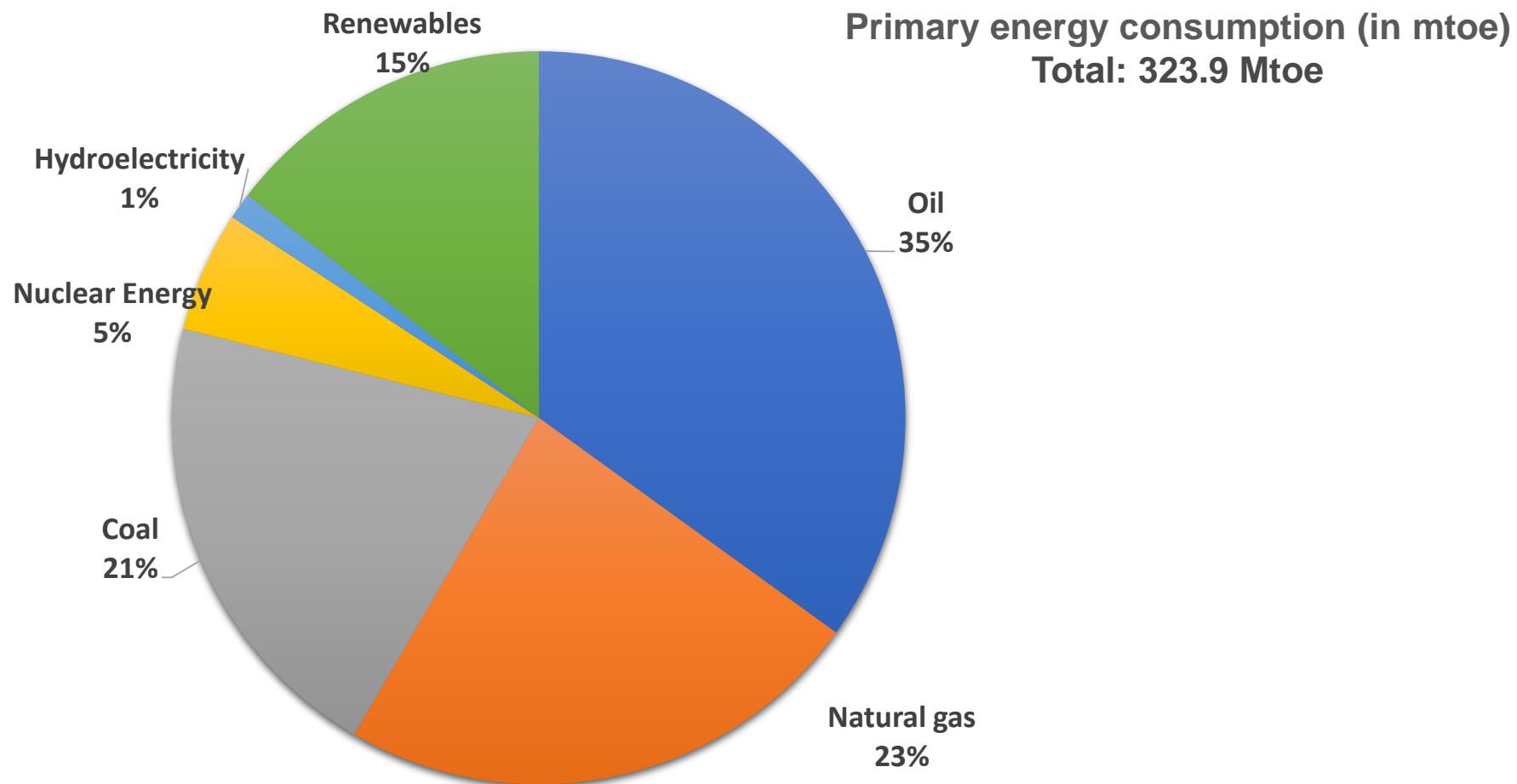
As energy is essential for human development, society faces a dual challenge: to provide reliable and affordable energy to a growing population, while reducing environmental impacts, including the risks of climate change.

