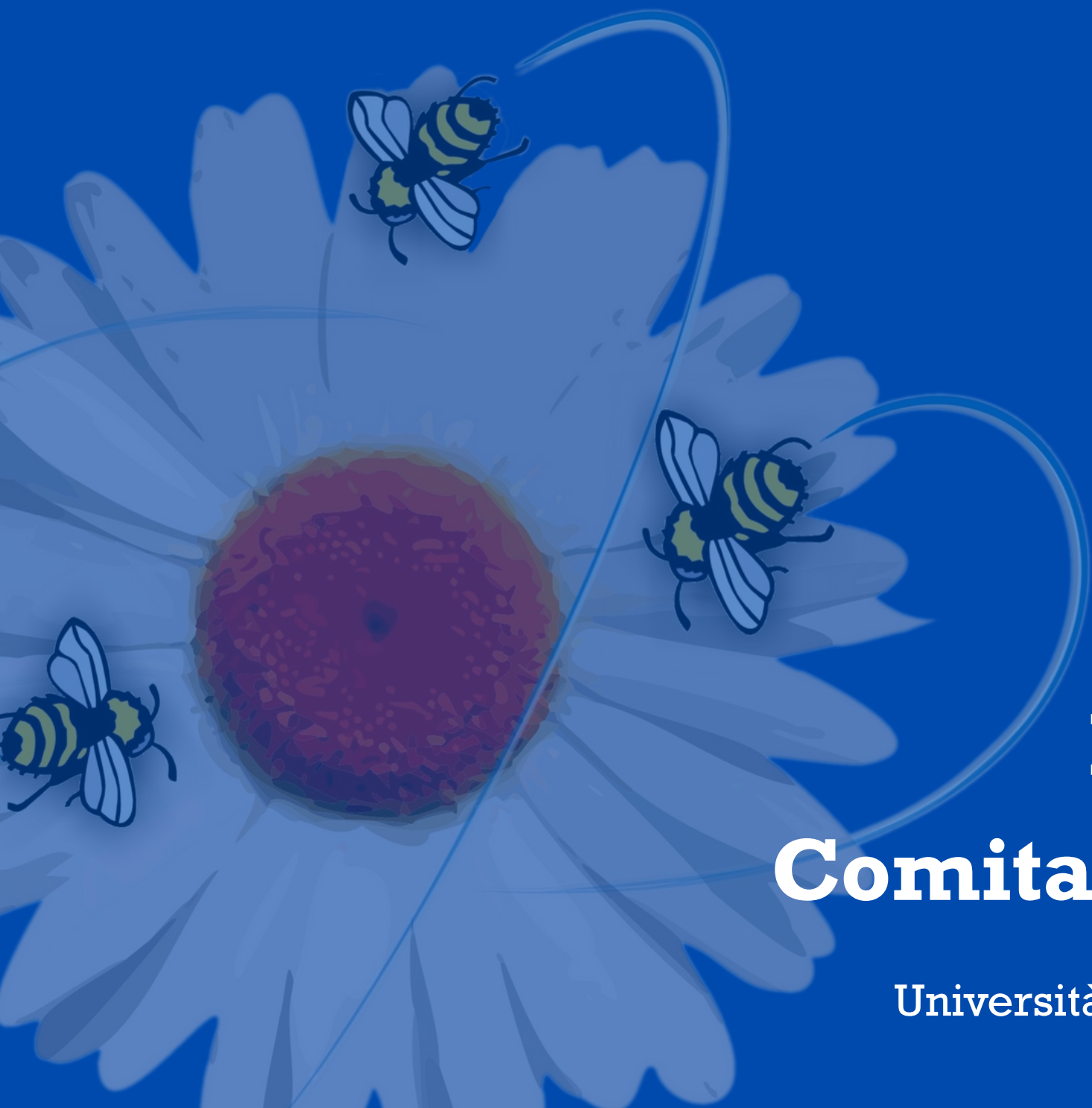


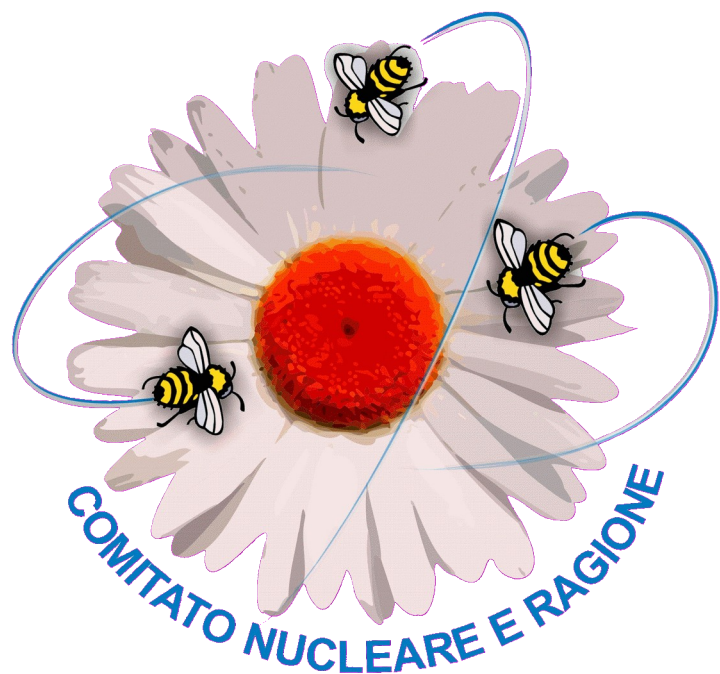
NUCLEARE

Prospettive future in Italia



Pierluigi Totaro
Comitato Nucleare e Ragione

Università degli Studi di Trieste - Aula 1B, Edificio D
18/03/2025



***Usare
la ragione

Per capire
il nucleare***

L'associazione è nata a **Trieste** nel 2011, a poche settimane dall'incidente di Fukushima.

Siamo una **comunità** di circa **300 studenti, dottorandi, post-doc, ricercatori, professori universitari, tecnici**, ma anche tanti "semplici" **appassionati**

Età media: 34 anni



Facciamo la nostra parte per...

- fornire ai cittadini **le basi e le conoscenze per poter comprendere e valutare i pregi e difetti** delle diverse tecnologie di approvvigionamento energetico
- promuovere il raggiungimento di un'**equilibrata strategia energetica**
- costruire una cittadinanza più **partecipe e consapevole**



Transizione Energetica: perché?

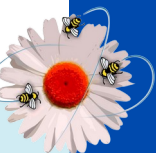
Il problema

Il principale indiziato

Le cause

Il contesto

La soluzione



Every solution breeds new problems.

