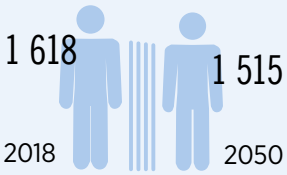
ENERGY TRANSFORMATION
EAST ASIA

Regional analysis covers five countries:

- China
- Democratic People's Republic of Korea (DPRK)
- Japan
- Mongolia
- Republic of Korea (ROK)

STATUS/CHARACTERISTICS AND NEEDS:

Population (millions)



Current: **21% of global population**, mainly in China (87%), Japan (8%) and ROK and DPRK (5%).

2050 outlook: Average **0.2% per year decline** to **1 515 million,** or 16% of global population.

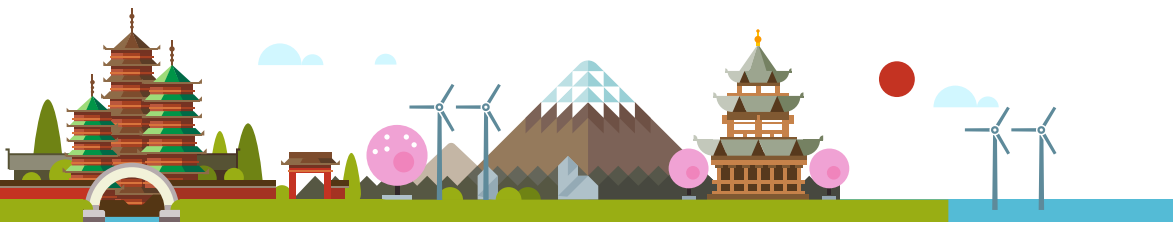
IRENA analysis based on E3ME.

GDP per capita (thousand USD 2015)

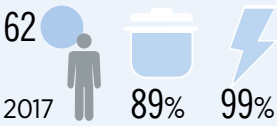
Current: **Around the global average** (10.9).

2050 outlook: **Swift development;**
▶ **PES:** CAGR = 3.4%

IRENA analysis based on E3ME.



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



Energy consumption per capita:

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

Electricity access:

Near-total in China, Japan and ROK; lower in Mongolia (>85%) and DPRK (44%).

Clean cooking access:

Only 43% in Mongolia.

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: **Supply and demand roughly in balance**; China is world's largest coal producer; ROK and Japan rely heavily on fossil-fuel imports.

2050 outlook: **Air pollution and resource challenges**; **vast untapped renewable energy potential**. ▶ **PES:** The total generation (est. 15993 TWh) represents **36%** 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).

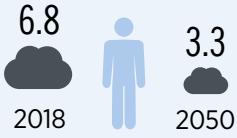
Energy-intensive industries (% in global consumption)

Current status: **Over half** of global **metal and minerals, chemicals, and iron and steel** energy demand is concentrated in the region.

2050 outlook: Deploy a mix of **emerging clean technologies** and **carbon capture solutions**.

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

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



Recent: **Region's annual emissions: 11.4 Gt** (2018). 34% of global energy-related emissions.

2050 outlook:

- ▶ **PES: 53% reduction to 5.4 Gt** with enabling policies.
- Increased CO_2 emissions from transport.

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

Urban air quality (%)

28%

Moderate

260 Cities

Good Moderate Unhealthy

China: Rapid, mainly coal-fueled development accelerating since 2010, reducing poverty; death rate from air pollution now 2nd highest (after India's); new regulations cut air pollution by 20% in 2015-17.

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

Electricity prices and renewables costs

Electricity price:

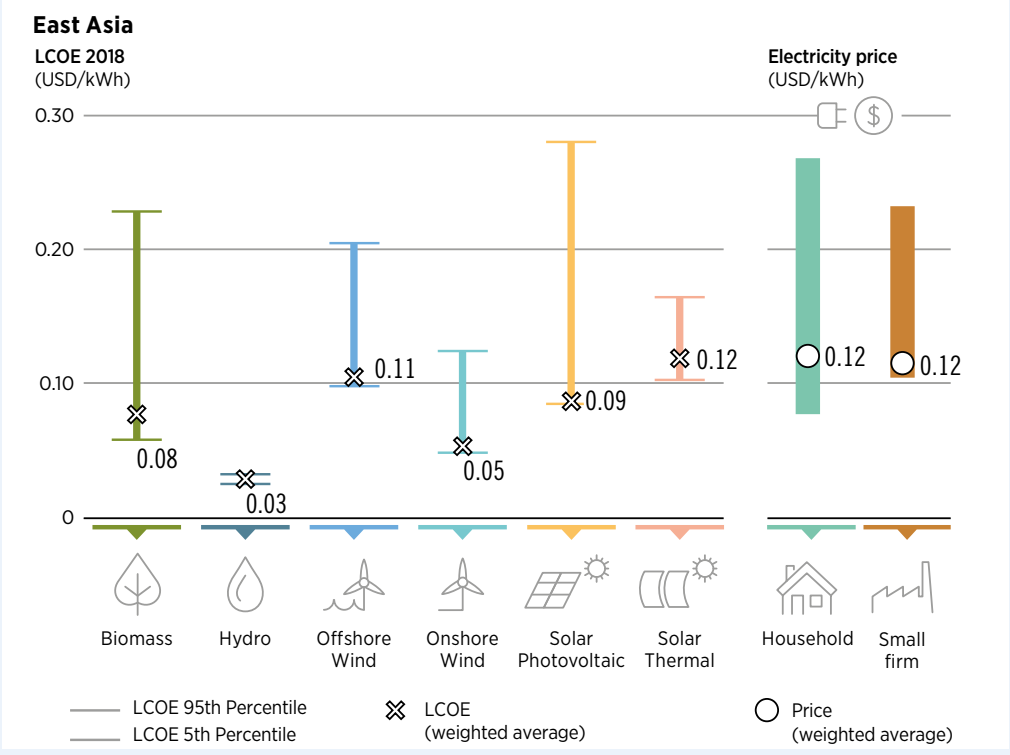
Mid-range (for households and industries) compared to other regions.

