

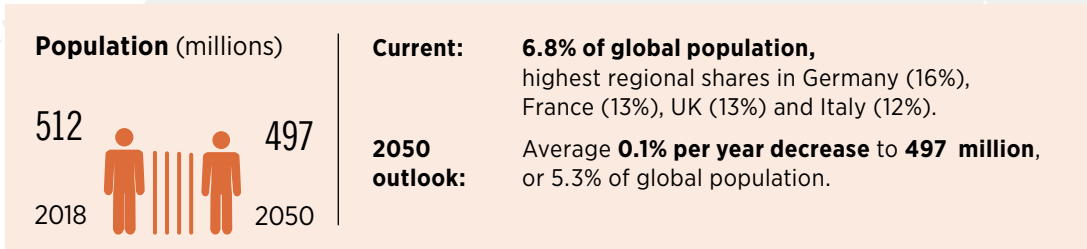
# ENERGY TRANSFORMATION

# EUROPEAN UNION

Regional analysis covers 28 member countries\*:

- Austria
- Estonia
- Italy
- Romania
- Belgium
- Finland
- Latvia
- Slovakia
- Bulgaria
- France
- Lithuania
- Slovenia
- Croatia
- Hungary
- Luxembourg
- Spain
- Cyprus
- Germany
- Malta
- Sweden
- Czech Republic
- Greece
- Poland
- Netherlands
- Denmark
- Ireland
- Portugal
- United Kingdom (UK)\*

## STATUS/CHARACTERISTICS AND NEEDS:



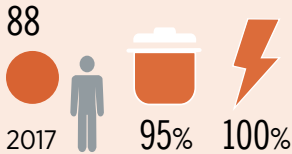
IRENA analysis based on E3ME.



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\* The UK officially exited the European Union (EU) in January 2020. Since the analysis was based on developments until April 2019, this report considers the UK as part of the EU.

### Energy consumption (GJ/capita) and energy access (%)



### Energy consumption per capita:

**Current: well above the global average** (51 GJ/year).

### Electricity access:

The region has long achieved full electrification and access to electricity.

### Clean cooking access:

There remains some marginal use of inefficient biomass cookstoves, particularly in rural areas.

Source: Access to electricity, 2017 values (World Bank Group, 2019a), access to clean cooking, 2016 values (World Bank Group, 2019b), TFEC, 2017 values (IEA, 2019), 2050 values based on IRENA analysis.

### Fossil fuel net import



### Current status:

**Very limited domestic fossil fuel resources** compared to primary energy consumption; heavy dependence on imported oil (93% of oil supply) and gas (79% of gas supply).

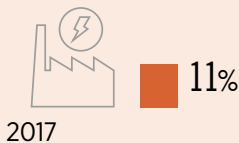
### 2050 outlook:

**Improved regional energy security;** the region has planned to be **climate-neutral** by 2050.

► **PES:** The total generation (est. 3796 TWh) represents **15%** of overall renewable power potential.

Note: IRENA analysis based on proportion of net imports of fossil fuels in TPES, 2017 values (IEA, 2019). 2050 outlook, IRENA analysis and potential based on Deng *et al.* (2015).

### Energy-intensive industries (% in global consumption)



### Current status:

Accounts for about **20% of global energy demand for pulp and paper, 17% for food and tobacco, about 11% for chemical and petrochemical industry** and the share in the **metals and minerals industry** accounts to roughly **9%**.

### 2050 outlook:

Need for urgent **emissions reduction** in heavy industries.

Note: Current status, IRENA analysis based on 2017 values (IEA, 2019).

### Energy-related CO<sub>2</sub> emissions per capita (tCO<sub>2</sub>/capita)



### Recent:

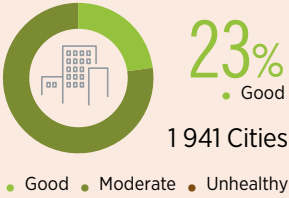
**Region's annual emissions: 3.3 Gt** (2018). 10% of global energy-related emissions.