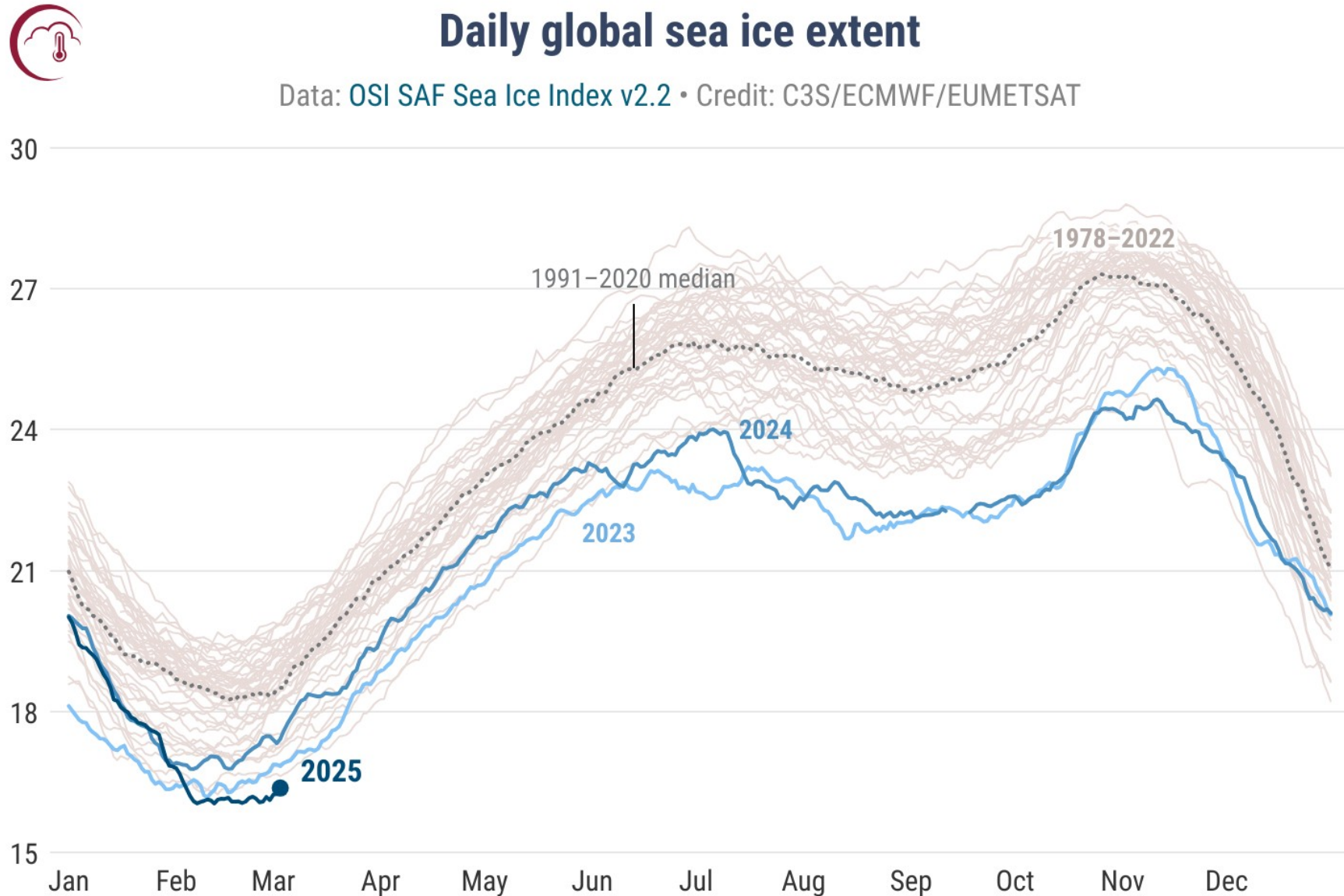
Artur Bloch

***There is always an easy solution to every problem:
neat, plausible, and wrong.***

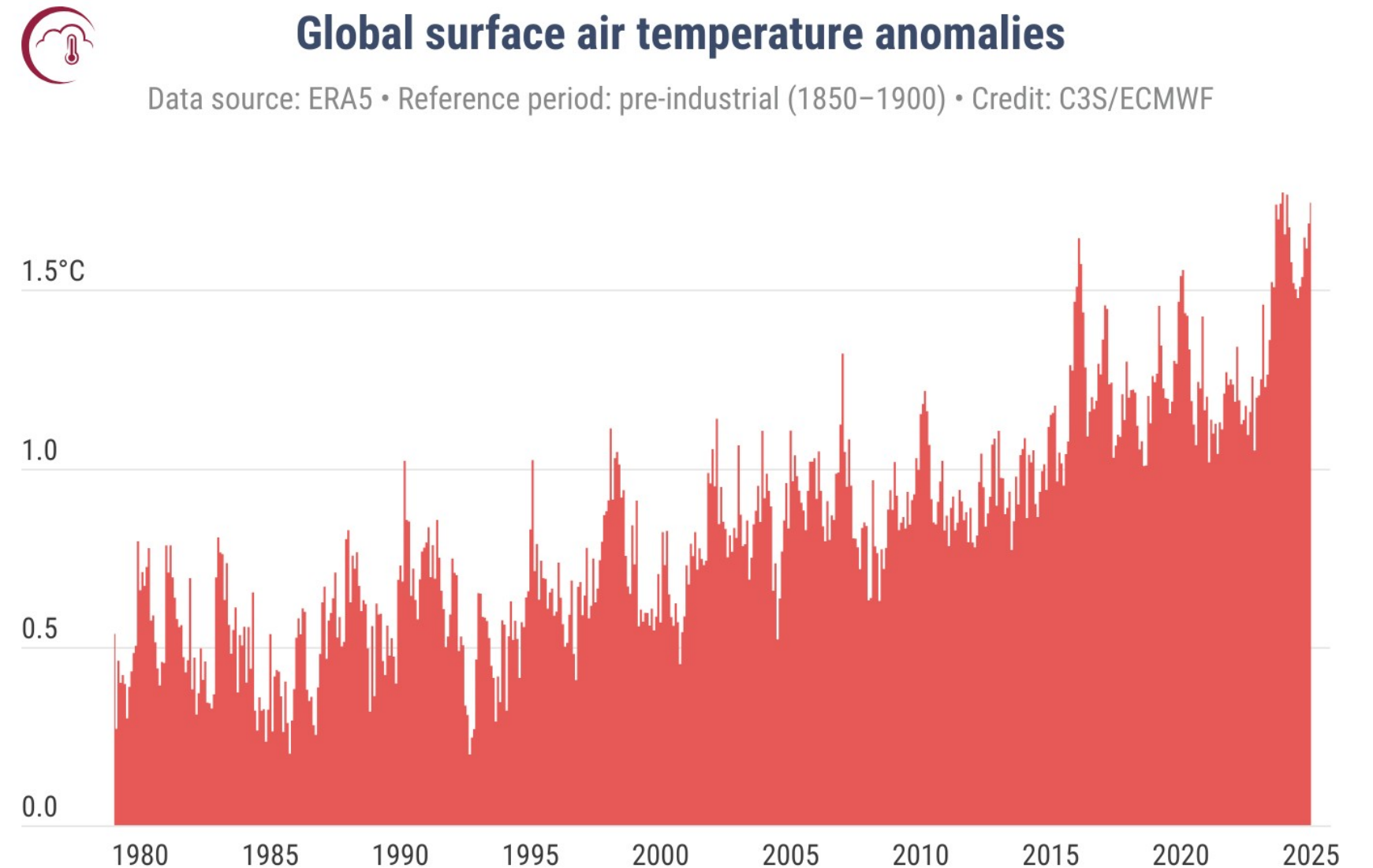
H. L. Mencken



Un problema globale



Data in million square kilometres

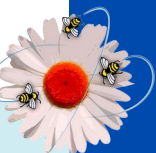


Select one option:

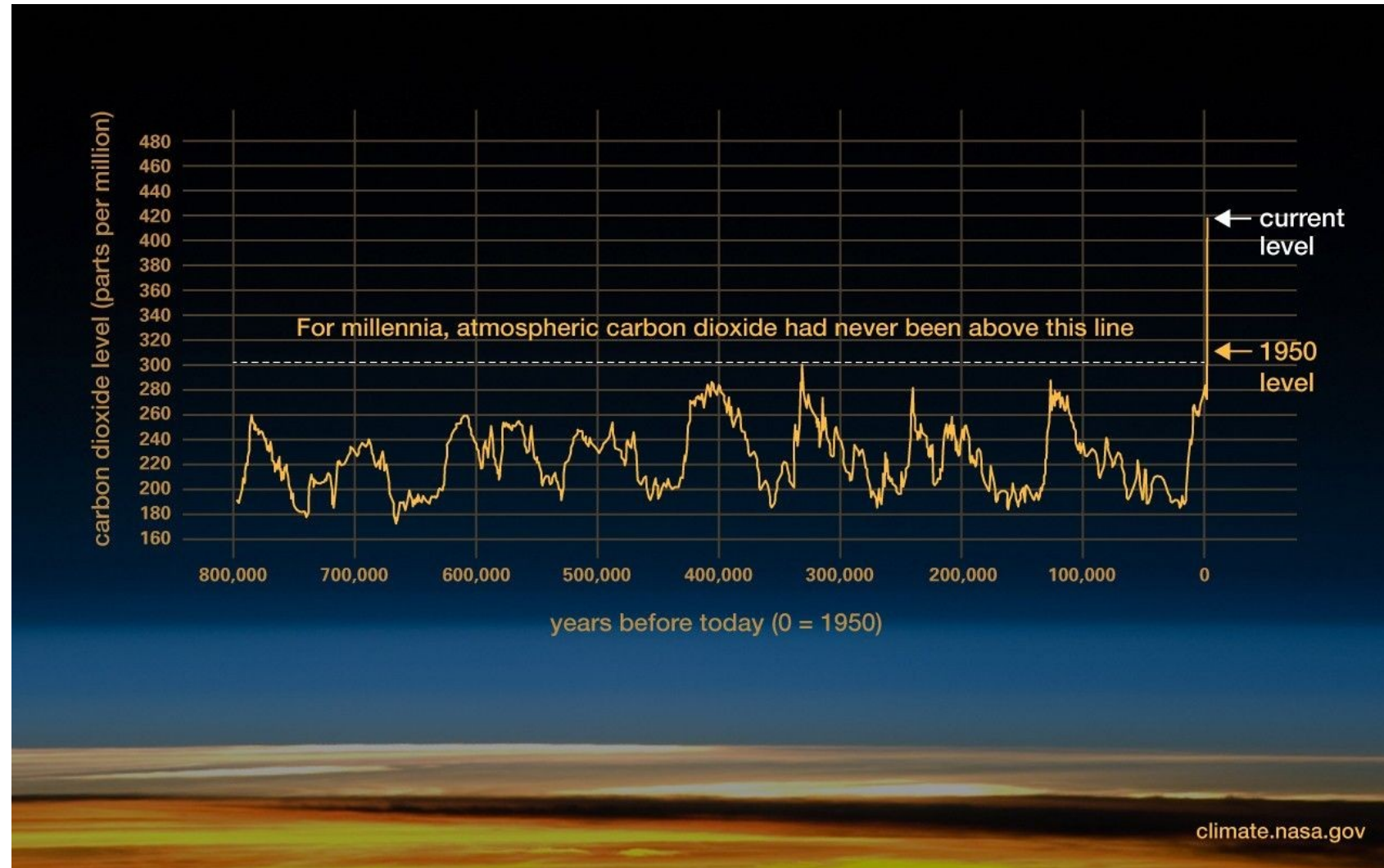
January all months 12-month average



<https://climate.copernicus.eu/>



Il principale indiziato

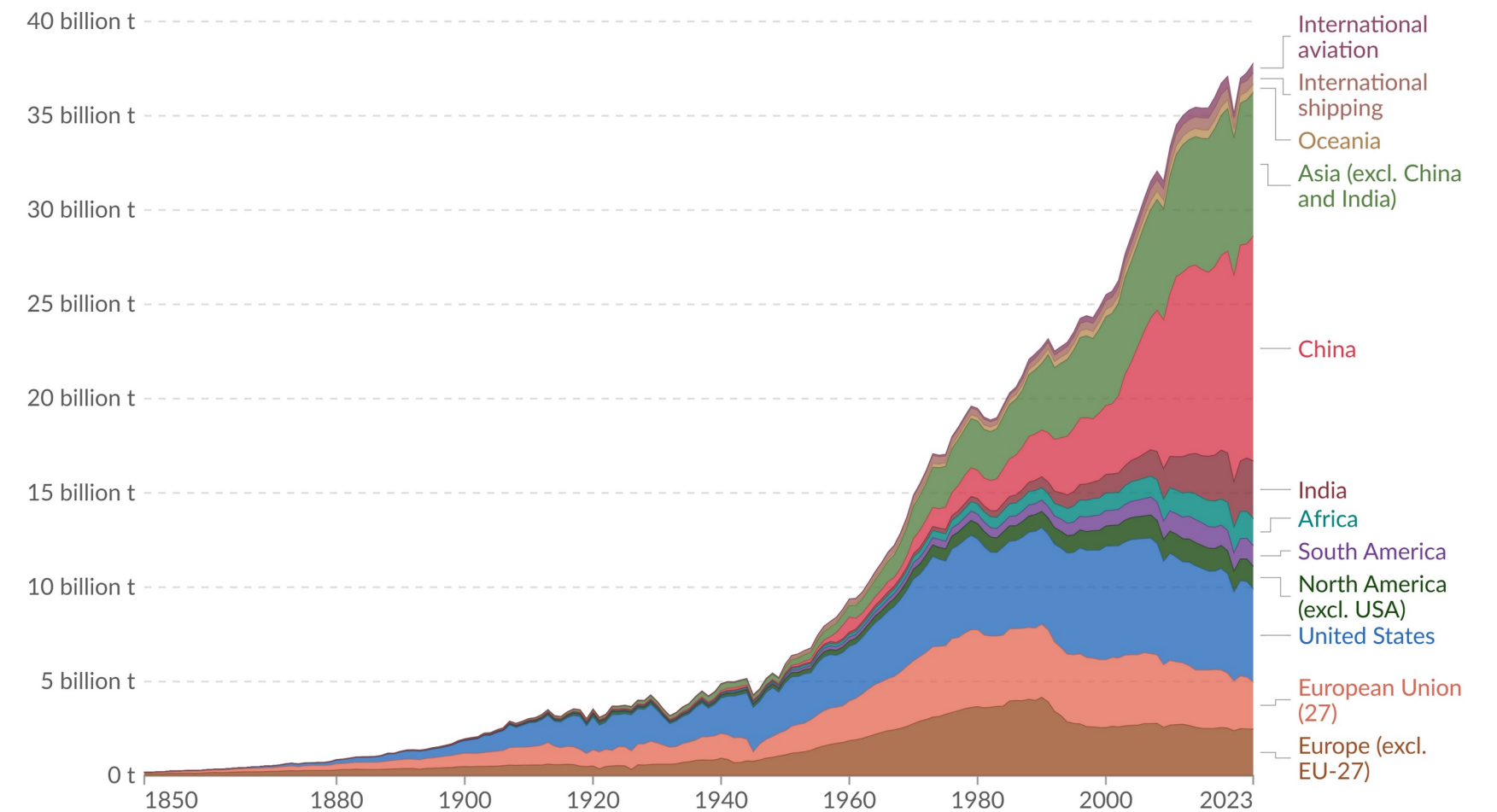


<https://science.nasa.gov/resource/graphic-the-relentless-rise-of-carbon-dioxide/>

Annual CO₂ emissions by world region

Emissions from fossil fuels and industry¹ are included, but not land-use change emissions. International aviation and shipping are included as separate entities, as they are not included in any country's emissions.

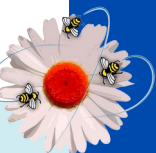
Our World
in Data



Data source: Global Carbon Budget (2024)

OurWorldinData.org/co2-and-greenhouse-gas-emissions | CC BY

1. Fossil emissions: Fossil emissions measure the quantity of carbon dioxide (CO₂) emitted from the burning of fossil fuels, and directly from industrial processes such as cement and steel production. Fossil CO₂ includes emissions from coal, oil, gas, flaring, cement, steel, and other industrial processes. Fossil emissions do not include land use change, deforestation, soils, or vegetation.

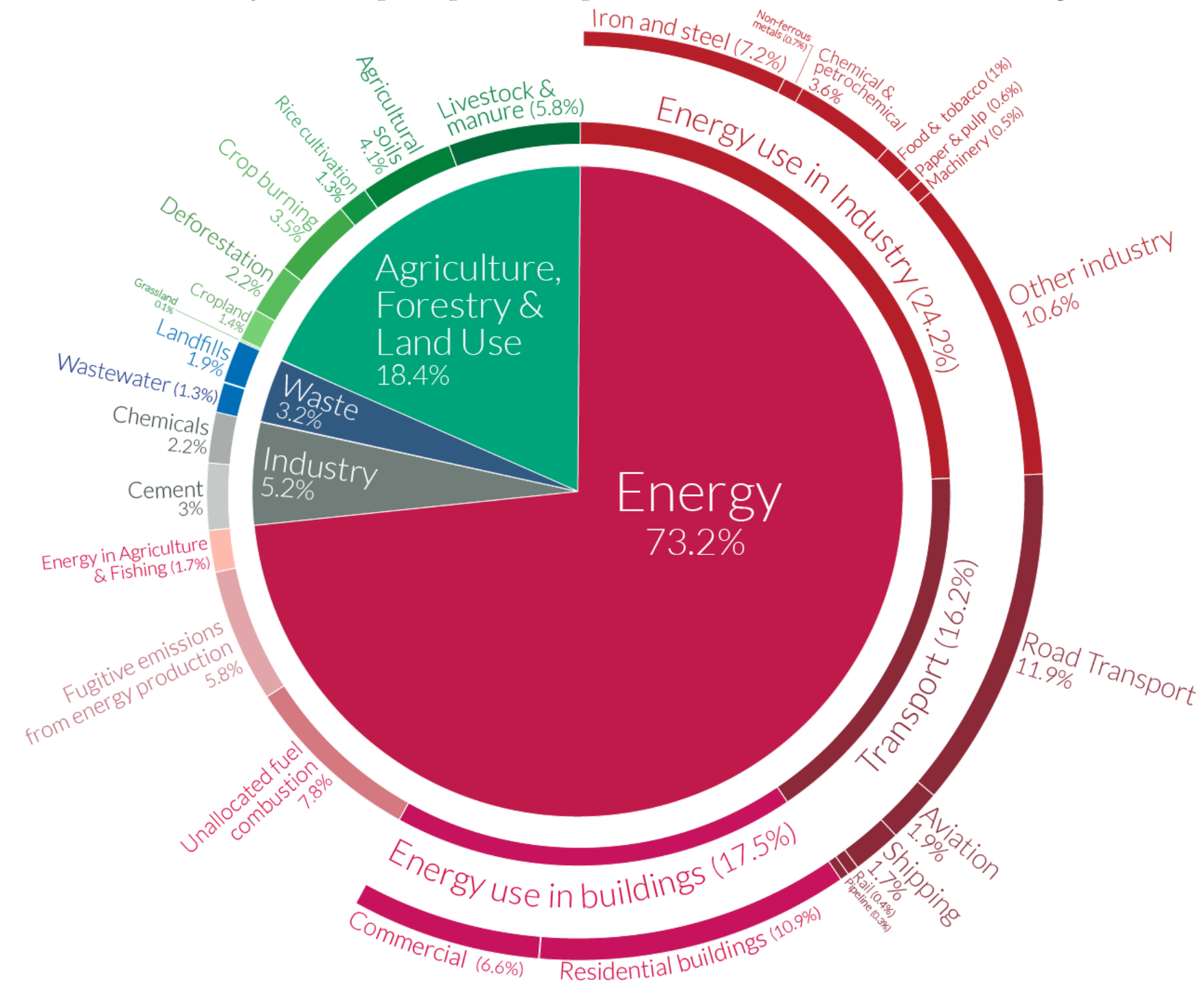


Le cause

Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.