Global Power Generation Mix



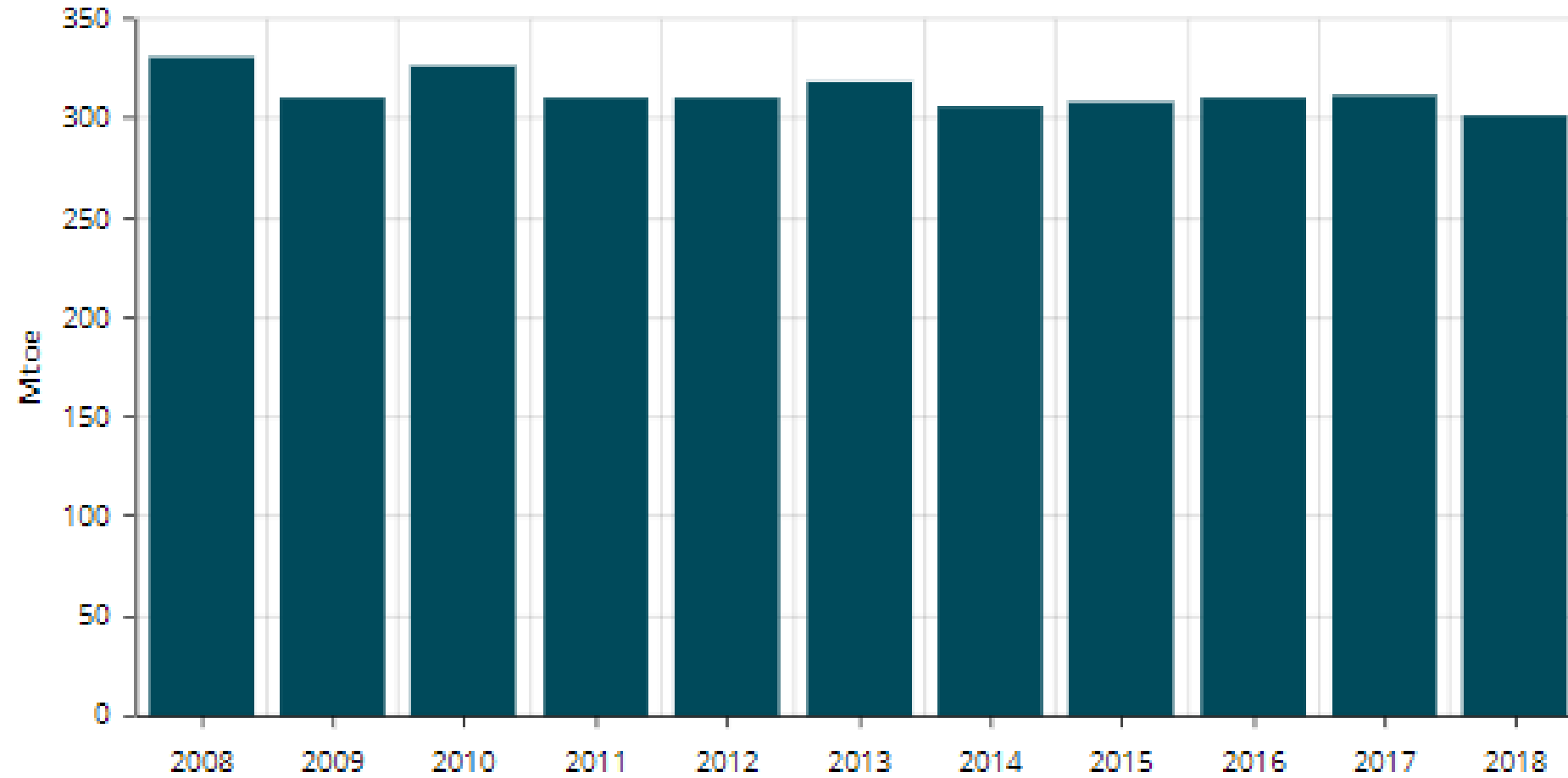
ENERGY MARKET SITUATION IN GERMANY

German Energy Mix 2018: Energy sources share in primary energy consumption

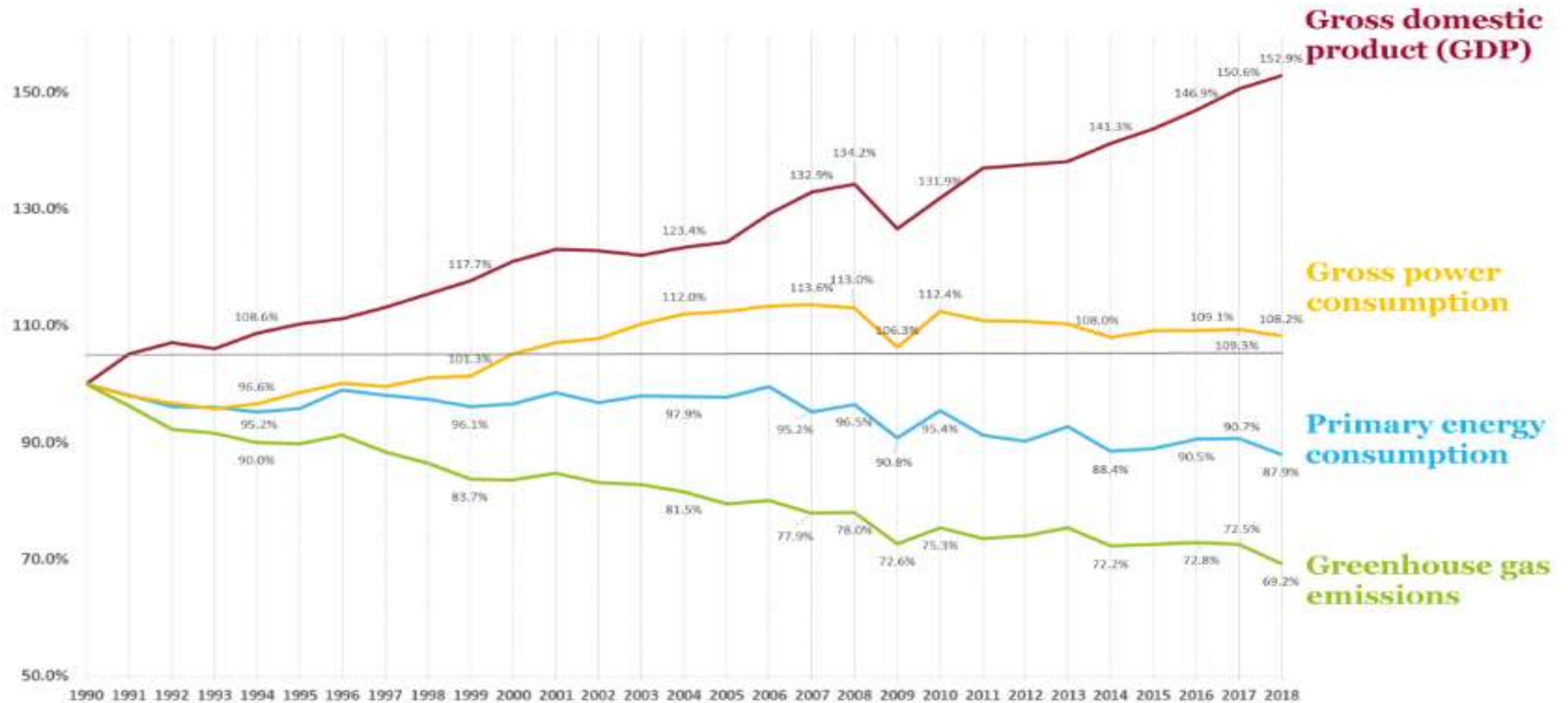


Source: BP Statistical Review of World Energy 2019

Energy Consumption, 2008-18



Economic Growth, energy consumption and GHG emissions 1990-2017



Source: Clean Energy Wire

The German Energy Transition



Federal Ministry
for Economic Affairs
and Energy



The German energy transition

*We have decided to fundamentally alter Germany's energy supply: away from nuclear energy and fossil fuels and towards renewable energy. **By 2025, at least 40 to 45 % of our energy is to be sourced from renewable energy, and we want to raise this to at least 80% by 2050.** Also, we are aiming to use energy more and more efficiently.*

This is quite a challenge for Germany !

