Source: The place where something comes from or starts at, the origin, or the cause of something.

When you write an article, you tend to look for more sources than you need. You would not normally look for sources [of information] when writing, say, a letter to a friend, but it makes sense if you are writing for a publication.

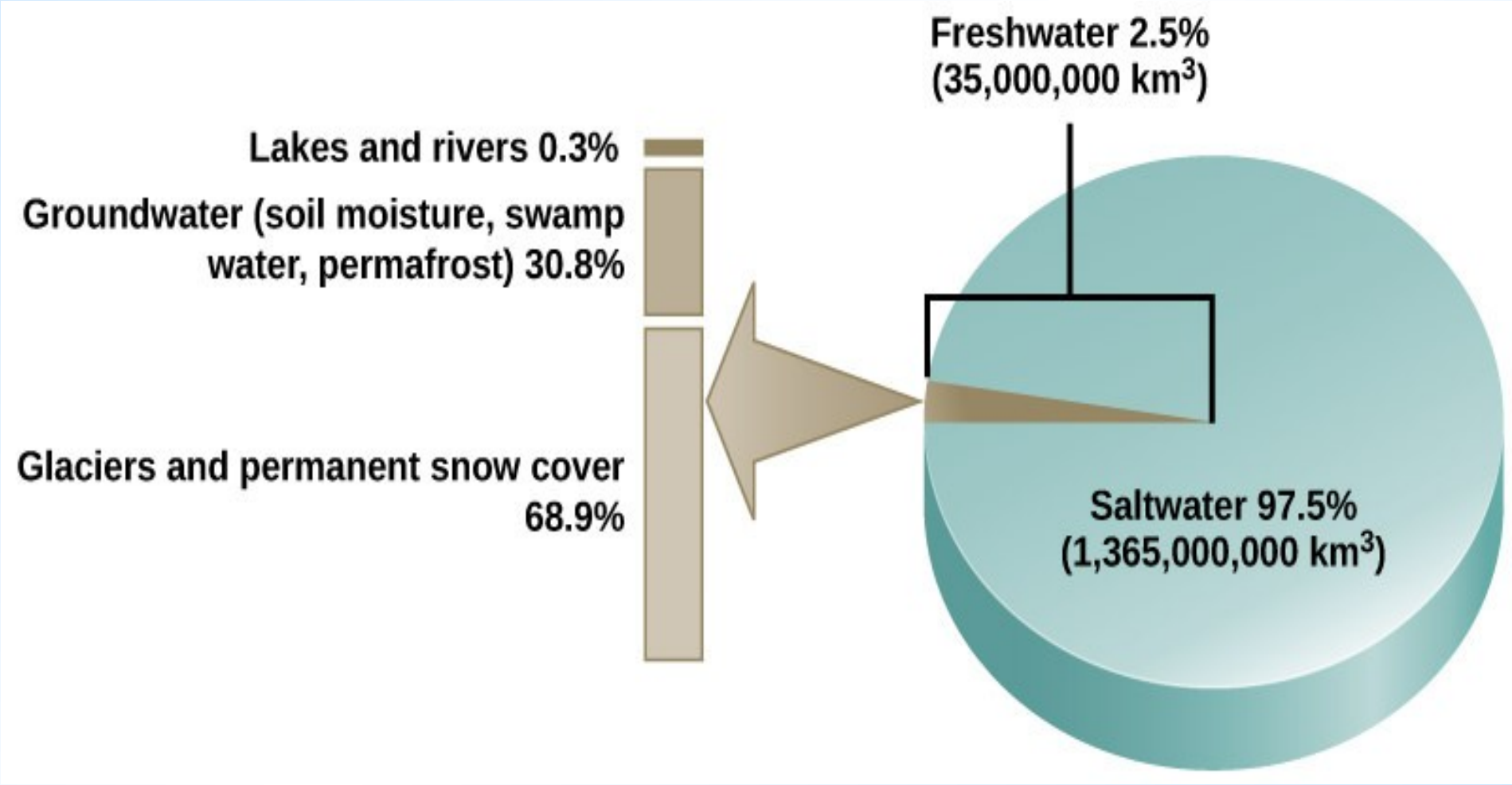
Resource: A useful or valuable possession or quality, readily available to use, again and again.

T*he local library is a valuable resource of information.*

Types of Natural Resources on Earth

- Energy resources
- Forest resources
- Water resources
- Land resources
- Mineral resources
- Food resources

WATER RESOURCES ON EARTH



Mineral Resources on Earth

Classification of Energy Resources (by Culp)

Based on usability

- Primary Resources — Coal, Oil, Natural gas, Uranium
- Secondary Resources — Electricity, Hydrogen

Based on tradition of use

- Conventional Energy — Fossil fuels, Nuclear, Hydro
- Non-conventional Energy — Solar, Geothermal, Wind

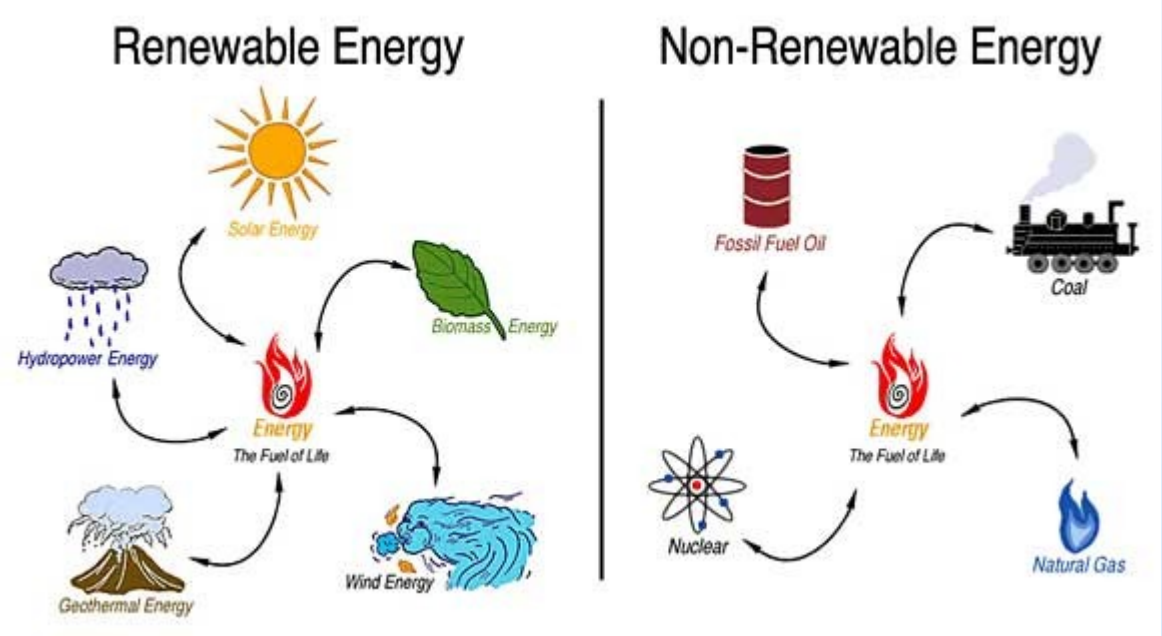
Based on availability

- Renewable Energy — Solar, Geothermal, Wind, Hydro, Bio
- Non-renewable Energy — Fossil fuels, Nuclear

3. On the basis of availability

a) Renewable Energy: It is the energy obtained from the repetitive currents of energy occurring in the natural environment, such as solar.

b) Non-renewable Energy: It is energy obtained from static deposits of any sources that remains bound unless exploited by human interaction. (These are available as reserves or deposits.)



Energy Resources:

- Oil
- Natural gas
- Coal

} Fossil Fuels

- Nuclear power
- Renewable energy → Hydro, Bio, Solar, Wind, Geothermal
- Electric energy (!)
- Hydrogen (!)

} Secondary

Read the IEA Report, «Future of Hydrogen», 2019, on «OdtuClass».

Energy forms

- Electrical
- Electromagnetic
- Chemical
- Nuclear
- Mechanical
- Thermal

Energy Resources:

- Fossils
  - Oil
  - Natural gas
  - Coal
- Nuclear
- Renewables
  - Hydro
  - Bio
  - Hydrogen
  - Solar
  - Wind
  - Geothermal

Distinguish between:

- Proven, available reserves
- Economically viable reserves
- Production
- Consumption
- Imports
- Exports

To produce a fossil fuel, the organic matter must be rapidly buried in the Earth so that it does not oxidize (react with oxygen in the atmosphere). Then a series of slow chemical reactions occur which turn the organic molecules into hydrocarbons- Oil and Natural Gas, together called Petroleum. ***Hydrocarbons*** are complex organic molecules that consist of chains of hydrogen and carbon.

Petroleum (oil and natural gas) consists of many different such hydrocarbons, but the most important of these are a group known as the paraffins. ***Paraffins*** have the general chemical formula:

$$C_nH_{2n+2}$$

As the value of n in the formula increases, the following compounds are produced:

"Hydrocarbon" and "carbohydrate" sound similar but are two very different types of compounds. Hydrocarbons consist of purely carbon and hydrogen, while carbohydrates also contain oxygen. Living organisms metabolize carbohydrates for energy, whereas hydrocarbons are used as fuels and in industrial applications.

Hydrocarbons are the simplest organic, or carbon-based, compounds. They are made only of carbon and hydrogen but can be virtually any size and shape. Methane, or swamp gas, is the simplest hydrocarbon, with the chemical formula CH_4. Other common hydrocarbons include Propane, used to fuel gas burners, and Octane, an ingredient in most automobile gasoline. Benzene, an industrial solvent, is also a hydrocarbon.

Not all compounds of carbon, hydrogen and oxygen are carbohydrates. To be a carbohydrate, a compound must have twice as many hydrogen atoms as oxygen atoms

n	Formula	Compound	Use
1	CH_4	methane	Natural Gas
2	C_2H_6	ethane	
3	C_3H_8	propane	
4	C_4H_{10}	butane	
5	C_5H_{12}	pentane	Gasoline
6	C_6H_{14}	hexane	
7	C_7H_{16}	heptane	
8	C_8H_{18}	octane	
9	C_9H_{20}	nonane	
>9	various	various	Lubricating Oils, Plastics

OIL – Proven Reserves

Economically Viable Reserves in millions of barrels US (EIA) Energy Information Administration, 2017		
Rank	**Country**	**Reserves**
1	Venezuela	300 878
2	Saudi Arabia	266 455
3	Canada	169 709
4	Iran	158 400
5	Iraq	142 503
6	Kuwait	101 500
7	UAE	97 800
8	Russia	80 000
9	Libya	48 363
10	USA	39 230
52	Turkey	389
	World Total	1 726 685

OIL – Production

Production in barrels per day US (EIA) Energy Information Administration, 2016		
Rank	**Country**	**Production**
1	Russia	10 551 497
2	Saudi Arabia	10 460 710
3	USA	8 875 817
4	Iraq	4 451 516
5	Iran	3 990 956
6	China	3 980 650
7	Canada	3 662 694
8	UAE	3 106 077
9	Kuwait	2 923 825
10	Brazil	2 515 459
53	Turkey	49 497
	World Total	80 622 000

OIL – Consumption

Consumption in barrels per day Statistical Review of World Energy, 2016		
Rank	**Country**	**Consumption**
1	USA	19 396 000
	European Union	15 000 000
2	China	11 968 000
3	India	4 159 000
4	Japan	4 150 000
5	Saudi Arabia	3 895 000
6	Brazil	3 157 000
7	Russia	3 113 000
8	South Korea	2 575 000
9	Germany	2 338 000
10	Canada	2 322 000
22	Turkey	835 000
	World Total	95 008 000

OIL – Exports

Exports in barrels per day The World Factbook			
Rank	**Country**	**Exports**	**Year of Information**
1	Saudi Arabia	7 416 000	2013
2	Russia	4 888 000	2013
3	Iraq	3 301 000	2016
4	Canada	3 210 000	2015
5	UAE	2 637 000	2013
6	Nigeria	2 231 000	2013
7	Angola	1 745 000	2013
8	Kuwait	1 711 000	2013
9	Venezuela	1 548 000	2013
10	Kazakhstan	1 466 000	2013

OIL – Imports

Imports in barrels per day The World Factbook			
Rank	**Country**	**Imports**	**Year of Information**
	European Union	11 658 750	2010
1	USA	9 080 000	2013
2	China	6 167 000	2014
3	India	3 812 000	2013
4	Japan	3 441 000	2014
5	South Korea	2 949 000	2014
6	Germany	1 830 000	2013
7	Philippines	1 503 000	2014
8	Italy	1 346 000	2013
9	Spain	1 224 000	2013
10	UK	1 221 000	2013
24	Turkey	379 600	2013

NATURAL GAS – Proven Reserves

Economically Viable Reserves in 10^6 m^3 The World Factbook, 2016		
Rank	**Country**	**Reserves**
1	Russia	47 800 000
2	Iran	34 020 000
3	Qatar	24 530 000
4	USA	10 440 000
5	Saudi Arabia	8 489 000
6	Turkmenistan	7 504 000
7	UAE	6 091 000
8	Venezuela	5 617 000
9	Nigeria	5 111 000
10	Algeria	4 504 000
85	Turkey (2010)	6 088
	World Total	205.34 trillion m^3

NATURAL GAS – Production

Production in 10^6 m^3/year The World Factbook			
Rank	**Country**	**Production**	**Date of Information**
1	USA	766 200	2015
2	Russia	635 500	2015
3	Iran	174 500	2014
4	Qatar	160 000	2014
5	Canada	151 500	2014
6	China	150 000	2014
	European Union	120 000	2015
7	Norway	108 800	2014
8	Saudi Arabia	102 400	2014
9	Algeria	83 290	2014
10	Turmenistan	76 000	2014
68	Turkey	632	2012
	World Total	3 479 000	2013

NATURAL GAS – Consumption

Consumption in 10^6 m^3/year The World Factbook, 2015		
Rank	**Country**	**Consumption**
1	USA	778 000
	European Union	402 100
2	Russia	391 500
3	Iran	191 200
4	China	177 300
5	Japan	113 400
6	Saudi Arabia	106 400
7	Canada	102 500
8	Mexico	83 200
9	Germany	74 600
10	Italy	71 400
18	Turkey	43 600
	World Total	3 468 600

NATURAL GAS – Exports

Exports in 10^6 m^3 The World Factbook, 2014		
Rank	**Country**	**Exports**
1	Russla	184 500
2	Qatar	118 900
3	Norway	114 400
4	Canada	77 960
5	Netherlands	53 650
6	Turkmenistan	45 790
7	USA	42 870
8	Algeria	40 800
9	Malaysia	34 870
10	Indonesia	31 730

