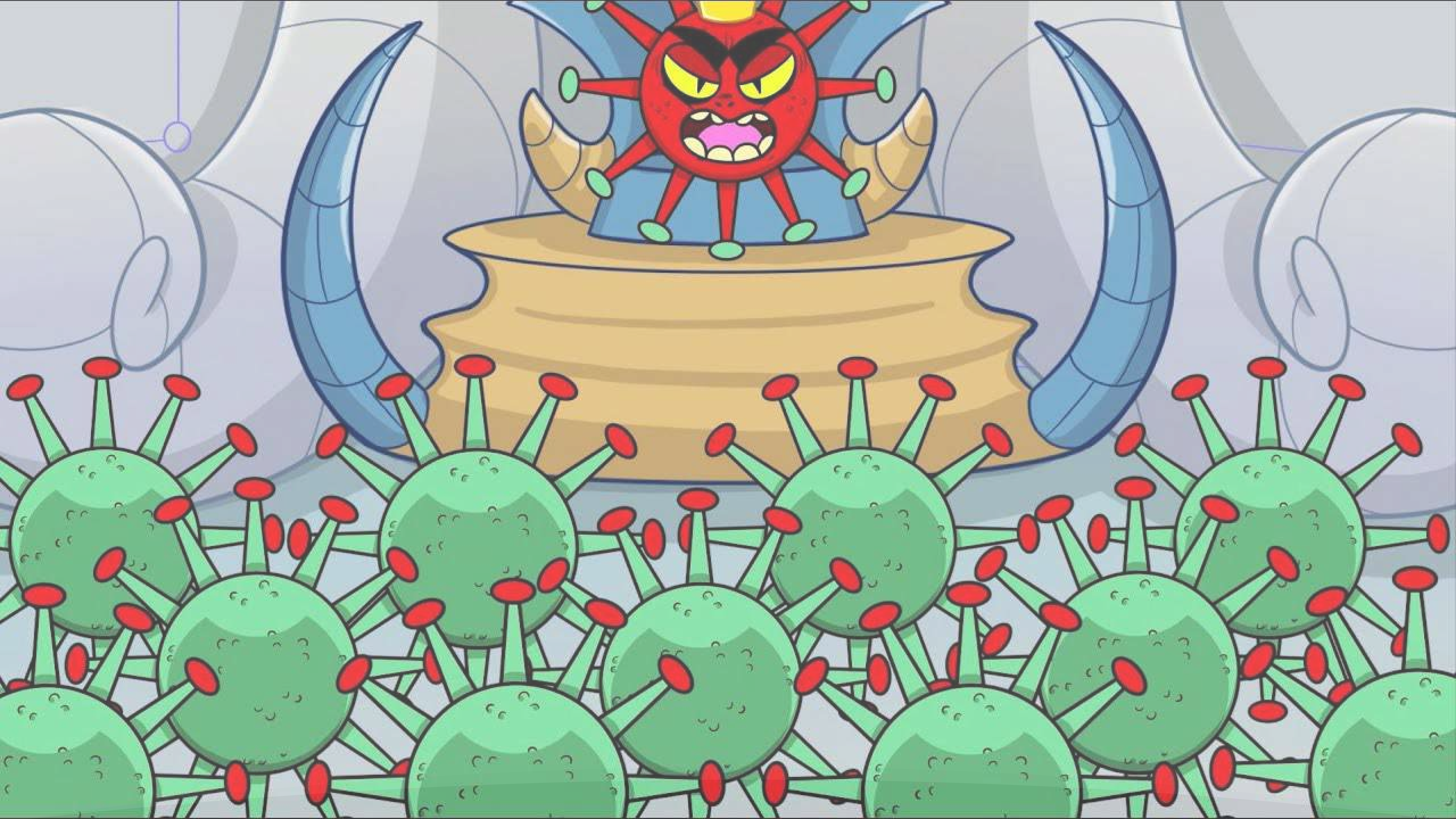
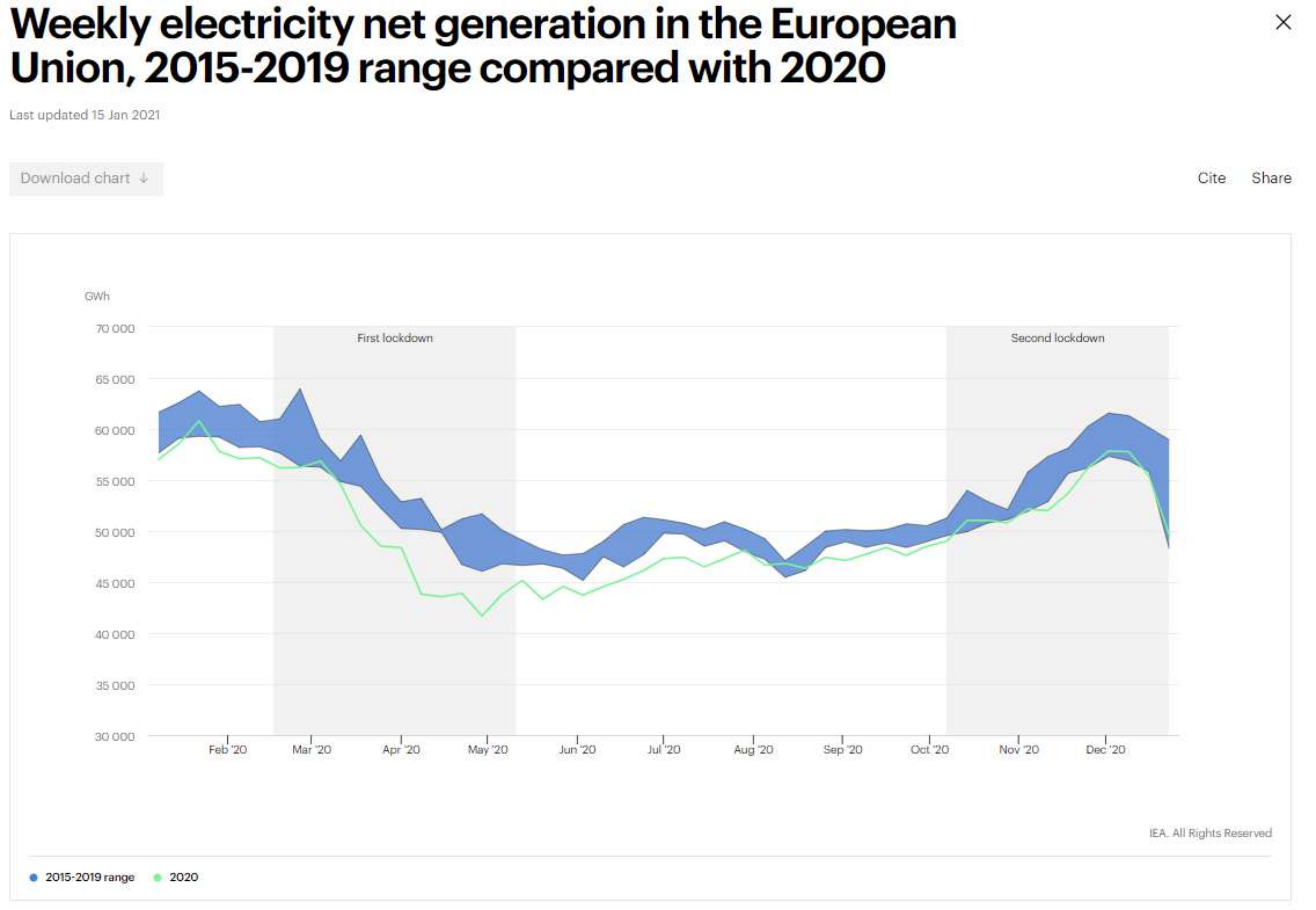
LA GEOLOGIA NEL MONDO DEL LAVORO
SEMINARI DI ORIENTAMENTO

Le geoscienze e l'esplorazione del sottosuolo:

il bene comune fra sostenibilità e fonti energetiche

1 aprile 2021





In EU, the fall in electricity demand and higher renewable production has driven non-renewable generation down.

From February to the first week of July, weekly renewable production has been higher than fossil fuel generation; it has reversed in July because of generally lower wind production. Natural gas generation has increased in the power mix supported by **low gas prices and higher carbon prices**; to compensate the decrease in production from other energy sources.

Due to strong wind conditions and high precipitation, weekly renewable production peaked sporadically in the fourth quarter of 2020; natural gas and coal power outputs adjusted to fluctuating renewable production to meet overall electricity demand levels, which are usually lower during the holiday’s season.

In EU, the fall in electricity demand and higher renewable production has driven

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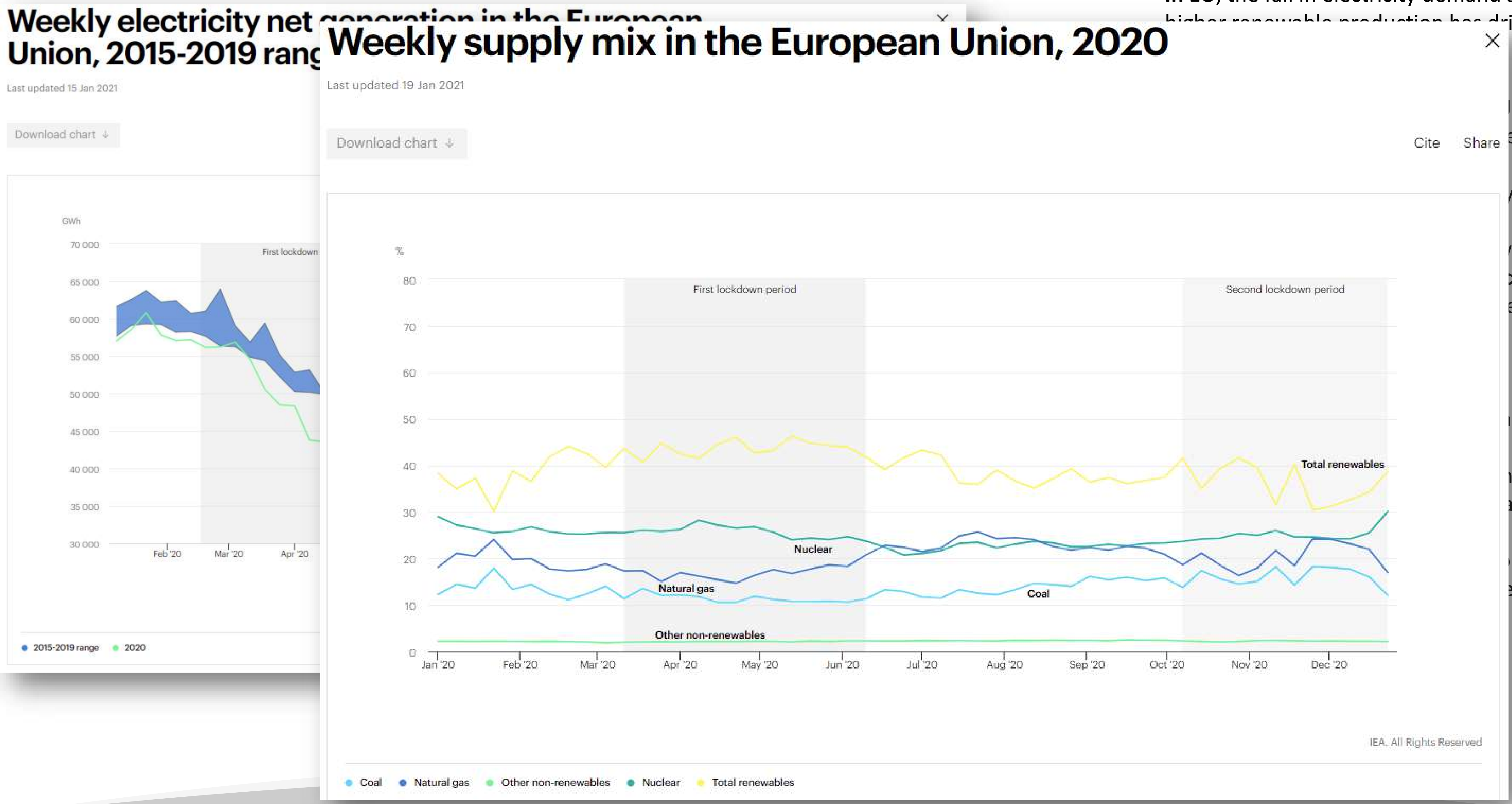

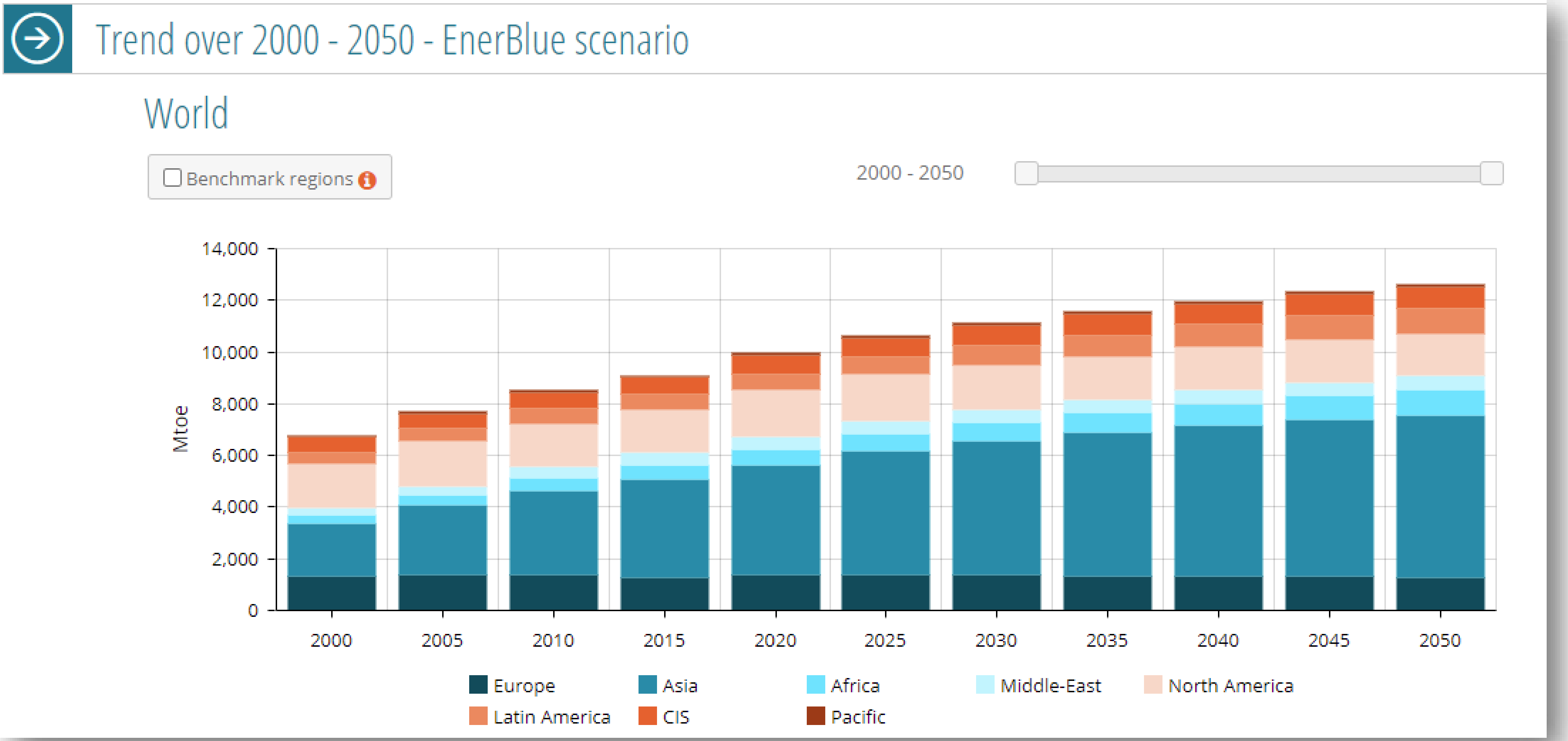
Trend over 2000 - 2050 - EnerBlue scenario
World
Benchmark regions
2000 - 2050
Mtoe
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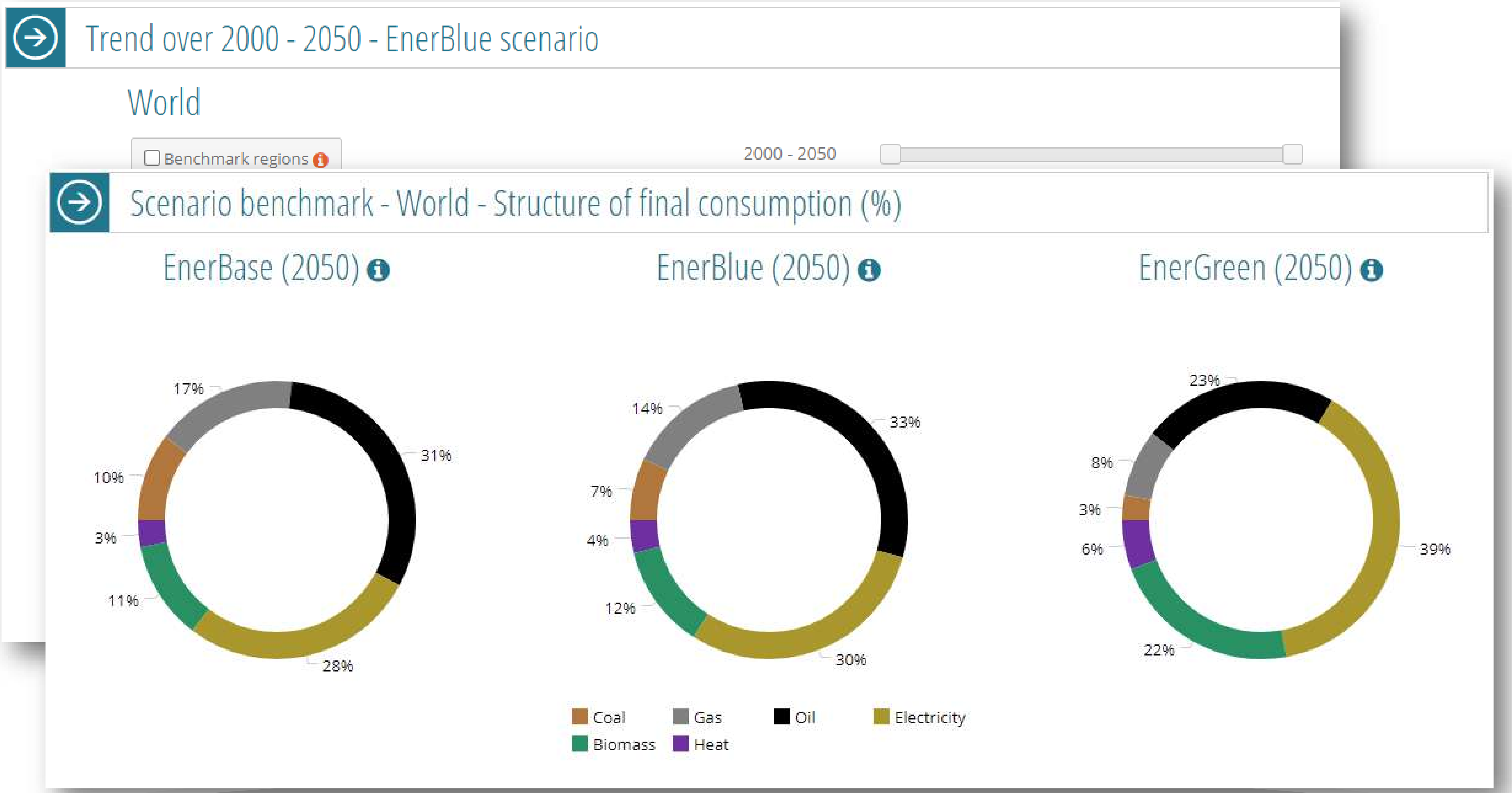
Latin America
CIS
Pacific

Agenda 2030 & the SDGs



Agenda 2030 & the SDGs

- **1992, Earth Summit, Rio de Janeiro***:* >178 countries adopt **Agenda 21***,* a global action plan to build a global partnership for sustainable development, to improve human life and protect the environment.
- **2000: New York.** ***A****doption of the *Millennium Declaration* with 8 **Millennium Development Goals** (MDGs) developed to reduce extreme poverty by 2015.
- **2002: UN World Summit, Johannesburg***:* the **Declaration on Sustainable Development** reaffirms the commitment of the global community to eradicate poverty and protect the environment***.***
- **2012: United Nations Conference on Sustainable Development (Rio + 20):** adoption of the document "**The Future We Want**" with the establishment of the United Nations high-level political forum on sustainable development.
- **2013***:* the General Assembly establishes an open working group of 30 members to develop GDS proposal
- **2015**: the General Assembly (Paris) adopts the *2030* **Agenda for sustainable development**, with *17 SDGs*.

"The **2030 Agenda for Sustainable Development** provides a shared model for peace and prosperity for people and the planet, now and in the future".

17 Sustainable Development Goals: an urgent **call to action** recognizing that *ending poverty* must go hand in hand with strategies that *improve health and education*, *reduce inequality* and *stimulate economic growth*, *tackling climate change* and *preserving oceans and forests*.