Our World
in Data



Il contributo del **settore energetico** sulle emissioni antropiche di gas serra è determinante

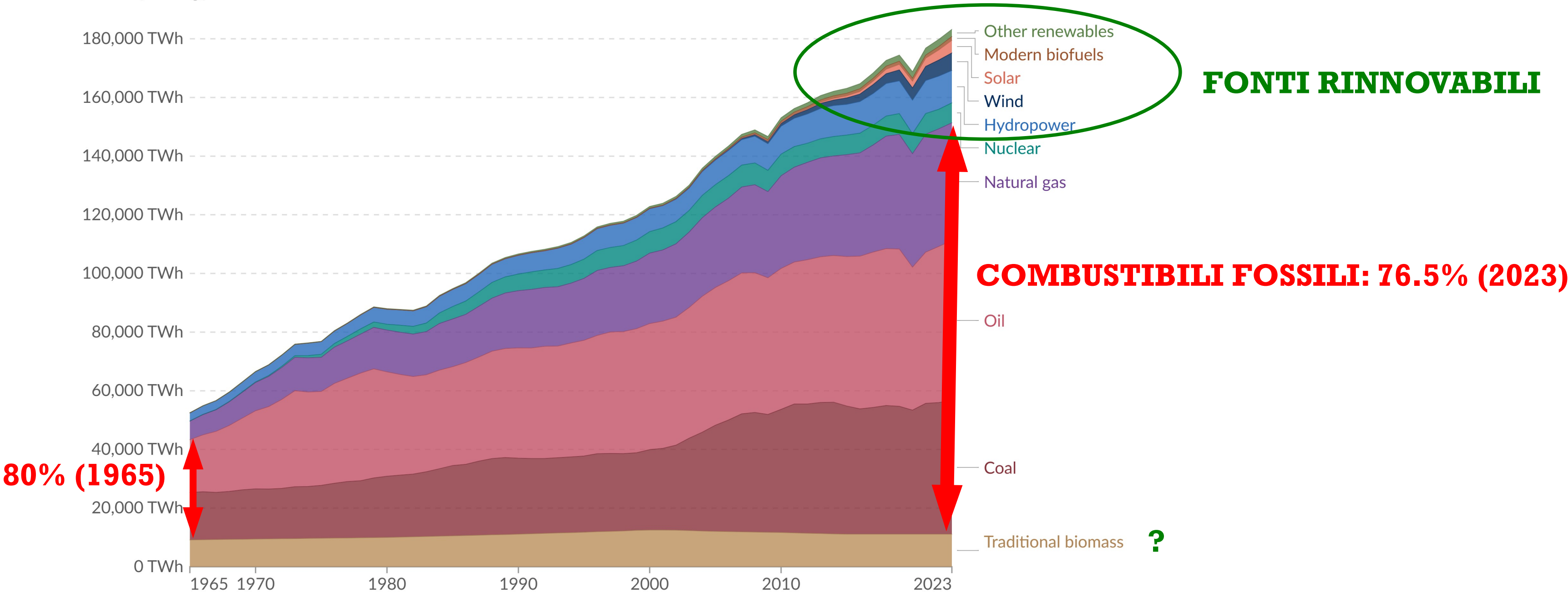


Il contesto: l'umanità ha “fame” di energia

Global primary energy consumption by source

Primary energy¹ is based on the substitution method² and measured in terawatt-hours³.

Our World
in Data



Data source: Energy Institute - Statistical Review of World Energy (2024); Smil (2017)
Note: In the absence of more recent data, traditional biomass is assumed constant since 2015.

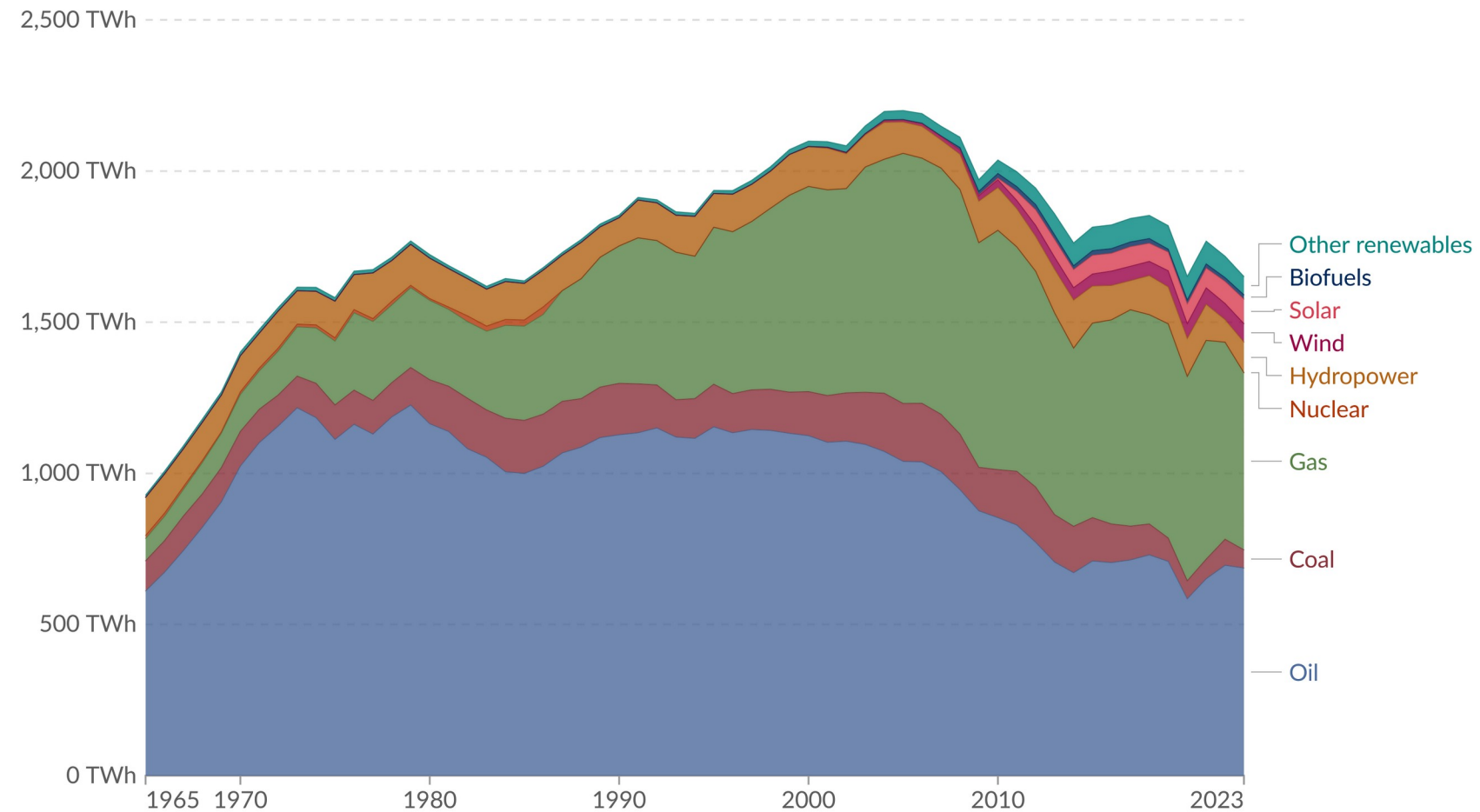
OurWorldinData.org/energy | CC BY



Il contesto: la situazione italiana

Energy consumption by source, Italy

Measured in terms of primary energy¹ using the substitution method².



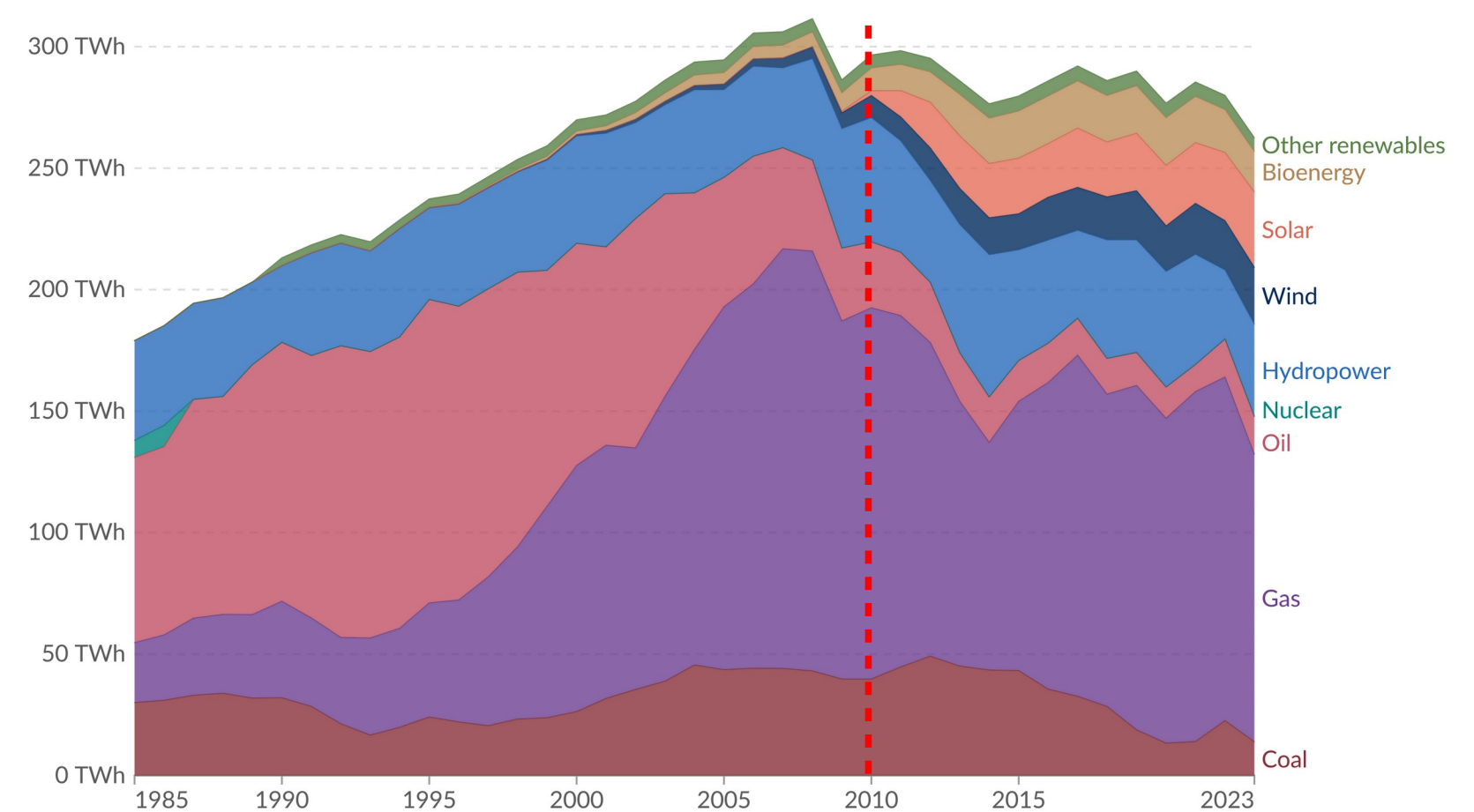
Data source: Energy Institute - Statistical Review of World Energy (2024)

Note: "Other renewables" include geothermal, biomass, and waste energy.