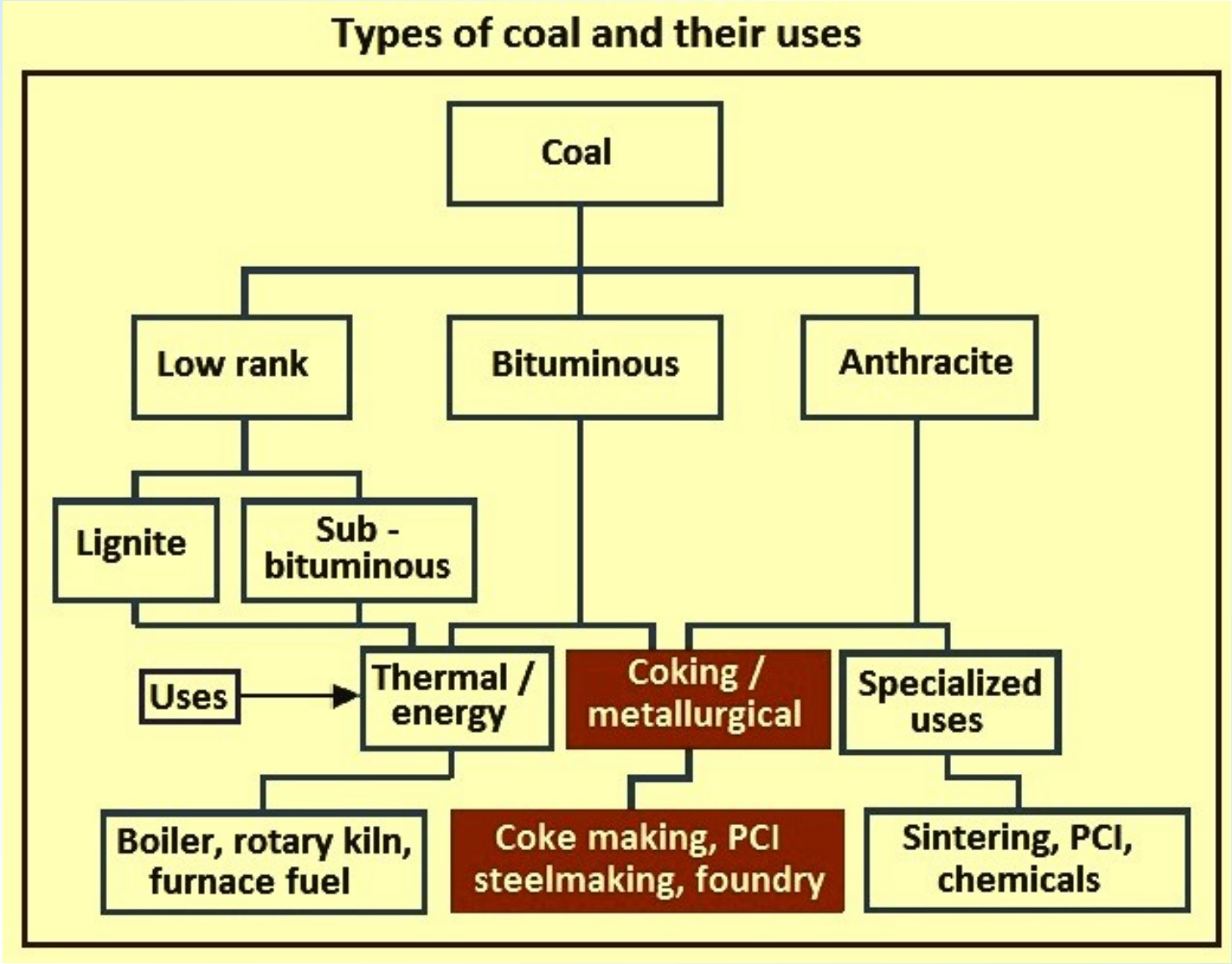
NATURAL GAS – Imports

Imports in 10^6 m^3 The World Factbook and AIE			
Rank	**Country**	**Imports**	**Year of Information**
	European Union	420 600	2010
1	Germany	99 630	2010
2	Japan	98 010	2010
3	Italy	70 200	2011
4	UK	53 630	2010
5	South Korea	46 830	2011
6	France	26 200	2010
7	USA	45 000	2012
8	Russia	38 200	2010
9	Turkey	38 040	2010
10	Spain	36710	2010
	World	957 600	2007

Oil and Gas Reserves, Billion Barrels Oil Equivalent

Saudi Aramco (Saudi Arabia)	302	ExxonMobil	23
National Iranian Oil Co	302	Pertamina (Indonesia)	22
Gazprom (Russia)	198	Lukoil (Russia)	21
Iraqi National Oil Co	136	BP	19
Qatar Petroleum	133	Pemex (Mexico)	19
Kuwait Petroleum Co	109	PetroChina	19
Petroleos de Venezuela	105	Shell	16
Adnoc (Abu Dhabi)	80	Yukos (Russia)	13
Nigerian Natnl Petroleum Co	41	Chevron	12
Sonatrach (Algeria)	38	Petrobras (Brazil)	12
Libya NOC	31	Total (France)	11
Rosneft (Russia)	28	Surgutneftgas (Russia)	9
Petronas (Malaysia)	26		

State Owned/Controlling Interest. Private Sector Owned


Types of coal and their uses
Coal
Low rank
Bituminous
Anthracite
Lignite
Sub - bituminous
Uses
Thermal / energy
Coking / metallurgical
Specialized uses
Boiler, rotary kiln, furnace fuel
Coke making, PCI steelmaking, foundry
Sintering, PCI, chemicals

Coal is a sedimentary/metamorphic rock produced in swamps where there is a large-scale accumulation of organic matter from plants. As the plants die they accumulate to first become peat. Compaction of the peat due to burial drives off volatile components like water and methane, eventually producing a black-colored organic- rich coal called ***lignite***. Further compaction and heating results in a more carbon- rich coal called ***bituminous coal***. If the rock becomes metamorphosed, a high grade coal called ***anthracite*** is produced. However, if temperatures and pressures become extremely high, all of the carbon is converted to graphite. Graphite will burn only at high temperatures and is therefore not useful as an energy source. Anthracite coal produces the most energy when burned, with less energy produced by bituminous coal and lignite.

COAL – Proven Reserves

Economically Viable Reserves in 10^6 tonnes, 2020 ttps://en.wikipedia.org/wiki/List_of_countries_by_coal_reserves				
Rank	**Country**	**Antracite & Bituminous**	**Sub-bituminous & Lignite**	**Total**
1	USA	220 167	30 052	250 219
2	Russia	69 634	90 730	160 364
3	Australia	70 927	76 508	147 435
4	China	130 351	7 968	138 819
5	India	96 468	4 895	101 363
6	Indonesia	26 122	10 878	37 000
7	Germany	3	36 100	36103
8	Ukraine	32 039	2 336	34 375
9	Poland	20 542	5 937	26 479
10	Kazakhstan	25 605	0	25 605
11	Turkey	551	10 975	11 526
	World	734 903	319 879	1 054 782

COAL – Production

Production in 10^6 tonnes, 2020 https://en.wikipedia.org/wiki/List_of_countries_by_coal_production		
Rank	**Country**	**Production**
1	China	3 902
2	India	756
3	Indonesia	562
4	USA	485
5	Australia	477
6	Russia	400
7	South Africa	248
8	Kazakhstan	113
9	Germany	107
10	Poland	101
11	Turkey	71
	World	7 742

COAL – Consumption

Consumption in 10^6 tonnes, 2023 https://www.globalfirepower.com/coal-consumption-by-country.php14		
Rank	**Country**	**Consumption**
1	China	4 506
2	India	884
3	USA	442
4	Russia	266
5	Japan	211
6	South Africa	170
7	Germany	145
8	South Korea	140
9	Indonesia	133
10	Poland	111
11	Turkey	108
	World	8 900

COAL – Exports

Exports in 10^6 tons, 2020 https://www.atlasbig.com/en-us/countries-coal-exports		
Rank	**Country**	**Exports**
1	Indonesia	429
2	Australia	367
3	Russia	210
4	USA	105
5	Colombia	84
6	South Africa	80
7	Mongolia	36
8	Canada	34
9	Netherlands	30
10	Mozambique	15
	World	1 413.9

COAL – Imports

Imports in 10^6 short tons, 2020 https://www.theglobaleconomy.com/rankings/coal_imports/		
Rank	**Country**	**Imports**
1	China	335
2	India	239
3	Japan	191
4	South Korea	136
5	Taiwan	70
6	Vietnam	60
7	Turkey	44
8	Malaysia	40
9	Germany	33
10	Phlippines	231
	World	1 492

URANIUM – Reserves

Reserves in tonnes OECD Nuclear Energy Agency and IAEA, 2015		
Rank	**Country**	**Reserves**
1	Australia	1 780 800
2	Kazakhstan	941 600
3	Canada	703 600
4	Namibia	463 000
5	South Africa	449 300
6	Niger	411 000
7	Russia	395 200
8	Brazil	276 800
9	China	272 500
10	Grenada	228 000
	Turkey	6 600
	World	7 641 600

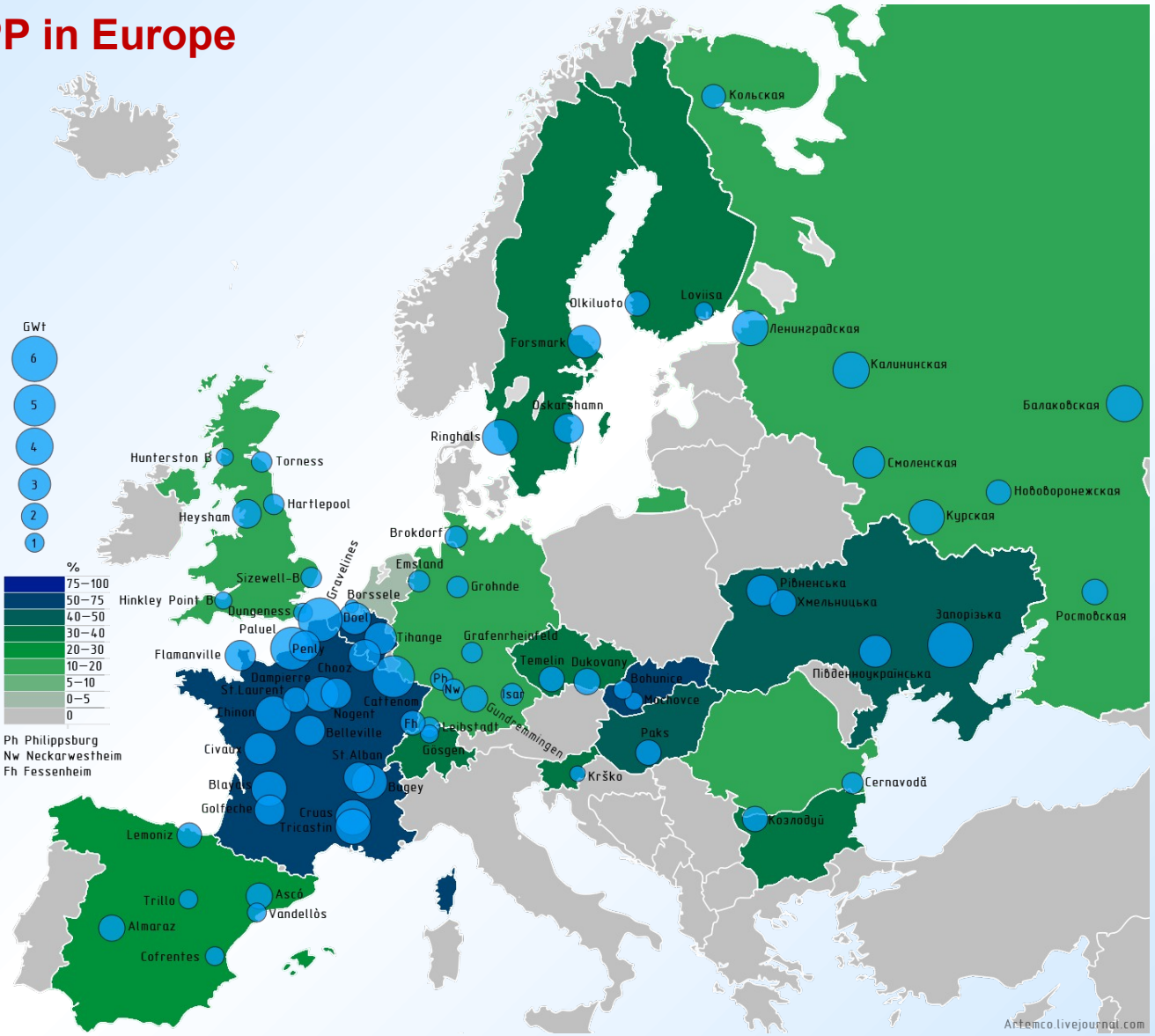
URANIUM – Production

Production in tonnes OECD Nuclear Energy Agency and IAEA, 2015		
Rank	**Country**	**Production**
1	Kazakhstan	23 800
2	Canada	13 325
3	Australia	5 654
4	Niger	4 116
5	Russia	3 055
6	Namibia	2 993
7	Uzbekistan	2 385
8	China	1 616
9	USA	1 256
10	Ukraine	1 200
	World	60 496

NUCLEAR POWER GENERATION

IAEA, Int. Atomic Energy Agency, 2016			
Rank	**Country**	**No. of Operated Reactors**	**Capacity, MWe**
1	USA	100	100 351
2	France	58	63 130
3	Japan	43	40 290
4	China	36	31 384
5	Russia	36	26 528
6	Rep. of Korea	25	23 077
7	Canada	19	13 554
8	Ukraine	15	13 107
9	Germany	8	10 799
10	Sweden	10	9 740
	World	451	392 553

Nuclear PP in Europe



Use of Resources

- Fossil fuels (coal, oil, natural gas)
- Nuclear
- Renewables (hydro, bio, solar, wind, geothermal)