Agenda 2030: <u>17 Goals</u> + 169 Targets + 242 Indicators

NO POVERTY: End poverty in all its forms

ZERO HUNGER: End hunger, achieve food security, improve nutrition and promote sustainable agriculture

GOOD HEALTH AND WELL-BEING. Ensure healthy lives and promote well-being for all at all ages

QUALITY EDUCATION. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

GENDER EQUALITY. Achieve gender equality and empower all women and girls

CLEAR WATER AND SANITATION. Ensure availability and sustainable management of water and sanitation for all

AFFORDABLE AND CLEAN ENERGY. Ensure access to affordable, reliable, sustainable and modern energy for all

DECENT WORK AND ECONOMIC GROWTH. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work conditions for all

Agenda 2030: 17 Goals + 169 Targets + 242 Indicators

INDUSTRY INNOVATION AND INFRASTRUCTURE. Build resilient infrastrucures, promote inclusive and sustainable industrialization and foster innovation

REDUCE INEQUALITIES. Reduce inequalities within and among countries

SUSTAINABLE CITIES AND COMMUNITIES. Make cities and human settlements inclusive, safe, resilient and sustainable

RESPONSIBLE CONSUMPTION AND PRODUCTION. Ensure sustainable consumption and production patterns

CLIMATE ACTION. Take urgent action to combat climate change and its impacts

LIFE BELOW WATER. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

LIFE ON LAND. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and biodiversity loss

PEACE, JUSTICE AND STRONG INSTITUTIONS. Promote peaceful and inclusive societies, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

PARTNERSHIP FOR THE GOAL. Strenghten the means of implementation and revitalize the Global Partnership for Sustainable Development

Goals – Targets - Indicators

7 AFFORDABLE AND CLEAN ENERGY

Ensure universal access to affordable, reliable and modern energy services

targets | indicators

Goals and targets (from the 2030 Agenda for Sustainable Development)	*Indicators*
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all	
7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1 Proportion of population with access to electricity 7.1.2 Proportion of population with primary reliance on clean fuels and technology
7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	7.2.1 Renewable energy share in the total final energy consumption
7.3 By 2030, double the global rate of improvement in energy efficiency	7.3.1 Energy intensity measured in terms of primary energy and GDP
7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	7.a.1 International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems
7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support	7.b.1 Investments in energy efficiency as a proportion of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to sustainable development services

1. **Access to electricity**
2. **Access to clean cooking**
3. **Growth of renewables in the energy mix**
4. **Improving of energy intensity**

stainabledevelopment.un.org/topics/sustainabledevelopmentgoals
https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%202019%20refinement_Eng.pdf

Goals – Targets - Indicators

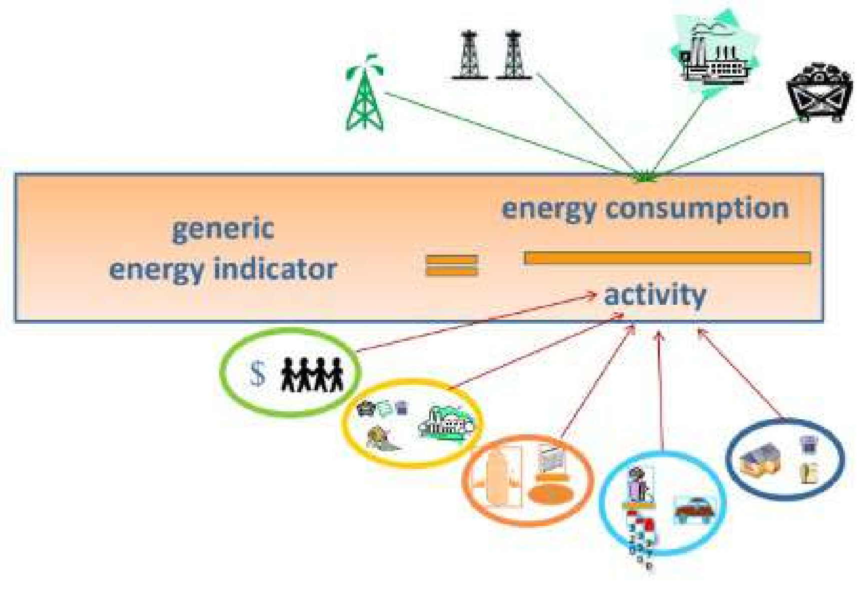
1. Access to electricity

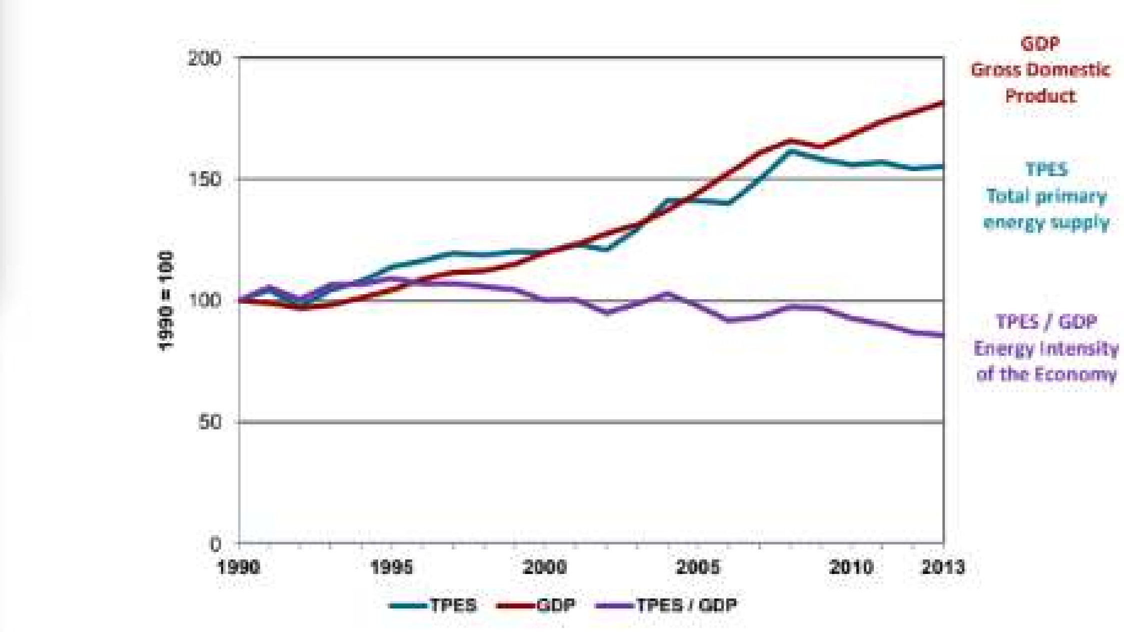
2. Access to clean cooking

ensity

Energy Intensity: energy (TPES) per unit activity (GDP).

Variable due to several reasons: e.g. changes in economic structure, climate, ...





developmentgoals

https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%202019%20refinement_Eng.pdf

What other goals/targets may be involved in Goal7?

7 AFFORDABLE AND CLEAN ENERGY

Ensure universal access to affordable, reliable and modern energy services

SDG & Ene

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7 AFFORDABLE AND CLEAN ENERGY

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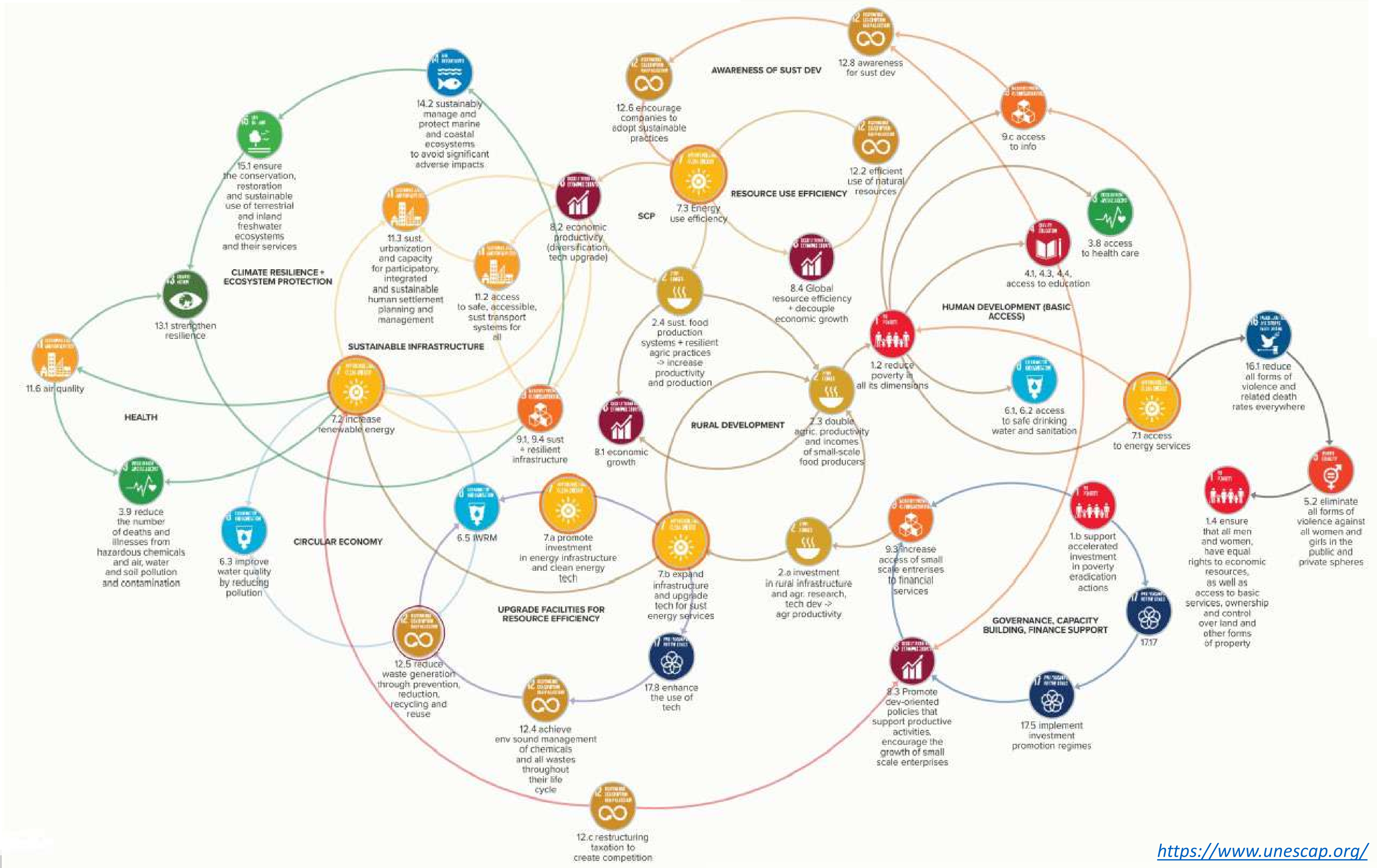


https://www.unescap.org/

Access to electricity-1

860 million people without access

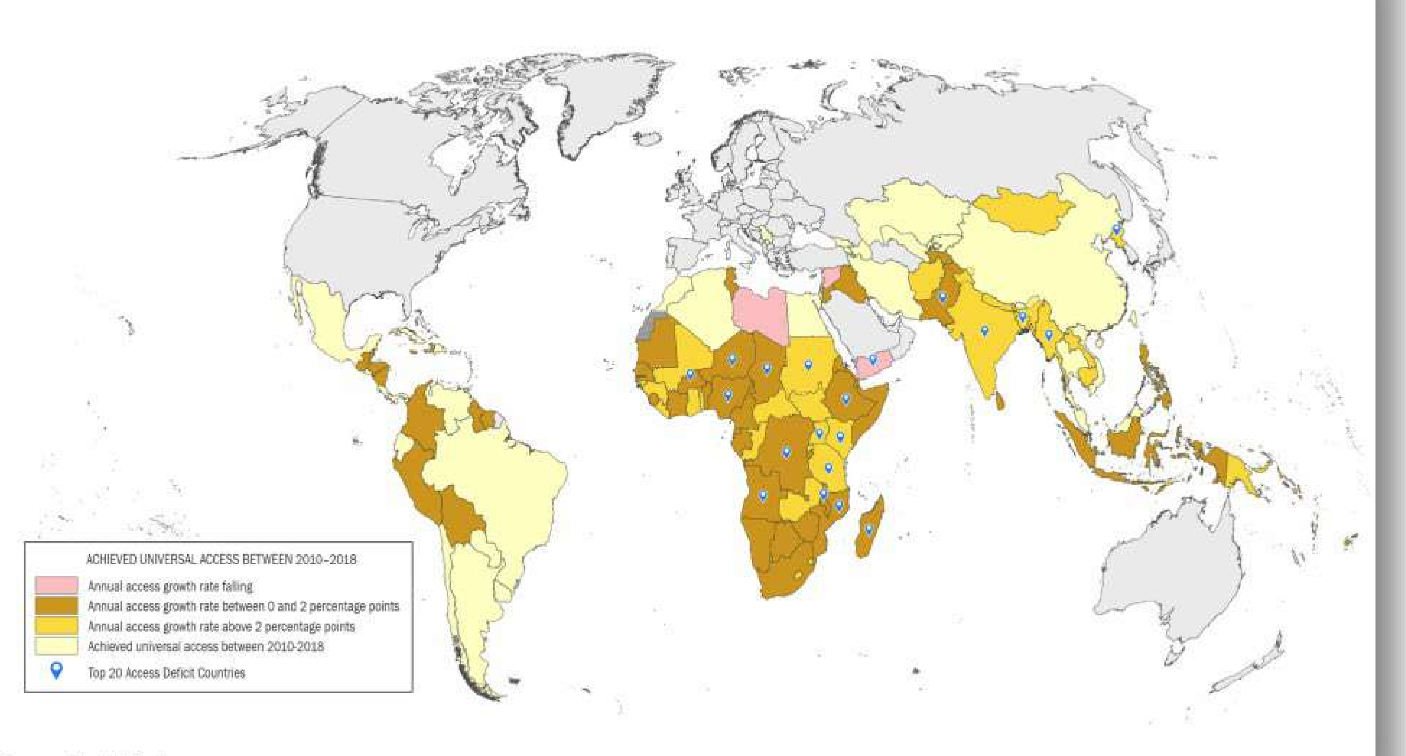
In 2018, the number of people without electricity access dropped to 860 million, a record in recent years.

Source: IEA, *World Energy Outlook -2019*

Electricity Access, Summary by Region

	Proportion of the population with access to electricity						
	National					Urban	Rural
	2000	2005	2010	2015	2018	2018	2018
WORLD	**73%**	**77%**	**80%**	**85%**	**89%**	**96%**	**79%**
Developing Countries	**64%**	**69%**	**74%**	**80%**	**86%**	**95%**	**77%**
Africa	**36%**	**39%**	**43%**	**49%**	**54%**	**79%**	**35%**
North Africa	91%	96%	>99%	>99%	>99%	>99%	>99%
Sub-Saharan Africa	24%	28%	33%	40%	45%	74%	26%
Developing Asia	**67%**	**74%**	**79%**	**87%**	**94%**	**98%**	**91%**
China	99%	>99%	>99%	>99%	>99%	>99%	>99%
India	43%	58%	68%	79%	95%	>99%	92%
Indonesia	53%	56%	67%	88%	98%	>99%	96%
Other Southeast Asia	65%	76%	79%	85%	90%	97%	83%
Other Developing Asia	38%	46%	57%	74%	79%	89%	73%
Central and South Ameri	**88%**	**91%**	**94%**	**96%**	**97%**	**99%**	**88%**
Middle East	**91%**	**90%**	**91%**	**92%**	**93%**	**98%**	**78%**

FIGURE 1.2 • Annual increase in access to electricity rate in access-deficit countries, 2010-18 (percentage points)



Source: World Bank.

Progress is irregular, with 80% of the 800 million people who gained access since 2010 concentrated in Asia.

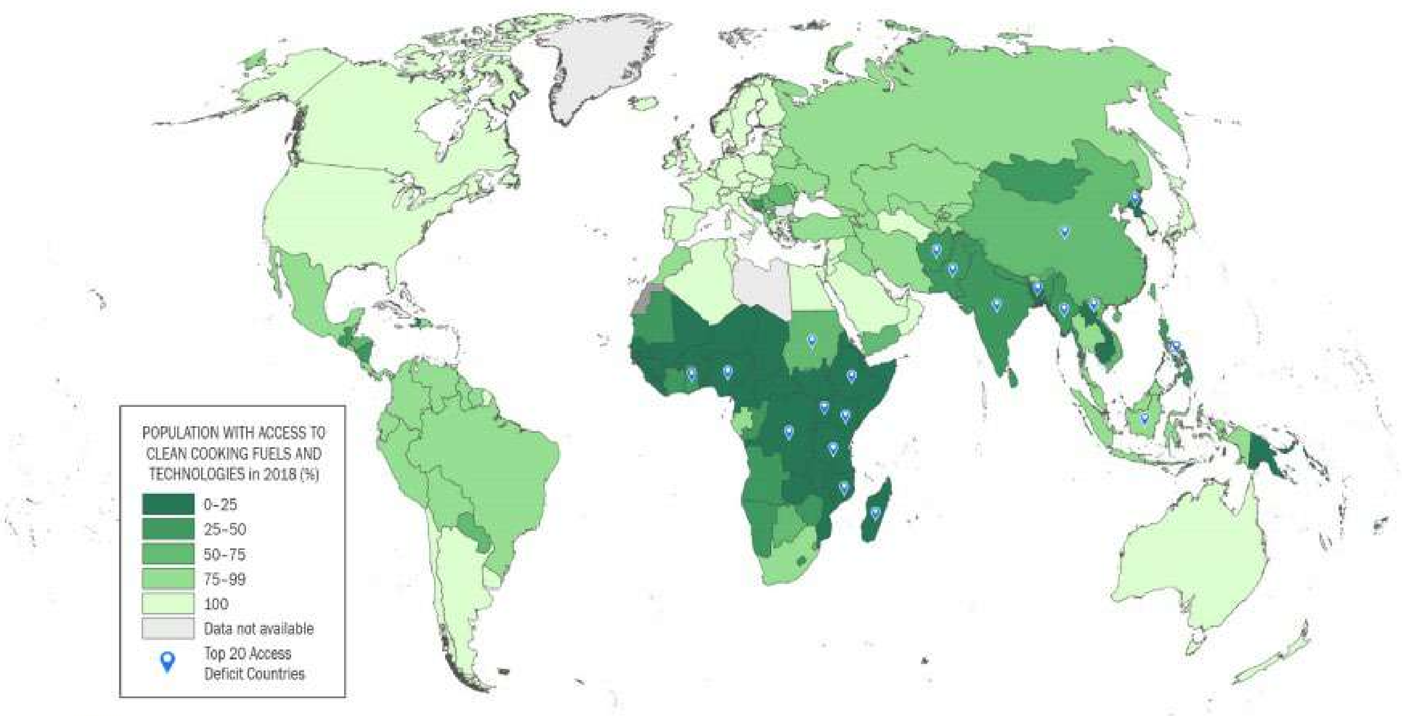
Efforts should step up in Africa if we are to reach universal access to electricity by 2030.

Access to clean cooking-1

2.6 billion people without access

Over **2.6 billion people in 2018** do not have access to clean cooking facilities, relying instead on solid biomass, kerosene or coal as their primary cooking fuel.
This figure has been gradually decreasing from **2.9 billion in 2010**, but efforts need to dramatically accelerate to put the world on track for universal access by 2030.

FIGURE 2.2 • Regional populations, by rate of access to clean cooking fuels and technologies, 2018



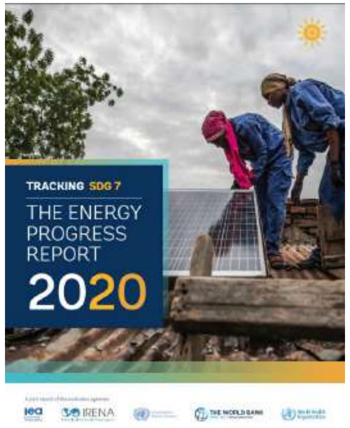
Source: WHO.