OurWorldinData.org/energy | CC BY

Electricity production by source, Italy

Measured in terawatt-hours¹.



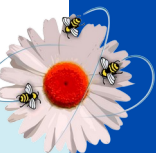
Data source: Ember (2024); Energy Institute - Statistical Review of World Energy (2024)

Note: "Other renewables" include waste, geothermal, wave, and tidal.

OurWorldinData.org/energy | CC BY

Transizione 1 (1990-2010):
petrolio → gas
fonti fossili: stabile 80%
Aumento costante consumi

Transizione 2 (2010-2025):
fossili → rinnovabili
fonti fossili: 80% → 60%
Stabilizzazione consumi



Missioni (im)possible: produrre energia senza emissioni (o quasi)

Our World
in Data

Greenhouse gas emissions

Measured in emissions of CO₂-equivalents per gigawatt-hour of electricity over the lifecycle of the power plant.
1 gigawatt-hour is the annual electricity consumption of 150 people in the EU.

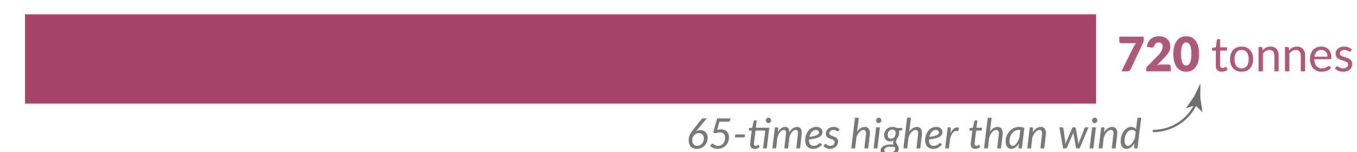
Coal

36% of global electricity



Oil

3% of global electricity



Natural Gas

22% of global electricity



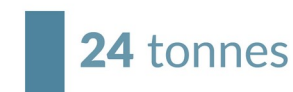
Biomass

2% of global electricity



Hydropower

12% of global electricity



Wind

7% of global electricity



Nuclear energy

10% of global electricity



Solar

4% of global electricity



N.B.: il grafico rappresenta i tassi
di **emissioni per ciclo di vita**

i.e. “*dalla culla alla tomba*”

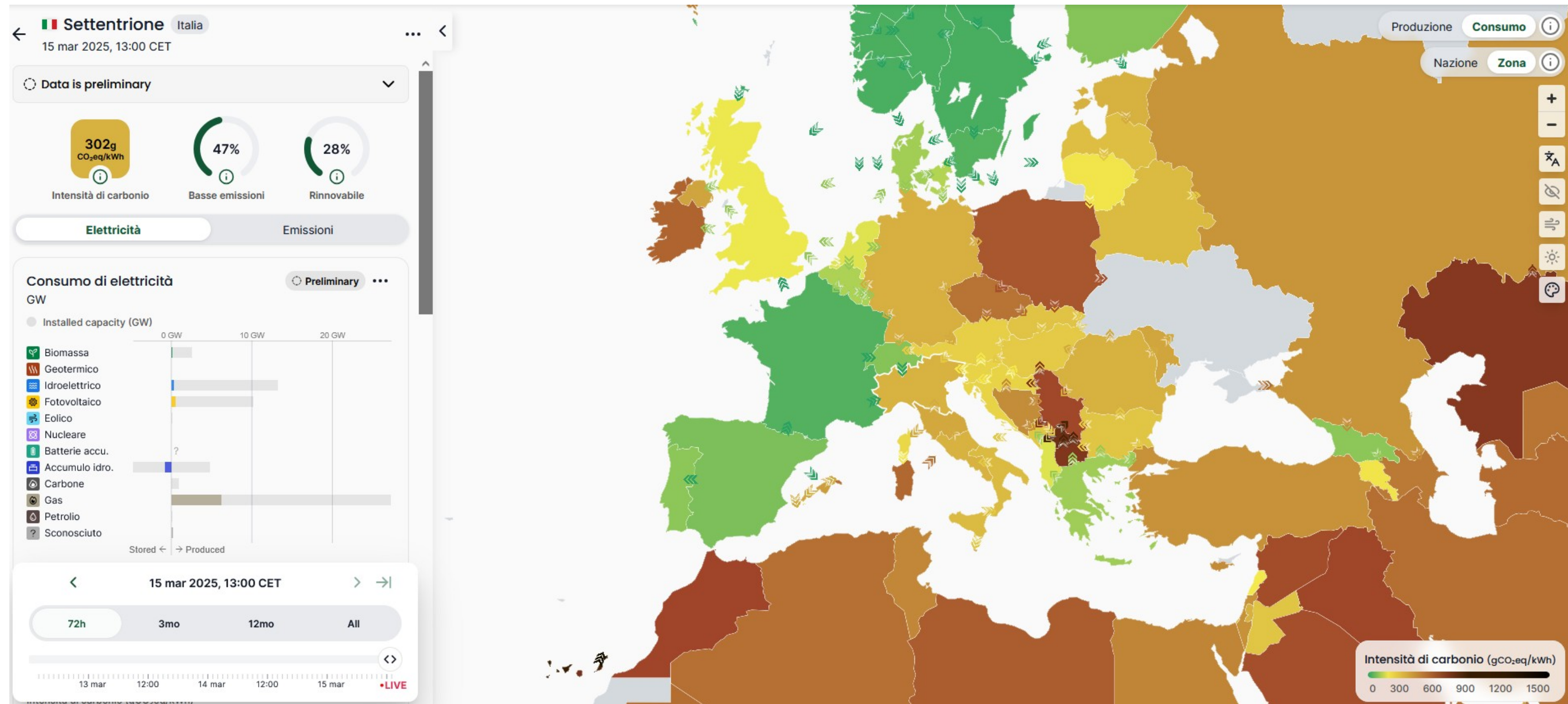
Death rates from fossil fuels and biomass are based on state-of-the art plants with pollution controls in Europe, and are based on older models of the impacts of air pollution on health. This means these death rates are likely to be very conservative. For further discussion, see our article: OurWorldinData.org/safest-sources-of-energy. Electricity shares are given for 2021.
Data sources: Markandya & Wilkinson (2007); UNSCEAR (2008; 2018); Sovacool et al. (2016); IPCC AR5 (2014); UNECE (2022); Ember Energy (2021).

OurWorldinData.org – Research and data to make progress against the world’s largest problems.

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Mix elettrico “a basse emissioni” lo stiamo facendo bene?