Energy related use

- Mechanical (transportation)
- Thermal (heating, cooling)
- Electricity

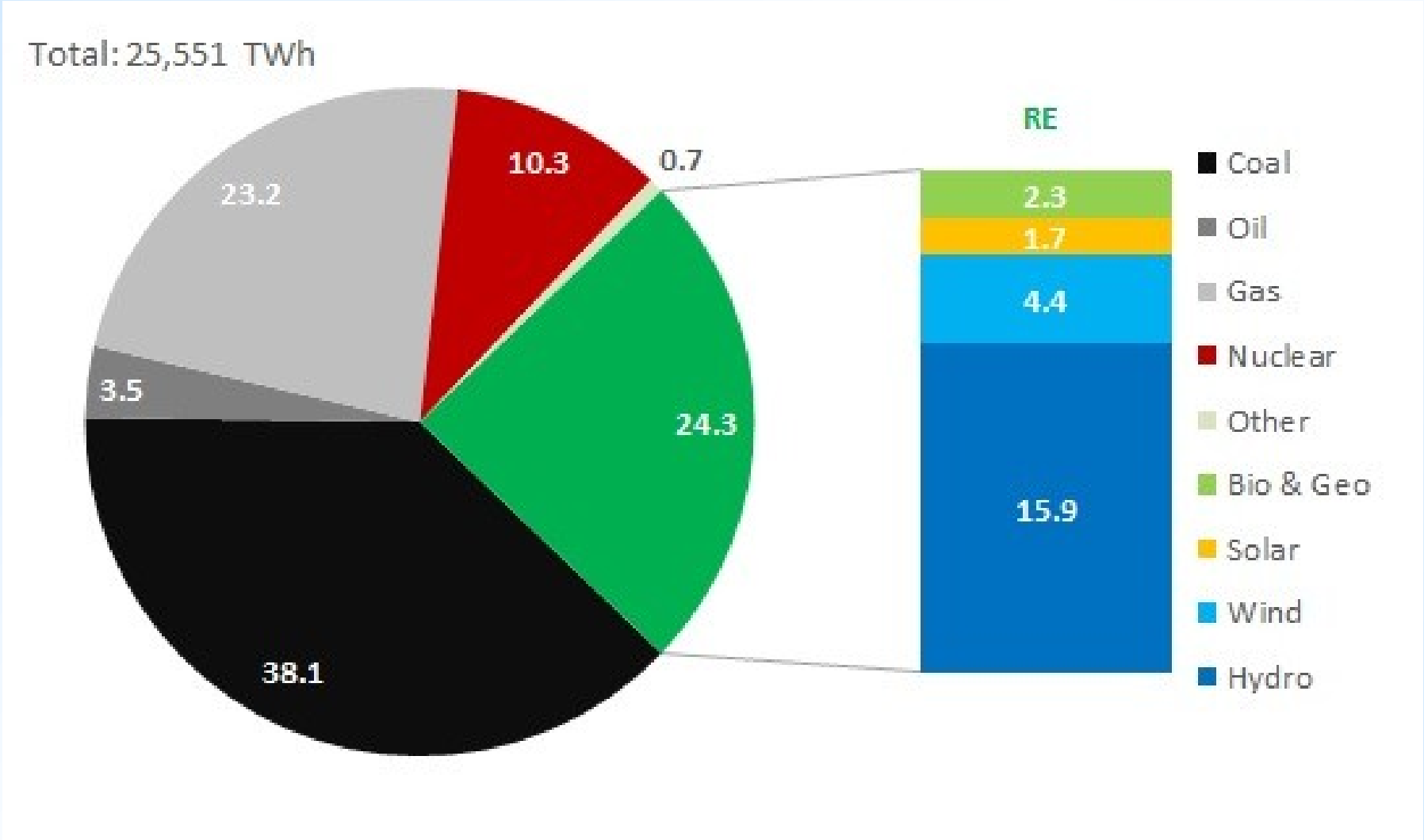
Non-energy related use

- Plastics
- Steel

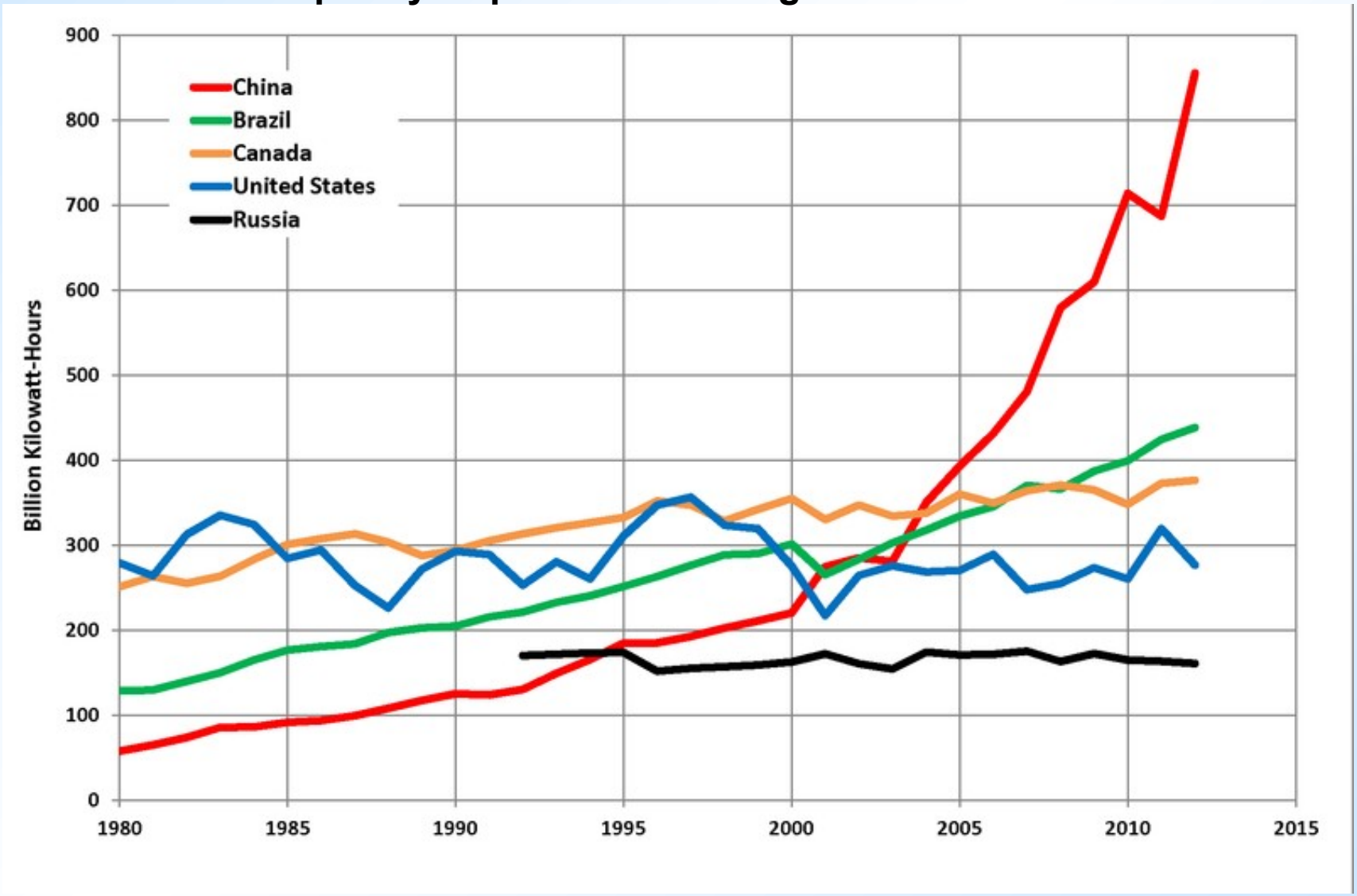
Lots of data on the use of resources. Be careful with

- Reliability of the source
- Time of release
- End product

Global Electricity Generation – BP Statistical Report 2018



Top 5 Hydropower Producing Countries



Renewable Energy - HYDROELECTRICITY

World Energy Statistics, 2015			
Rank	**Country**	**Annual Production, TWh**	**Installed Capacity, Mwe**
1	China	1 064	311 000
2	Canada	383	76 000
3	Brazil	373	89 000
4	USA	282	102 000
5	Russia	177	51 000
6	India	132	40 000
7	Norway	129	31 000
8	Japan	87	50 000
9	Venezuela	87	15 000
10	France	69	25 000

Renewable Energy - WIND

Worldwide Elec. Prod. from Renewable Energy Sources, 2012		
Rank	**Country**	**Annual Production, TWh**
1	USA	140.9
2	China	118.1
3	Spain	49.1
4	Germany	46.0
5	India	30.0
6	UK	19.6
7	France	14.9
8	Italy	13.4
9	Canada	11.8
10	Denmark	10.3
	Others	80.2
	World	534.3

Renewable Energy - PHOTOVOLTAIC

Snapshot of Global Photovoltaic Markets, 2016		
Rank	**Country**	**Installed Capacity, MWe**
1	China	78 070
2	Japan	42 750
3	Germany	41 220
4	USA	40 300
5	Italy	19 280
6	UK	11 630
7	India	9 010
8	France	7 130
9	Australia	5 900
10	Spain	5 490
29	Turkey	830
	World	303 000

Renewable Energy - GEOTHERMAL

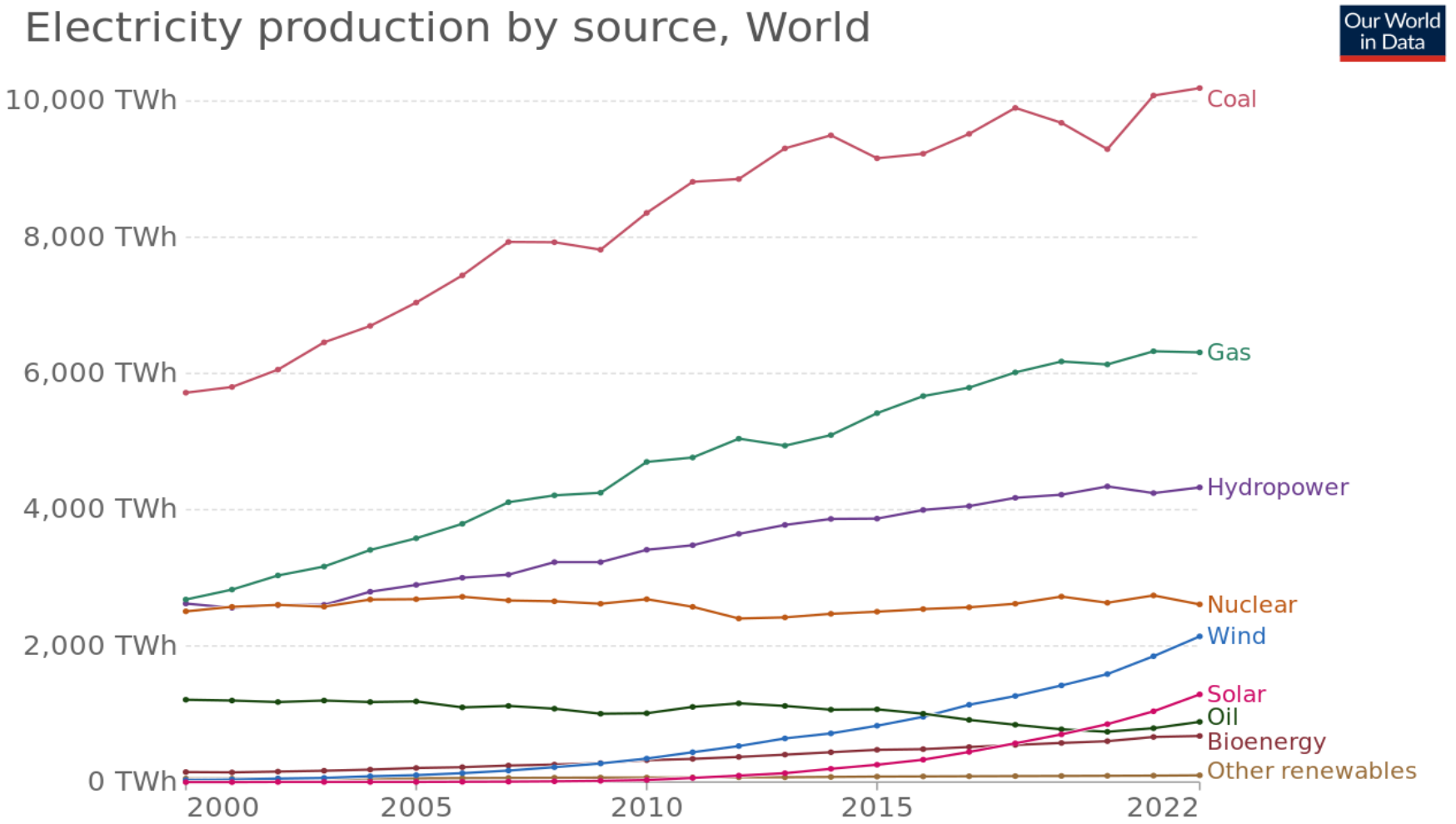
Proceedings World Geothermal Congress, 2015			
Rank	**Country**	**Installed Capacity, MWe**	**Share of National Generation, %**
1	USA	3 450	0.3
2	Philippines	1 870	27.0
3	Indonesia	1 340	3.7
4	Mexico	1 017	3.0
5	New Zealand	1 005	14.5
6	Italy	916	1.5
7	Iceland	665	30.0
8	Kenya	594	51.0
9	Japan	519	0.1
10	Turkey	397	0.3
	World	12 636	

Renewable Energy – SOLAR WATER HEATING

Int. Energy Agency, 2013		
Rank	**Country**	**Solar Thermal Power, MW_{th}**
1	China	262 000
	European Union	31 400
2	USA	16 800
3	Germany	12 100
4	Turkey	11 000
5	Australia	5 800
6	Brazil	6 700
7	Japan	3 200
8	Austria	3 500
9	Greece	2 900
10	Israel	2 900

ELECTRIC ENERGY – Production

BP Statistical Review of World Energy, 2016 (by resource 2011)								
Rank	**Country**	**Electricity Production, GWh/year (2016)**	**Coal**	**Natural Gas**	**Oil**	**Hydro**	**Other Ren.**	**Nuclear**
1	China	6 142 490	79 %	1.8 %	0.2 %	14.8	2.2	1.8
2	USA	4 350 800	43.3 %	24 2 %	0.9 %	7.4 %	4.8 %	12.2 %
	EU	3 247 300						
3	India	1 400 000	67.9 %	10.3 %	1.2 %	12.4 %	5.0 %	3.2 %
4	Russia	1 087 100	15.5 %	49.3 %	2.6 %	15.7 %	0.1 %	16.4 %
5	Japan	999 600	27.0 %	35 9 %	10.1 %	8.0 %	4.2 %	9.8 %
6	Canada	663 000	12.0 %	9.8 %	1.0 %	59.0 %	3.3 %	14.7 %
7	Germany	648 400	45.1 %	13.9 %	1.1 %	2.9 %	17.6 %	17.9 %
8	Brazil	581 700						
9	France	553 400	3.1 %	4.8	0.6 %	8.0 %	3.6 %	79.4 %
10	South Korea	551 200	43.2 %	22.3 %	3.2 %	0.9 %	0.6 %	29.8 %
17	Turkey	272 700	30.2 %	47.9 %	0.9 %	16.1	4.9 %	0
	World	24 816 400	41.5 %	22.1 %	3.9 %	16.1 %	4.2 %	12.2 %


Electricity production by source, World
Our World in Data
10,000 TWh
8,000 TWh
6,000 TWh
4,000 TWh
2,000 TWh
0 TWh
2000
2005
2010
2015
2022
Coal
Gas
Hydropower
Nuclear
Wind
Solar
Oil
Bioenergy
Other renewables
Source: Ember's Yearly Electricity Data; Ember's European Electricity Review; Energy Institute Statistical Review of World Energy
Note: 'Other renewables' includes waste, geothermal and wave and tidal energy.