Access to Clean Cooking, Summary by Region

	Proportion of the population with access to clean cooking					Population without access (million)	Population relying on (million)
	2000	2005	2010	2015	2018	2018	2018
WORLD	52%	55%	58%	63%	65%	2651	2374
Developing Countries	37%	41%	45%	53%	56%	2651	2374
Africa	23%	25%	26%	28%	29%	910	853
North Africa	87%	93%	96%	98%	98%	4	4
Sub-Saharan Africa	10%	11%	13%	15%	17%	905	848
Developing Asia	33%	37%	43%	53%	57%	1674	1460
China	47%	51%	55%	67%	72%	399	242
India	22%	28%	34%	44%	49%	688	681
Indonesia	12%	18%	40%	68%	68%	85	55
Other Southeast Asia	36%	42%	48%	54%	58%	164	163
Other Developing Asia	22%	26%	27%	33%	35%	337	318
Central and South Americ	78%	82%	85%	88%	89%	57	53
Middle East	84%	91%	95%	96%	96%	10	9

Renewables-1

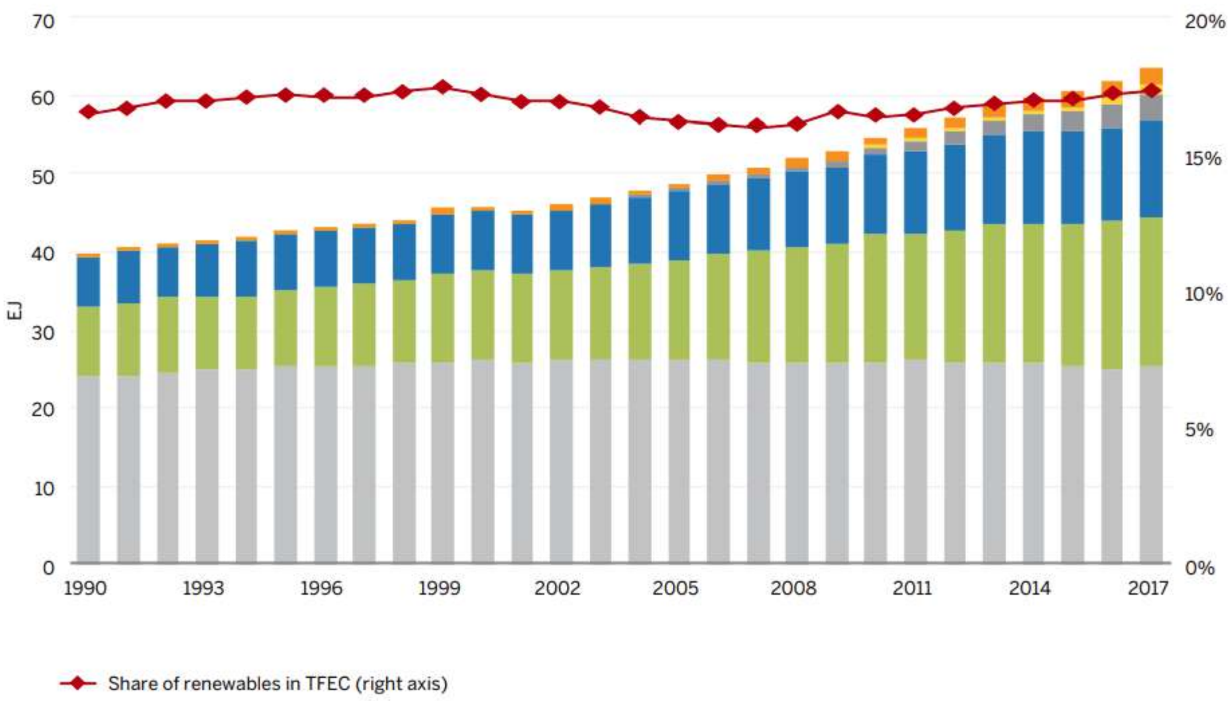
“Modern” renewables are @ 10.6% of total final energy consumption



After **2007**, the share of renewable energy slowly increased after a period of modest decline, due to strong growth in coal consumption in China. In 2016 it recovered to the same level as in 2000.
Overall, bioenergy accounts for 70% of global renewable energy consumption, followed by hydropower.

2018: renewable energy’s share of total final energy consumption increased at a faster rate at 17.3%: rapid growth of hydropower and wind and solar.

FIGURE 3.1 • **Renewable energy consumption by technology, and share in total energy consumption, 1990–2017**

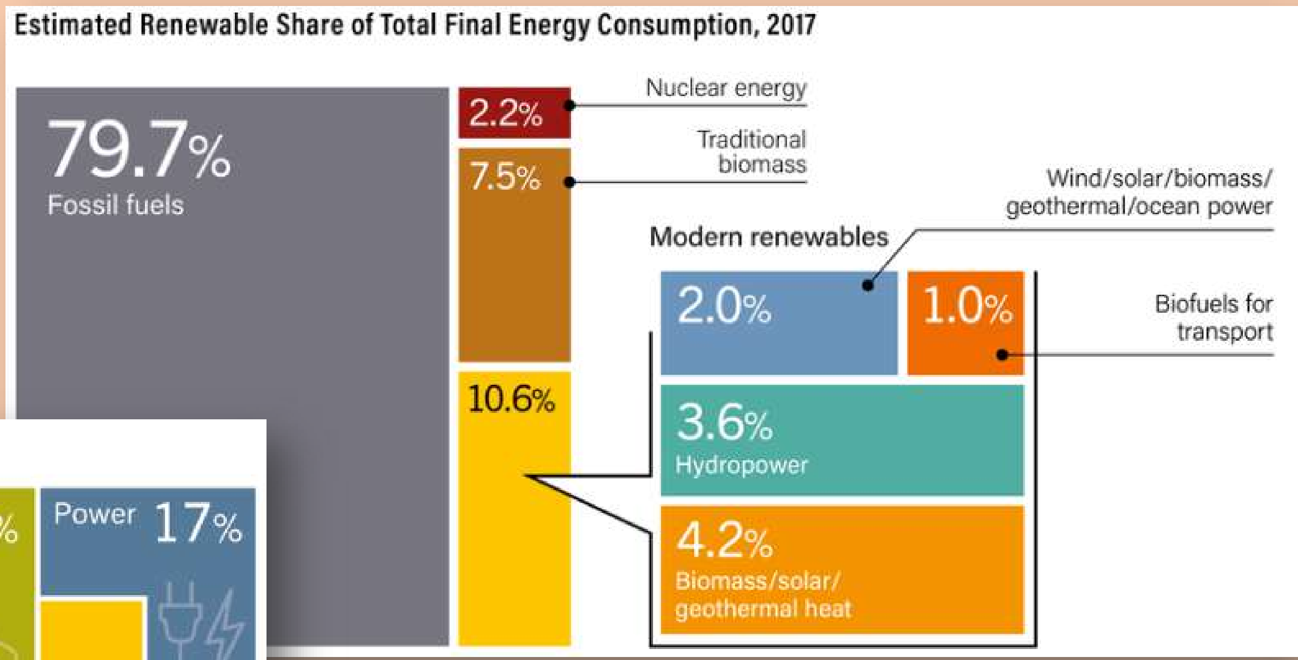


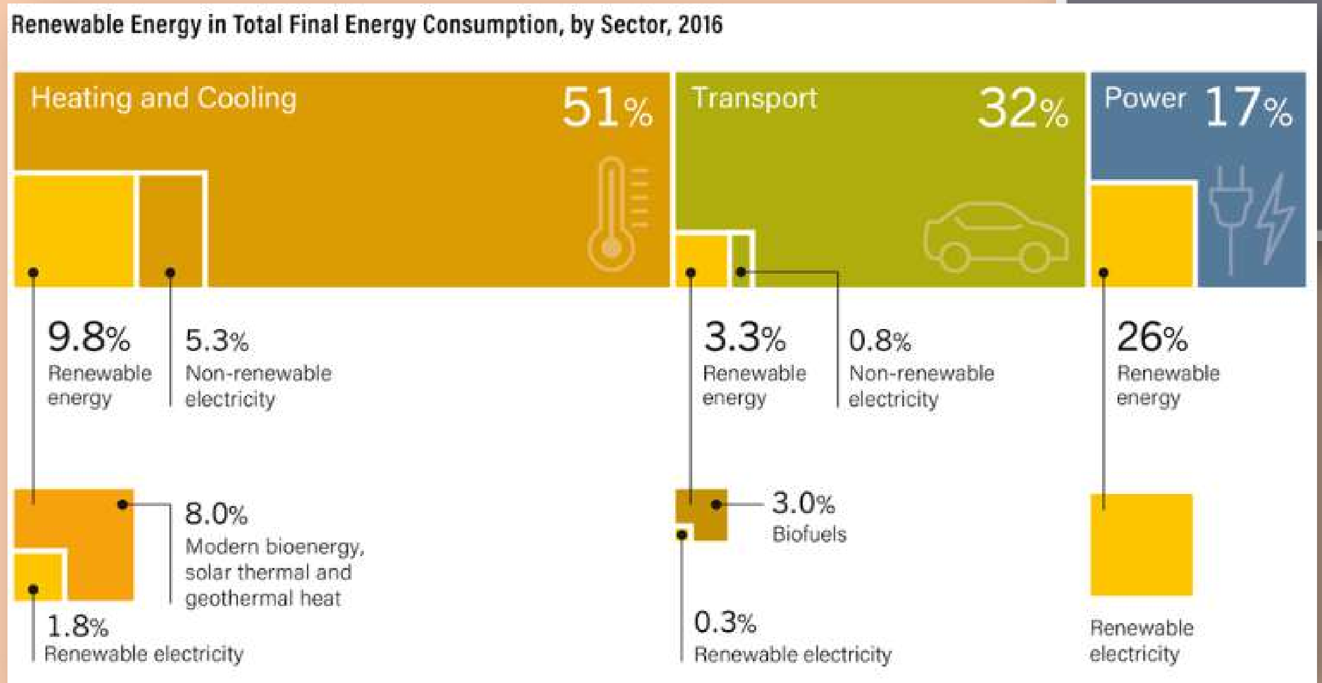
Source: IEA and UNSD.

2018: 17.3%
2017: 17.5%

__Bioenergy__ is renewable energy made available from materials derived ***from biological sources****. Biomass is any organic material which has stored sunlight in the form of chemical energy. As a fuel it may include wood, wood waste, straw, and other crop residues, manure, sugarcane, and many other by-products from a variety of agricultural processes.*

Modern renewables: renewable technologies with exception to traditional biomass. These include **hydropower**, **solar**, **wind**, **geothermal** and **modern biofuel** production (including modern forms of waste-to-biomass conversion).

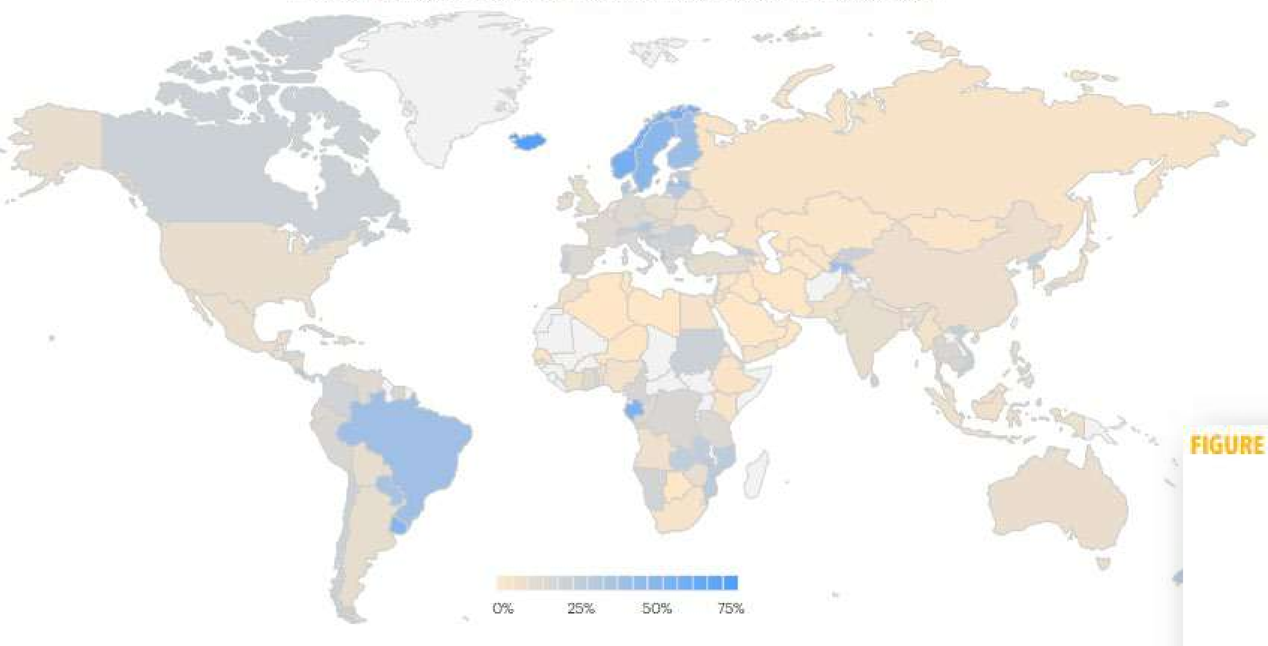




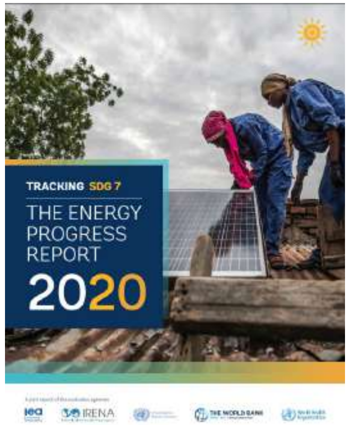
www.ren21.net/gsr-2019/chapters/chapter_01/chapter_01/#target_i_01

products from agricultural processes.

Renewables-2



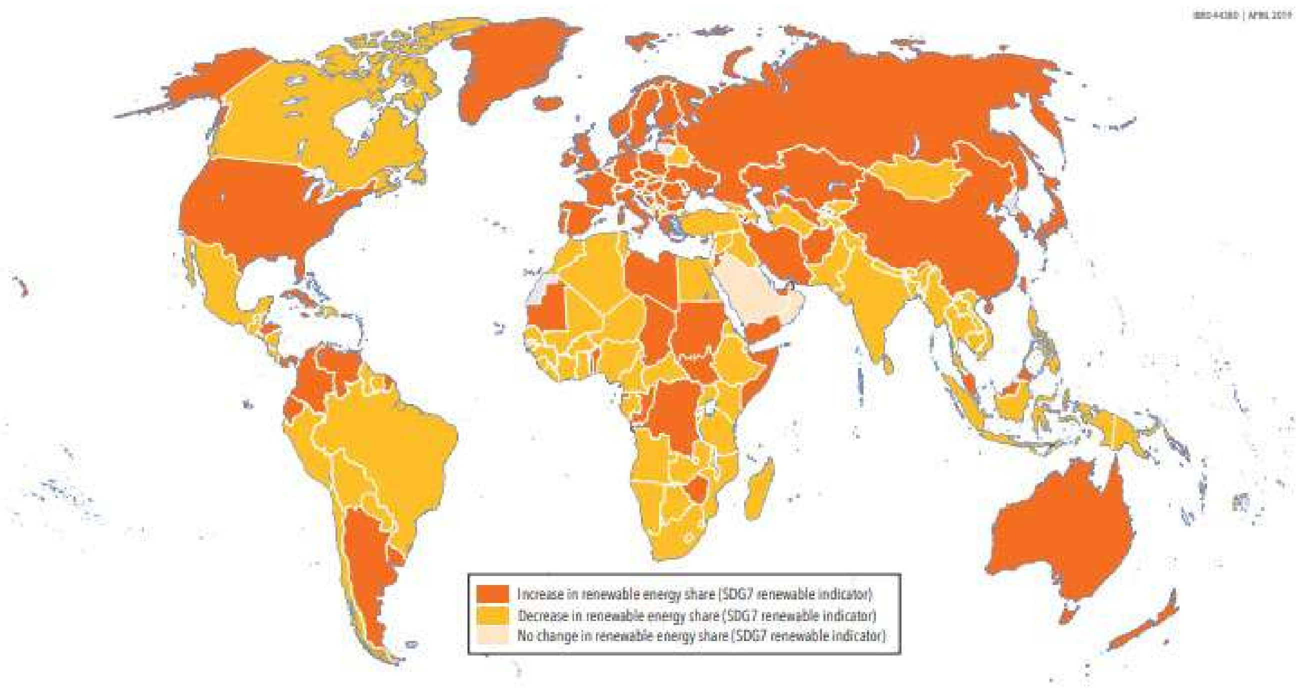
"Modern" renewables are @ 10.6% of total final energy consumption



In **2018**, the share of modern renewables rose to almost 11% of total final energy consumption, having steadily increased since the 2000s.

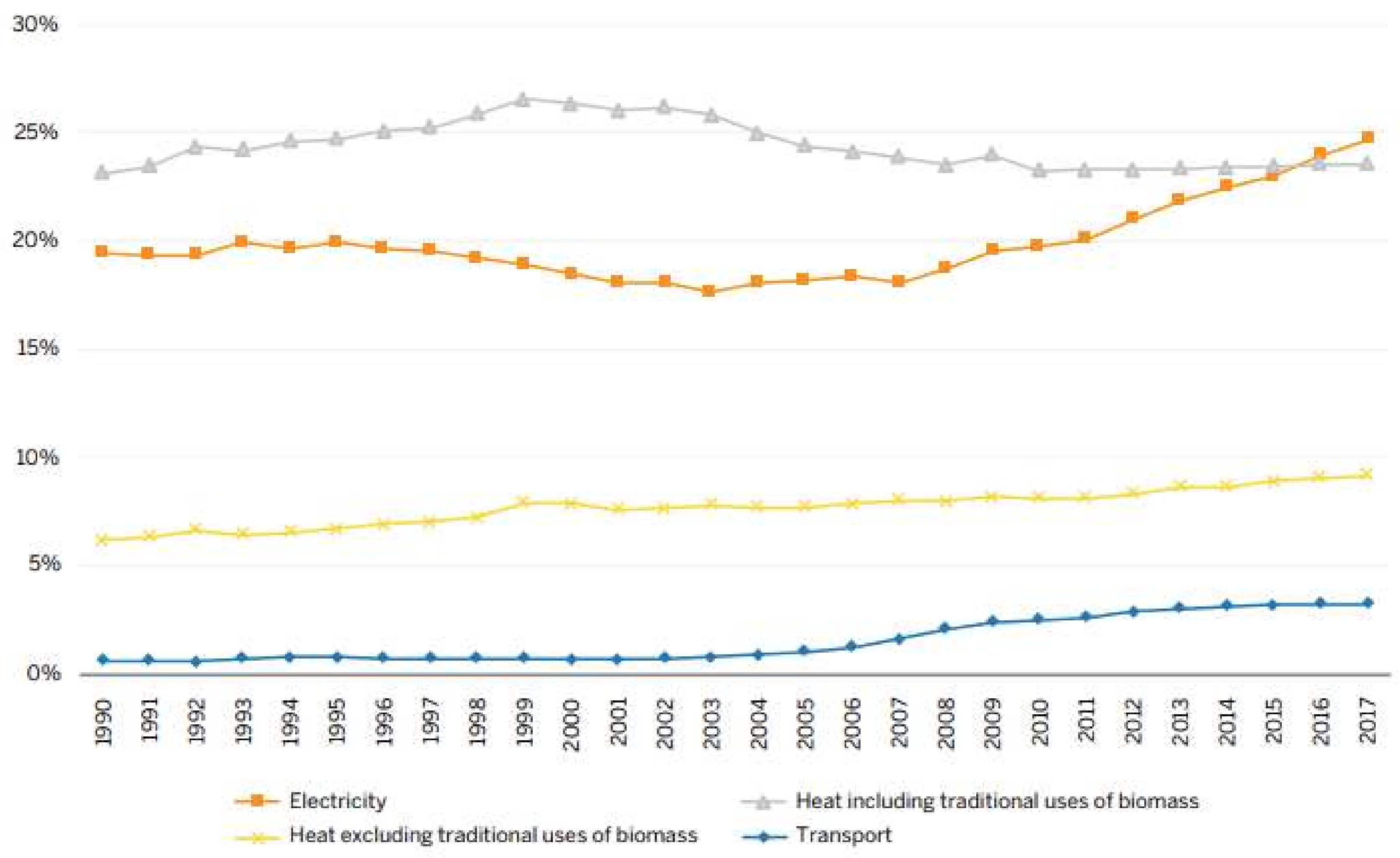
Nonetheless, an acceleration is needed to realise a substantial increase, as set out in SDG target 7.2.