### 2050 outlook:

► **PES: Drop by 41% to 1.9 Gt** with enabling policies; Reductions driven by improvements in energy intensity and the adoption of renewable energy.

Note: 2050 values based on IRENA analysis and historical data based on Global Carbon Atlas (2019).

**Urban air quality (%)**



Air pollution moderate to unhealthy in about 75% of the EU cities, mainly from transport (passenger cars, trucks).

IRENA analysis based on PM 2.5 concentration, 2016 and 2017 values (WHO, 2019).

**Electricity prices and renewables costs**

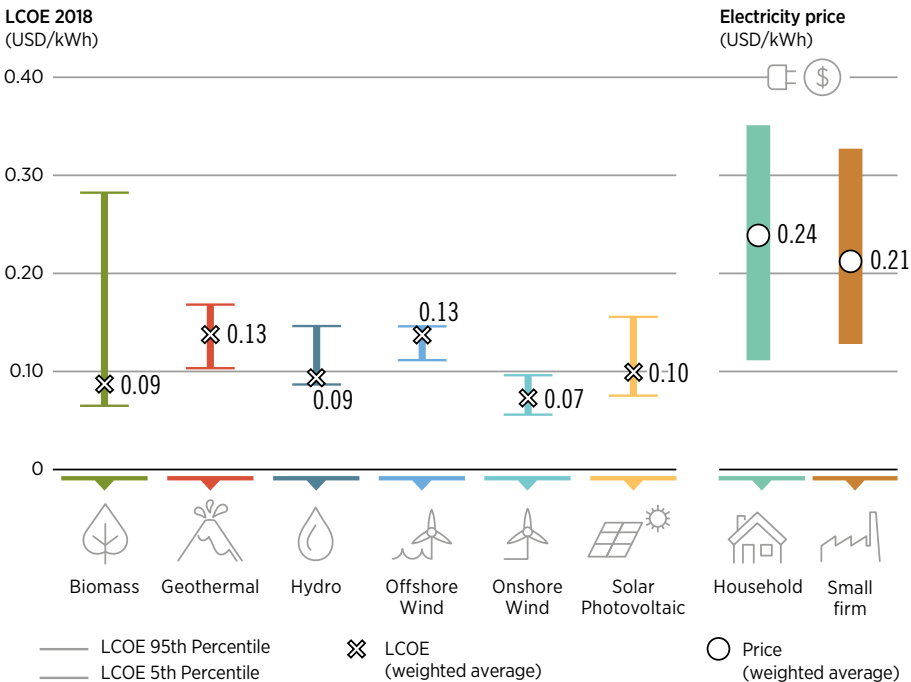
**Electricity price:**

**The highest values for households and the second-highest for industries compared to the other regions**

**Renewables cost and auctions:**

**Cost-competitive**, or even least cost, when compared to coal or natural gas. Average prices for historical projects are around USD 0.08/kWh for solar and USD 0.05/kWh for wind. Lower than other regions; new solar projects showing costs of around USD 0.02-0.03/kWh, and wind projects at around USD 0.03-0.04/kWh.

**European Union**



Note: LCOE based on IRENA (2019a) and electricity prices based on Global Petrol Prices (2019).  
 Note: The LCOE data is for projects commissioned in 2018. Real weighted average cost of capital (WACC) is 7.5% for OECD countries and China and 10% for the rest of the world.