ELECTRIC ENERGY – Consumption

The World Fact Book, 2014 , 2015				
Rank	**Country**	**Electricity Consumption, GWh/year**	**Population, 2016**	**kWh/person/year**
1	China	5 920 000	1 373 541 000	4 310
2	USA	3 911 000	323 995 528	12 071
	EU	2 771 000	513 949 445	5 391
3	Russia	1.065 000	142 355 415	7 481
4	India	1 001 191	1 266 883 598	1 122
5	Japan	934 000	126 702 133	7 371
6	Germany	533 000	80 722 292	6 602
7	Canada	528 000	35 362 905	14 930
8	Brazil	518 000	205 823 665	2 516
9	South Korea	495 000	50 924n172	9 720
10	France	431 000	66 836 154	6 448
20	Turkey	207 000	80 274 604	2 578
	World	21 776 089	7 322 811 468	2 674

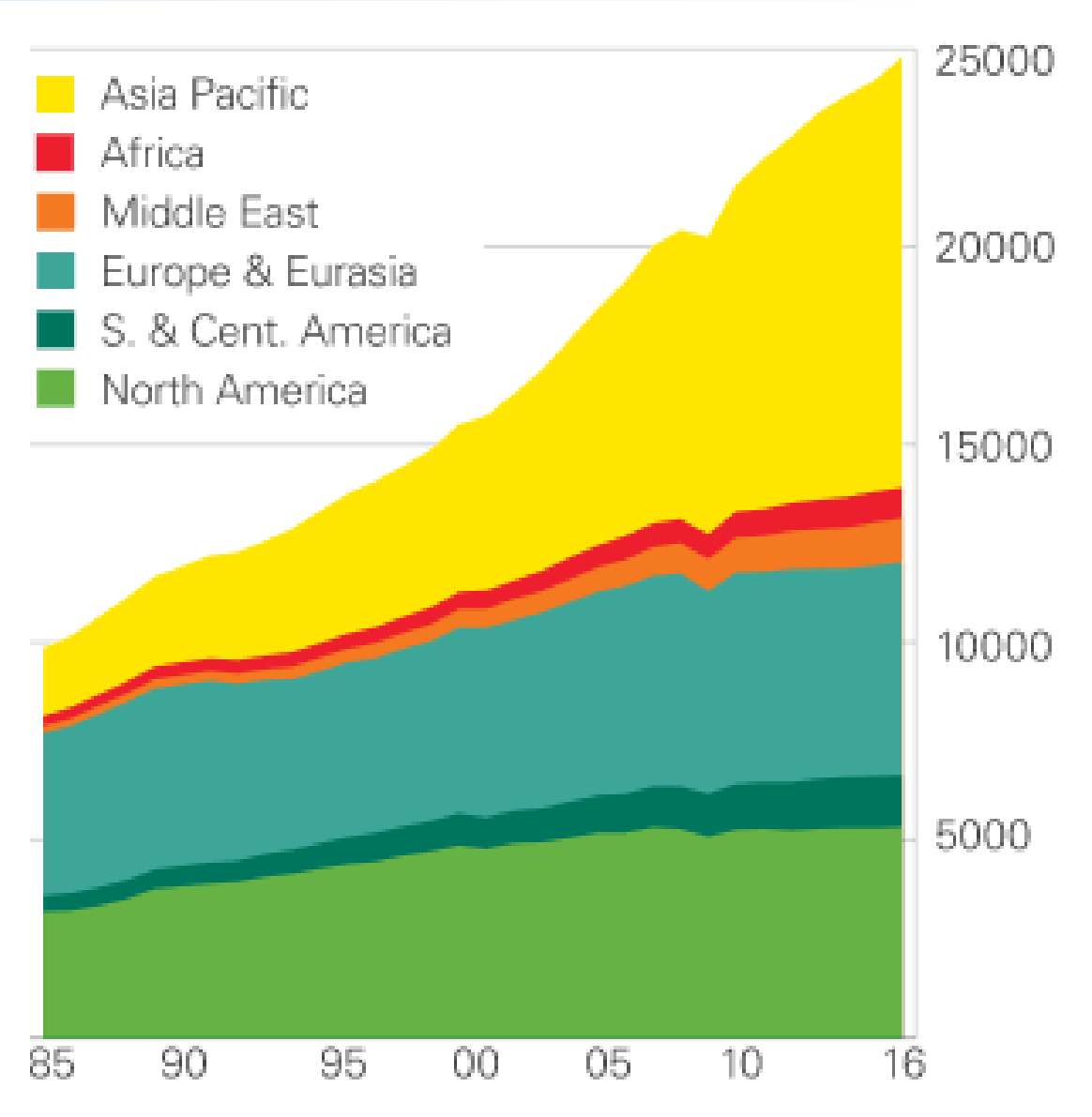
ELECTRIC ENERGY – Exports

The World Factbook			
Rank	**Country**	**Exports, kWh**	**Date of Info.**
1	France	75 060	2014
2	Canada	58 400	2014
3	Switzerland	43 340	2015
4	Paraguay	41 000	2014
5	Czech Rep.	28 000	2014
6	Sweden	22 600	2015
7	Netherlands	19 340	2016
8	Austria	19 310	2015
9	China	18 910	2016
10	Spain	16 000	2014
43	Turkey	2 576	2007

ELECTRIC ENERGY – Imports

The World Factbook, 2007		
Rank	**Country**	**Imports, 10^6 kWh**
1	USA	51 400
2	Italy	48 570
3	Germany	46 130
4	Brazil	40 470
5	Switzerland	34 820
6	Netherlands	23 140
7	Austria	22 130
8	Canada	19 660
9	Sweden	16 610
10	Belgium	15 730
58	Turkey	863

Electricity Generation, TheraWatt-hours



See the Article on «OdtuClass»:

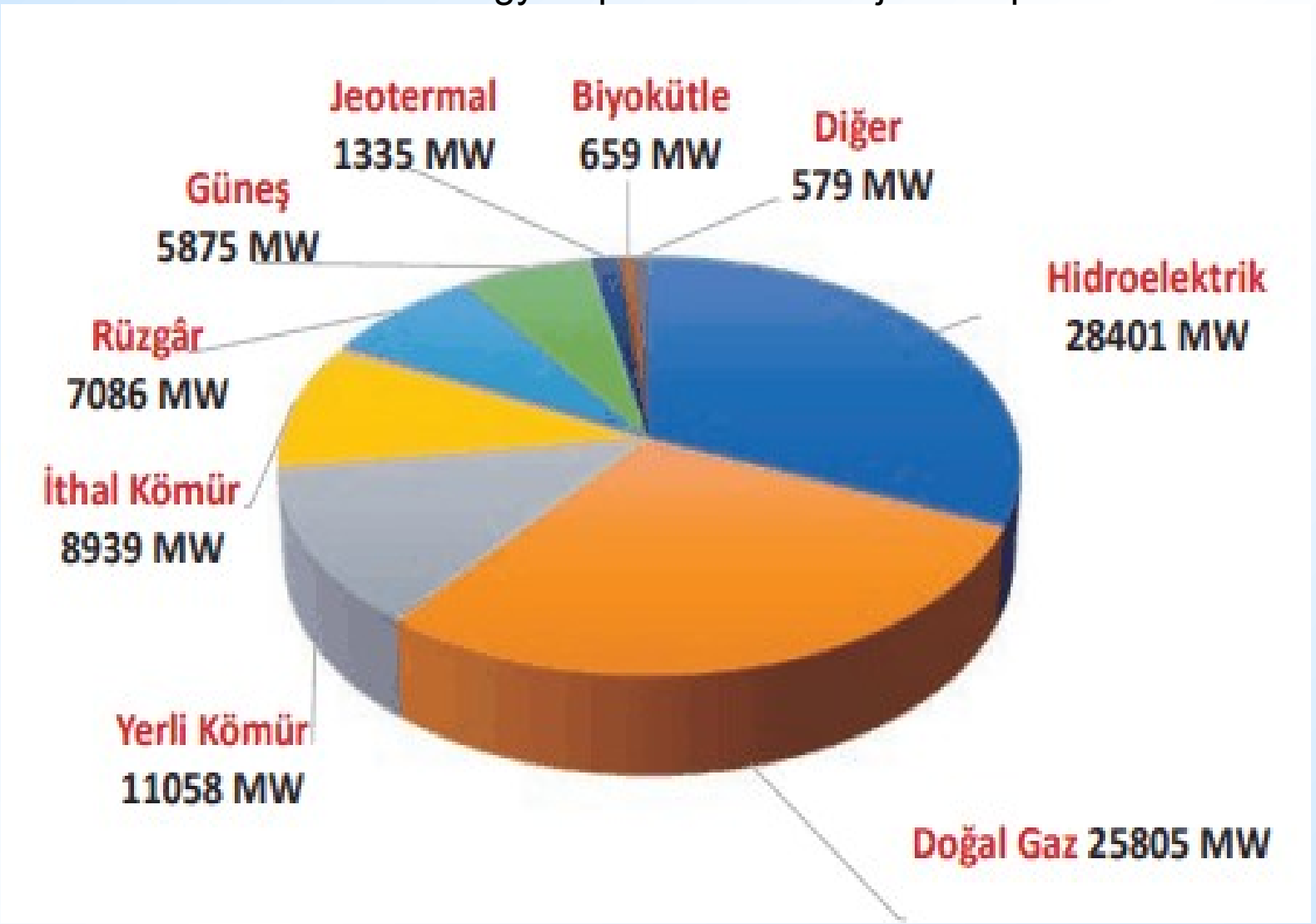
BP-Statistical-Review-of-World-Energy-2022-Full-Report.pdf

In a move seen as part of BP's shift away from fossil fuels, the company stopped releasing its Statistical Review of World Energy, which it first published in 1952. The new custodian of the report is EI (Energy Institute).

See the EI publication on «OdtuClass»:

«Statistical Review of World Energy», published in 28 June 2023

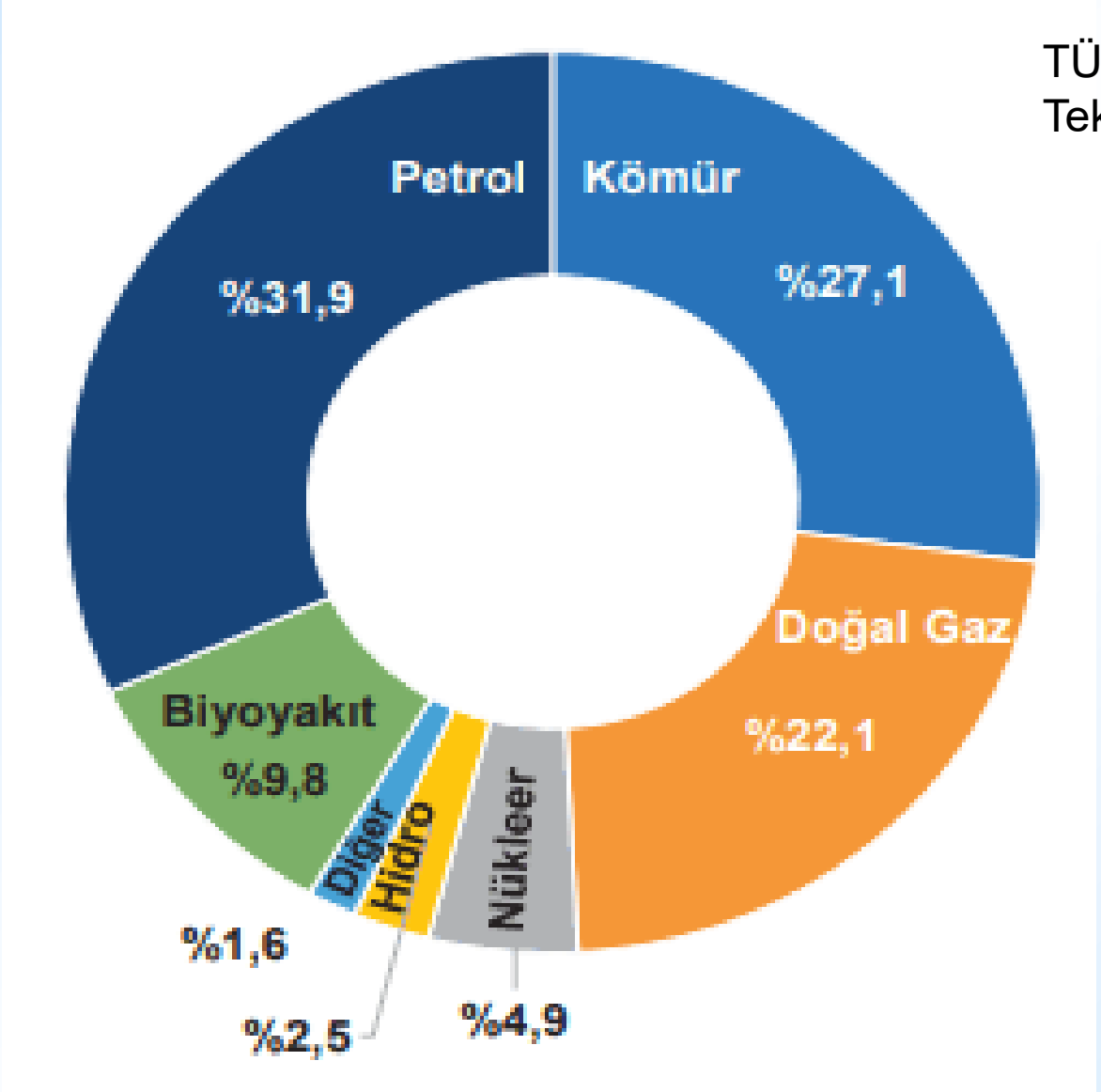
TÜBA Energy Depolama Teknolojileri Raporu - 2020