FIGURE ES6 • CHANGE IN RENEWABLE ENERGY'S SHARE OF TOTAL FINAL ENERGY CONSUMPTION BETWEEN 2010 AND 2016

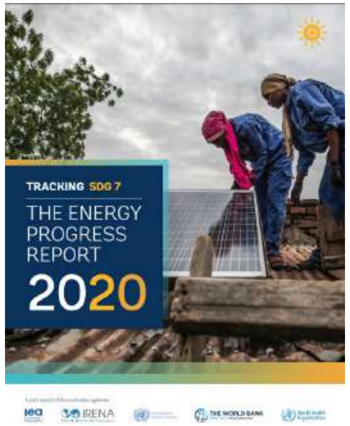


Renewables-2

FIGURE 3.3 • Renewable energy share by end use, 1990–2017



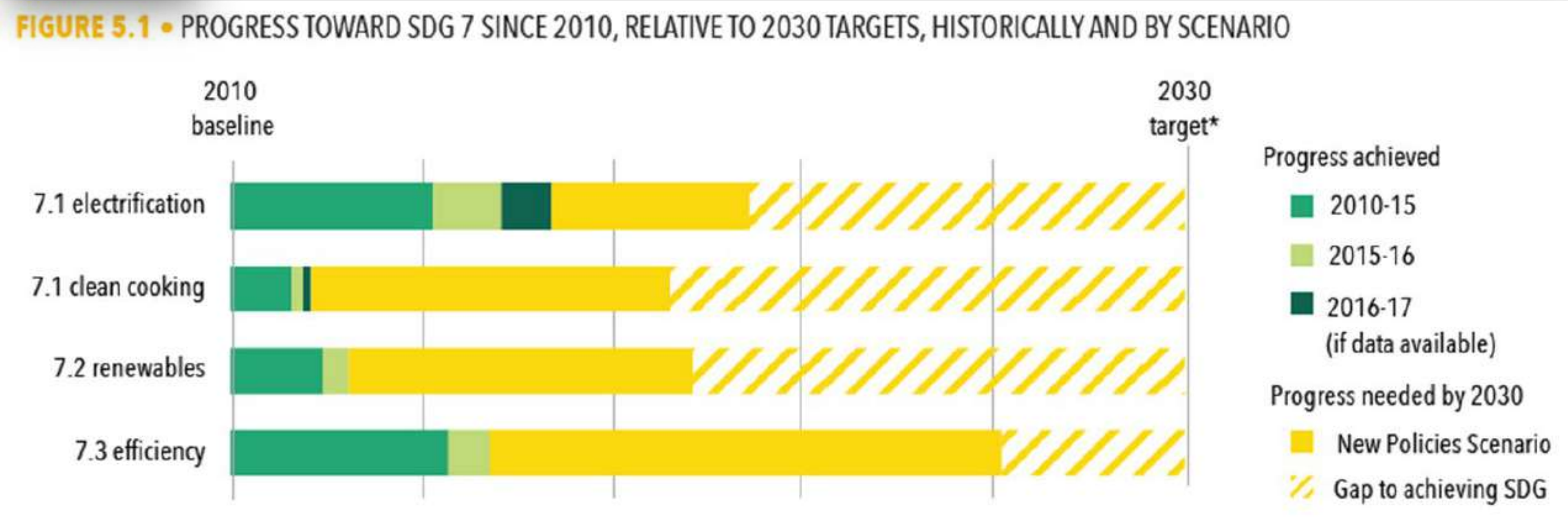
Source: IEA and UNSD.

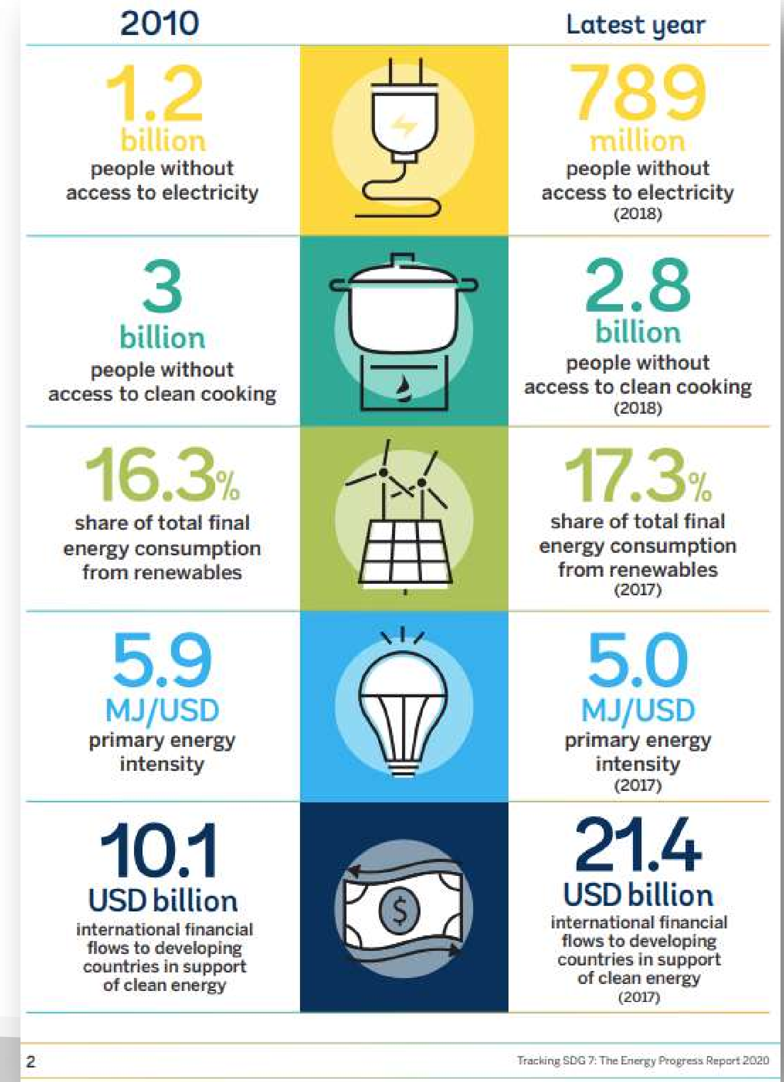


SDGs & Energy - IEA

Ensure universal access to affordable, reliable and modern energy services

Main messages, outlook for overall progress by 2030





Two scenarios developed by IEA as benchmarks:

- ✓ The **New Policies Scenario**, which accounts for current and planned policies, shows that none of the SDG 7 targets will be achieved by 2030.
- ✓ The **Sustainable Development Scenario** indicates a possible pathway by which the world's energy system could be on track to achieve the SDG targets most closely related to energy.

The world is not on track to achieve Sustainable Development Goal (SDG) 7 at the current rate of progress

Energy statistics – World outlook - IPPC

Issued October 2019

Table 2.6 | Global primary energy supply of 1.5°C pathways from the scenario database (Supplementary Material 2.SM.1.3).
Values given for the median (maximum, minimum) across the full range of 85 available 1.5°C pathways. Growth Factor = [(primary energy supply in 2050)/(primary energy supply in 2020) – 1]

	Median (max, min)	Count	Primary Energy Supply (EJ)			Share in Primary Energy (%)			Growth (factor) 2020-2050
			2020	2030	2050	2020	2030	2050	
Below-1.5°C and 1.5°C-low-OS pathways	total primary	50	565.33 (619.70, 483.22)	464.50 (619.87, 237.37)	553.23 (725.40, 289.02)	NA	NA	NA	–0.05 (0.48, –0.51)
	renewables	50	87.14 (101.60, 60.16)	146.96 (203.90, 87.75)	291.33 (584.78, 176.77)	14.90 (20.39, 10.60)	29.08 (62.15, 18.24)	60.24 (87.89, 38.03)	2.37 (6.71, 0.91)
	biomass	50	60.41 (70.03, 40.54)	77.07 (113.02, 44.42)	152.30 (311.72, 40.36)	10.17 (13.66, 7.14)	17.22 (35.61, 9.08)	27.29 (54.10, 10.29)	1.71 (5.56, –0.42)
	non-biomass	50	26.35 (36.57, 17.78)	62.58 (114.41, 25.79)	146.23 (409.94, 53.79)	4.37 (7.19, 3.01)	13.67 (26.54, 5.78)	27.98 (61.61, 12.04)	4.28 (13.46, 1.45)
	wind & solar	44	10.93 (20.16, 2.61)	40.14 (82.66, 7.05)	121.82 (342.77, 27.95)	1.81 (3.66, 0.45)	9.73 (19.56, 1.54)	21.13 (51.52, 4.48)	10.00 (53.70, 3.71)
	nuclear	50	10.91 (18.55, 8.52)	16.26 (36.80, 6.80)	24.51 (66.30, 3.09)	2.10 (3.37, 1.45)	3.52 (9.61, 1.32)	4.49 (12.84, 0.44)	1.24 (5.01, –0.64)
	fossil	50	462.95 (520.41, 376.30)	310.36 (479.13, 70.14)	183.79 (394.71, 54.86)	82.53 (86.65, 77.73)	66.58 (77.30, 29.55)	32.79 60.84, 8.58)	–0.59 (–0.21, –0.89)
	coal	50	136.89 (191.02, 83.23)	44.03 (127.98, 5.97)	24.15 (71.12, 0.92)	25.63 (30.82, 17.19)	9.62 (20.65, 1.31)	5.08 (11.43, 0.15)	–0.83 (–0.57, –0.99)
	gas	50	132.95 (152.80, 105.01)	112.51 (173.56, 17.30)	76.03 (199.18, 14.92)	23.10 (28.39, 18.09)	22.52 (35.05, 7.08)	13.23 (34.83, 3.68)	–0.40 (0.85, –0.88)
	oil	50	197.26 (245.15, 151.02)	156.16 (202.57, 38.94)	69.94 (167.52, 15.07)	34.81 (42.24, 29.00)	31.24 (39.84, 16.41)	12.89 (27.04, 2.89)	–0.66 (–0.09, –0.93)

2.4.2 Energy Supply

Several energy supply characteristics are evident in 1.5°C pathways assessed in this section:

i. growth in the share of energy derived from low-carbon-emitting sources (incl. **REN, nuclear and fossil fuel with CCS**) (Section 2.4.2.1),

ii. rapid decline in the carbon intensity of electricity generation simultaneous with further electrification of energy end-use (Section 2.4.2.2),

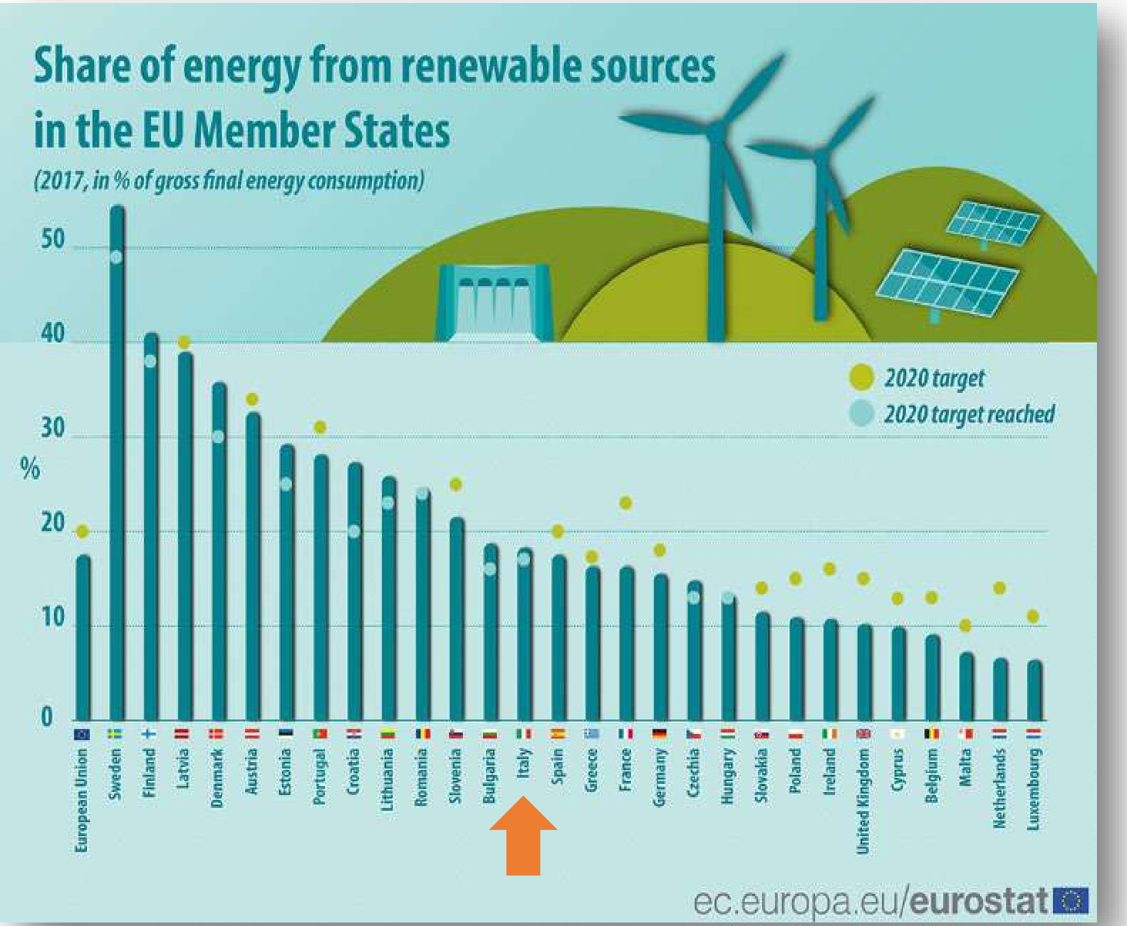
iii. growth in the use of **CCS applied to fossil and biomass** carbon in most 1.5°C pathways (Section 2.4.2.3)

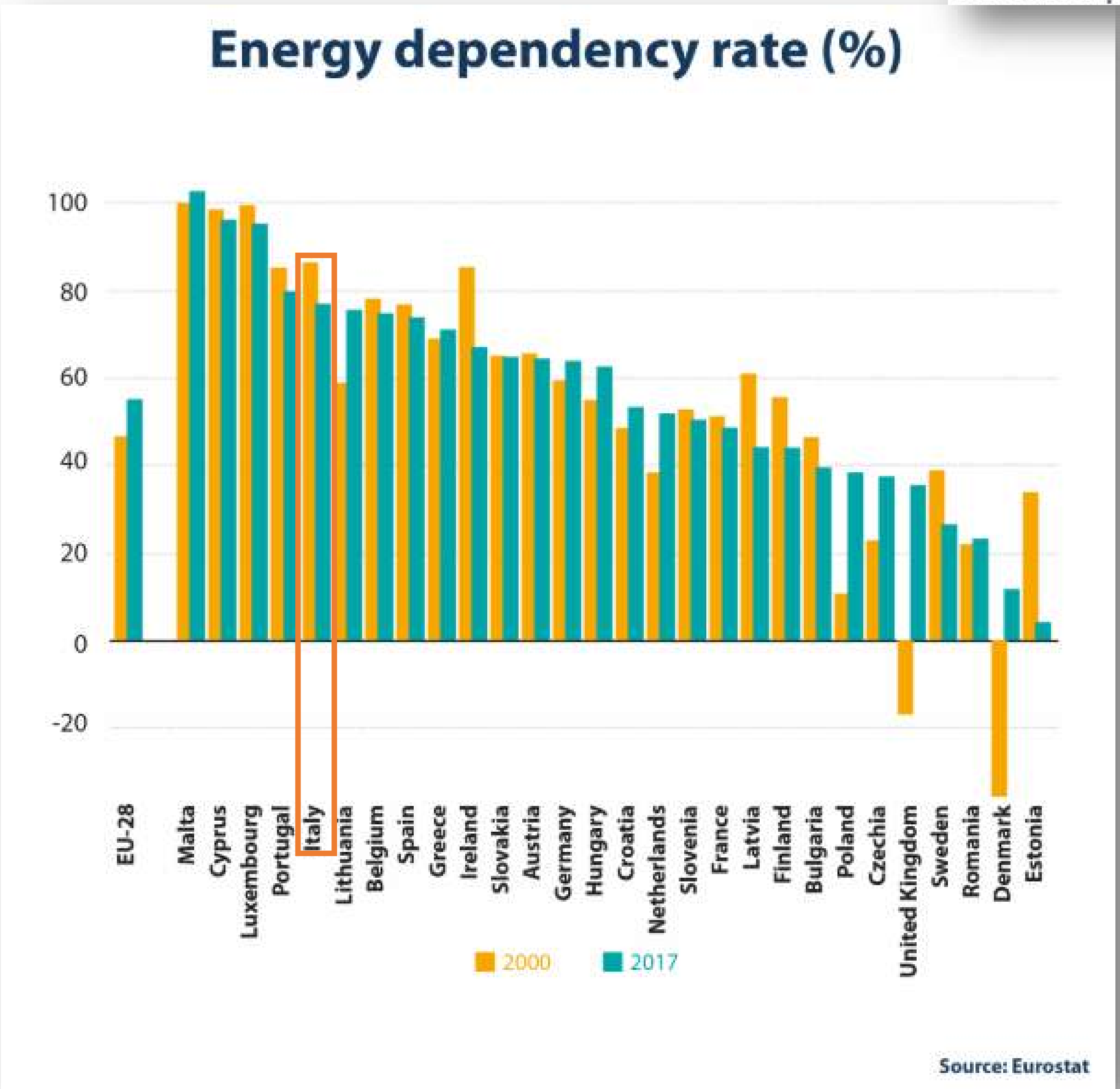
https://www.ipcc.ch/sr15/

1. **Glossario**
2. Le **geoscienze** in un mondo che cambia
   - **2.1 Agenda 2030** e i 17 Sustainable Development Goals-SDGs
   - **2.2 SDG7**: Energia
   - **2.3 Statistiche** dell'energia: mondo, UE, Italia
   - **2.4 Transizione energetica e geoscienze**: una opportunità da cogliere
3. Le geoscienze delle risorse energetiche: il **petroleum geologist**
   - 3.1 Quando è stato perforato il **primo pozzo** di petrolio in USA? E in Italia?
   - **3.2 Quanti pozzi** di petrolio e di gas sono stati perforati in Italia?
   - 3.3 La **ricerca petrolifera** è fine a sé stessa?
   - **3.4 Quanto petrolio e quanto gas** ancora ci sono?
   - 3.5 Quale è il **ruolo del geologo** nell'esplorazione del sottosuolo?
   - 3.6 Il **lavoro di campagna** non serve più? Il geologo sarà sostituito dai **computer**?

Energy statistics - EU

eurostat
Statistics Explained





Energy statistics - Italy

National Energy Balance in 2018 «La situazione energetica Nazionale» (MiSE) https://dgsaie.mise.gov.it/situazione-energetica


MINISTERO DELLO SVILUPPO ECONOMICO

LA SITUAZIONE ENERGETICA NAZIONALE NEL 2018

GIUGNO 2019

Tabella 1 : Il Bilancio dell'energia in Italia (Mtep)

	2017	2018(1)						
	Totale	Solidi	Gas	Petrolio	Rinnovabili	Energia elettrica	Totale	Var % (2018/17)
Produzione	39,147	0,252	4,462	4,684	34,021		43,419	10.9%
Importazione	163,461	9,479	55,588	81,494	1,572	10,378	158,511	-3,0%
Esportazione	33,936	0,252	0,320	29,526	0,272	0,719	31,089	-8,4%
Variazioni scorte	-0,997	0,241	0,216	-1,920	-0,004		-1,467	
Consumo interno lordo	**169,669**	**9,238**	**59,514**	**58,572**	**35,325**	**9,659**	**172,308**	**1,6%**

Fonte: Ministero dello Sviluppo Economico - Bilancio Energetico Nazionale (1) Dati provvisori

Tabella 9: Consumi finali lordi di energia in Italia (Mtep)

Fonte	**2013**	**2014**	**2015**	**2016**	**2017**	**2018***
CFL FER – Settore Elettrico	8,9	9,2	9,4	9,5	9,7	9,7
CFL FER – Settore Termico	10,6	9,9	10,7	10,5	11,2	10,9
CFL FER – Settore Trasporti	1,3	1,1	1,2	1,0	1,1	1,2
Consumi finali lordi di energia da FER	**20,7**	**20,2**	**21,3**	**21,1**	**22,0**	**21,8**
Consumi finali lordi di energia (CFL)	123,9	118,5	121,5	121,1	120,4	120,8
Quota dei CFL coperta da FER	**16,7%**	**17,1%**	**17,5%**	**17,4%**	**18,3%**	**18,1%**

(a) Stime preliminari

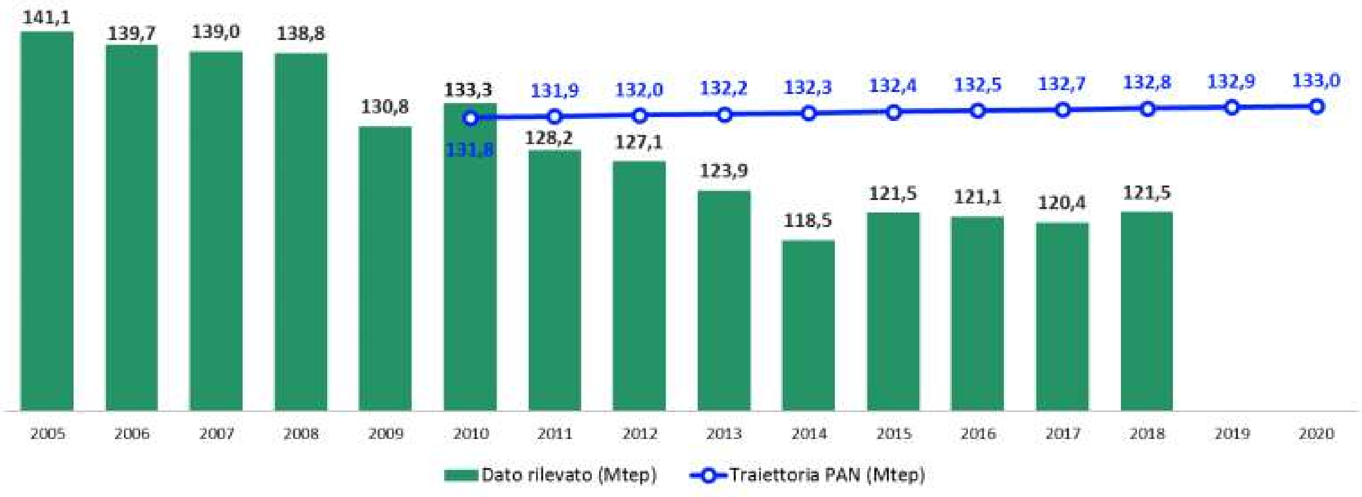
Renewable resources (FER/RES) = **18.1% of gross final consumption**, above the 2020 targets set by Europe for Italy (17%). An excellent result when compared with other EU countries, but which denotes how long the road towards total removal from fossil sources is still.