## ENERGY TRANSFORMATION: KEY BENEFITS

1

**CLEAN  
TECHNOLOGY  
HUB**

- ▶ Global leadership on energy transition
- ▶ Carbon neutrality by 2050 (EU target)
- ▶ High-efficiency levels
- ▶ Affordable energy supply



2

**ENERGY  
SECURITY**

- ▶ Increased energy self-sufficiency
- ▶ Reduced oil and gas dependence
- ▶ Transformative shift to efficiency and renewables



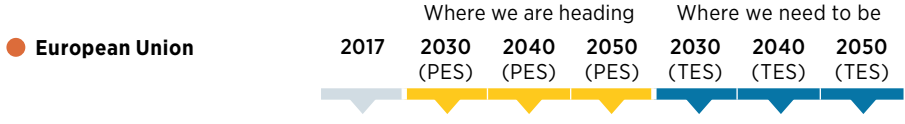
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**ECONOMIC  
AND SOCIAL  
DEVELOPMENT**

- ▶ Economic growth driven by investment and supportive policies
- ▶ Job creation and skills development
- ▶ Pollution reduction, improved health and well-being



## ENERGY TRANSFORMATION ROADMAP TO 2050



Energy (EJ)							
Supply (TPES)	68	62	57	55	54	49	45
Consumption (TFEC)	45	43	42	42	38	34	29

Renewables shares (modern)							
Supply (TPES)	15%	23%	28%	33%	39%	50%	71%
Consumption (TFEC)	17%	24%	30%	34%	36%	48%	70%
Power generation	31%	44%	50%	58%	55%	73%	86%



Electricity share in final energy consumption							
End-use consumption	22%	25%	27%	29%	30%	38%	49%
Industry	31%	31%	37%	38%	40%	47%	54%
Transport	2%	4%	6%	8%	7%	14%	32%
Buildings	33%	35%	37%	39%	42%	48%	55%

Renewable installed capacity (GW)							
Bioenergy	34	45	44	47	55	82	107
Hydropower	130	136	137	140	140	141	143
Solar PV	107	204	243	281	284	512	784
Wind	169	235	288	360	319	469	621



Biofuels							
Liquid biofuels (billions of litres per year)	25	42	46	52	72	86	97



CO <sub>2</sub> emissions (energy-related)							
Annual level (Gt CO <sub>2</sub> /yr)	3.4	2.6	2.2	1.9	1.9	1.2	0.6
Reduction vs. today	NA	-22%	-35%	-42%	-43%	-64%	-82%

## ● European Union

Where we are heading  
**Planned Energy  
Scenario 2016 - 2050**  
(PES)

Where we need to be  
**Transforming Energy  
Scenario 2016-2050**  
(TES)

**Energy system investments (average annual, 2016-50) USD billion/year**

Power	98	145
- Renewable	38	78
- Non-renewable	22	12
- Power grids and system flexibility	38	56
Industry (RE + EE)	6	8
Transport (electrification + EE)	18	32
Buildings (RE + EE)	89	130
Biofuel supply	2	5
Renewable hydrogen – electrolyzers	0	0.7

Note: RE = renewable energy; EE = energy efficiency

The findings in this report consider targets and developments as of April 2019. The wind and solar PV capacities in the Transforming Energy Scenario in 2030 in this report are slightly higher than the estimates presented in IRENA's reports (IRENA, 2019b; 2019c) which consider developments as of the third quarter of 2019.

**SOCIO-ECONOMIC OUTLOOK TO 2050**

## ● European Union

2019e

2030

2050

Population (thousands) region-wide	511 528	506 687	496 892
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**GDP (USD 2015)**

GDP (million): PES	20 903 940	26 987 610	34 800 915
GDP (million): TES	21 279 174	27 940 359	37 372 375
GDP changes (million): TES vs. PES	375 234	952 749	2 571 460
GDP changes (%): TES vs. PES	1.8	3.5	7.4
Per capita GDP (thousand): PES	40.9	53.3	70.0
Per capita GDP (thousand): TES	41.6	55.1	75.2

**Employment****Economy-wide employment (thousands)**

Employment: PES	237 331	241 626	228 604
Employment: TES	238 323	244 026	234 073
Employment changes: TES vs. PES	992	2 400	5 469
Employment changes (%): TES vs. PES	0.42%	0.99%	2.39%



● European Union

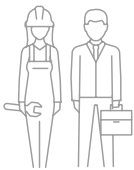


Energy sector jobs (thousands)