<https://app.electricitymaps.com>

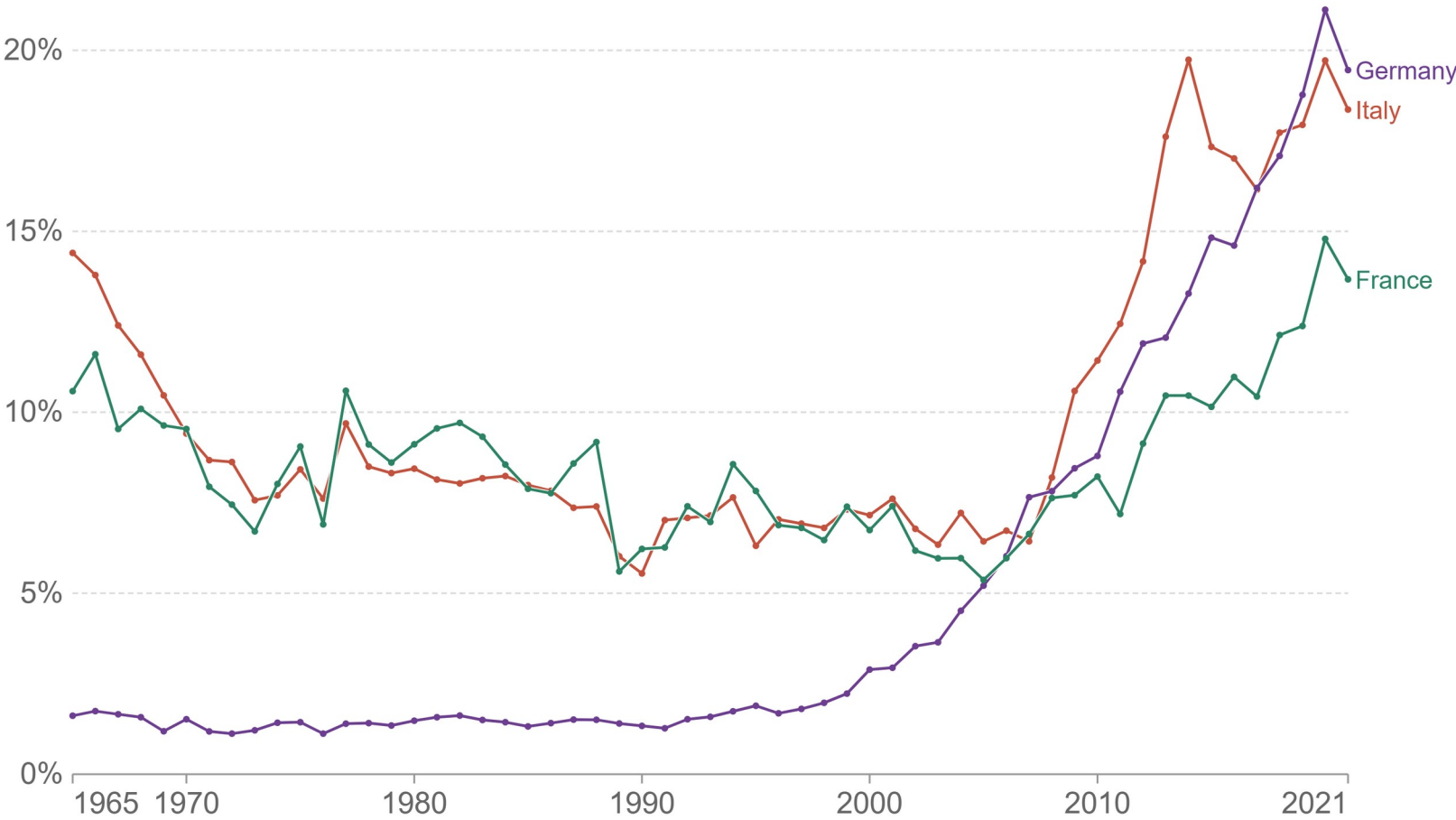


Decarbonizzazione: i fini e i mezzi

Share of primary energy from renewable sources

Renewable energy sources include hydropower, solar, wind, geothermal, bioenergy, wave, and tidal. They don't include traditional biofuels, which can be a key energy source, especially in lower-income settings.

Our World
in Data



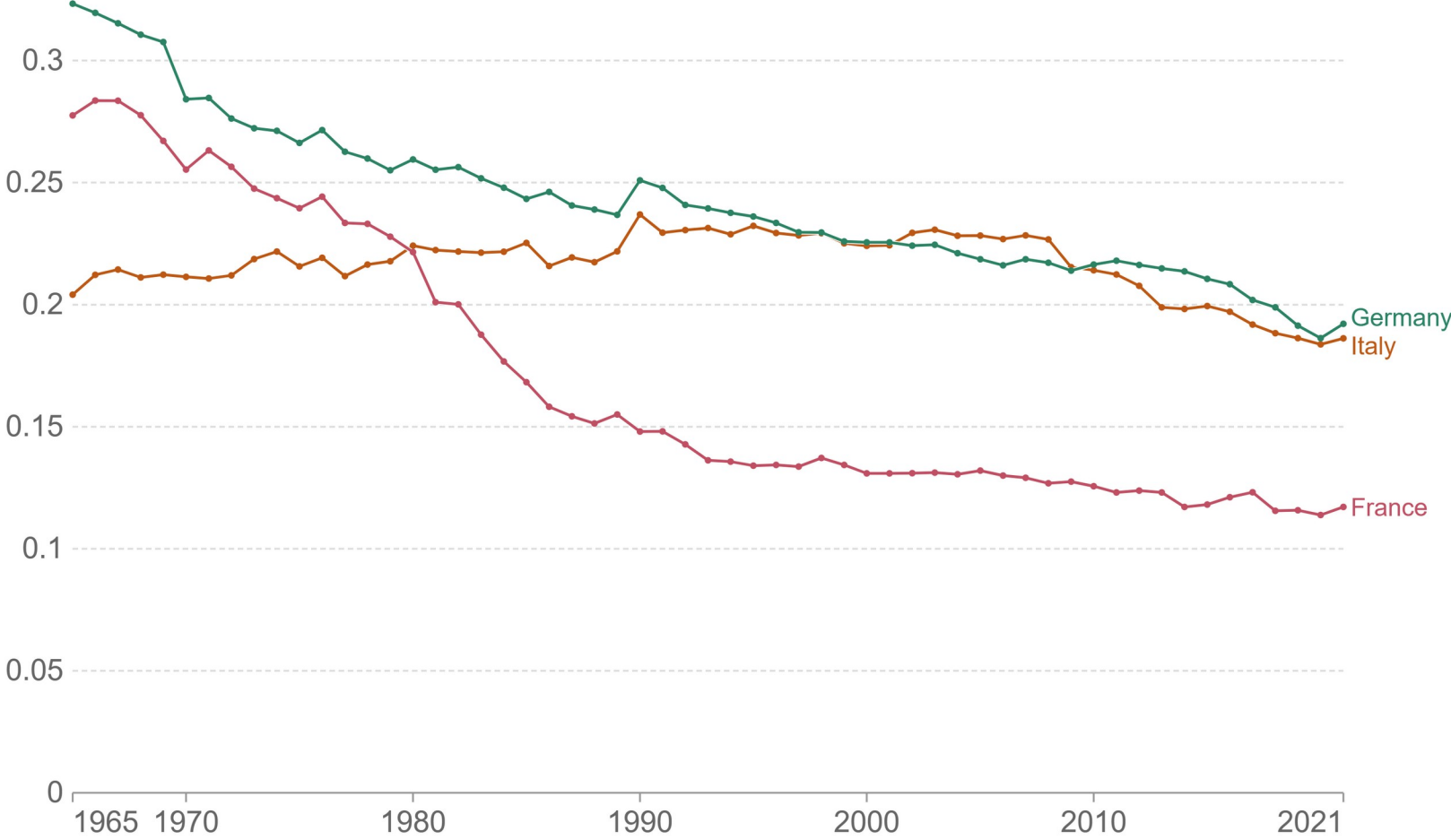
Source: Our World in Data based on BP Statistical Review of World Energy (2022)
Note: Primary energy is calculated using the 'substitution method', which accounts for the energy production inefficiencies of fossil fuels.

OurWorldInData.org/energy • CC BY

Carbon intensity of energy production

This measures the amount of carbon dioxide emitted per unit of energy production. This is measured in kilograms of CO₂ per kilowatt-hour.

Our World
in Data



Source: Our World in Data based on the Global Carbon Project (2022)

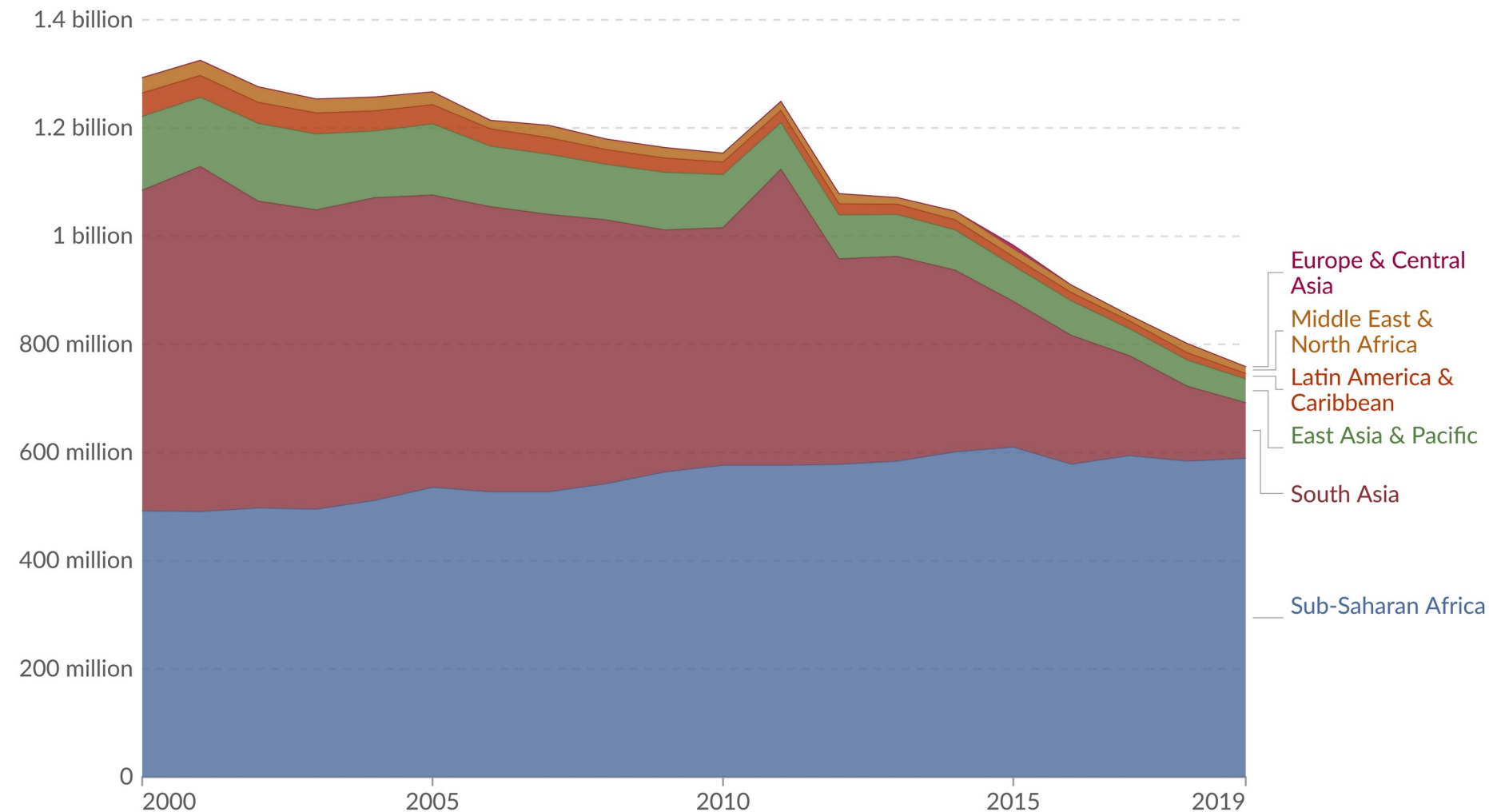
OurWorldInData.org/emissions-drivers • CC BY



Non c'è solo il climate change

Number of people without access to electricity

Having access to electricity is defined in international statistics as having an electricity source that can provide very basic lighting, and charge a phone or power a radio for 4 hours per day.