Gross Final Consumption (CFL) of energy from renewables in 2018 = 21.8 Mtoe, in line with the 2017.

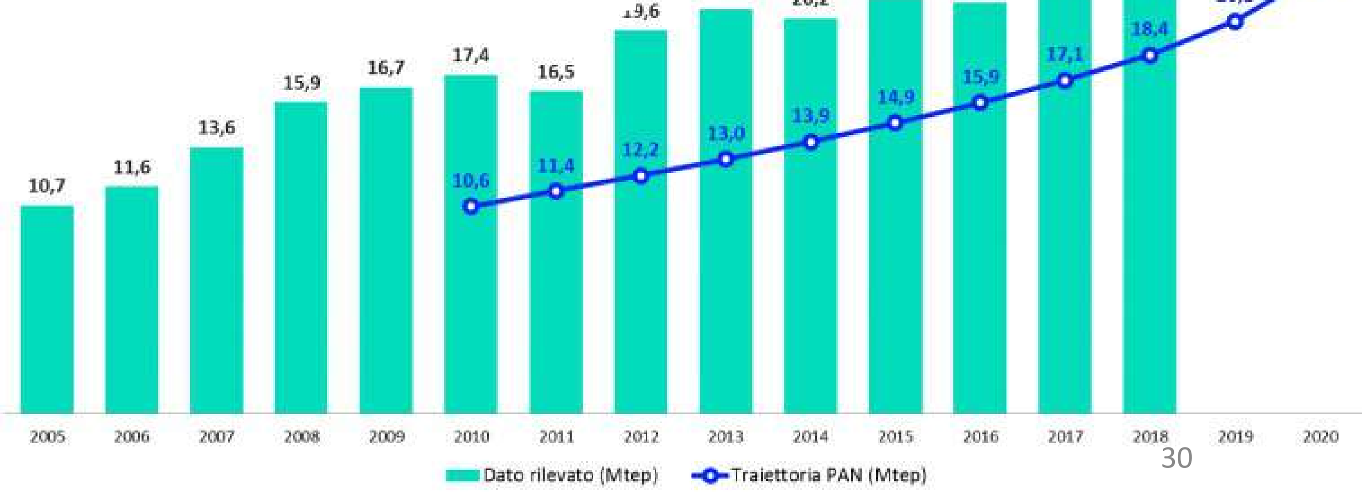
Energy statistics - Italy

Rapporto Statistico sulle Fonti Rinnovabili (2017) (GSE, https://www.gse.it/documenti_site/Documenti%20GSE/Rapporti%20statistici/GSE%20-%20Rapporto%20Statistico%20FER%202018.pdf

Consumi finali lordi di energia e Overall target fissato dal PAN (Mtep)



Consumi finali lordi di FER e Overall target fissato dal PAN (Mtep)



** **Piano d'Azione Nazionale per le energie rinnovabili (PAN)**, (Directive 2009/28/EC: "Promotion of the use of energy from renewable sources". It implements the 2020 objectives defined for each EU Member State, the trajectories foreseen for achieving them and the main policies to be implemented.*

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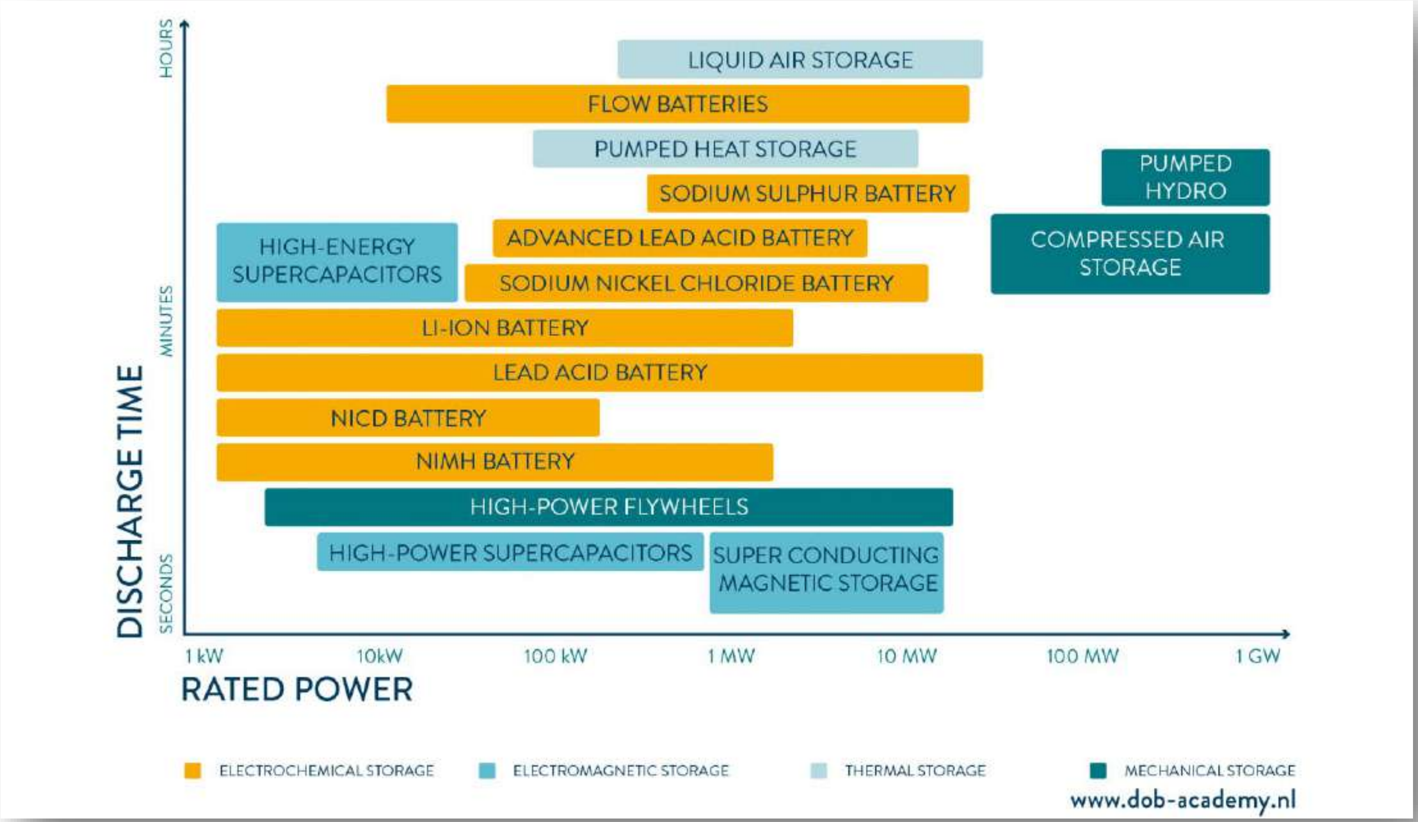
what future for a geologist in the changing world?

Traditional energy sources: the resource availability is homogeneous; the delivery of power/energy from their production plants can be modulated according to the demand

Renewable energy sources: the delivery of power/energy from their production plants is higly dependant on the resource availability/storage. **Intermittent energy sources**

Energy storage



Intermittency of energy supply: increase of energy storage capabilities. This could include:

- advancement in **battery technologies**
- **subsurface air & thermal energy** and **pumped hydro**

Decarbonisation/transition of power generation, industry, transport and heating needs expansion in renewables and nuclear, many of which require **critical raw materials and metals** to manufacture (which rely on sources of minerals and metals e.g. lithium, cobalt, cadmium).

A **sustainable and secure supply of mined materials** is required

The Role of Geoscience in Decarbonisation

The Geological Society
serving science, profession & society

21 - 23 January 2019
The Geological Society, Burlington House
https://www.geolsoc.org.uk/Lovell19

Decarbonisation/transition of power generation, industry, transport and heating to meet climate change targets: a major challenge that intrinsically involves the subsurface and geoscience.

Renewables	increase in grid-scale energy storage to cover intermittency: greater efforts on more efficient batteries, pumped storage and compressed air energy storage
Civil nuclear	understanding of risks associated with natural hazards (seismicity); challenge of geological disposal of radioactive waste
Geothermal power, heating and cooling	assessment of resources and impacts
Hydrogen *(it is a vector, not a source!!!)*	development of technology; environmental and geological assessment for underground storage and transport
Carbon Capture and Storage (CCS)	definition of the reservoirs and volumes of potential storage; risks assessment associated with natural and induced hazards (seismicity, …)
Natural gas	the **energy resource for the transition** needs environmental and resources assessment

All require **geological studies**: investigating the geological origin and prospectivity of transition metals and rare earth elements for batteries; for siting of power station, dams and tunnels in pumped water storage; geological studies for CCS; detailed characterisation of the subsurface for radio- waste disposal.

Scientific and technological challenges for Geosciences in the Energy Transition

21 - 23 January 2019
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- ✓ **Characterise** the physical properties, chemistry and structure of the subsurface to determine feasibility of various subsurface storage and infrastructure projects.
- ✓ **Improve** understanding of how the properties of the subsurface respond to changing physical and chemical conditions, e.g. during cyclical pressurisation and depressurisation of hydrogen or thermal fluids.
- ✓ **Assess** the origin, distribution and extractability of subsurface critical raw materials needed for decarbonisation.
- ✓ **Develop** and design effective and cost-efficient monitoring techniques for various uses of the subsurface.
- ✓ **Improve** scientific understanding on how fluids flow in the subsurface (HC, thermal energy storage, geothermal resources).

Critical to the success of the decarbonisation initiative is **knowledge and data sharing** across geographical borders, between industries, and by all “subsurface stakeholders”.

There are key geoscientific lessons to be learned across
planning, exploration, exploitation, decommissioning and remediation

The opportunity for Geosciences in the Energy Transition

Europe is well placed to develop subsurface decarbonisation technologies. It has an excellent base of worldclass universities, research institutes, and **the experience of Oil&Gas companies**.
A combination of state-of-the-art technology, improvements to efficiency and low-carbon fuel switching will be needed to achieve the ambitious decarbonisation targets.

However, for some industrial processes, such as steel manufacturing, cement production, and refining, subsurface carbon-capture technologies are the only viable decarbonising solution.

According to IPCC, **negative emissions** can only realistically be achieved adding **nuclear and carbon capture and storage (CCS)**

The oppo

Europe is w
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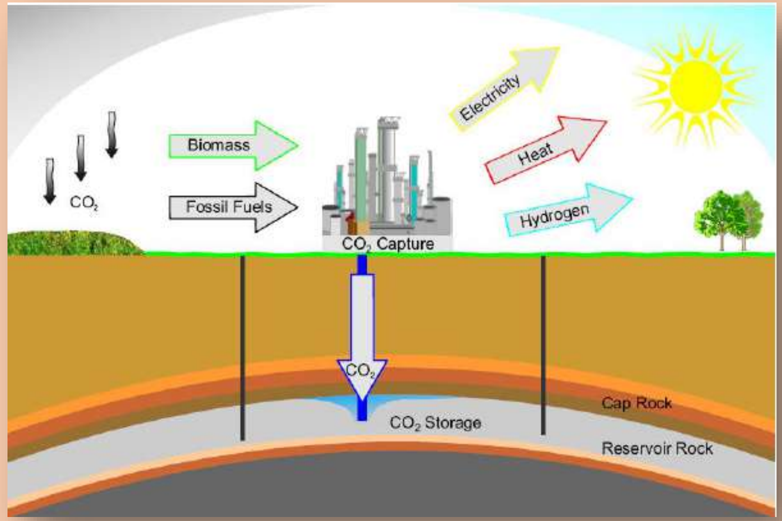
However, f
carbon-cap
realistically

CCS - Carbon Capture & Storage

The quantity of CO_2 to be stored via CCS over this century in 1.5°C pathways ranges, depending by different scenarios, from zero to >1,200 $GtCO_2$.

The **2005 IPCC Special Report on Carbon Dioxide Capture and Storage** found that, worldwide, it is likely that there was a technical potential of at least about 2,000 $GtCO_2$ of storage capacity in geological formations, with possible additional potential for geological storage in saline formations.

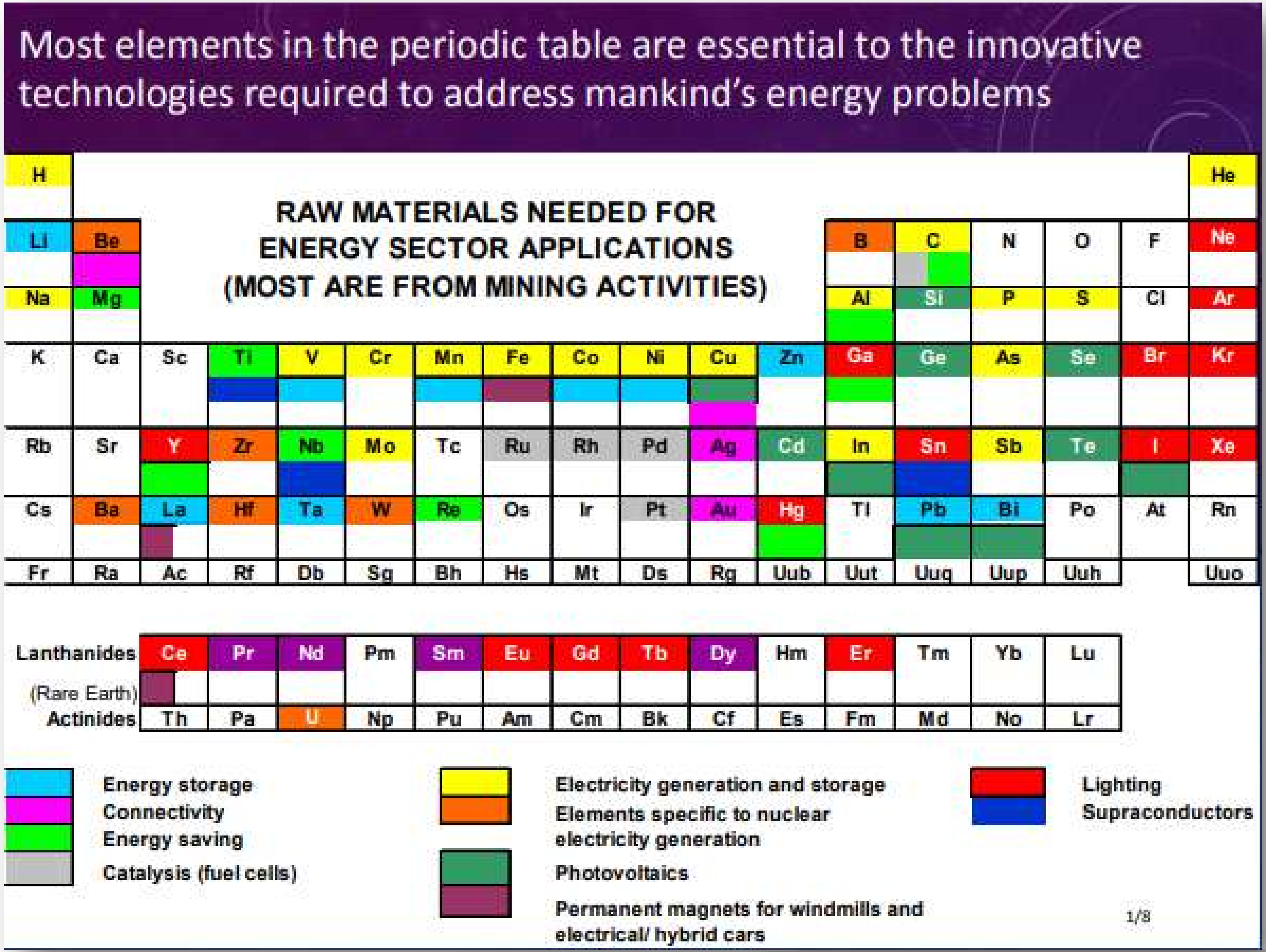


The **cumulative demand for CO_2 storage was small compared to a practical storage capacity estimate worldwide**.

The global potential storage capacity is estimated today from 8,000 to 55,000 $GtCO_2$,which is sufficient at a global level for this century.

The storage capacity of all of these global estimates is likely to be larger than the cumulative CO_2 stored via CCS in 1.5°C pathways over this century

Mining



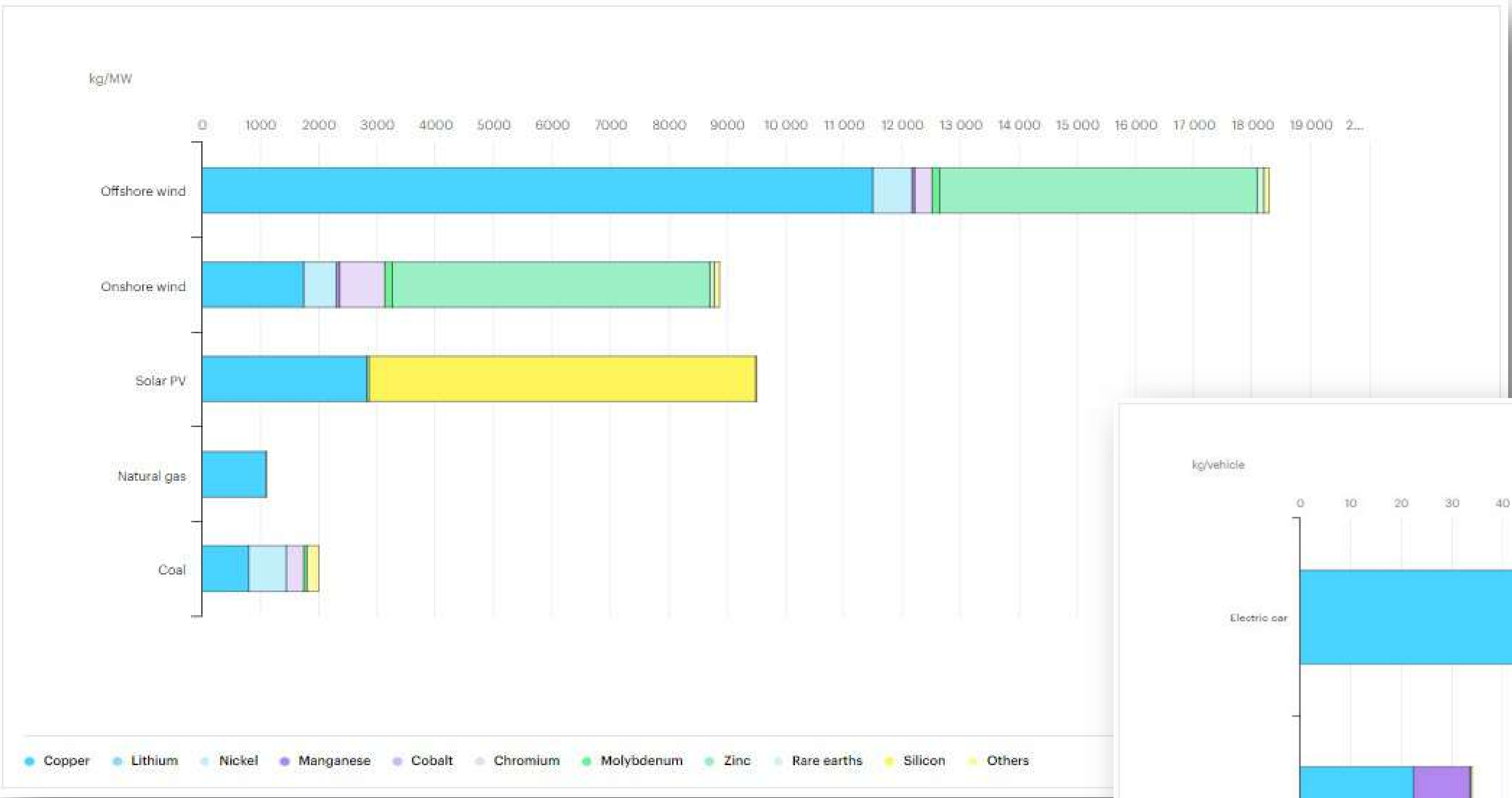
The **energy sector** contributes to the rapid demand growth for a **wide range of minerals and metals.**

The production of minerals and metals

- **requires energy** (currently about 10.5% of the global production),
- **generates emissions** (CO2, sulfur and nitrogen oxydes, particulate matter, mercury from coal production, radionucleides from coal combustion and rare earth production…).

http://www.mineralinfo.fr/sites/default/files/upload/ancre_rapport_2015-ressources_minerales_et_energie_0.pdf

Mining



https://www.iea.org/articles/clean-energy-progress-after-the-covid-19-crisis-will-need-reliable-supplies-of-critical-minerals

AAPG Energy Transition Forum
A New Era in Geoscience
[https://energytransition.aapg.org/2018/About/About-the Conferenc](https://energytransition.aapg.org/2018/About/About-the)

Geosciences drivers underpinning the transition:

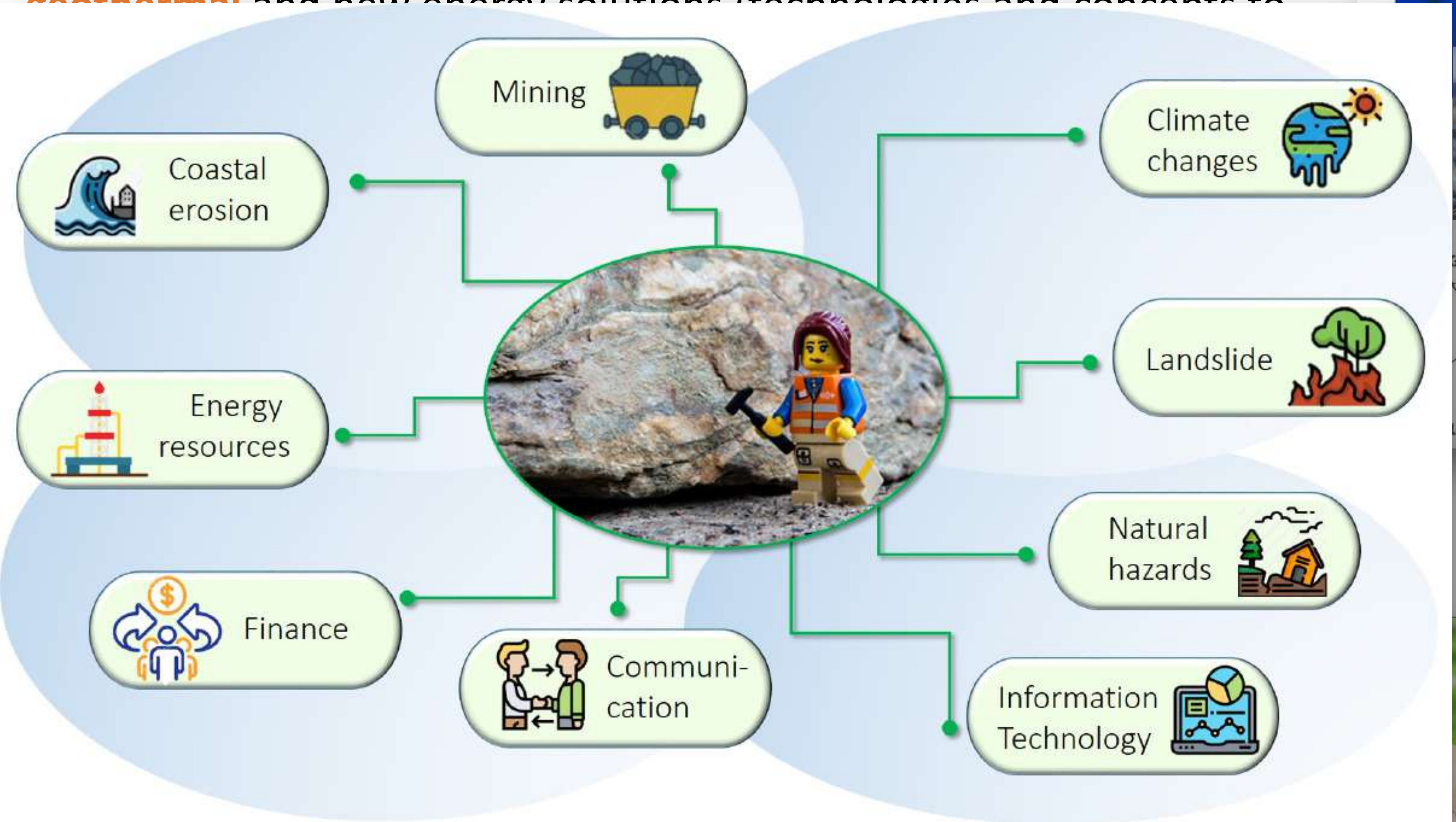
The **hydrocarbon era** is not over soon: fossil fuel use might flatten from 2035, with oil and coal in decline but gas use continuing to expand.

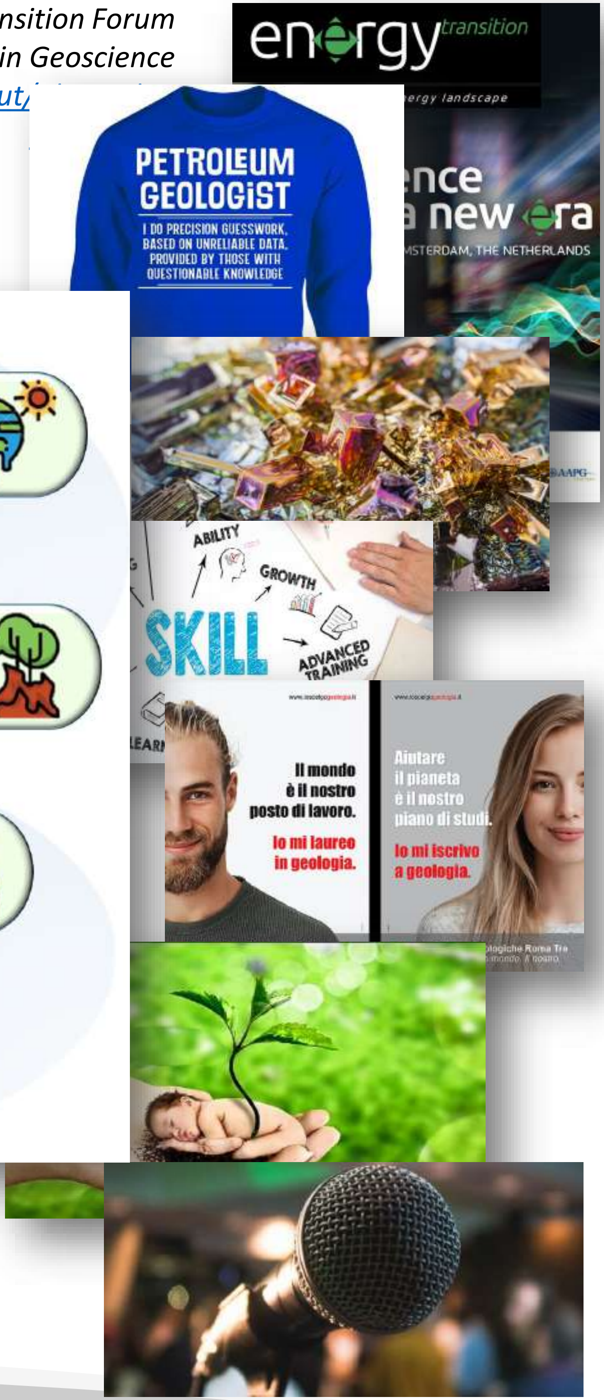
- **Coal demand**: peak expected in next 10y, with a rapid shift toward gas. Gas is a viable and profitable alternative to coal.
- **Oil demand**: expected to peak in the next 15-20y. Decline won't be for lack of supply: technological and economic competition for oil is coming, with a shift from oil-based transport to electricity based transport. The question is "when" rather than "if".
- **Gas demand**: will continue to grow to 2040, due to its affordability relative to other fuels, technologies and policies.
- **Electrification**, particularly in buildings and road transport, underlies an acceleration of electricity demand. Energy intensity is improving across regions and end-use sectors with the switches to more efficient fuels and technologies. Strong improvements in economics of electric vehicles trigger rapid uptake. In a disrupted case, electricity demand growth could be boosted to 2.9%/y.
- **Renewables**' cost decline accelerates, out-competing new-built fossil capacity today and existing capacity in 5-10 years causing electricity demand to grow four times faster than all other fuels.
- **CCS & Nuclear** can play a prominent role in the Energy Transition, but face much resistance from communities. Technological, political and social constraints are the challenge.

AAPG Energy Transition Forum
A New Era in Geoscience
https://energytransition.aapg.org/2018/About/

Geosciences in the Energy transition.

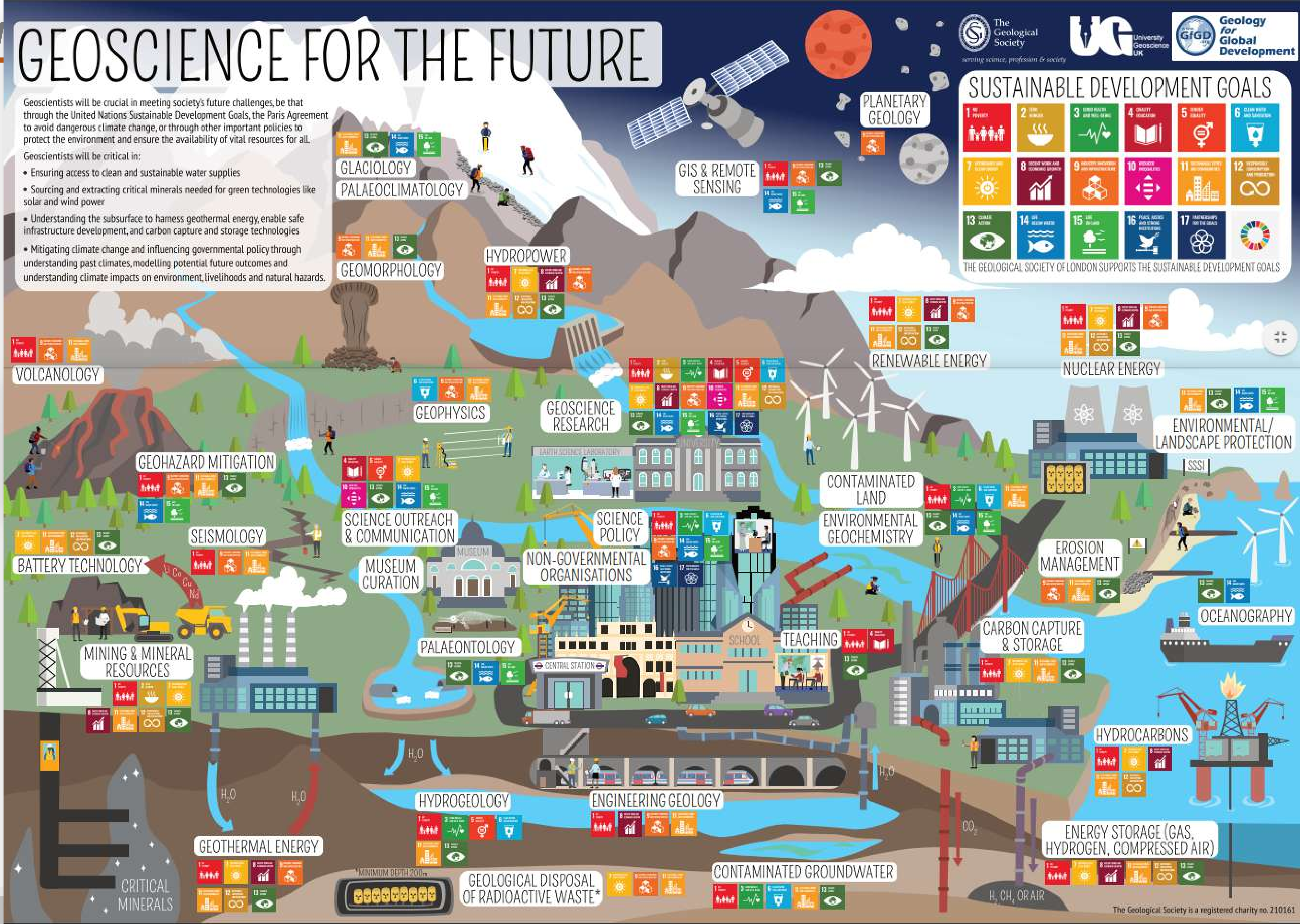
- Natural energy resources: a primary role for oil and mainly gas E&P– certainly until 2050 - 2060. Crucial in CCS, geothermal and new energy solutions (technologies and concepts to be developed;
- The 2050 2°c econo
  200% for aluminum
  Challenge? Very litt
- The mix of skills of
  complex problems.
  geological knowled
  contribute because
  at systems thinking
- Universities need to
  geologists are still n
  profession is promo
- The next generation
  professionals/politicians inject optimism and empowerment into the next generation of decision makers;
- We have to develop the ability to speak easy and, more important, the ability to listen to the requests and doubts of the local communities. This is the only way for a correct dissemination of knowledge.





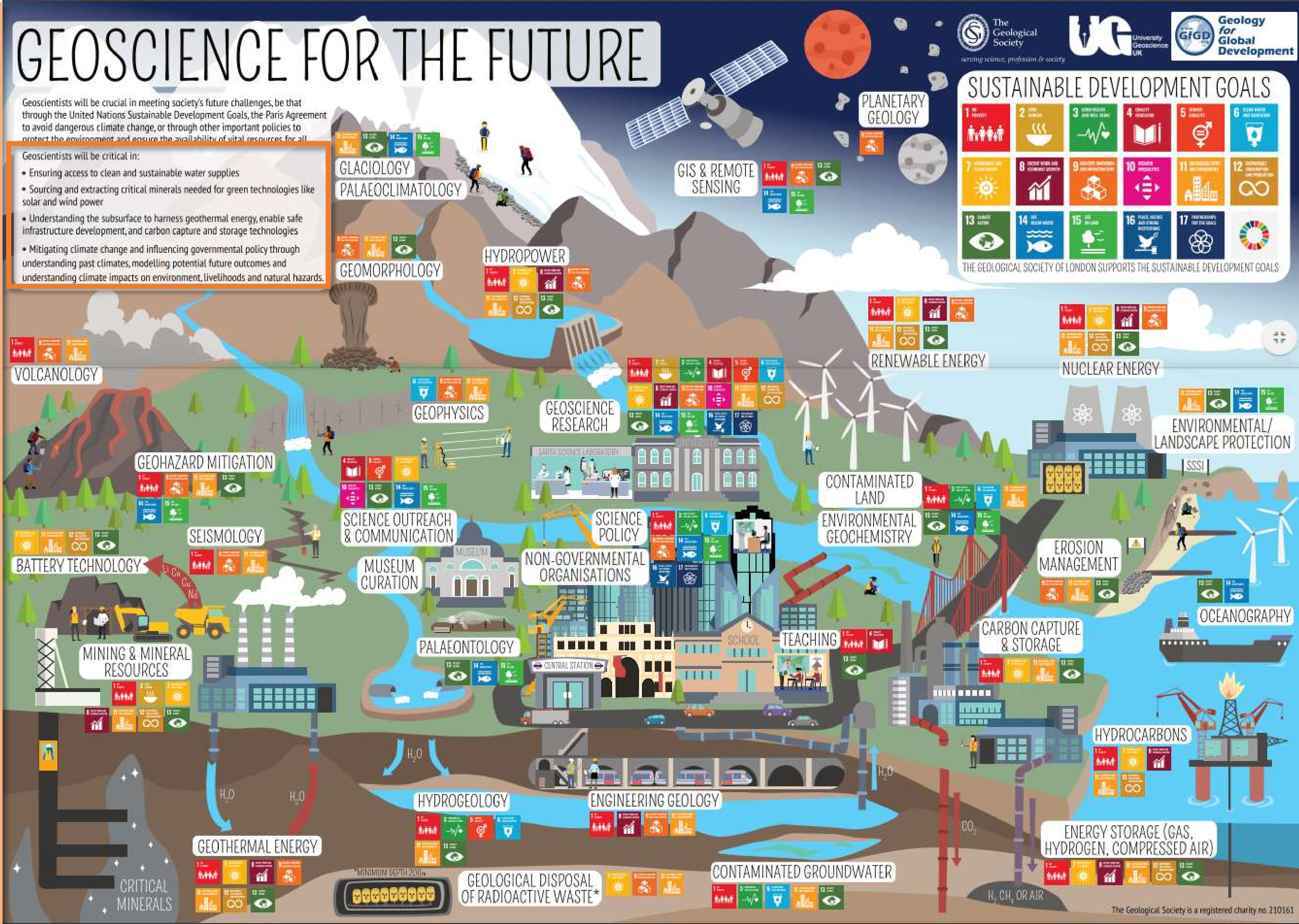
Geosciences in the changing world

To sum up:



Le geoscienze saranno fondamentali per:

- **Garantire** l'accesso a forniture idriche pulite e sostenibili
- **Esplorare e produrre** i minerali critici necessari per tecnologie pulite come l'energia solare ed eolica
- **Comprendere** il sottosuolo per sfruttare O&G e l'energia geotermica; **consentire** lo sviluppo di infrastrutture sicure e di tecnologie CCS
- **Mitigare** i cambiamenti climatici influenzando le politiche governative attraverso la comprensione del passato, la modellazione di scenari futuri e degli impatti climatici sull'ambiente, sulla vita e sugli eventi naturali



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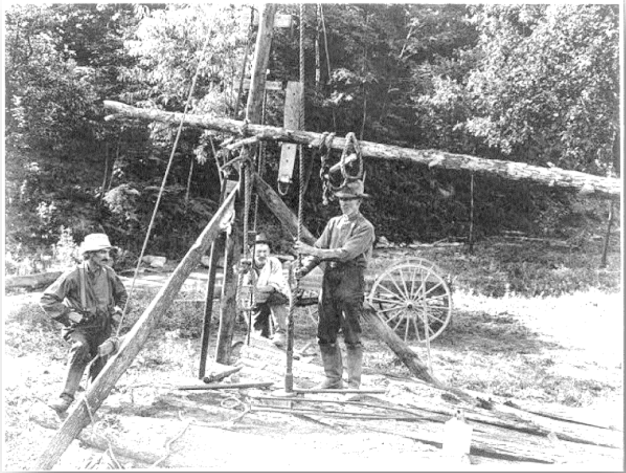
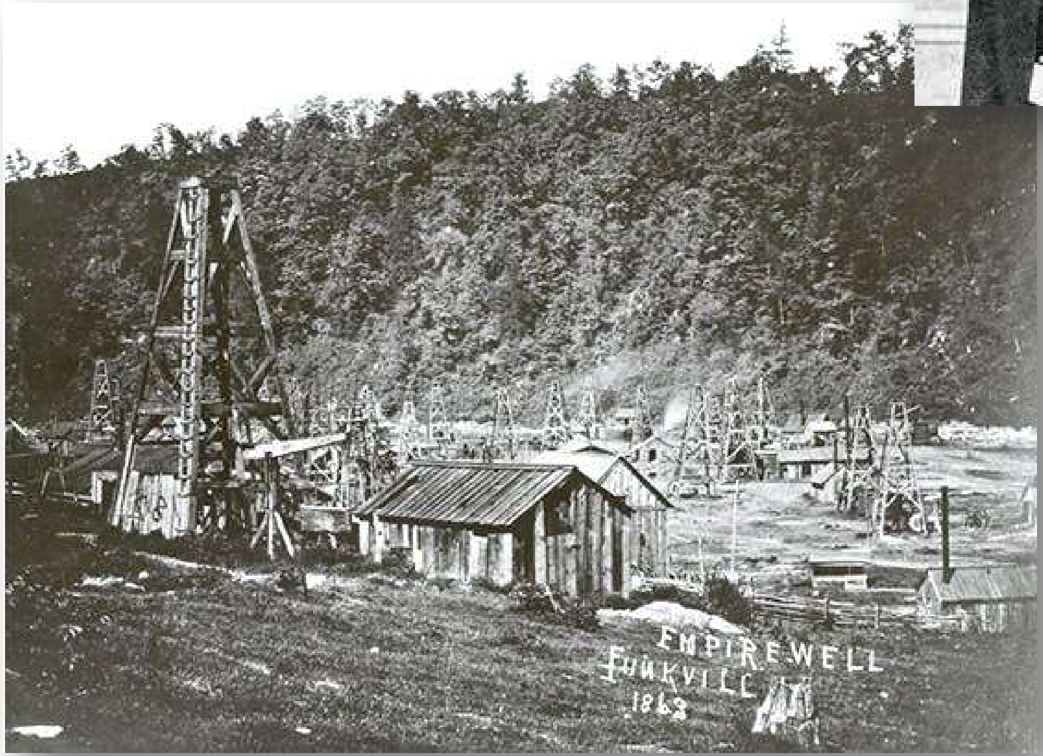
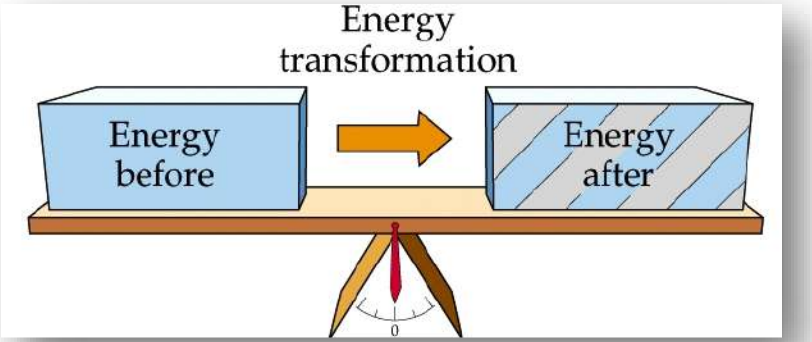
1859: Titusville (Nord Pennsylvania, 125 abitanti).
Il finto colonnello progetta una torre di perforazione basata sul semplice assemblaggio di un bastone di legno con una trivella a bilanciere, mossa da un movimento alternato verticale.