Installed Capacity for Electricity Generation

Installed Capacity in 2022 100 GW

Installed Capacity in 2024 113 GW



TÜBA Energy Depolama Teknolojileri Raporu - 2020

Primary Energy Consumption

TURKEY – RENEWABLE RESOURCE POTENTIAL WAITING FOR DEVELOPMENT

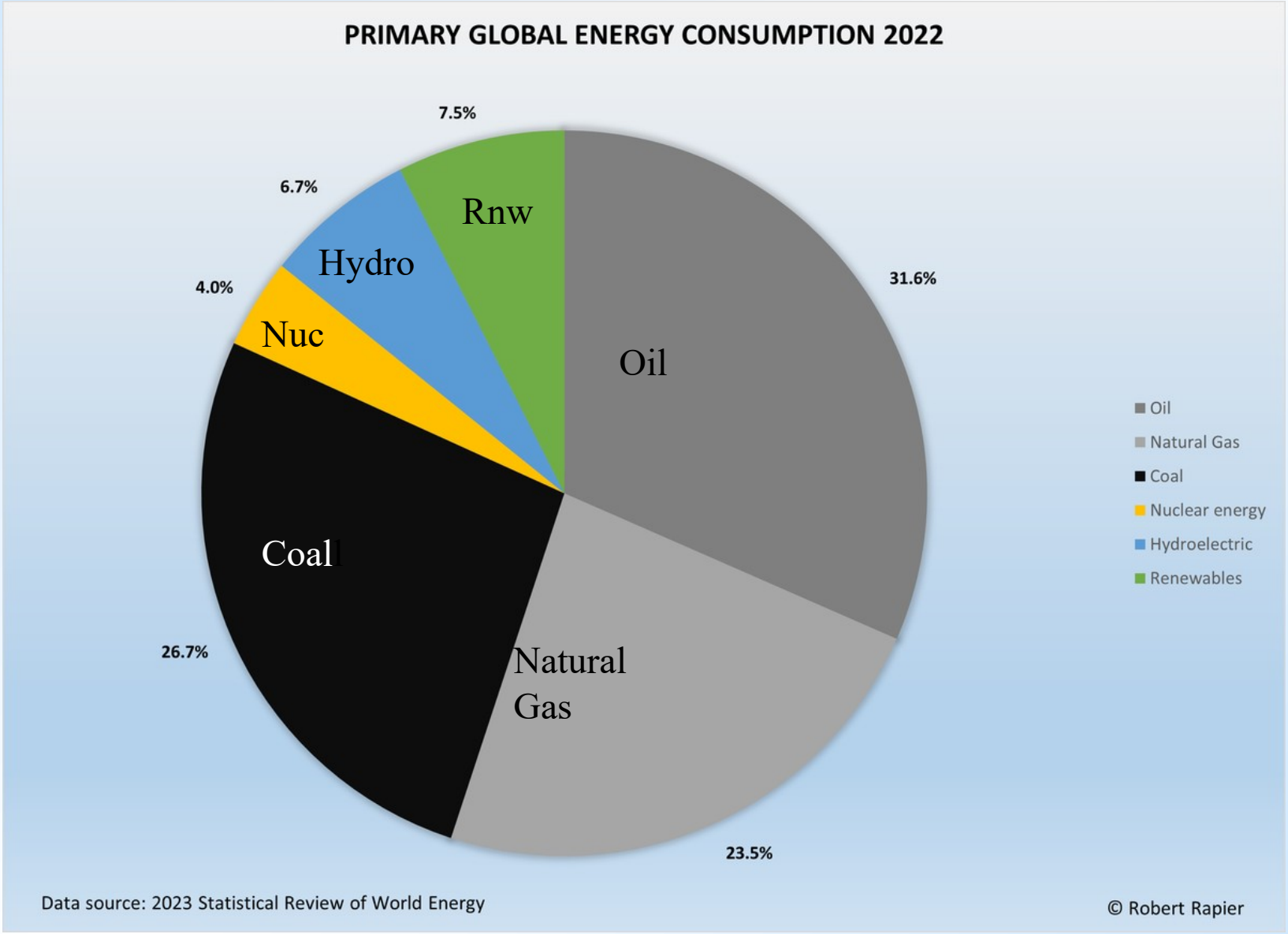
(Updated by Pamir, 2020)

ENERGY SOURCE	INSTALLED CAPACITY, end 2019, MW	REMAINING GENERATING POTENTIAL, Billion kWh	REMAINING POTENTIAL for INSTALMENT, MW
HYDRO-ELECTRIC (3400 hours/year), 46.477 MW	28.502	61	17.975
WIND (3000 hours/year), 47.849 MW	7.591	121	40.259
GEOTHERMAL (7120 hours/year); 2.000 MW	1.515	3,5	485
SOLAR: 260.000 MW*	5.995	391	254.005
BIOMASS; 12.000 MW	801	33	11.199
TOTAL, RENEWABLES	44.404	609,5 billion kWh	323.923

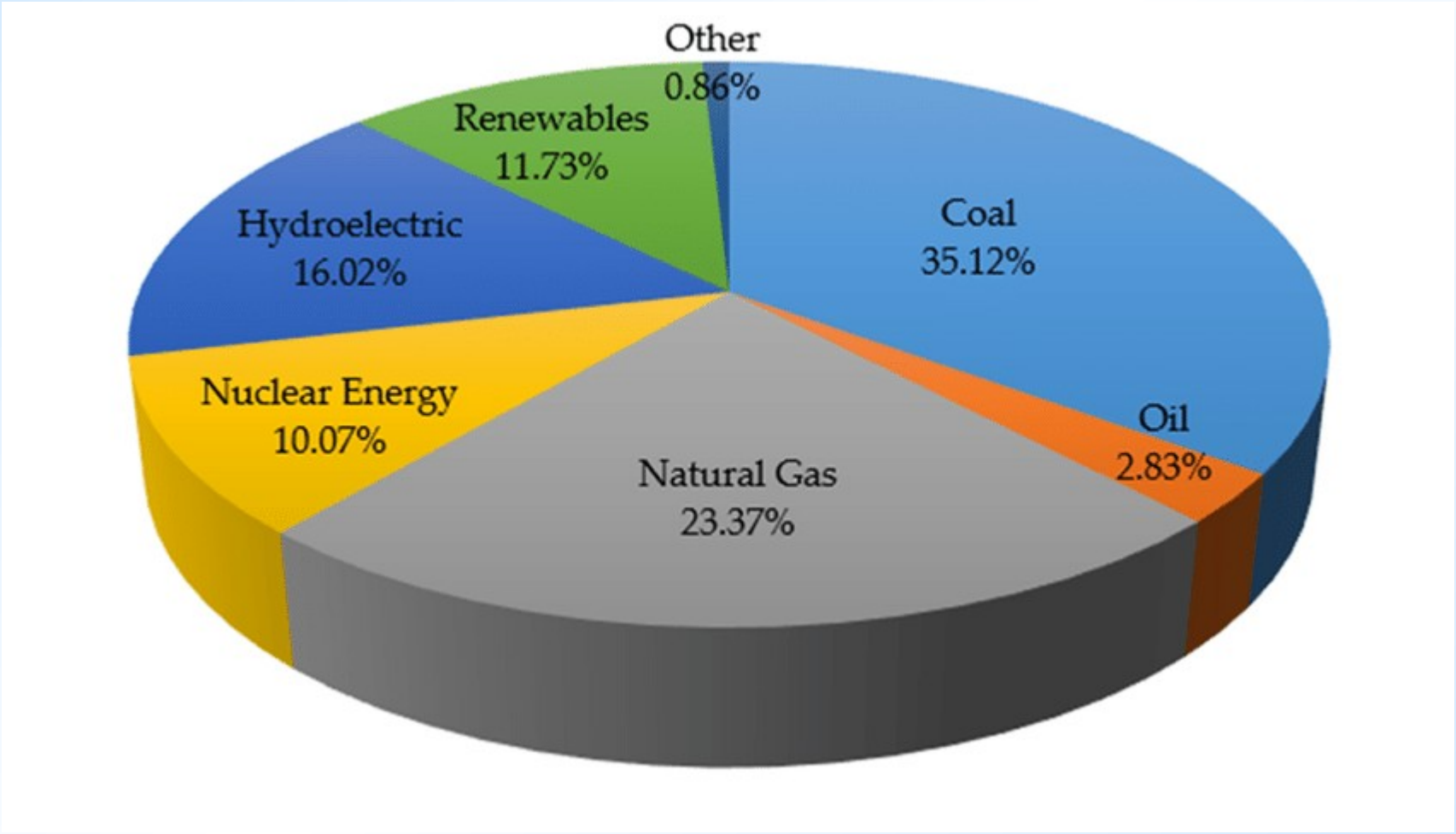
If existing plants could operate with full capacity, additional generation would be between 95 - 145 billion kW-h. Increasing energy efficiency in all sectors would further add a 25%.

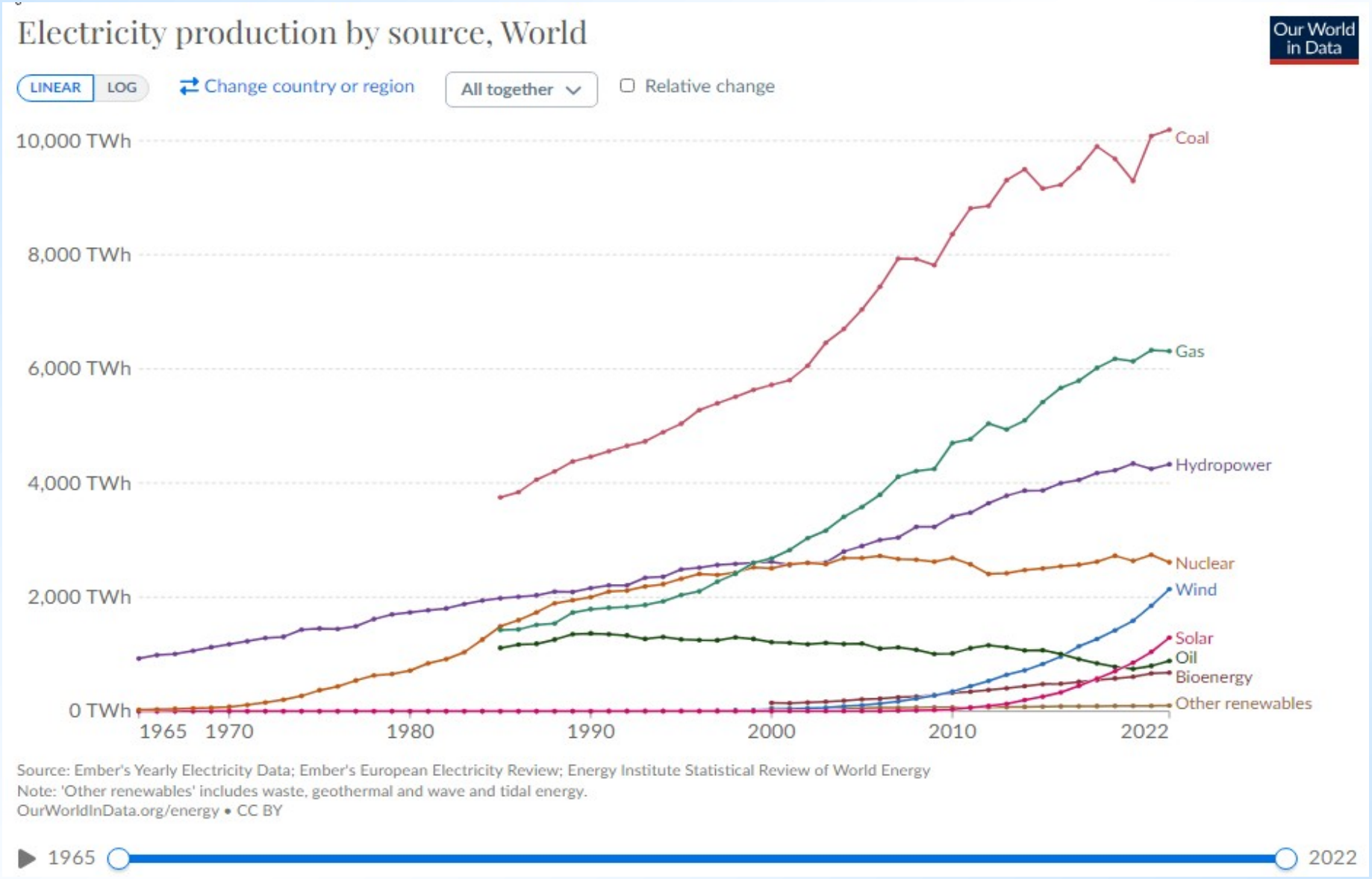
* 1 MW Solar Plant can generate 1.540.000 kWh in Turkey

2019 electricity consumption: 290 billion kWh

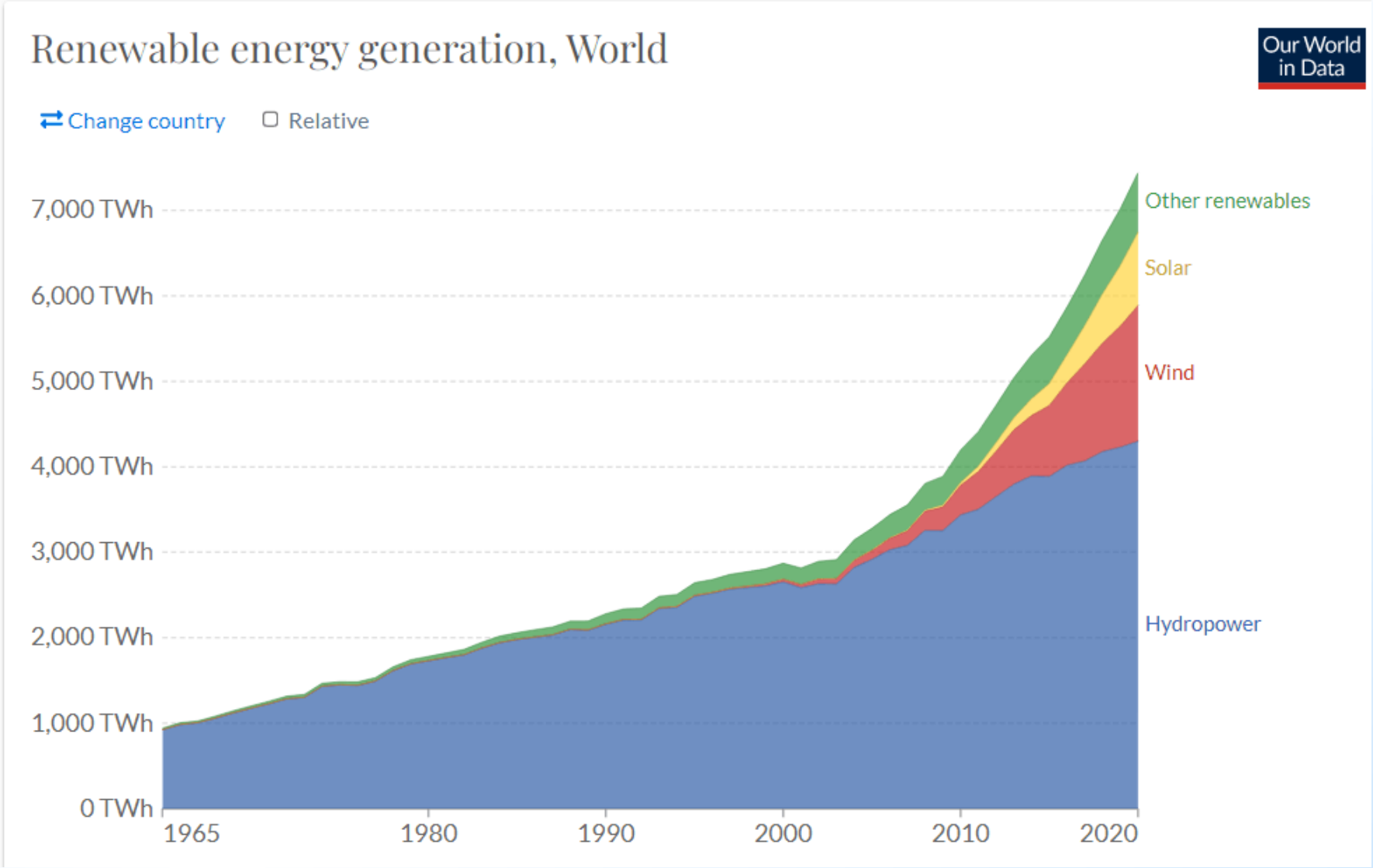

PRIMARY GLOBAL ENERGY CONSUMPTION 2022
7.5%
6.7%
Rnw
Hydro
4.0%
Nuc
31.6%
Oil
Coal
26.7%
Natural Gas
23.5%
Oil
Natural Gas
Coal
Nuclear energy
Hydroelectric
Renewables
Data source: 2023 Statistical Review of World Energy
© Robert Rapier