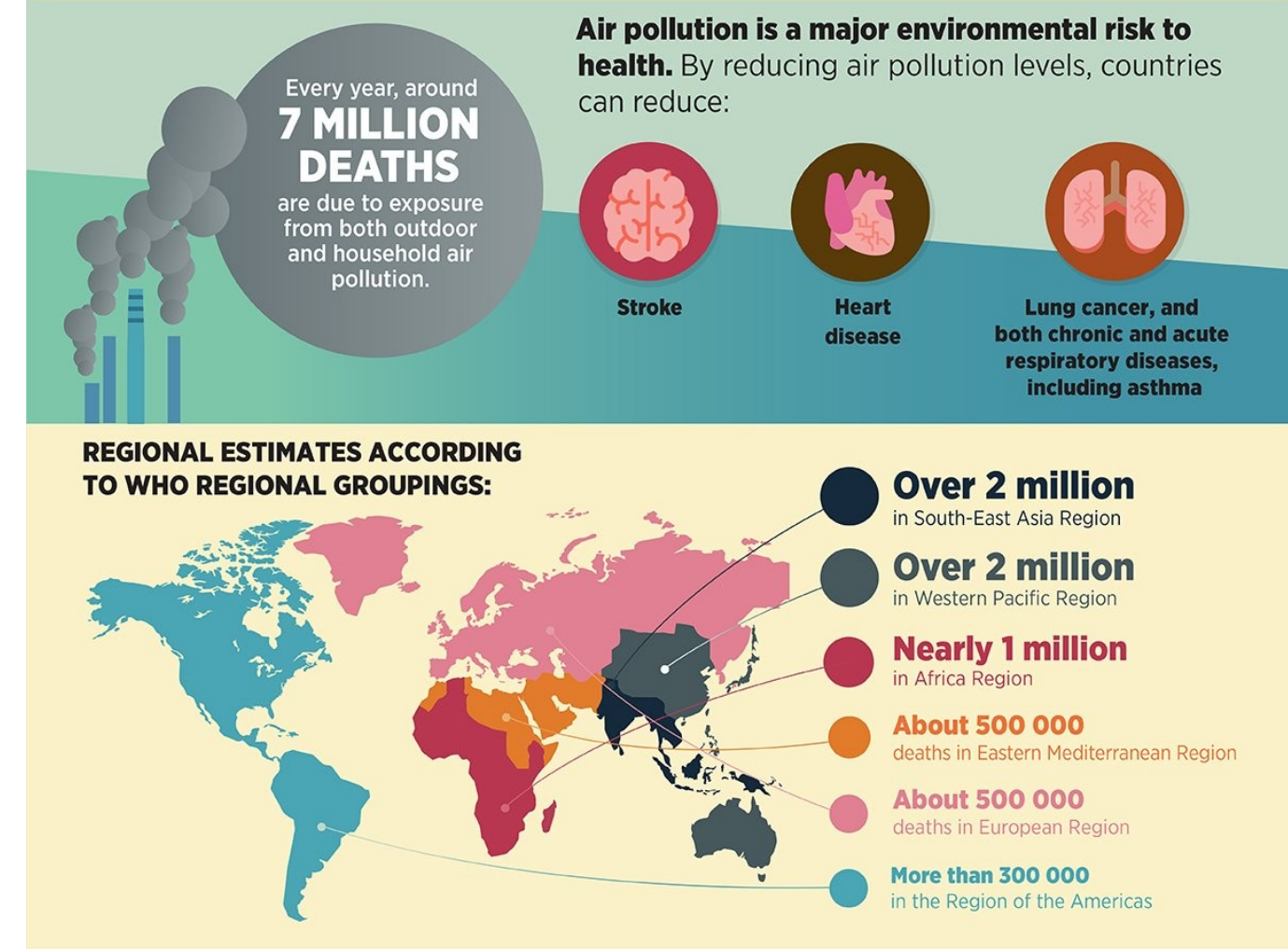


Data source: World Bank

OurWorldinData.org/energy | CC BY

Our World
in Data

AIR POLLUTION – THE SILENT KILLER



CLEAN AIR FOR HEALTH

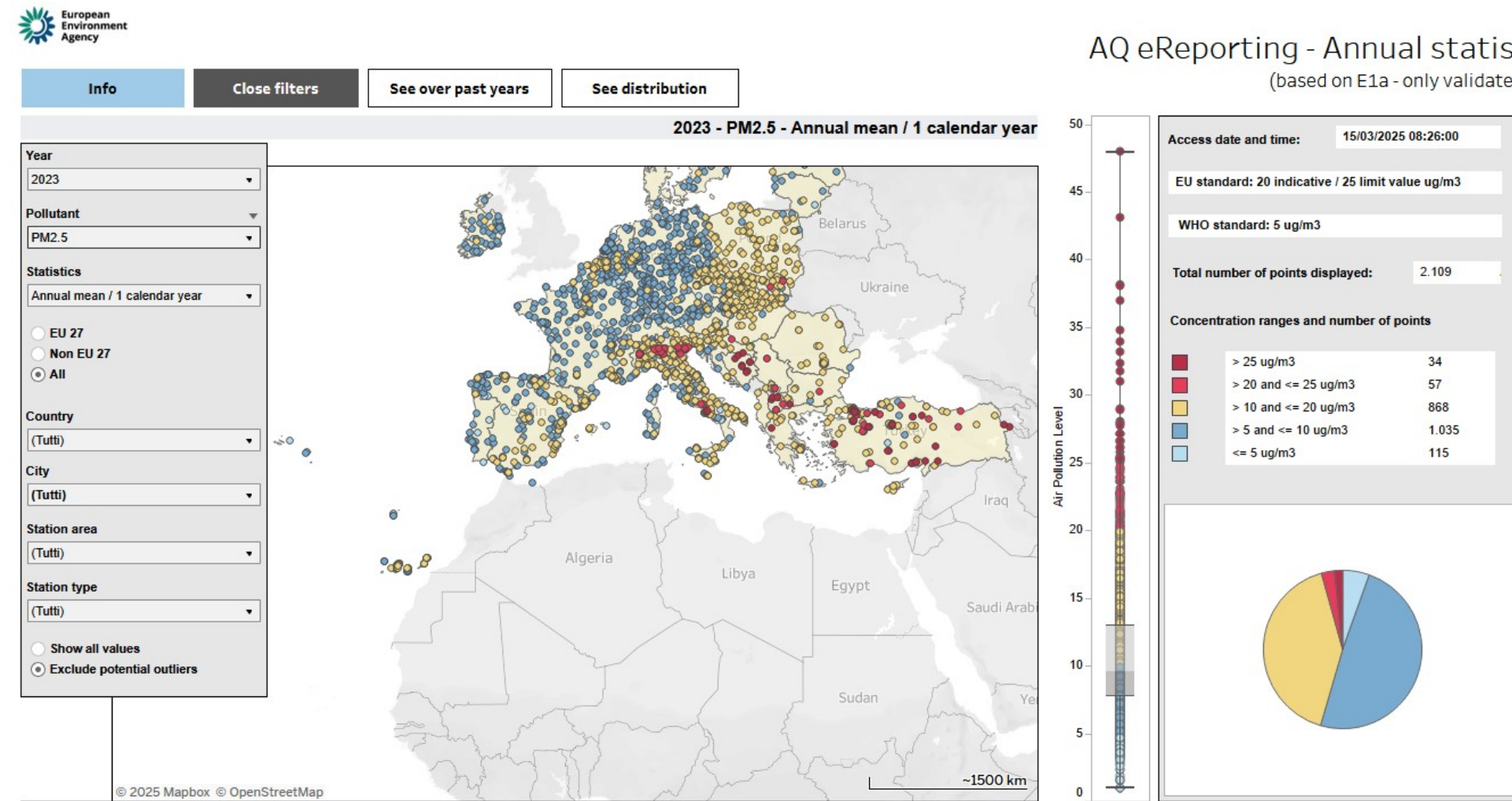
#AirPollution



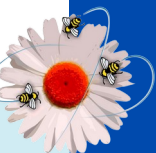
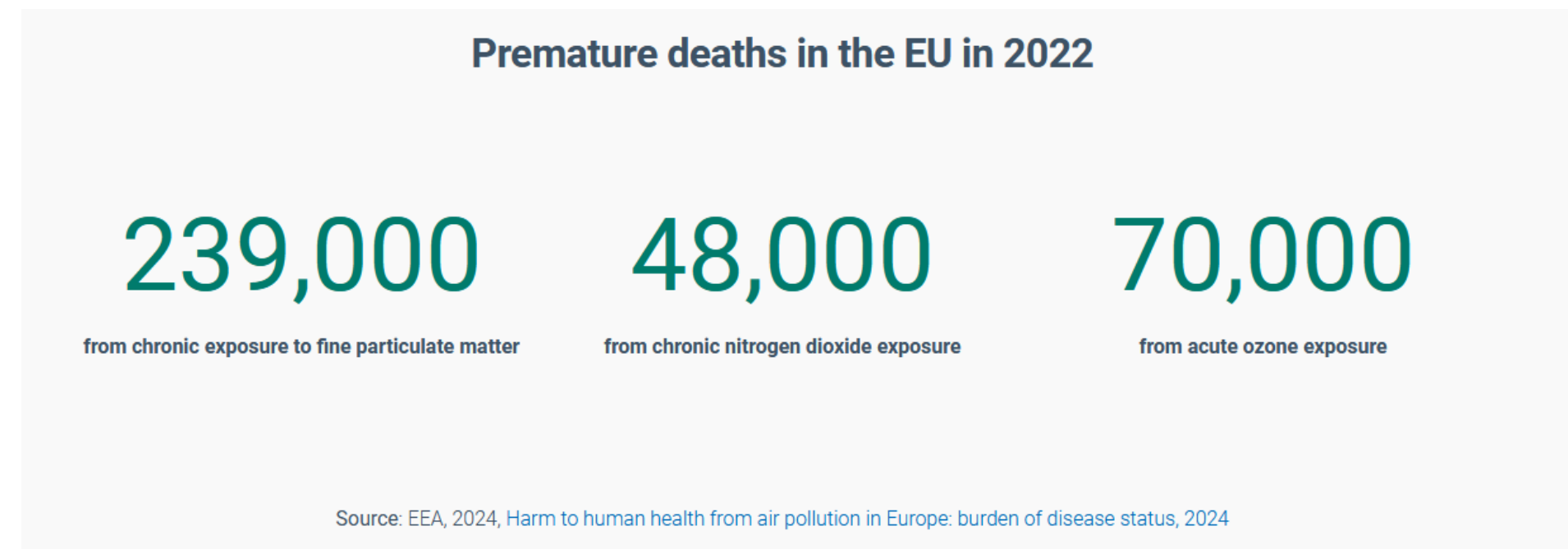
<https://www.iea.org/reports/energy-and-air-pollution>
<https://www.iea.org/reports/energy-access-and-air-pollution>
<https://www.who.int/health-topics/air-pollution>



Non c'è solo il climate change



<https://www.eea.europa.eu/en/topics/in-depth/air-pollution>



Energia rinnovabile o Energia Sostenibile?



OBIETTIVI PER LO SVILUPPO SOSTENIBILE



7 AFFORDABLE AND CLEAN ENERGY



<<Ensure access to affordable, reliable, sustainable and modern energy for all>>



<https://nucleareeragione.org/tassonomia-ue/>



Il nucleare è sostenibile?



