ENERGY TRANSFORMATION

MIDDLE EAST AND NORTH AFRICA

STATUS/CHARACTERISTICS AND NEEDS:

Regional analysis covers major oil and gas exporters as well as net importers, spanning the Gulf States, other parts of the Middle East, and North Africa.

Middle East:

- Bahrain
- Iran (Islamic Republic of)
- Iraq
- Israel
- Jordan
- Kuwait
- Lebanon
- Oman
- Qatar
- Saudi Arabia
- State of Palestine
- Syrian Arab Republic
- United Arab Emirates
- Yemen

North Africa:

- Algeria
- Egypt
- Libya
- Morocco
- Tunisia
- Western Sahara
- Djibouti

Population (millions)

Current: **6% of global population,** highest regional share in Egypt (22%), Iran (18%) and Algeria (9.4%).

2050 outlook: Average **1.1% per year increase** to **677 million**, or 7% of global population.

IRENA analysis based on E3ME.

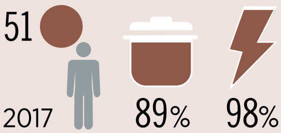
GDP per capita (thousand USD 2015)

Current: **Below the global average** (10.9).

2050 outlook: **Adequate development;**
▶ **PES:** CAGR = 3%

IRENA analysis based on E3ME.

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



Energy consumption per capita:

Current: in line with global average (51 GJ/year).

Electricity access:

Countries reached high electrification (close to 100%).

Clean cooking access:

Rural areas depend on traditional energy sources or diesel generators.

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).

Fossil fuel net import

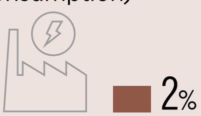
Current status: Region contributes to **37% of global oil production and 35% of global natural gas production**; with oil production dominated by Saudi Arabia (35%), Iran (14%) and Iraq (13%) and gas production dominated by Iran (28%), Qatar (22%) and Saudi Arabia (14%) (Tagliapietra, 2019).

2050 outlook: **Vast untapped renewable energy potential.**

- **PES:** The total generation (est. 3477 TWh) just represents **5%** of overall renewable power potential.

Note: Current status, 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)

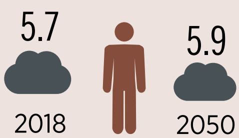


Current status: Only a tiny share (2%) comes from energy intensive industries of the region (mainly from the **chemical and petrochemical** sector).

2050 outlook: Need for **alternative clean energy technological solutions and emission-capture measures.**

IRENA analysis based on 2017 values (IEA, 2019).

Energy-related CO_2 emissions per capita (tCO_2/capita)



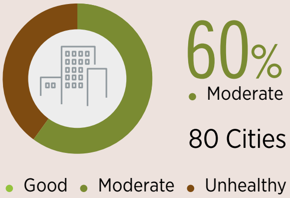
Recent: **Region's annual emissions: 2.6 Gt** (2018). 8% of global energy-related emissions.

2050 outlook:

- **PES: 27% increase to 3.2 Gt** with enabling policies.

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

Urban air quality (%)



Air quality has **deteriorated dramatically** in recent decades. Few cities (3%) with more than 100 000 inhabitants in low- and middle-income MENA countries meet **WHO air quality guidelines** (2018).