	2017	2030 (PES)	2050 (PES)	2030 (TES)	2050 (TES)
Nuclear power	104	118	73	96	27
Fossil fuels	1113	1645	1135	1346	726
Renewables	1290	1730	1636	2502	2701
Energy efficiency	312	1715	1496	2723	1717
Power grids and energy flexibility	483	694	574	757	821
<b>Total</b>	<b>3 303</b>	<b>5 901</b>	<b>4 914</b>	<b>7 424</b>	<b>5 993</b>
Energy jobs in economy-wide employment (%)		2.4%	2.1%	3.0%	2.6%

Renewable energy jobs (thousands)

	2017	2030 (PES)	2050 (PES)	2030 (TES)	2050 (TES)
Bioenergy	661	736	709	968	1065
Solar	139	282	311	646	866
Hydropower	136	245	151	280	144
Wind	344	456	454	592	608
Geothermal	9	10	9	13	15
Ocean	1	1	2	2	4
<b>Total</b>	<b>1 290</b>	<b>1 730</b>	<b>1 636</b>	<b>2 502</b>	<b>2 701</b>
Renewable energy jobs in energy-sector employment (%)		29.3%	33.3%	33.7%	45.1%



Job differential in 2050 (thousands) TES vs. PES

Economy-wide	5 469
Changes in conventional energy (A)	-454
Changes in transition related technologies (B)	1533
Net jobs (A+B)	1079

## ▶ Jobs in 2050: TES / ● European Union

Technology jobs (thousands)		Segment value chain (thousands)		Occupational requirements (thousands)	
Solar PV	629	Construction & installation	600	Workers and technicians	1101
Solar water heaters (SWH)	221	Manufacturing	549	Experts	164
Onshore wind	443	Operation and maintenance	324	Engineers and higher degrees	139
Offshore wind	165	Biofuel supply	-	Marketing and administrative	69
Geothermal	15				
<b>Total</b>	<b>1473</b>		<b>1473</b>		<b>1473</b>

Welfare improvement (%):  
TES vs. PES

Indicator	2030	2050
	Economic	0.9
Social	3.1	5.1
Environmental	1.7	3.5
<b>Total</b>	<b>5.7</b>	<b>10.6</b>



## REFERENCES:

Deng, Y., Haigh, M., Pouwels, W., Ramaekers, L., Brandsma, R., Schimschar, S., Grözinger, J. & de Jager, D. (2015), *Quantifying a realistic, worldwide wind and solar electricity supply*, *Global Environmental Change* 31, 239-52, <https://doi.org/10.1016/j.gloenvcha.2015.01.005>.

Global Carbon Atlas (2019), *Global Carbon Atlas – CO<sub>2</sub> emissions*, <https://doi.org/10.5194/essd-11-1675-2019>.

Global Petrol Prices (2019), *Electricity prices around the world*, [www.globalpetrolprices.com/electricity\\_prices/](http://www.globalpetrolprices.com/electricity_prices/) (accessed 5 March 2020).

IEA (2019), *IEA Beyond 20/20 – 2019 edition*, International Energy Agency, Paris.

IRENA (2019a), *Renewable Cost Database*, 2019.

IRENA (2019b), *Future of solar photovoltaic – Deployment, investment, technology, grid integration and socio-economic aspects*, International Renewable Energy Agency, Abu Dhabi.

IRENA (2019c), *Future of wind – Deployment, investment, technology, grid integration and socio-economic aspects*, International Renewable Energy Agency, Abu Dhabi.

WHO (2019), *WHO Global Ambient Air Quality Database* (update 2018), World Health Organization, [www.who.int/airpollution/data/cities/en/](http://www.who.int/airpollution/data/cities/en/) (accessed 5 March 2020).

World Bank Group (2019a), *Access to electricity (% of population)*, World Bank Group.

World Bank Group (2019b), *Access to clean fuels and technologies for cooking (% of population)*, World Bank Group.