.... and it is both a challenge & a chance for German process technology industry !

German energy targets

Nations Unies

Conférence sur les Changements Climatiques

COP21/CMP11

Paris France



The targets of the German energy transition



	2017	2020	2030	2050
GHG-reduction (baseline 1990)	- 27,5%	at least -40%	at least -55%	-80 to -95%
RES Share of gross electricity consumption	36%	at least 35%	at least 50%	at least 80%
Energy productivity	1,0% p.a. (2008-2017)	2,1% p.a. (2008-2050)		
Energy consumption in buildings (baseline 2008)	-18,8%	—————→		80%
Energy consumption transport (baseline 2005)	- 6,5%	-10%	—————→	- 40%


Decoupling of economic growth and energy consumption

The economy is growing, while energy consumption is falling

Development of gross domestic product and primary energy consumption

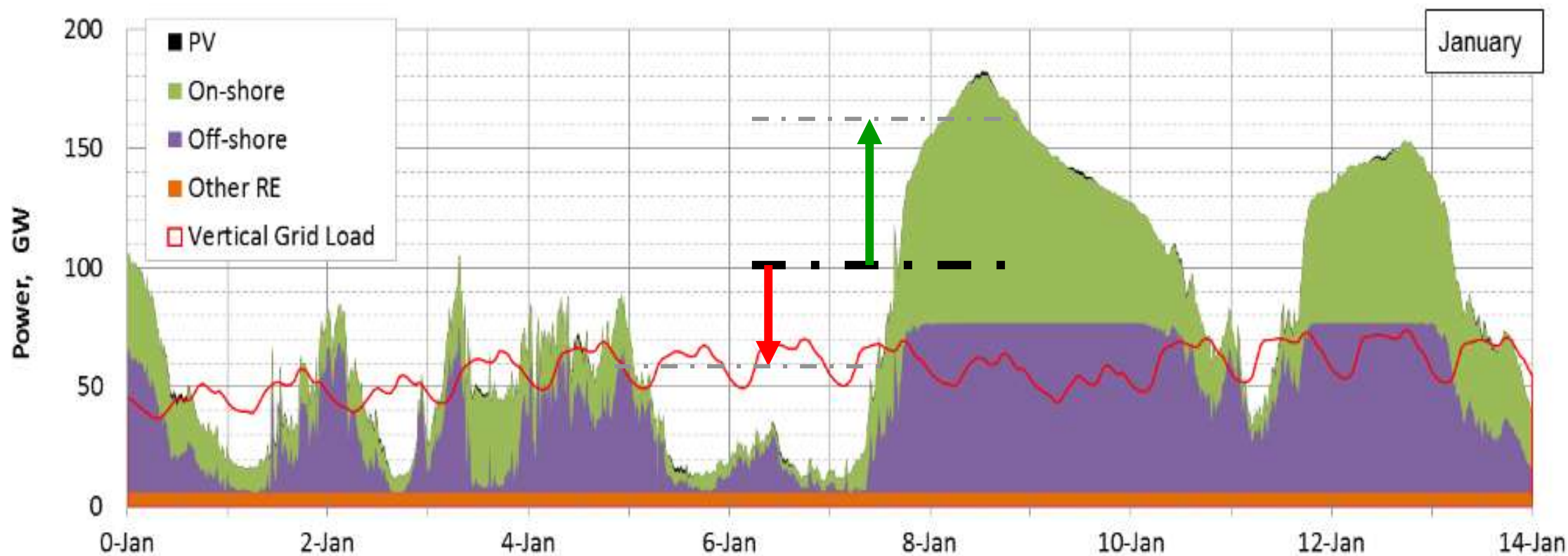


 Gross domestic product in billions of euros.
+1.4% per year on average since 1990.