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

Electricity prices and renewables costs

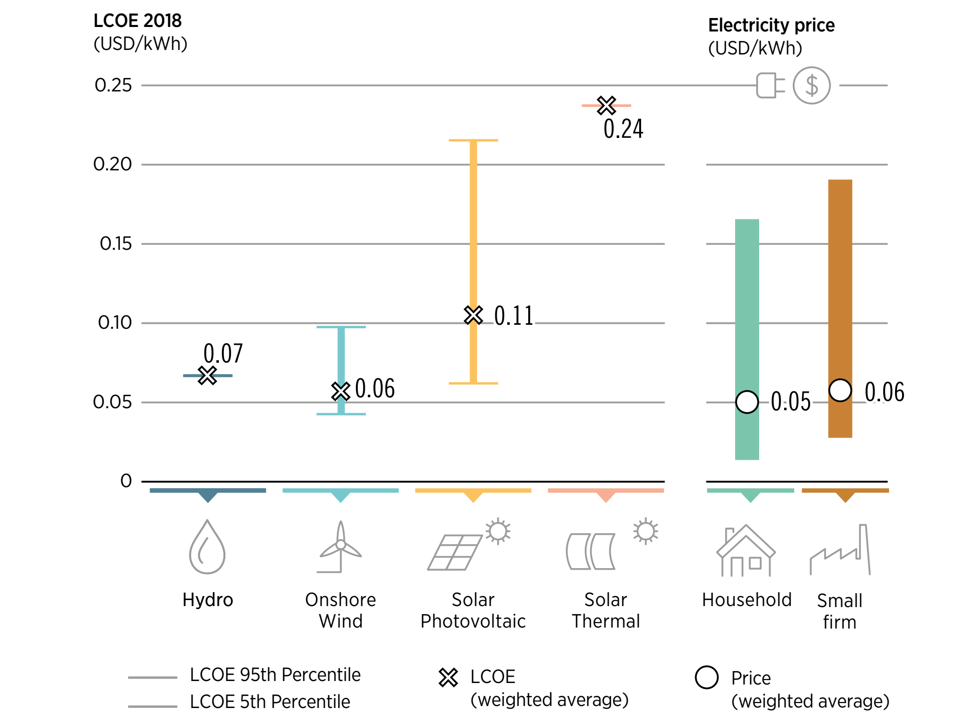
Electricity price:

The lowest compared to the other regions due to fossil-fuel subsidies.

Renewables cost and auctions:

In 2019, Morocco auctioned an advanced hybrid (CSP/PV) plant for a record-low peak-hour tariff of USD 0.071/kWh (IRENA, 2019a). United Arab Emirates contracted solar power at USD 0.299/kWh (IRENA, 2017).

Middle East and North Africa



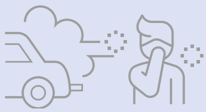
LCOE based on IRENA (2019b) and electricity prices based on Global Petrol Prices (2019).
Note: The LCOE data is for projects commissioned in 2018. Real weighted average cost of capital (WACC) is 7.5% for OECD countries and China and 10% for the rest of the world.

ENERGY TRANSFORMATION: KEY BENEFITS

1

REDUCED EMISSIONS AND LOCAL AIR POLLUTION

- Lower CO_2 emissions
- Better local air quality
- Efficient energy services extended to rural areas



2

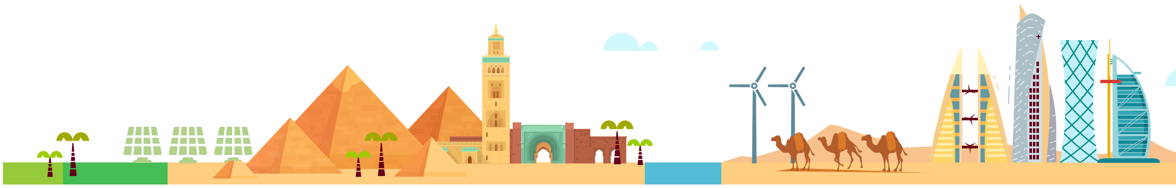
ENERGY SECURITY AND ECONOMIC SELF-RELIANCE

- Diversified energy supply
- Reduced import dependence (oil importers)
- Focus on high-value exports (oil exporters)
- Cross-border electricity trade

3

SUSTAINABLE DEVELOPMENT

- Diversified economy and sustainable economic activities
- Local job creation
- Improved welfare