Renewable power costs:

Onshore wind around G20 average (USD 0.05/kWh). Solar PV below G20 average (USD 0.096/kWh).

Auction prices:

Lower than other regions; China's largest solar auction (1 GW new capacity) achieved lowest price (USD 0.077/kWh) in 2017.



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 ENERGY SUPPLY

- Lower CO_2 emissions
- Better local air quality
- Leverage innovation (hydrogen, batteries, etc.)

2

ENERGY INDEPENDENCE

- Diversified energy supply
- Resilience to external shocks
- Lower investment risks

3

SUSTAINABLE DEVELOPMENT

- Added economic value
- Higher employment
- Empowered societies and improved awareness

ENERGY TRANSFORMATION ROADMAP TO 2050

East Asia	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)	159	185	172	159	166	148	129
Consumption (TFEC)	102	114	107	100	105	97	89
Renewables shares (modern)							
Supply (TPES)	7%	17%	27%	39%	27%	44%	65%
Consumption (TFEC)	8%	20%	30%	43%	31%	49%	70%
Power generation	23%	42%	59%	73%	60%	77%	90%
Electricity share in final energy consumption							
End-use consumption	25%	33%	40%	48%	37%	47%	58%
Industry	26%	39%	45%	53%	41%	51%	65%
Transport	3%	7%	20%	33%	14%	30%	46%
Buildings	32%	44%	48%	52%	45%	51%	57%
Renewable installed capacity (GW)							
Bioenergy	14	74	74	74	82	84	87
Hydropower	349	484	533	582	490	539	588
Solar PV	186	1175	1734	2305	1644	2396	3118
Wind	169	706	1407	2106	1263	1990	2696
Biofuels							
Liquid biofuels (billions of litres per year)	5	31	32	33	36	36	37
CO_2 emissions (energy-related)							
Annual level (Gt CO_2/yr)	11.2	10.3	7.8	5.4	8.4	5.3	2.2
Reduction vs. today	NA	-8%	-30%	-52%	-25%	-53%	-80%

East Asia	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	314	386
– Renewable	172	246
– Non-renewable	63	35
– Power grids and system flexibility	80	105
Industry (RE + EE)	25	35
Transport (electrification + EE)	101	114
Buildings (RE + EE)	133	196
Biofuel supply	5.4	13.4
Renewable hydrogen – electrolysers	2.2	5.9

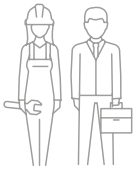
Note: RE = renewable energy; EE = energy efficiency

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

East Asia	2019e	2030	2050
Population (thousands) region-wide	1 621 179	1 627 194	1 514 571
GDP (USD 2015)			
GDP (million): PES	17 550 968	25 739 253	46 369 936
GDP (million): TES	18 075 537	26 577 659	47 521 377
GDP changes (million): TES vs. PES	524 569	838 406	1 151 441
GDP changes (%): TES vs. PES	3	3.3	2.5
Per capita GDP (thousand): PES	10.8	15.8	30.6
Per capita GDP (thousand): TES	11.1	16.3	31.4
Employment			
Economy-wide employment (thousands)			
Employment: PES	997 554	979 427	839 204
Employment: TES	1 001 937	984 319	839 750
Employment changes: TES vs. PES	4 382	4 892	545
Employment changes (%): TES vs. PES	0.44%	0.50%	0.06%

East Asia	2017	2030 (PES)	2050 (PES)	2030 (TES)	2050 (TES)
Energy sector jobs (thousands)					
Nuclear power	139	222	254	215	185
Fossil fuels	9 952	10 170	7 765	8 765	4 800
Renewables	4 617	8 494	12 194	10 591	15 007
Energy efficiency	1 912	7 521	7 748	9 672	8 852
Power grids and energy flexibility	2 339	4 406	5 332	4 746	5 673
Total	**18 959**	**30 813**	**33 293**	**33 989**	**34 517**
Energy jobs in economy-wide employment (%)		3.1%	4.0%	3.5%	4.1%
Renewable energy jobs (thousands)					
Bioenergy	414	1 069	801	1 185	1 005
Solar	3 211	5 571	7 630	6 725	9 404
Hydropower	469	621	716	604	688
Wind	519	1 225	2 999	2 061	3 844
Geothermal	4	7	46	12	50
Ocean	0	1	2	4	15
Total	**4 617**	**8 494**	**12 194**	**10 591**	**15 007**
Renewable energy jobs in energy-sector employment (%)		27.6%	36.6%	31.2%	43.5%



Job differential in 2050 (thousands) TES vs. PES	
Economy-wide	545
Changes in conventional energy (A)	-3 034
Changes in transition related technologies (B)	4 257
Net energy sector jobs (A+B)	1 223

Jobs in 2050: TES / East Asia

Technology jobs (thousands)		Segment value chain (thousands)		Occupational requirements (thousands)	
Solar PV	7 896	Construction & installation	5 894	Workers and technicians	9 972
Solar water heaters (SWH)	1 437	Manufacturing	4 236	Experts	1 475
Onshore wind	3 144	Operation and maintenance	3 098	Engineers and higher degrees	1 275
Offshore wind	699	Biofuel supply	-	Marketing and administrative	505
Geothermal	50				
Total	**13 228**		**13 228**		**13 228**

Welfare improvement (%): TES vs. PES	2030	2050
Indicator		
Economic	0.6	0.4
Social	3.8	7.4
Environmental	1.9	4
Total	**6.3**	**11.8**

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