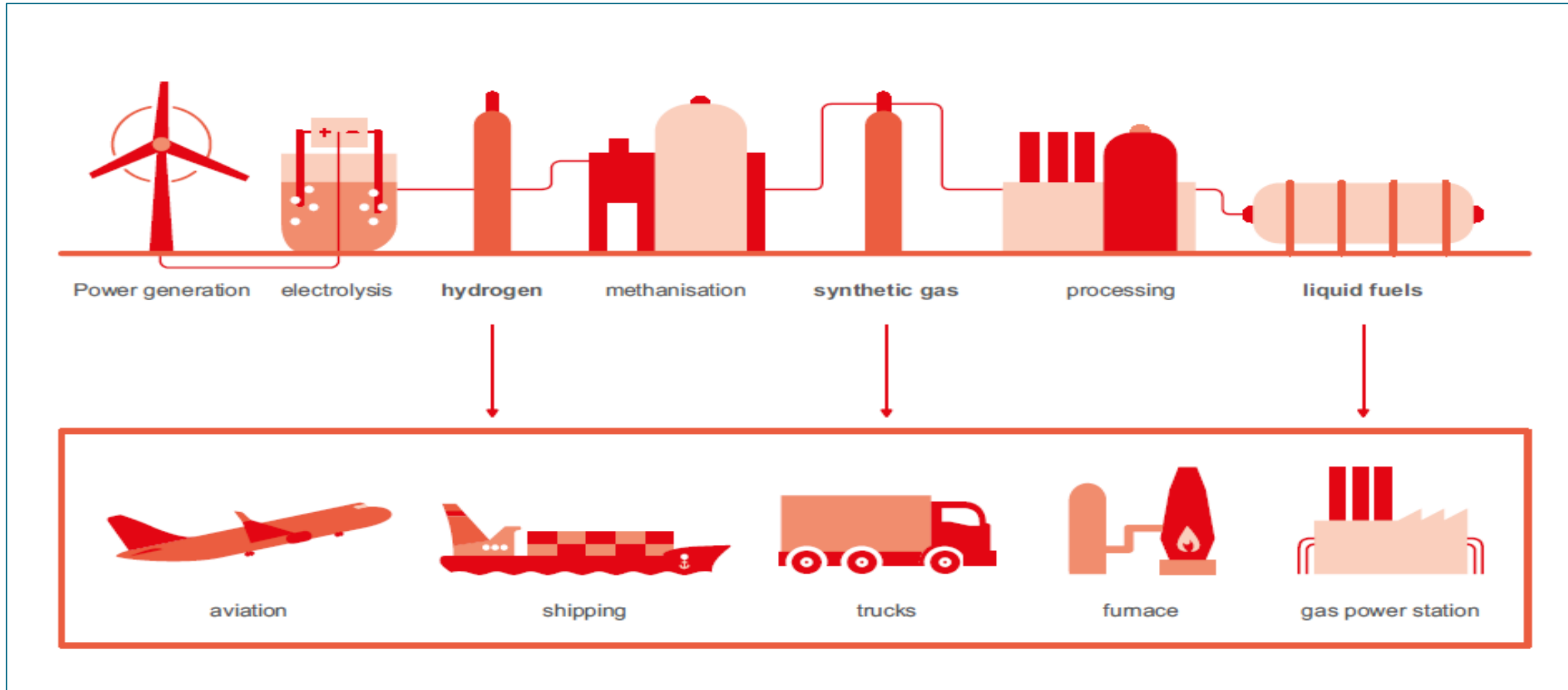
 Primary energy consumption in petajoules.
-0.5% per year on average since 1990.

Focus on wind and solar energy requires efficient storage of excess energy

Energy sector needs to build capacity to allow storage of surplus energy for each sector



Pathways of power-to-X and its applications



Pathways of power-to-X and its applications



ABOUT US



German Engineering Federation (VDMA)

Where ever you are, **We are there for you**



Largest Industrial Association in Europe



More than 3250 Members which stands for:

- **1,031,000** Employees
- **€ 232 Billion** production
- **78%** Export rate (approx.)



127 year old history



38 Specialized Sectors



Offices/Subsidiaries in:

- India
- China
- Brazil
- CIS
- Japan
- Belgium



125 YEARS
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Mr. Rajesh Nath-Felicited with „Cross of the Order of Merit“ – Highest Civilian honour by German Government



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The conflicting goals of the energy transition



As energy is essential for human development, society faces a dual challenge: to provide reliable and affordable energy to a growing population, while reducing environmental impacts, including the risks of climate change.