ENERGY TRANSFORMATION ROADMAP TO 2050

Middle East and North Africa	2017	Where we are heading 2030 (PES)	2040 (PES)	2050 (PES)	Where we need to be 2030 (TES)	2040 (TES)	2050 (TES)
Energy (EJ)							
Supply (TPES)	40	52	60	62	39	36	30
Consumption (TFEC)	23	33	39	41	25	24	20
Renewables shares (modern)							
Supply (TPES)	1%	4%	6%	7%	9%	16%	26%
Consumption (TFEC)	1%	4%	4%	5%	8%	15%	26%
Power generation	3%	14%	17%	20%	27%	39%	53%
Electricity share in final energy consumption							
End-use consumption	19%	16%	18%	20%	20%	27%	38%
Industry	12%	8%	8%	9%	12%	15%	20%
Transport	0.1%	0.3%	1%	2%	2%	7%	15%
Buildings	43%	44%	46%	50%	48%	59%	77%
Renewable installed capacity (GW)							
Bioenergy	0	2	2	3	2	3	3
Hydropower	20	18	21	23	20	23	26
Solar PV	2	53	71	85	66	108	147
Wind	2	51	100	138	76	158	212
Biofuels							
Liquid biofuels (billions of litres per year)	NA	3	3	4	4	5	6
CO_2 emissions (energy-related)							
Annual level (Gt CO_2/yr)	2.5	2.9	3.2	3.2	2	1.6	1.1
Reduction vs. today	NA	16%	29%	30%	-20%	-34%	-56%

● **Middle East and North Africa**	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	55	53
– Renewable	9	16
– Non-renewable	22	14
– Power grids and system flexibility	24	23
Industry (RE + EE)	8	11
Transport (electrification + EE)	11	15
Buildings (RE + EE)	52	76
Biofuel supply	1.1	3
Renewable hydrogen – electrolysers	0.3	2.8

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, 2019c; 2019d) which consider developments as of the third quarter of 2019.

SOCIO-ECONOMIC OUTLOOK TO 2050

● **Middle East and North Africa**	**2019e**	**2030**	**2050**
Population (thousands) region-wide	491 460	567 708	677 439
GDP (USD 2015)			
GDP (million): PES	4 516 464	7 372 988	15 494 435
GDP (million): TES	4 580 811	7 358 619	15 112 505
GDP changes (million): TES vs. PES	64 347	-14 368	-381 930
GDP changes (%): TES vs. PES	1.4	-0.2	-2.5
Per capita GDP (thousand): PES	9.2	13.0	22.9
Per capita GDP (thousand): TES	9.3	13.0	22.3
Employment			
Economy-wide employment (thousands)			
Employment: PES	175 696	187 016	186 184
Employment: TES	175 742	186 825	185 801
Employment changes: TES vs. PES	46	-191	-382
Employment changes (%): TES vs. PES	0.03%	-0.10%	-0.21%

Middle East and North Africa	2017	2030 (PES)	2050 (PES)	2030 (TES)	2050 (TES)
Energy sector jobs (thousands)					
Nuclear power	15	56	70	55	42
Fossil fuels	2 815	3 693	3 379	3 257	2 625
Renewables	542	789	895	1 226	2 064
Energy efficiency	1 113	1 809	1 328	2 731	1 537
Power grids and energy flexibility	622	927	885	900	1 014
Total	**5 108**	**7 274**	**6 557**	**8 168**	**7 283**
Energy jobs in economy-wide employment (%)		3.9%	3.5%	4.4%	3.9%

Middle East and North Africa	2017	2030 (PES)	2050 (PES)	2030 (TES)	2050 (TES)
Renewable energy jobs (thousands)					
Bioenergy	196	290	282	584	846
Solar	88	180	265	283	703
Hydropower	250	262	250	266	239
Wind	7	55	93	90	273
Geothermal	1	2	4	3	4
Ocean	0	0	0	0	0
Total	**542**	**789**	**895**	**1 226**	**2 064**
Renewable energy jobs in energy-sector employment (%)		10.8%	13.6%	15.0%	28.3%

Job differential in 2050 (thousands) TES vs. PES	
Economy-wide	-382
Changes in conventional energy (A)	-782
Changes in transition related technologies (B)	1 507
Net jobs (A+B)	726

Jobs in 2050: TES / ● Middle East and North Africa

Technology jobs (thousands)		Segment value chain (thousands)		Occupational requirements (thousands)	
Solar PV	343	Construction & installation	559	Workers and technicians	774
Solar water heaters (SWH)	332	Manufacturing	153	Experts	80
Onshore wind	273	Operation and maintenance	240	Engineers and higher degrees	76
Offshore wind	0	Biofuel supply	-	Marketing and administrative	22
Geothermal	4				
Total	**952**		**952**		**952**

Welfare improvement (%): TES vs. PES

Indicator	2030	2050
Economic	0.0	0.0
Social	4.3	7.7
Environmental	1.9	4.6
Total	**6.2**	**12.3**

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