Gloal Use of Resources for Electricity Generation

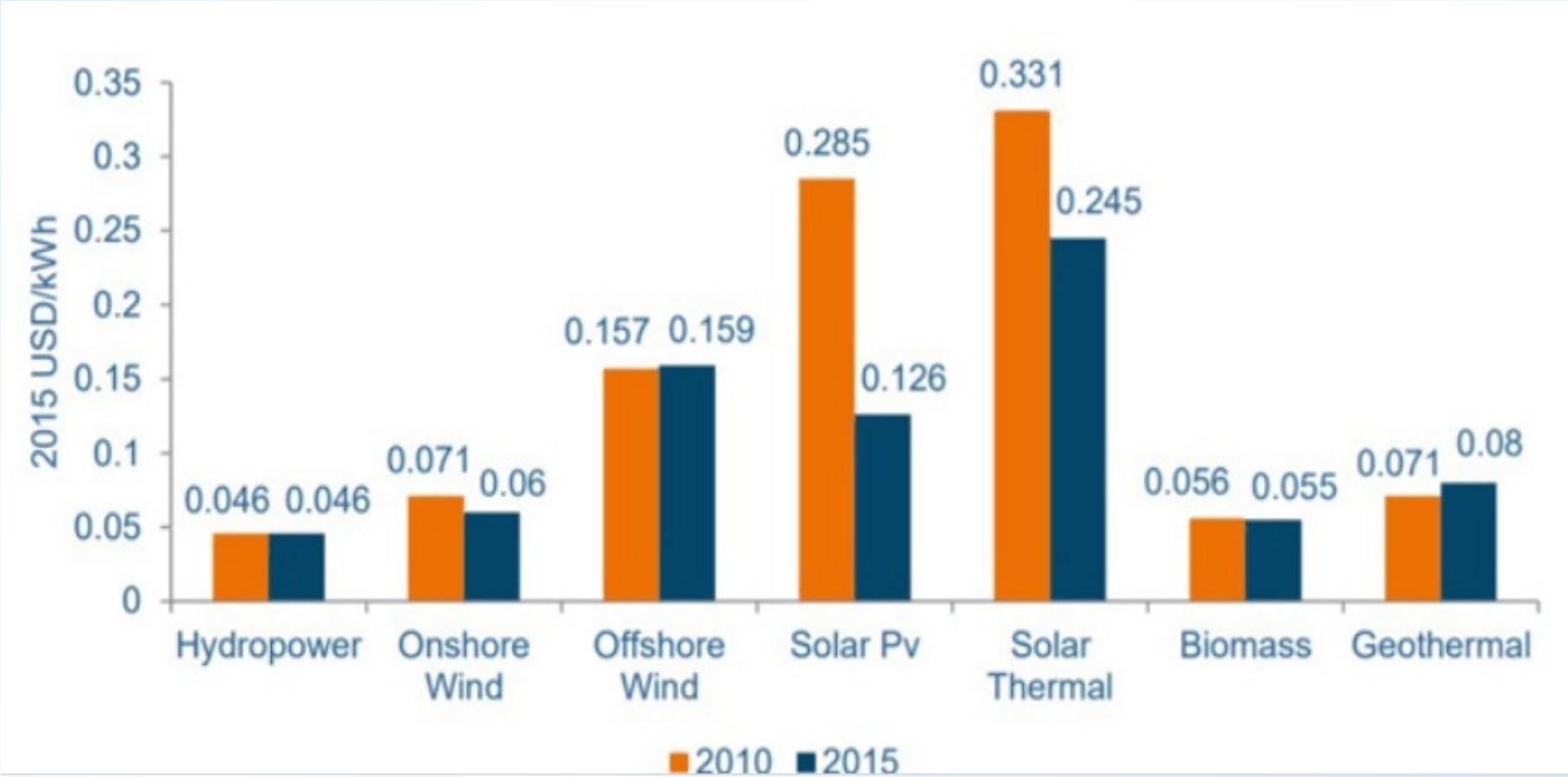



Electricity production by source, World
Our World in Data
LINEAR
LOG
Change country or region
All together
Relative change
10,000 TWh
8,000 TWh
6,000 TWh
4,000 TWh
2,000 TWh
0 TWh
1965
1970
1980
1990
2000
2010
2022
Coal
Gas
Hydropower
Nuclear
Wind
Solar
Oil
Bioenergy
Other renewables
Source: Ember's Yearly Electricity Data; Ember's European Electricity Review; Energy Institute Statistical Review of World Energy
Note: 'Other renewables' includes waste, geothermal and wave and tidal energy.
OurWorldInData.org/energy • CC BY
1965
2022

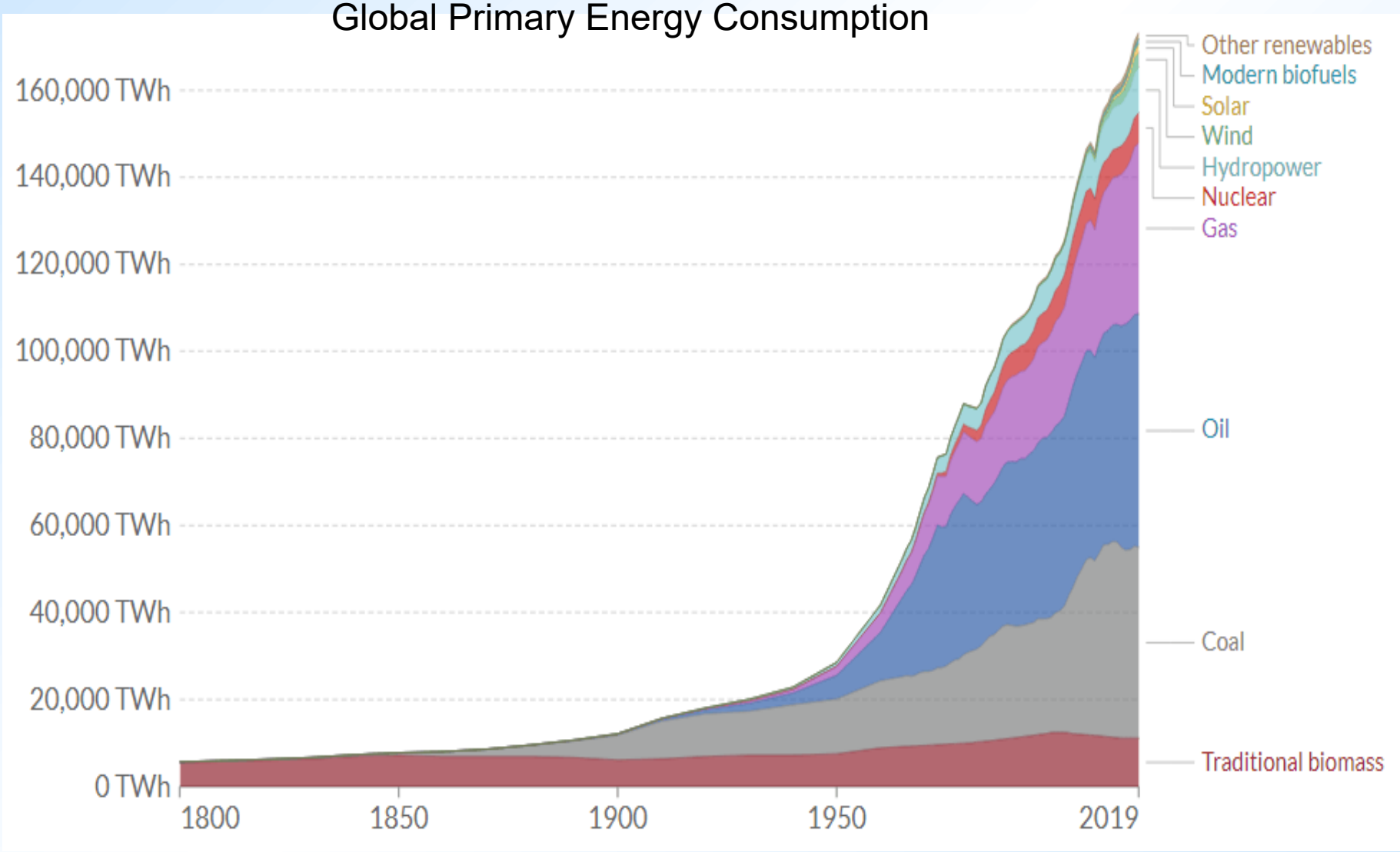
Mega	M	10^{6}
Giga	G	10^{9}
Tera	T	10^{12}
Peta	P	10^{15}
Exa	E	10^{18}
Zetta	Z	10^{21}

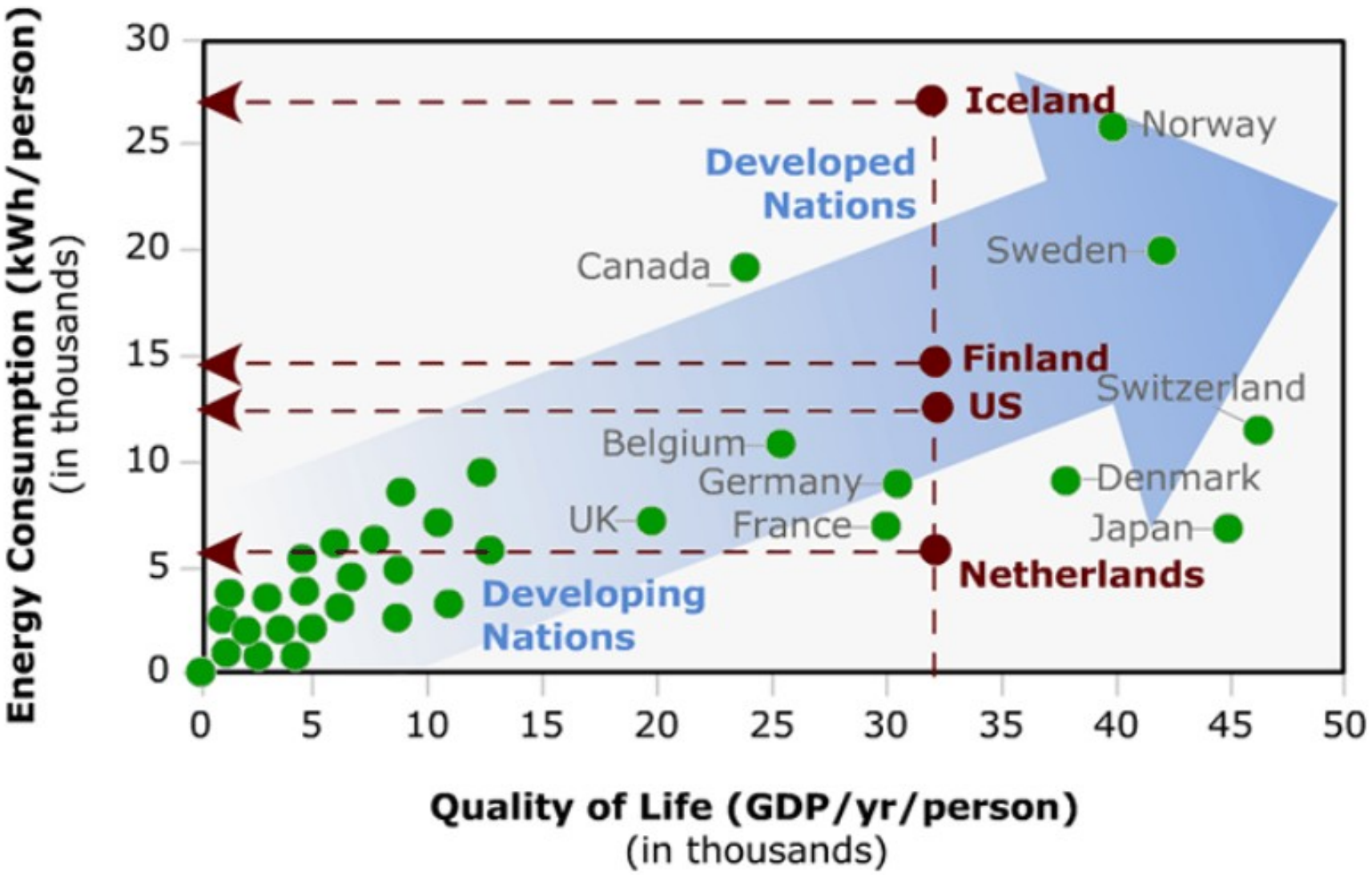

Renewable energy generation, World
Our World in Data
Change country
Relative
7,000 TWh
6,000 TWh
5,000 TWh
4,000 TWh
3,000 TWh
2,000 TWh
1,000 TWh
0 TWh
1965
1980
1990
2000
2010
2020
Other renewables
Solar
Wind
Hydropower

The below chart shows the cost of electricity taking into account construction costs including profits the complete life cycle cost of kWh of energy. In 2015 the cost of electricity from hydro was 0.046 USD per kWh.



Global Primary Energy Consumption

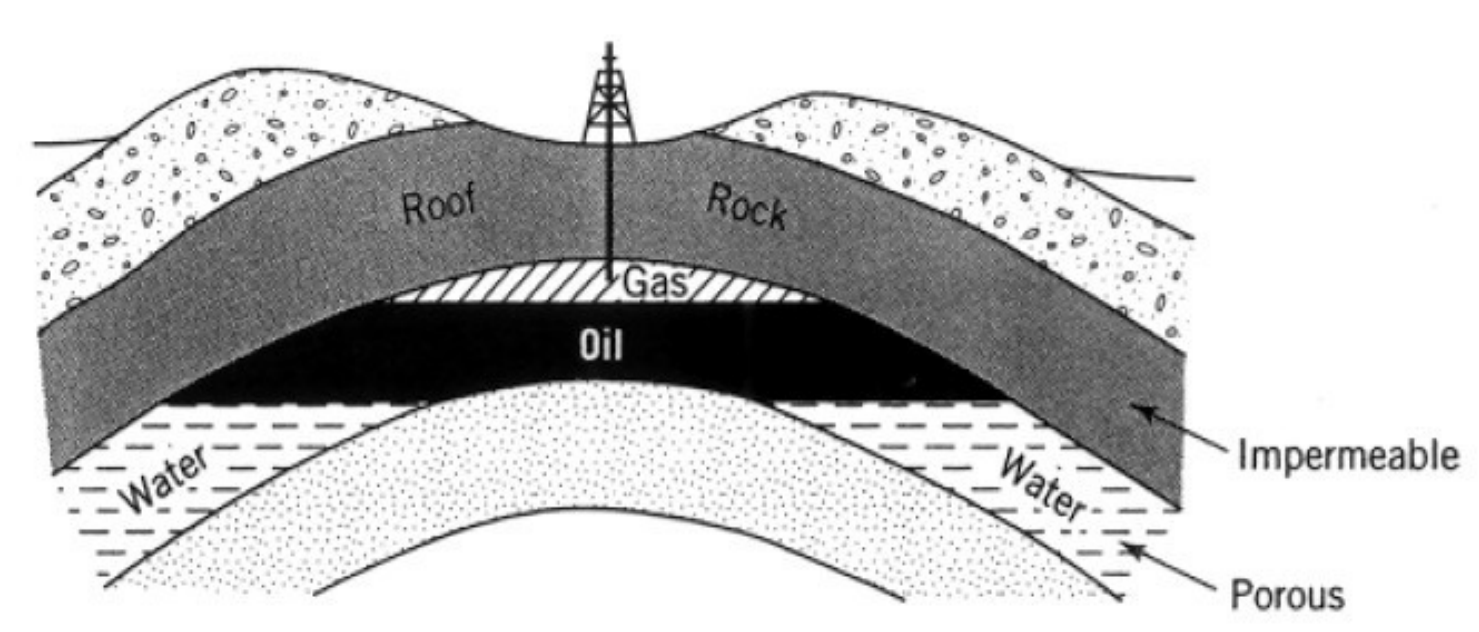



Energy Consumption (kWh/person)
(in thousands)
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
45
50
Quality of Life (GDP/yr/person)
(in thousands)
Iceland
Norway
Developed Nations
Canada
Sweden
Finland
US
Switzerland
Belgium
Germany
Denmark
UK
France
Japan
Netherlands
Developing Nations

Gross domestic product (**GDP**) is the value of a nation's finished domestic goods and services during a specific time period. A related but different metric, the gross national product (**GNP**), is the value of all finished goods and services owned by a country's residents over a period of time.