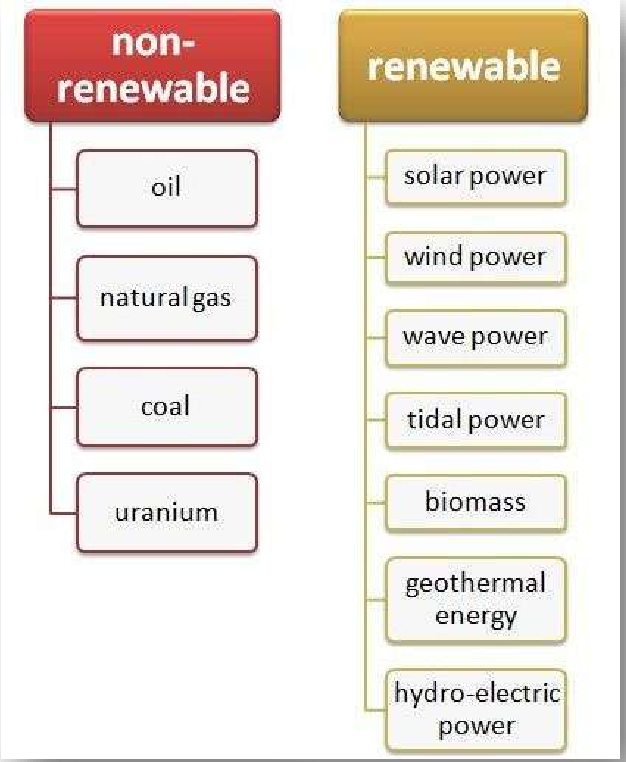
Dopo mesi di infruttuoso lavoro e di continua perdita di denaro, i finanziatori della società Seneca Oil Company inviano una lettera con l'ordine di terminare le trivellazioni.
Il 29 agosto, il giorno prima che gli venisse recapitata la lettera, il «colonnello» vede il petrolio fuoriuscire da un pozzo della profondità di 20 metri.

Prima legge della termodinamica
«in un Sistema isolato l'energia non si crea nè si distrugge, ma si trasforma da una forma ad un'altra»

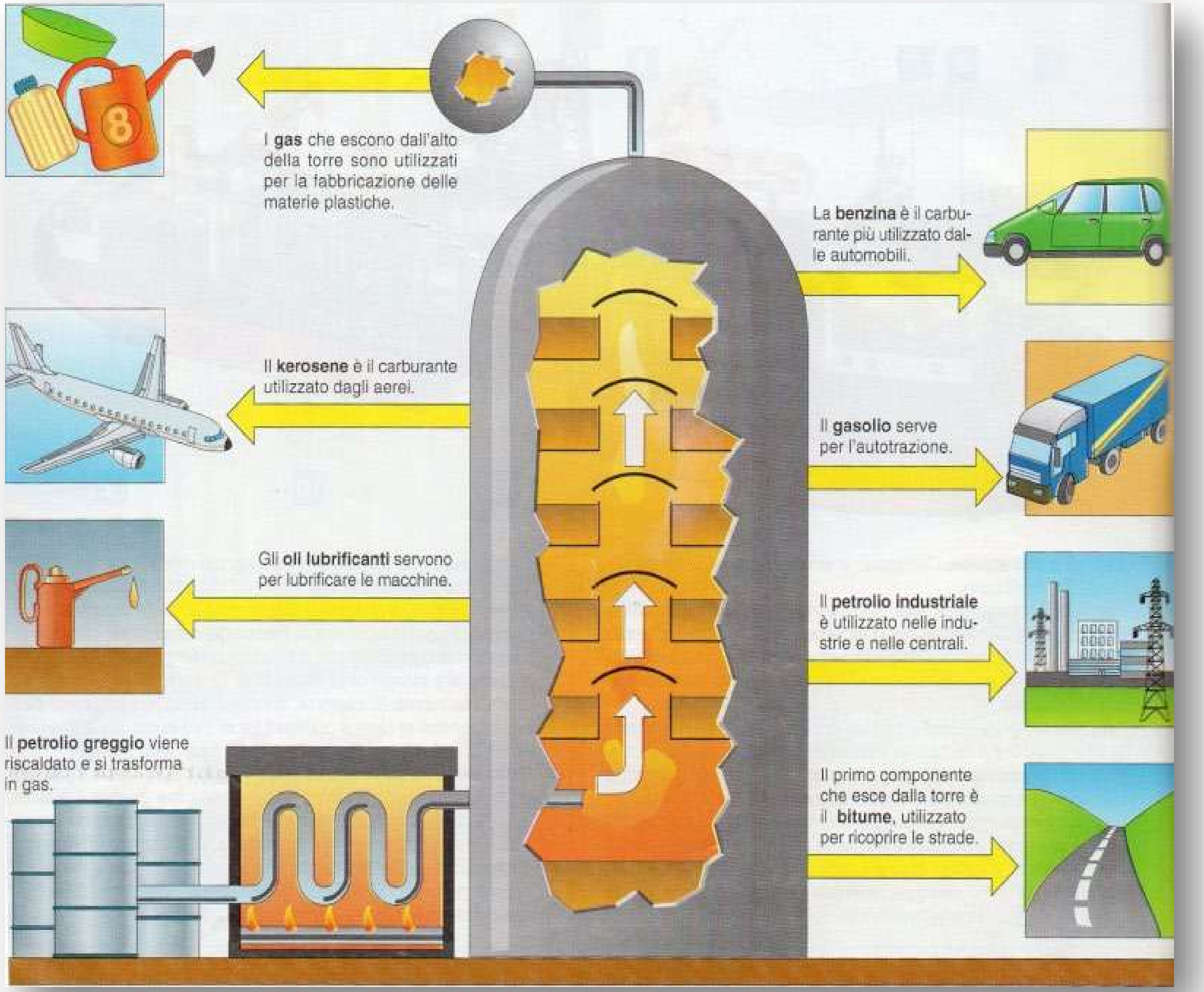


Fonti energetiche:

- **Primaria** se è presente in natura e utilizzabile tal quale. L'energia non deriva dalla trasformazione di una altra fonte
  - **Fonte rinnovabile:** solare, eolica, idroelettrica, geotermica, da biomasse
  - **Fonte non-rinnovabile:** fonti fossili utilizzabili tal quali (combustibili greggi, gas natural, carbone, nucleare)
- **Secondaria** se può essere usata solo attraverso una sua trasformazione (benzina, elettricità, idrogeno)



IL PETROLIO –raffinazione e usi



- Cuori artificiali e protesi sanitarie
- Strumenti medicali e sanitari
- Aspirina
- Palloncini
- Bende
- Frullatori
- Macchine fotografiche
- Candele
- Lettori CD
- Indumenti
- CD/DVD
- Computer
- Televisori
- Cellulari
- Contenitori
- Pastelli colorati
- Carte di credito
- Dentiere
- Deodoranti
- Orologi digitali
- Tinture
- Fertilizzanti
- Conservanti alimentari
- Palloni da calcio
- Mobili
- Schiuma da barba
- Lenti a contatto morbide
- Tavole da surf
- Telefoni
- Tende da campeggio
- Dentifrici
- Giocattoli
- Ombrelli
- Sacchi per l'immondizia
- Occhiali
- Colla
- Palline da golf
- Asciugacapelli
- Deltaplani
- Vernici
- Inchiostro
- Insetticidi
- Giubbotti salvagente
- Rossetti
- Valigie
- Apparecchi medicali
- Medicine
- Lettori MP3
- Collant
- Strutture protettive per patio/veranda
- Profumi
- Pellicole fotografiche
- Fotografie
- Tasti del pianoforte
- Rollerblade
- Coperture per tetti
- Shampoo
- …

Quando fu perforato il primo pozzo «moderno» in Italia?

ITALIA: PIÙ DI 7000 POZZI PERFORATI DAL 1860

1860	Primo pozzo perforato in Italia (Parma)
1868	Nasce la Miniera delle Petroglie (Ripi, Frosinone)
1869	Prime città illuminate a gas (Torino)
1926	Nasce l'AGIP
1944	Caviaga (Pianura Padana): primo giacimento a gas dell'Europa
1959	Sicilia: primo pozzo a mare in Europa
1973	Malossa (Pianura Padana): giacimento più profondo d'Europa (>5000 m)
1980	Adriatico: primo pozzo in acque profonde (>300 m di acqua)
1984	Trecate (Pianura Padana): giacimento più profondo in Europa (>6000 m)
1988	Basilicata: giacimenti di petrolio più grandi d'Europa in terraferma
2008	Ultimo pozzo esplorativo perforato nei mari italiani

APPENNINO DI PARMA E PIACENZA, ABRUZZO, LAZIO - UNA LUNGHISSIMA STORIA

Sono conosciute manifestazioni superficiali di gas e petrolio sin dall'antichità (lat. mediev. *petroleum, petrae oleum* «**olio di pietra**») in Emilia e in Abruzzo, e la loro presenza era anche temuta come presenza demoniaca.

- I secolo dC: **Plinio il Vecchio** (*Naturalis Historia*) in occasione del terremoto di Modena del 91 a.C. parla dello "...*scontro di due monti che poi tornavano ad allontanarsi con grande frastuono, fiamme e fumo*..."
- 1200: **Giovanni De Mussis** (*Chronicon Placentinum*) racconta di affioramenti di petrolio nei terreni: "*Sunt etiam in dicto episcopatu Placentino aliquae fonte set putei qui producunt oleum petronicum quod vales ad multa infirmitates" (*"Vi sono invero in questo vescovado di Piacenza anche alcune fonti e pozzi che producono olio di pietra, che serve contro molte malattie*"*)
- 1781: il canonico **Serafino Volta** raccontava dei fuochi di Velleja (Piacenza)
- 1866: **Giovanni Cappellini**: Relazione all'Univ. di Bologna «*Petrolio di Tocco e Bitumi di Letto Monopello*»
- 1876: l'abate **Antonio Stoppani** (*Il Belpaese*) racconta di Fornovo e dei trenta pozzi in muratura come i pozzi per l'acqua, profondi 10-20 metri, che producevano ciascuno circa 25 kg di petrolio al giorno

Sin dal '600, in moltissimi centri si ritrovavano pozze d'acqua ricoperte di uno strato oleoso, «scolato» dall'acqua e venduto per innumerevoli impieghi, in particolare medicinali.

Fino al XIX secolo il petrolio era impiegato per diversi usi; combustibile per le lampade o rimedio medicamentoso (funghi, psoriasi, …).

APPENNINO DI PARMA E PIACENZA, ABRUZZO, LAZIO - UNA LUNGHISSIMA STORIA

Figure 1. A) Piacenza; B) Parma; C) Reggio Emilia; D) Modena; E) Southern Lazio; F) Abruzzo Citeriore.

...uperficiali di gas e petrolio sin dall'antichità (lat. mediev...
...e la loro presenza era anche temuta come presenza de...
...(*Naturalis Historia*) in occasione del terremoto di M...
...*i tornavano ad allontanarsi con grande frastuono, fiam...*
...*hronicon Placentinum*) racconta di affioramenti di pet...
...*aliquae fonte set putei qui producunt oleum petr...*
...in questo vescovado di Piacenza anche alcune fonti...
...malattie*"*)
...a raccontava dei fuochi di Velleja (Piacenza)
...azione all'Univ. di Bologna «*Petrolio di Tocco e Bitumi d...*
...i (*Il Belpaese*) racconta di Fornovo e dei trenta pozzi in...
...che producevano ciascuno circa 25 kg di petrolio al gior...

Figure 2. Section of Abruzzo named Citeriore, drawn by Abate Antonio Stoppani. *Il Bel Paese*. Milan, 1873.

...ritrovavano pozze d'acqua ricoperte di uno...
...nali.
...combustibile per le...
(funghi, psoria...

Fuochi prodotti dai terreni nella campagna emiliana. Stampa in A. Volta, Lettere, 1777)

Uomini in barca raccolgono bitume con le spugne al largo di Agrigento. Incisione di P. Galle (1537-1612) su disegno di J. van der Street (1523-1605)

APPENNINO DI PARMA E PIACENZA, ABRUZZO, LAZIO - UNA LUNGHISSIMA STORIA

Figure 1. A) F
Emilia; D) Mo
Abruzzo Citer

perficiali di gas e petrolio sin dall'antichità (lat. mediev
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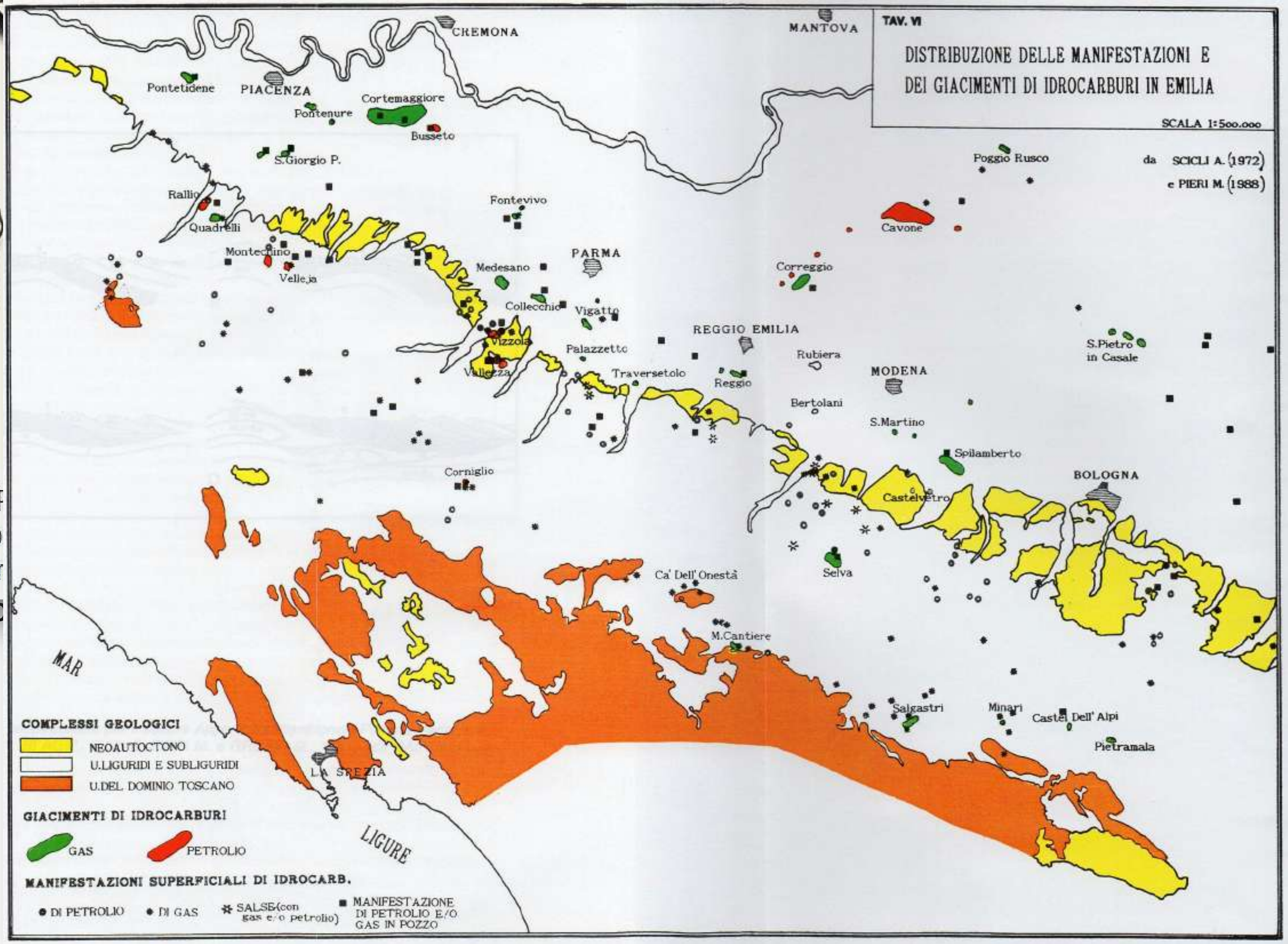

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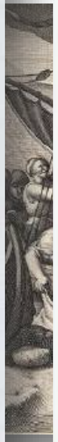

bitur
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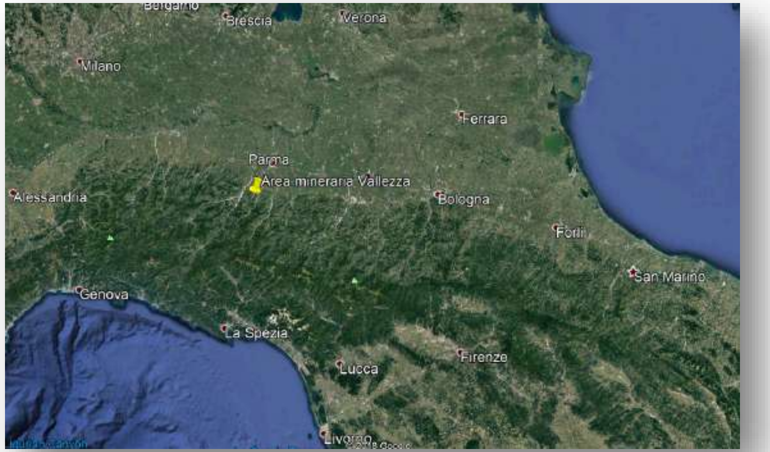
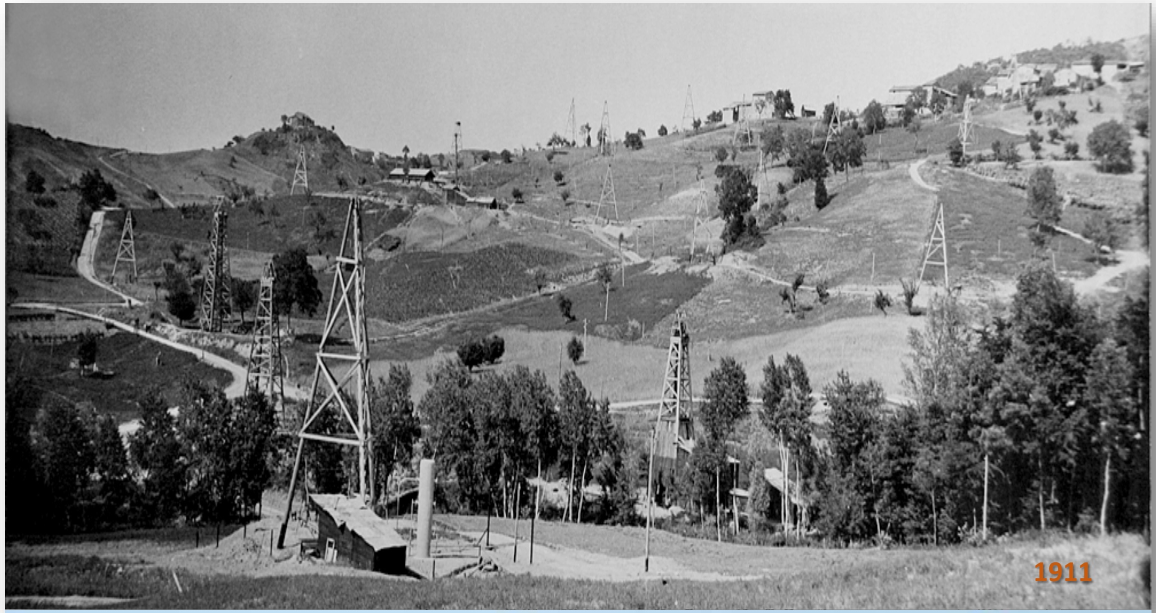
Street (1523-1605)

VALLEZZA (PARMA)





1860: **primo pozzo** “moderno” in Europa

1905: nasce la **Società Petrolifera Italiana** spa, la più antica d’Italia, per la perforazione e l’estrazione di petrolio nell’Appennino parmense.