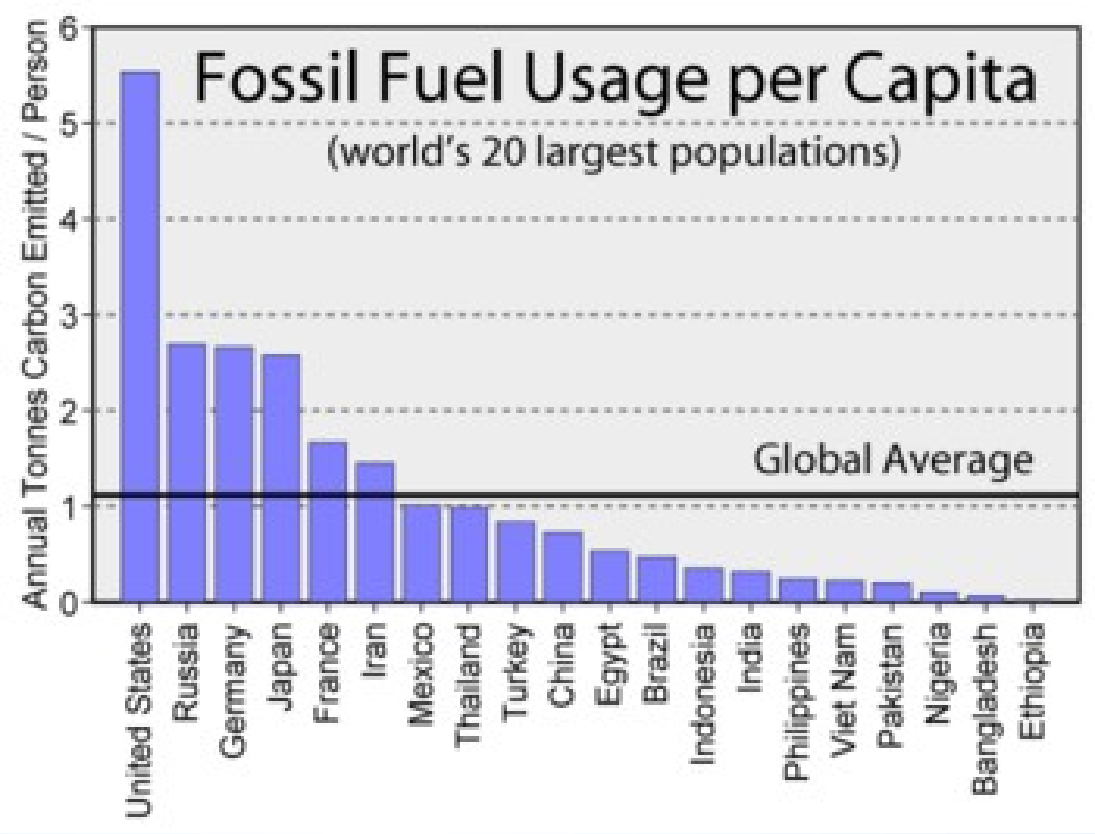
- Gross domestic product (GDP) and gross national product (GNP) are both widely used measures of a country's aggregate economic output.
- GDP measures the value of goods and services produced within a country's borders, by citizens and non-citizens alike.
- GNP measures the value of goods and services produced by only a country's citizens but both domestically and abroad.
- GDP is the most commonly used by global economies. The United States abandoned the use of GNP in 1991, adopting GDP as its measure to compare itself with other economies.

Fossil Fuels: Oil & Natural Gas ($CH_4 + C_2H_6$)



A typical geological formation in which oil and natural gas are found – gas above oil above water all interspersed in porous media.

Fossil Fuels: Oil, Coal, Natural Gas



Major usage of fossil fuels:

- Transportation (26.5 %)
- Industrial: (32.5 %)
- Residential/Commercial (41 %)
- Electrical power: (0.7 %)

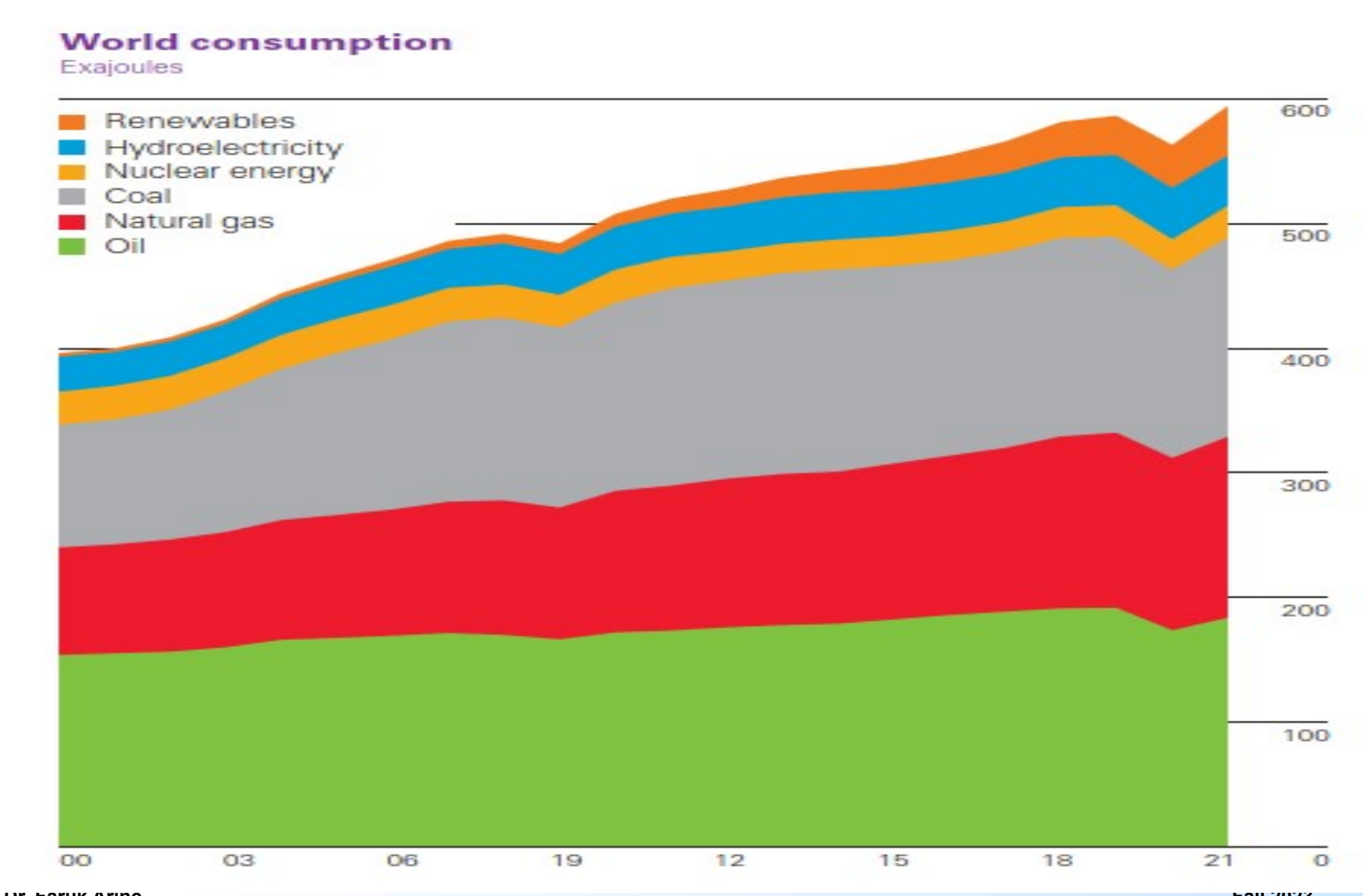
Industrial Use of Fossil Fuels (Coal, Oil, Natural Gas):

- Heat in industrial processes and space heating in buildings
- Boiler fuel to generate steam or hot water for process heating and generating electricity
- Feedstocks (raw materials) to make products such as plastics and chemicals

Major Industries Using Fossil Fuels as Energy Resource:

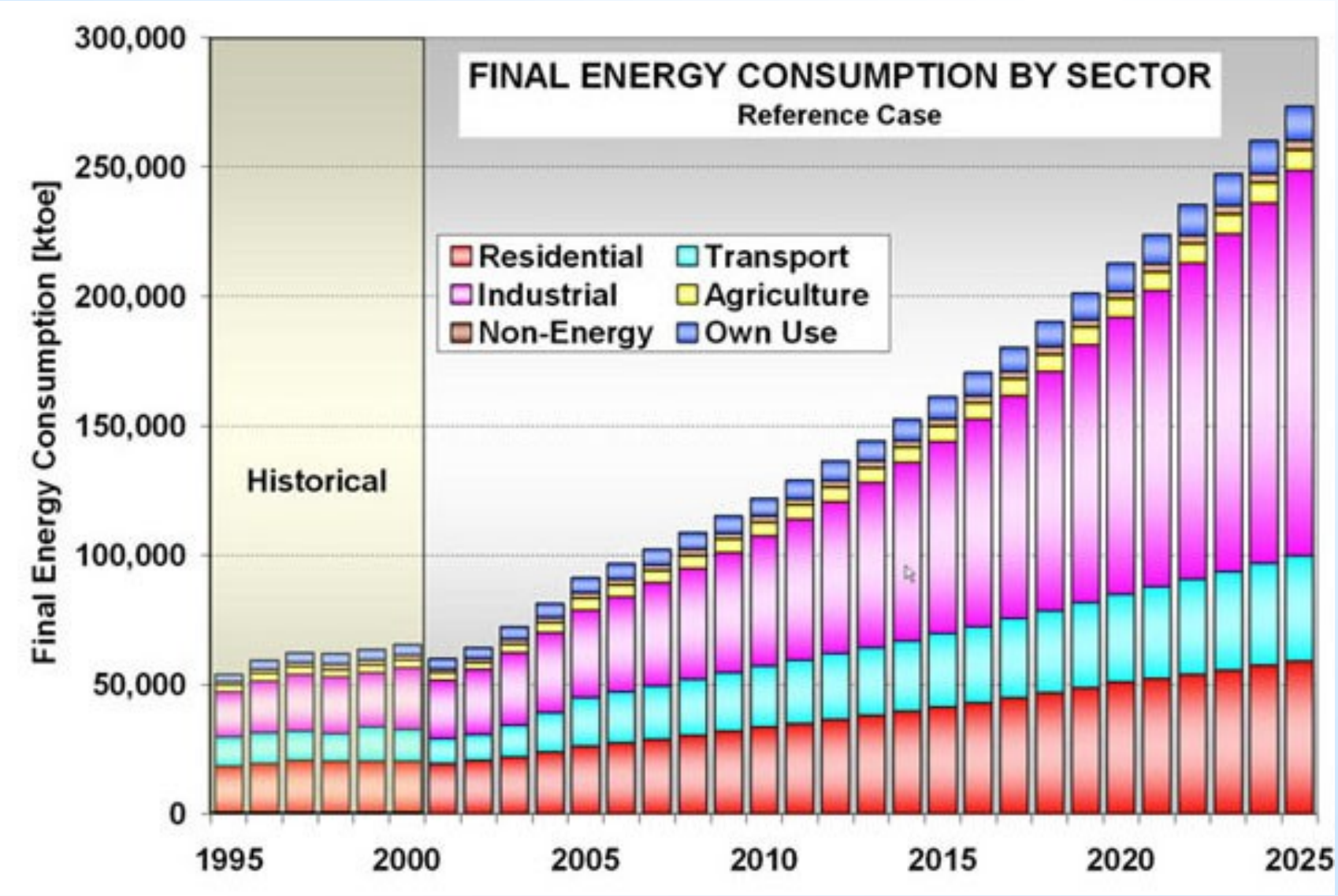
- Manufacturing 77 %
- Mining: 12 %
- Construction: 7 %
- Agriculture: 5 %

World Consumption – BP Statistical Report 2022



China and Coal

Coal makes up 69 percent of China's total primary energy consumption, and China is both the largest consumer and producer of coal in the world. China holds an estimated 126.2 billion short tons of recoverable coal reserves, the third-largest in the world behind the United States and Russia. Northern China, especially Shanxi Province, contains most of China's easily accessible coal and virtually all of the large state-owned mines. Coal from southern mines tends to be higher in sulfur and ash, and therefore unsuitable for many applications. In 2004, China consumed 2.1 billion short tons of coal, representing more than one third of the world total and a 46 percent increase since 2002. Coal consumption has been on the rise in China over the last five years, reversing the decline seen from 1997 to 2000.