1912: **10 pozzi** che producono 15 quintali/giorno. Circa 250-300 lavoratori con le loro famiglie

1916: nasce la prima raffineria «moderna» d’Italia

1933: 16 pozzi che producono 20.649 tonn (80% della produzione nazionale). **SPI costituisce il Dipartimento di studi geologici**

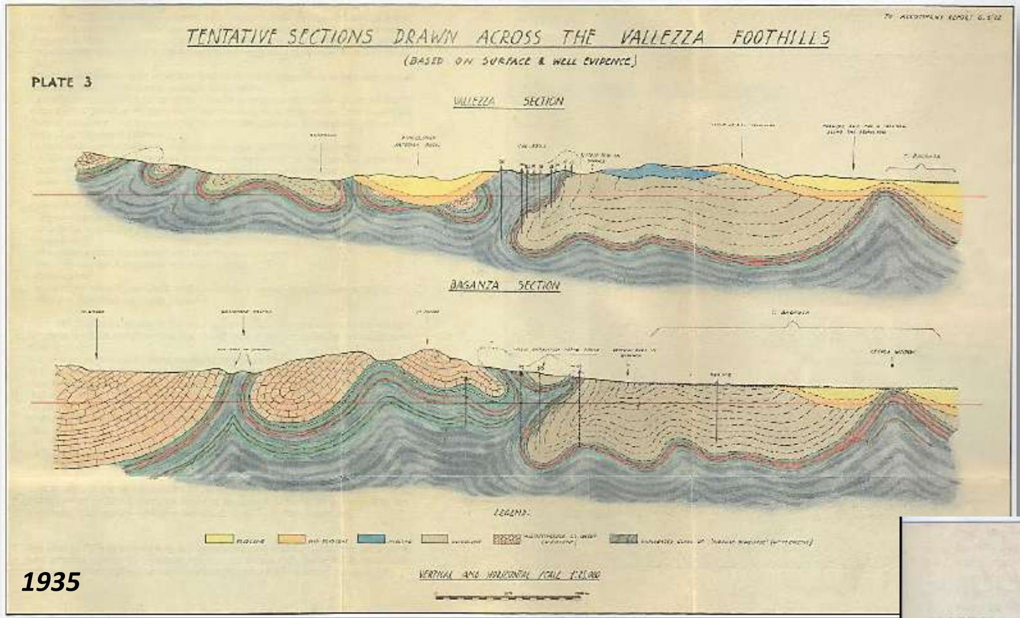
1946: la SPI passa alla Standard Oil & Company (ESSO) che avvia la ricostruzione dopo i bombardamenti subiti nella II Guerra Mondiale

1980: perforato il **pozzo 201**

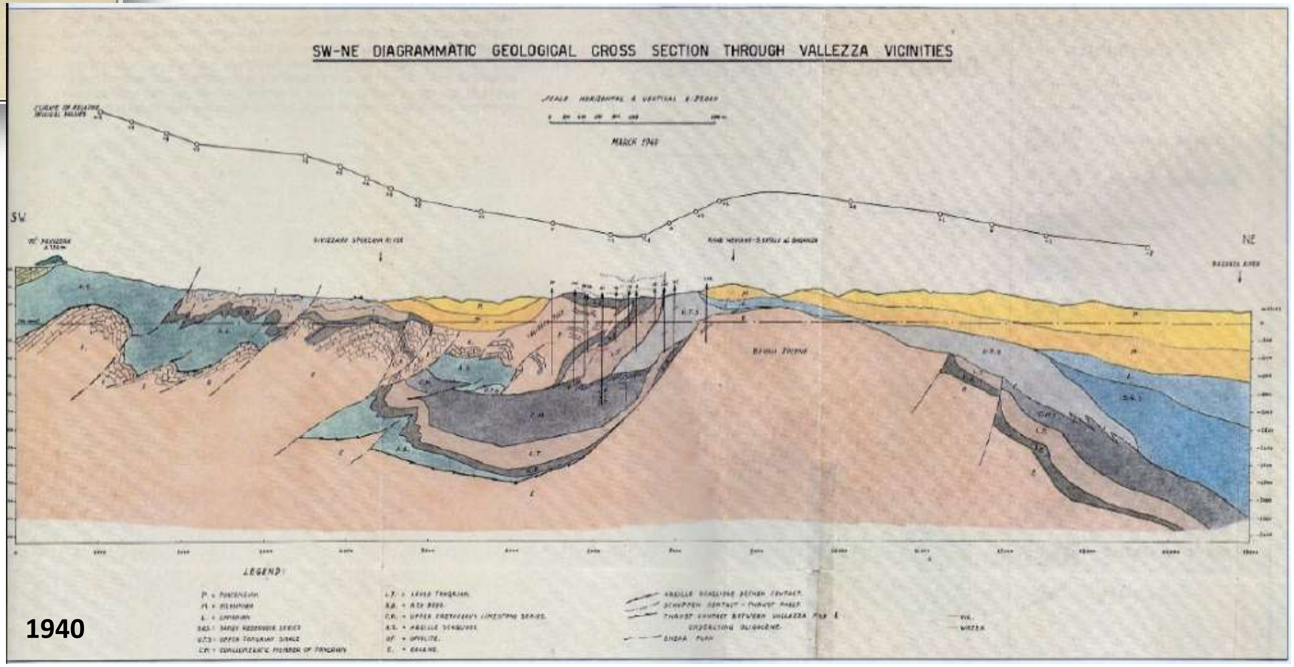
1994: il giacimento di Vallezza viene dichiarato **esaurito** e inizia la chiusura mineraria dei pozzi e la bonifica dei siti

VA

VALLEZZA (PARMA)

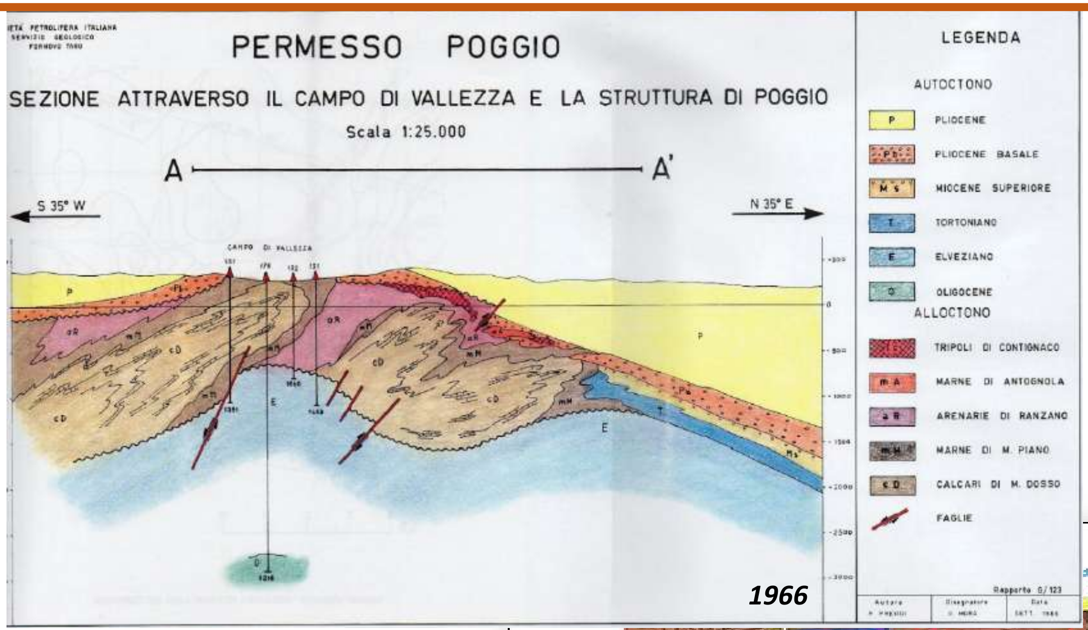


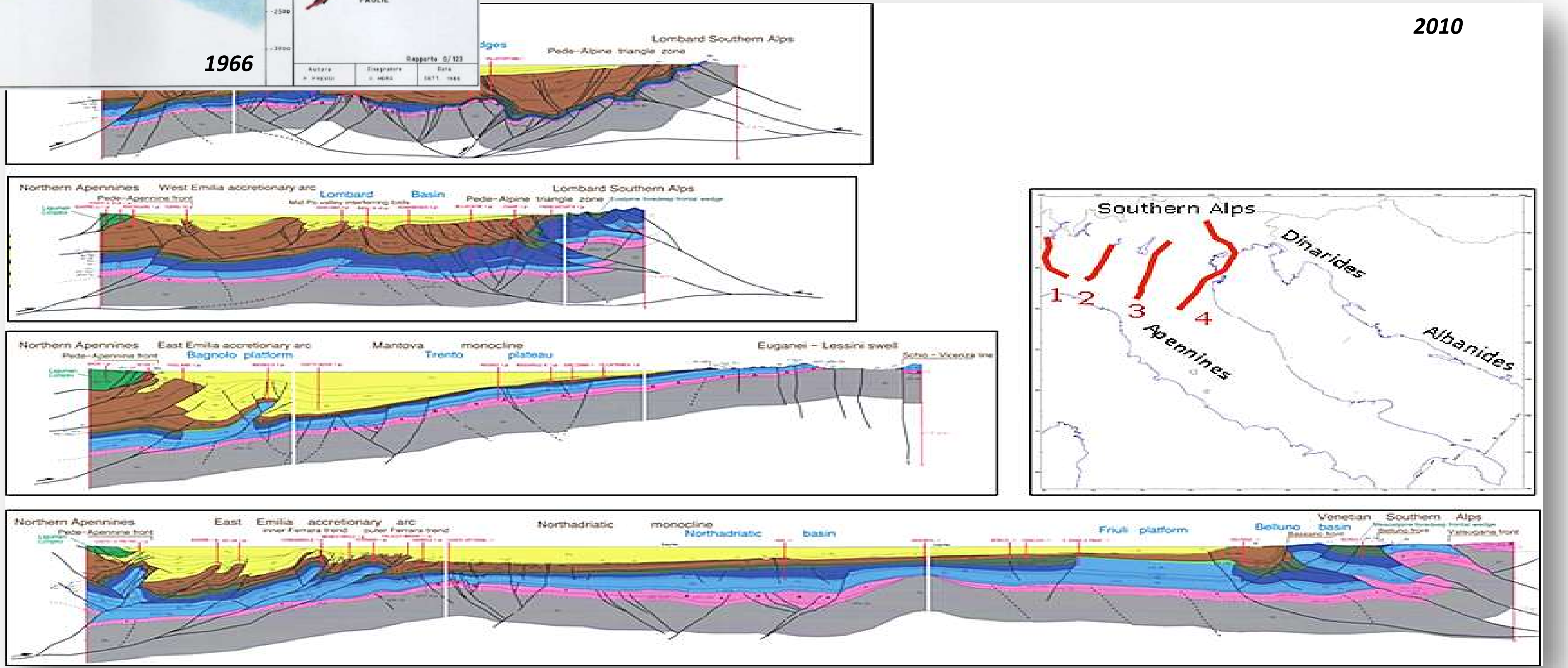
1935

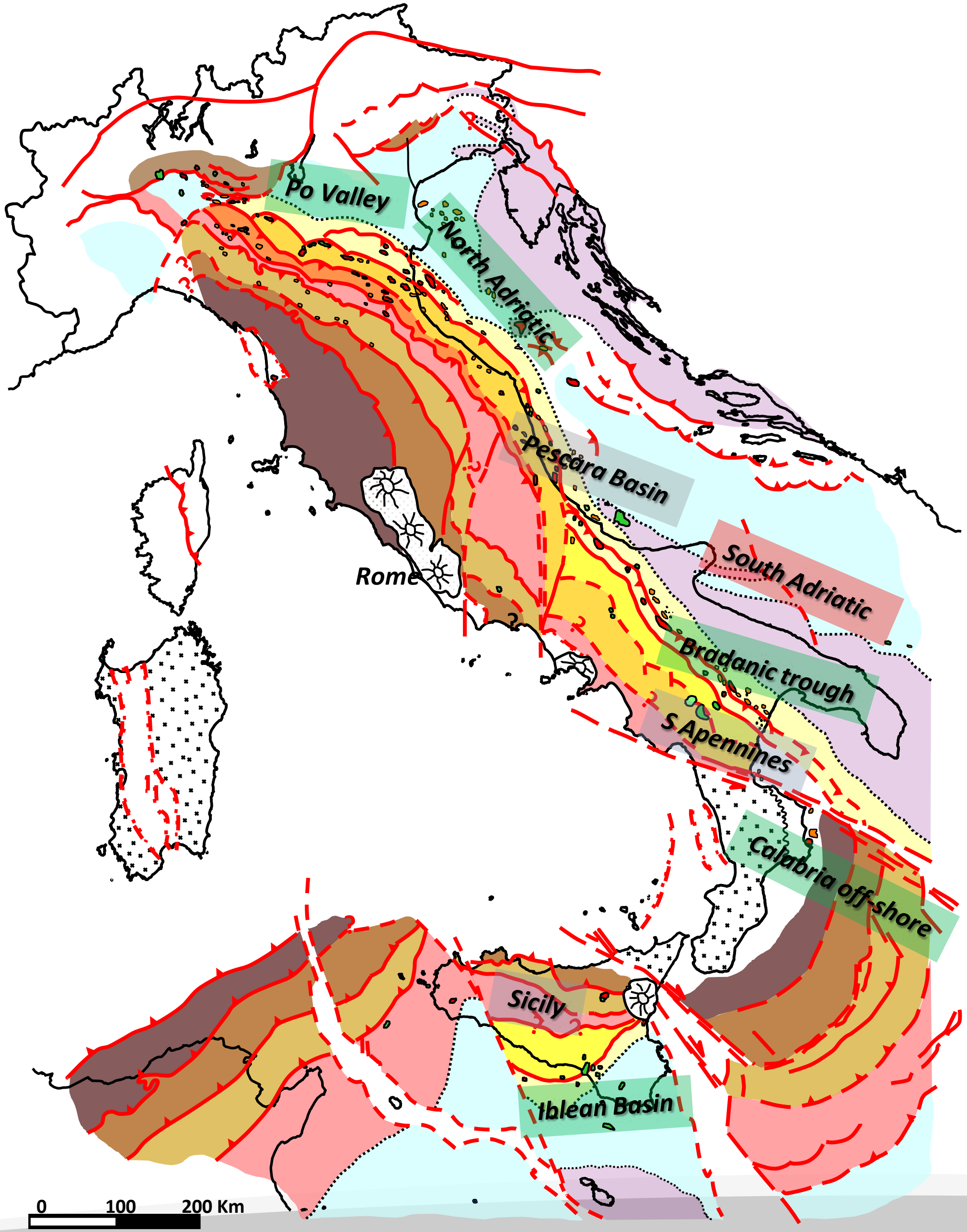


1940

VALLEZZA (PARMA)







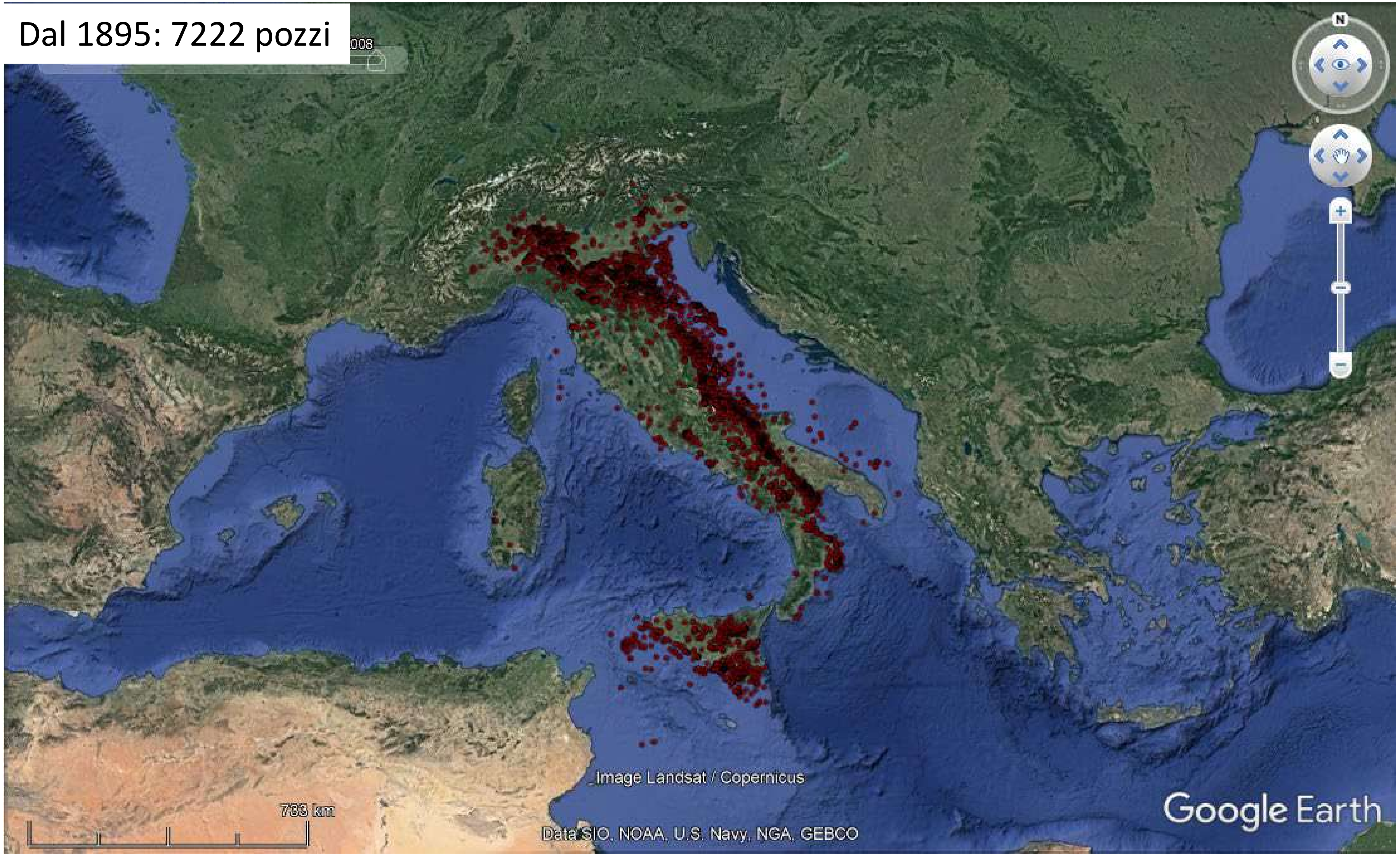
Un connubio indissolubile

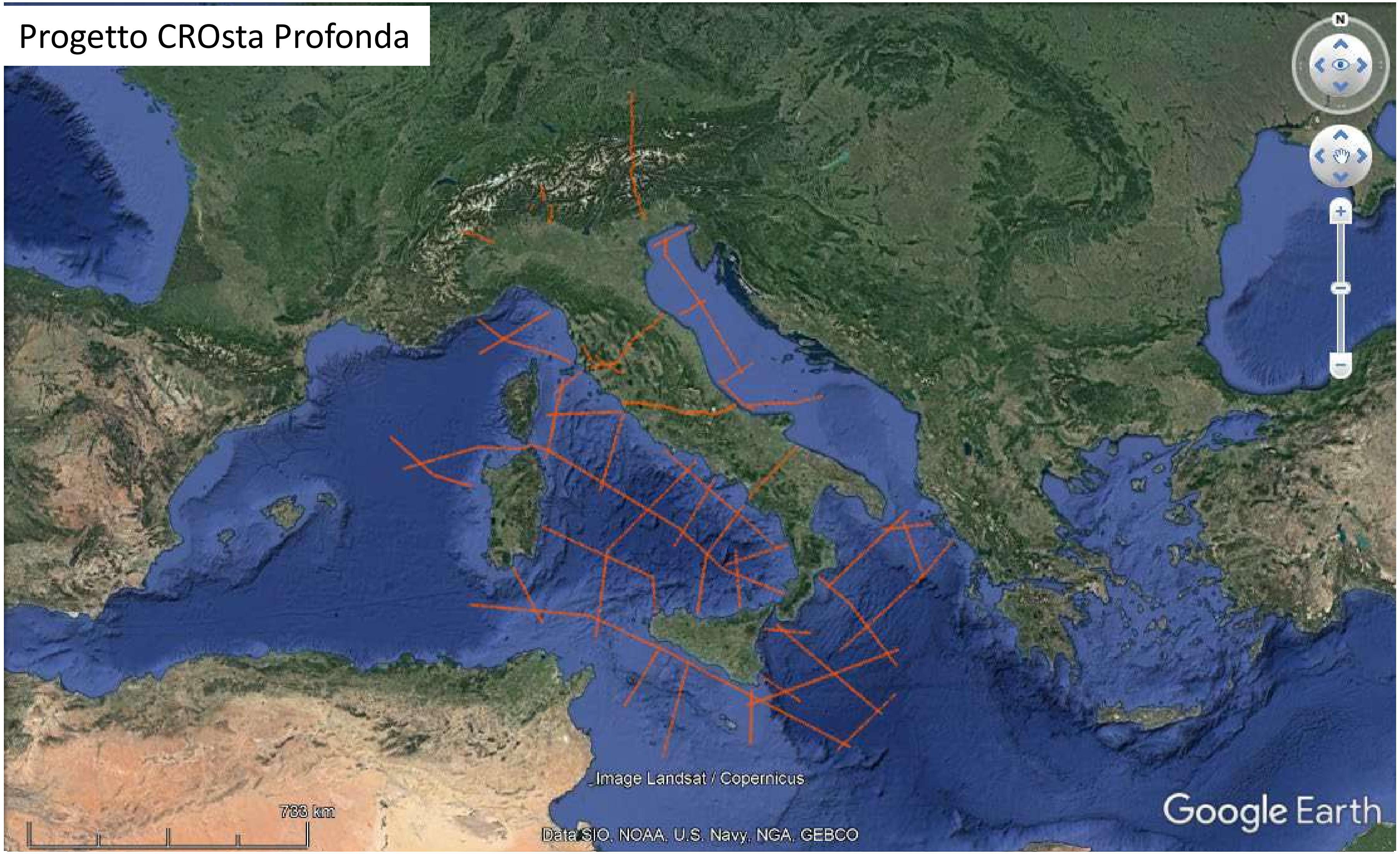
Geoscienze: conoscenza e consapevolezza del territorio, diffusione della conoscenza

Risorse del sottosuolo: fame di energia, dipendenza dall'estero, notevoli risorse potenziali, scuola di scienza

Dagli anni ‘50, la Penisola è stata oggetto di **prospezioni** geofisiche e di **perforazioni** di pozzi (scientifici, di ricerca idrocarburi, geotermici), che oltre a dare accesso alle risorse naturali, hanno permesso di aumentare la **conoscenza delle strutture tettoniche** e di ipotizzarne il loro grado di **pericolosità sismica**

IL DATO


Dal 1895: 7222 pozzi
Image Landsat / Copernicus
733 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth


Progetto CROsta Profonda
Image Landsat / Copernicus
783 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth

Sismica riconoscitiva