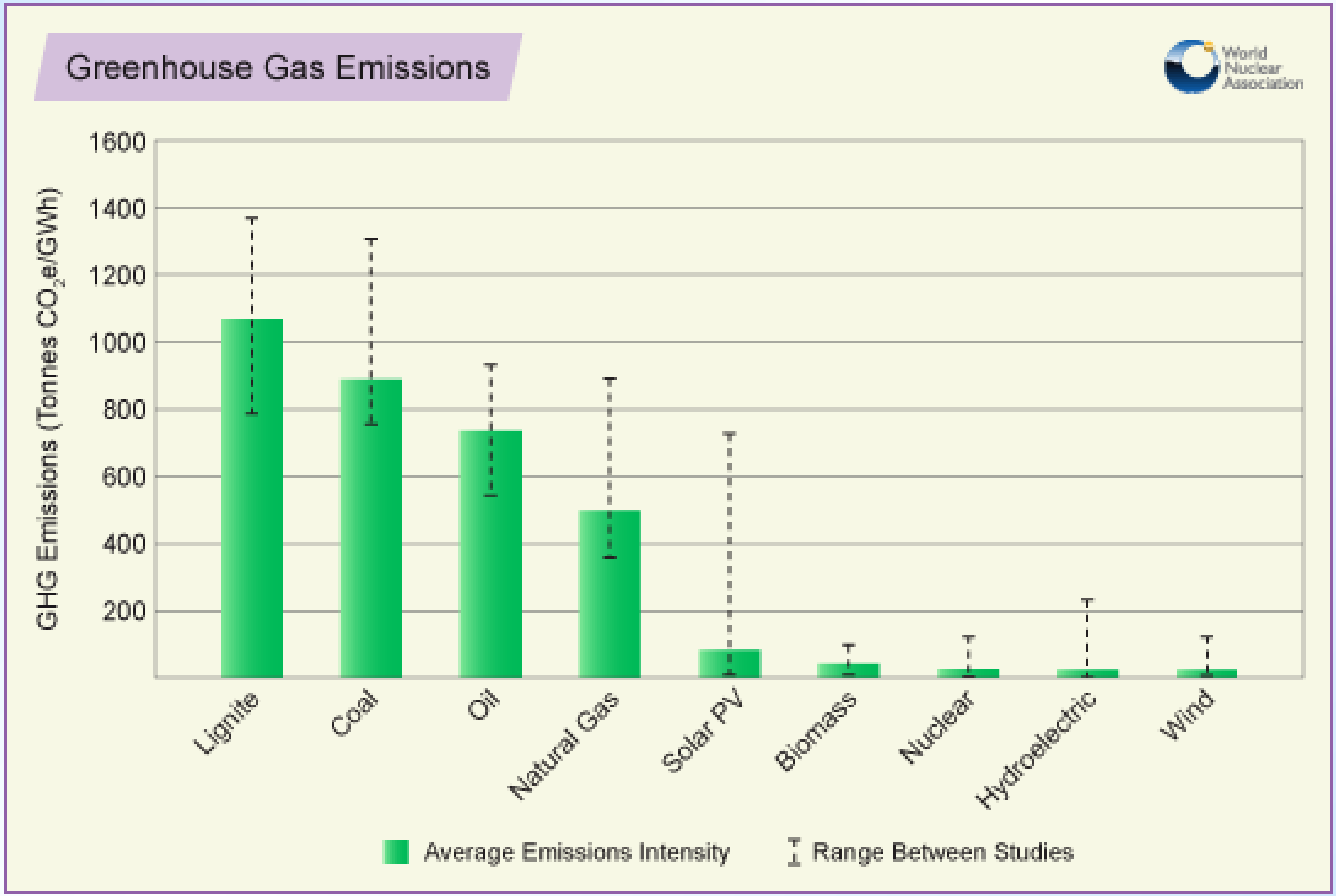

FINAL ENERGY CONSUMPTION BY SECTOR
Reference Case
Final Energy Consumption [ktoe]
300,000
250,000
200,000
150,000
100,000
50,000
0
Historical
Residential
Industrial
Non-Energy
Transport
Agriculture
Own Use
1995
2000
2005
2010
2015
2020
2025

Renewable Energy Resources: Solution of energy crisis ?

- Renewable energy uses energy sources that are continually replenished by nature—the sun, the wind, water, the Earth's heat, and plants.
- The renewable energy is ready to be harnessed, inexhaustible and, more importantly, it is clean alternative to fossil fuels.
- Today we primarily use fossil fuels but we have a limited supply of these fuels on the Earth. We are using them much more rapidly than they are being created. Eventually, they will run out.
- Burning of fossil fuel, such as coal, oil and natural gas will cause green house effect, rise in sea effect, impact on our ecosystem and agriculture production, and most commonly pollutants into atmosphere.

Why is this such a big deal environmentally?

- Fossil fuels have to be extracted from the Earth or the Ocean; often there are environmental consequences from extracting fossil fuels (e.g. strip mining, oil spills, etc.)
- Fossil fuels are pollutants, especially crude oil. Major oil leaks create an environmental/economic/political nightmare.
- Burning fossil fuels releases greenhouse gases (CO_2, methane, etc.), which have been associated with global climate change.
- Burning fossil fuels releases several pollutants:
- Coal burning releases sulfates in the air that produce acid rain
- Burning of gasoline releases CO_2,volatile organic compounds, nitric oxides, and ozone.


Greenhouse Gas Emissions
World Nuclear Association
GHG Emissions (Tonnes CO_2e/GWh)
1600
1400
1200
1000
800
600
400
200
Lignite
Coal
Oil
Natural Gas
Solar PV
Biomass
Nuclear
Hydroelectric
Wind
Average Emissions Intensity
Range Between Studies

Facts, Advantages, Disadvantages

Solar Energy

Key Facts

1. Solar energy is converted to electricity by a photovoltaic cell in which an electron is dislodged to produce electrical currents.
2. We could meet all of the world's energy needs by constructing a solar facility 291 miles on each side (square) in a low latitude region. However, as of 1998, solar energy made up only 0.009% of global energy consumption.
3. It can be used in many ways, from heating to growing plants, and is currently one of the world's cleanest energy sources.

Solar Power Plant in Karapınar, Konya. Installed capacity: 1000 MW.

Solar Energy

Advantages

1. It is free, inexhaustible, versatile, produces no wastes, and has no moving parts.
2. Can be used anywhere, especially places with ample sunlight and poor agricultural conditions (e.g., many developing countries).

Disadvantages

1. It can be unreliable due to weather and time of day, time of year, location, etc.
2. It is very expensive (both to make the solar cells and build the facility)

(*Solar energy costs are about $0.20 per kWh compared with $0.04 per kWh for new conventional power plants)*

Wind Power

Key Facts

1. Wind energy depends on the sun; it is a form of solar energy. Heating and cooling of air causes the wind to circulate.
2. Method: turbines convert wind energy into mechanical energy and then into electrical. It works like a fan in reverse.
3. Wind turbines now manufactured have power ratings from 250 W to 1.8 MW.

Wind Power

Advantages

1. Low price (~4 - 6 cents per kWh), renewable source, dependent on the sun. (*This compares with $0.04 per kWh for new conventional power plants so wind energy is close to competitive without subsidies)*
2. Does not pollute
3. A domestic source. Wind turbines on few percent of our land could generate all our electricity

Disadvantages

1. Higher initial investment, not cost competitive in the short-term
2. Cannot be stored and timing of wind cannot be controlled
3. Noise, aesthetics, and bird danger

Biodiesel

Key Facts

1. Can be created from agricultural products like vegetable oil, palm oil and animal fat.
2. It is as biodegradable as sugar.
3. It is a byproduct of glycerin which has commercial uses.

Advantages

1. Utilizes crop rotation by providing farmers with an alternate crop for revenue.
2. Burns 75% cleaner than conventional diesel.
3. *Does not add net CO_2 to the atmosphere since the carbon source in plants is the atmosphere (it just puts back what one takes out growing the plants).*

Disadvantages

1. Expensive to produce and petroleum prices would have to stay above $40-50 per barrel to make it economic.
2. High viscosity makes it a poor alternative for cold climates, but this can be alleviated with a $100 block heater.

Natural Gas for Vehicles

Key Facts

1. There are 130,000 natural gas vehicles in the USA and 2.5 million worldwide (mostly in Europe).
2. Clean burning fuel – produces far less airborne toxins.

Advantages

1. Low vehicle emissions could reduce air pollutions
2. Safer than gas because it does not combust

Disadvantages

1. Limited range and trunks space and higher initial cost
2. Lack of refueling infrastructure
3. More expensive than gas powered cars to refuel and maintain
4. In the long term, most of the Worlds natural gas is in Russia so we will not reduce our reliance on imported hydrocarbons

Hydro Power

Key Facts

1. Build dams along streams to create reservoirs
2. Allow water to flow through the dam
3. Spin a turbine-generator couple to produce electricity

Advantages

1. Produces no pollution;
2. Totally renewable;
3. Can be used for flood control;
4. Can be used as a water resource (irrigation, cooling water for power plants, etc.);
5. Can be used for recreation (sailing, water skiing, etc)

Itaipu hydropower station at border of Brazil and Paraguay. With a capacity of 14.0 GW, the Itaipu hydropower station is one of the world's largest and generates about 20 % of Brazil's electricity.

Disadvantages

1. Very expensive to build. Take years to complete.
2. Multiple uses are not always compatible with each other. One may want the reservoir to be full (water resource, power generation), while another may want it to be below capacity (flood control). Which use has a higher priority?
3. Destroy natural habitats and species by the flooding of the stream valley, often for tens or even hundreds of kilometers upstream. Towns and cities have to be abandoned or relocated.
4. Hinders or even stops fish migrations. Salmon industry in the Northwest U.S. has been nearly destroyed by the many dams along the region's rivers.
5. Sediment is trapped behind the dam. Silts up reservoir and prevents sediment from reaching the ocean or the sea, starving coastal beaches and increasing shoreline erosion

Nuclear Power

Key Facts

1. High density, reliable energy source that relies on Uranium-235
2. Works on a large scale and it is very technologically advanced
3. It has been on the decline since the 1970's but new technologies are now available

Advantages

1. It does not produce carbon dioxide (so it can be considered green) and the waste has a low volume
2. We know a lot about it and it is feasible to generate a large proportion global energy needs using existing technology.

Nuclear Power

Disadvantages

1. Disposal of nuclear waste is problematic: The waste will remain highly radioactive for thousands of years. All the waste in the US has no permanent home.
2. A potential target for terrorists: Peaceful nuclear power may be used to disguise efforts to construct nuclear bombs.
3. Safety: Regardless of the facts and new technologies, public perceptions of safety are very low.
4. Regulation: It takes years (or decades) to permit new nuclear facilities.

Geothermal

Key Facts

1. It is the energy obtained from the earth(geo), hot rocks and water/steam resevoirs present inside the earth.
2. It is produced due to the fission of radioactive materials in the earth's core and some places inside the earth become very hot.
3. They cause water deep inside the earth to form steam. As more steam is formed, it gets compressed at high pressure and comes out in the form of hot springs which produces geothermal power.

Nesjavellir geothermal power station, Iceland. Due the high concentration of volcanoes, Iceland has an unusual advantage of utilizing geothermal energy. Shown here is Nesjavellir Geothermal Power Station with a capacity of 120 MW.

Geothermal

Advantages

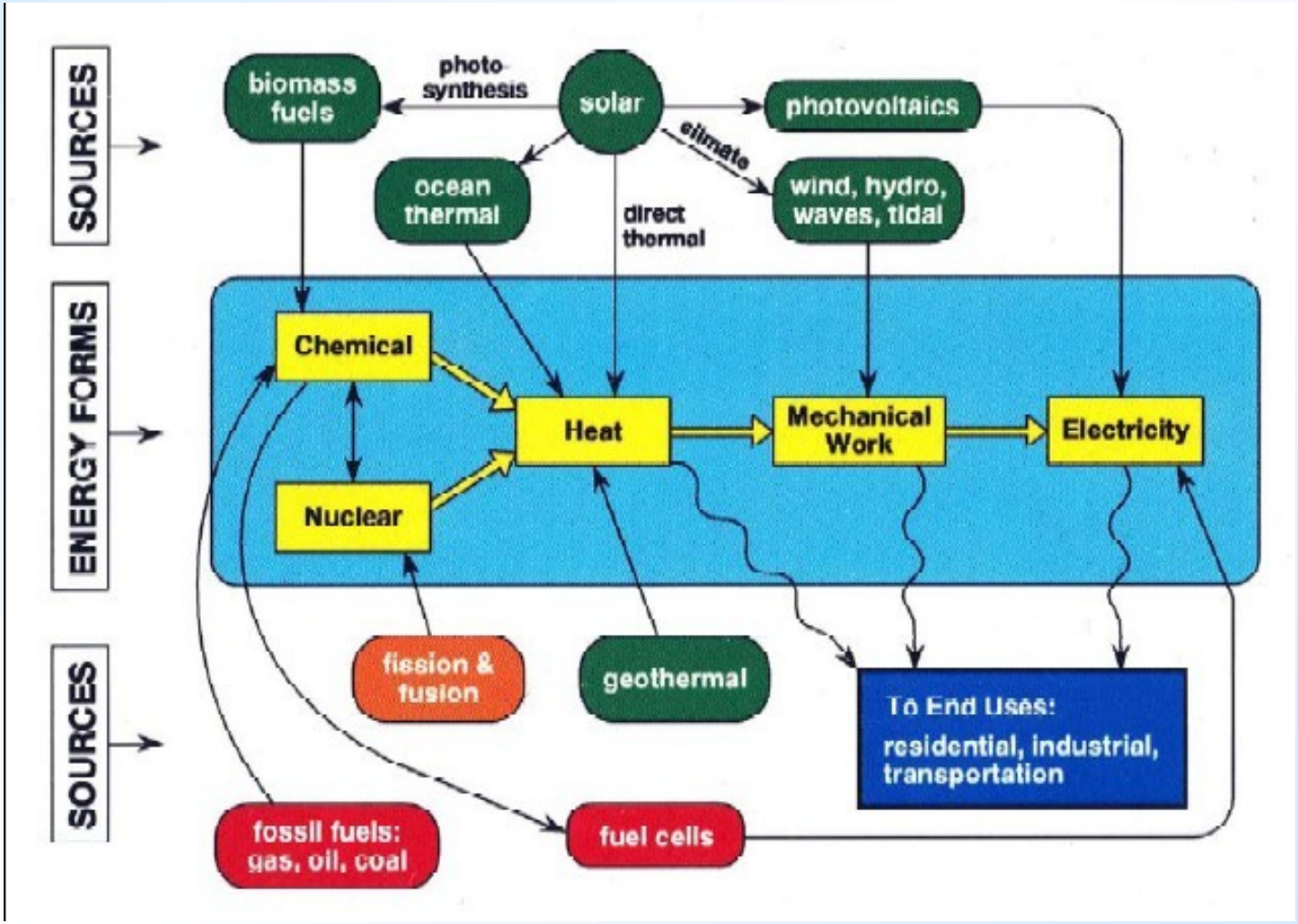
1. It is a renewable source of energy.
2. By far, it is non-polluting and environment friendly.
3. There is no wastage or generation of by-products.
4. Geothermal energy can be used directly. In ancient times, people used this source of energy for heating homes, cooking, etc.
5. Maintenance cost of geothermal power plants is rather small.
6. Geothermal power plants don't occupy too much space and thus help in protecting natural environment.
7. Unlike solar energy, it is not dependent on the weather conditions.

Geothermal

Disadvantages

1. Only few sites have the potential of Geothermal Energy.
2. Most of the sites, where geothermal energy is produced, are far from markets or cities, where it needs to be consumed.
3. Total generation potential of this source is rather small.
4. Installation cost of steam power plant is quite high.
5. There is no guarantee that the amount of energy which is produced will justify the capital expenditure and operations costs.
6. It may release some harmful, poisonous gases that can escape through the holes drilled during construction.
7. Geothermal fluid can be poisonous to the environment due to dissolved minerals and gasses it contains

Energy Sources and Conversion Processes



Read the article on OdtuClass titled «Shale Oil in Turkey», by M.V Kök, et.al.

Read: http://www.dailymail.co.uk/sciencetech/article-4192182/World-leaders-duped-manipulated-global-warming-data.html

Read: https://www.cnbc.com/2018/06/13/permian-will-soon-pump-enough-oil-to-be-opecs-2nd-biggest-producer.html

This is about shale oil in the Permian Basin in Texas, USA.