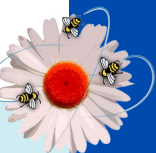
*“L’energia nucleare è uno strumento indispensabile per raggiungere gli obiettivi globali di **sviluppo sostenibile**. Essa riveste un ruolo cruciale nella **decarbonizzazione del settore energetico**, così come nell’**eradicare la povertà, sconfiggere la fame, fornire acqua pulita ed energia a buon mercato, promuovere la crescita economica e l’innovazione industriale**”.*

<https://unece.org/sustainable-energy/publications/nuclear-entry-pathways>

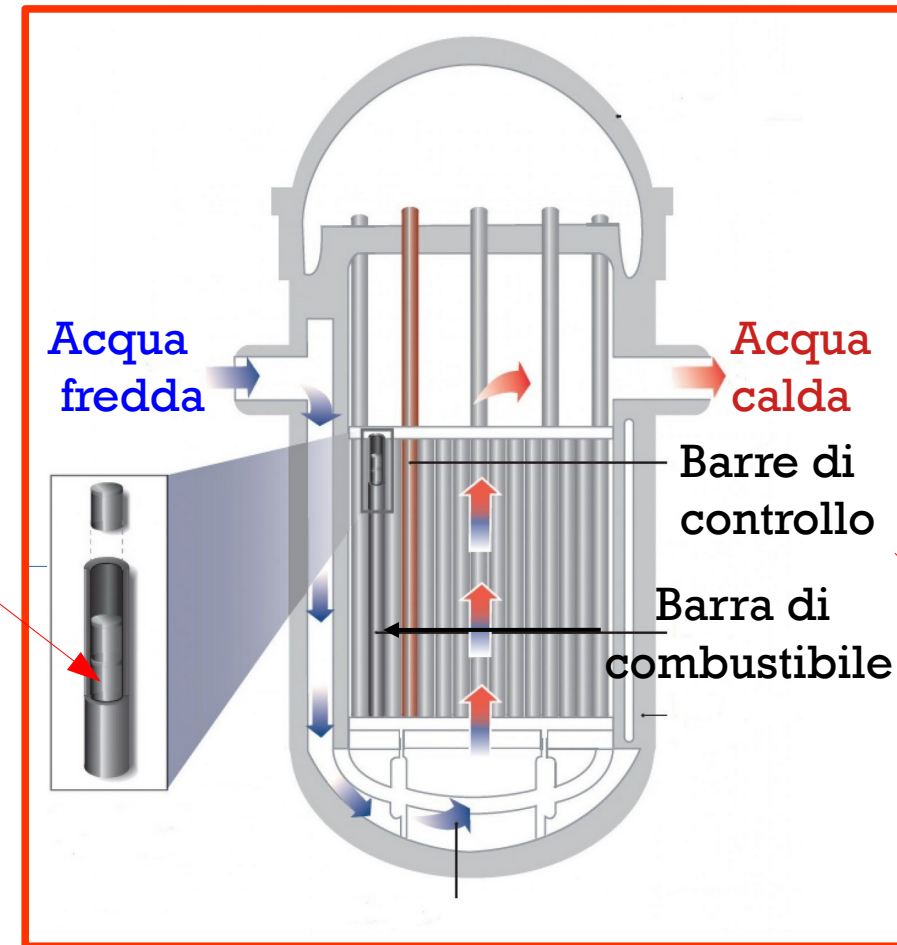
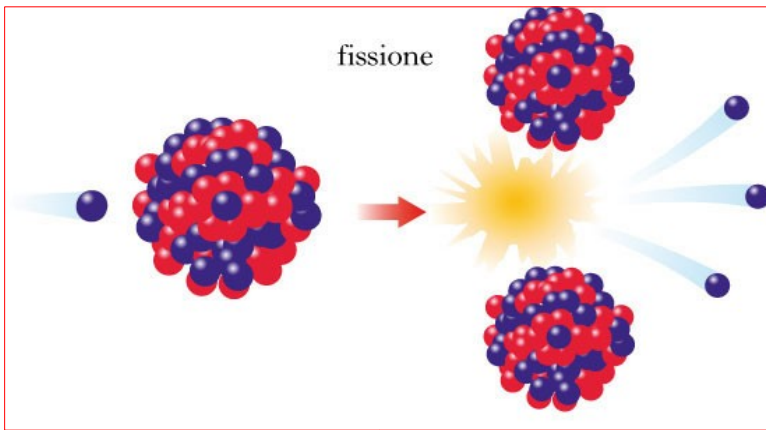


*“Le analisi non rivelano **nessuna evidenza scientifica che l’energia nucleare sia più dannosa per la salute delle persone o per l’ambiente di altre tecnologie di produzione di energia elettrica** già incluse nella tassonomia come attività di mitigazione del cambiamento climatico”*

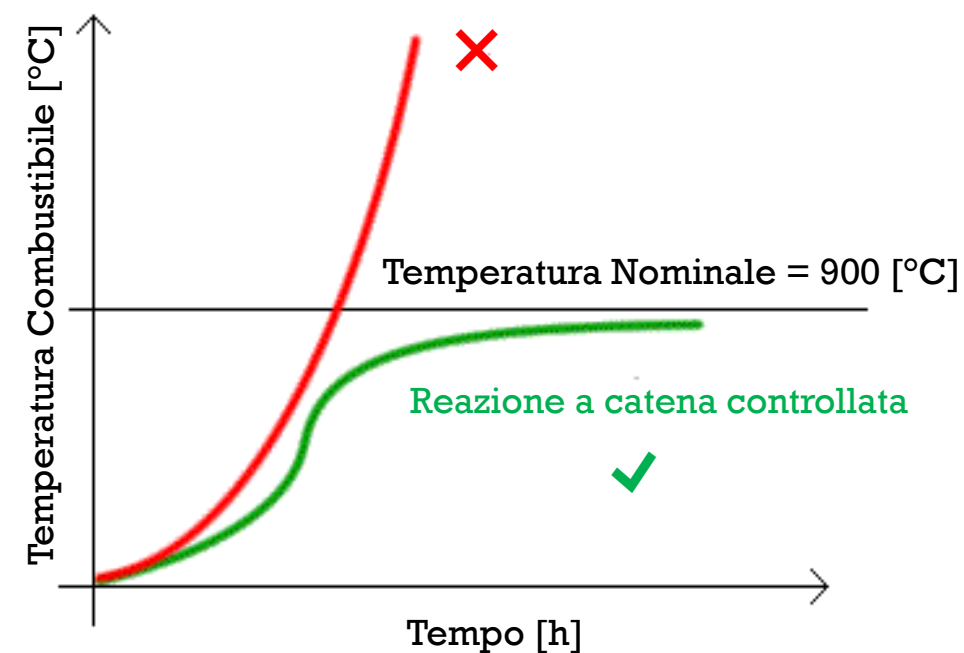
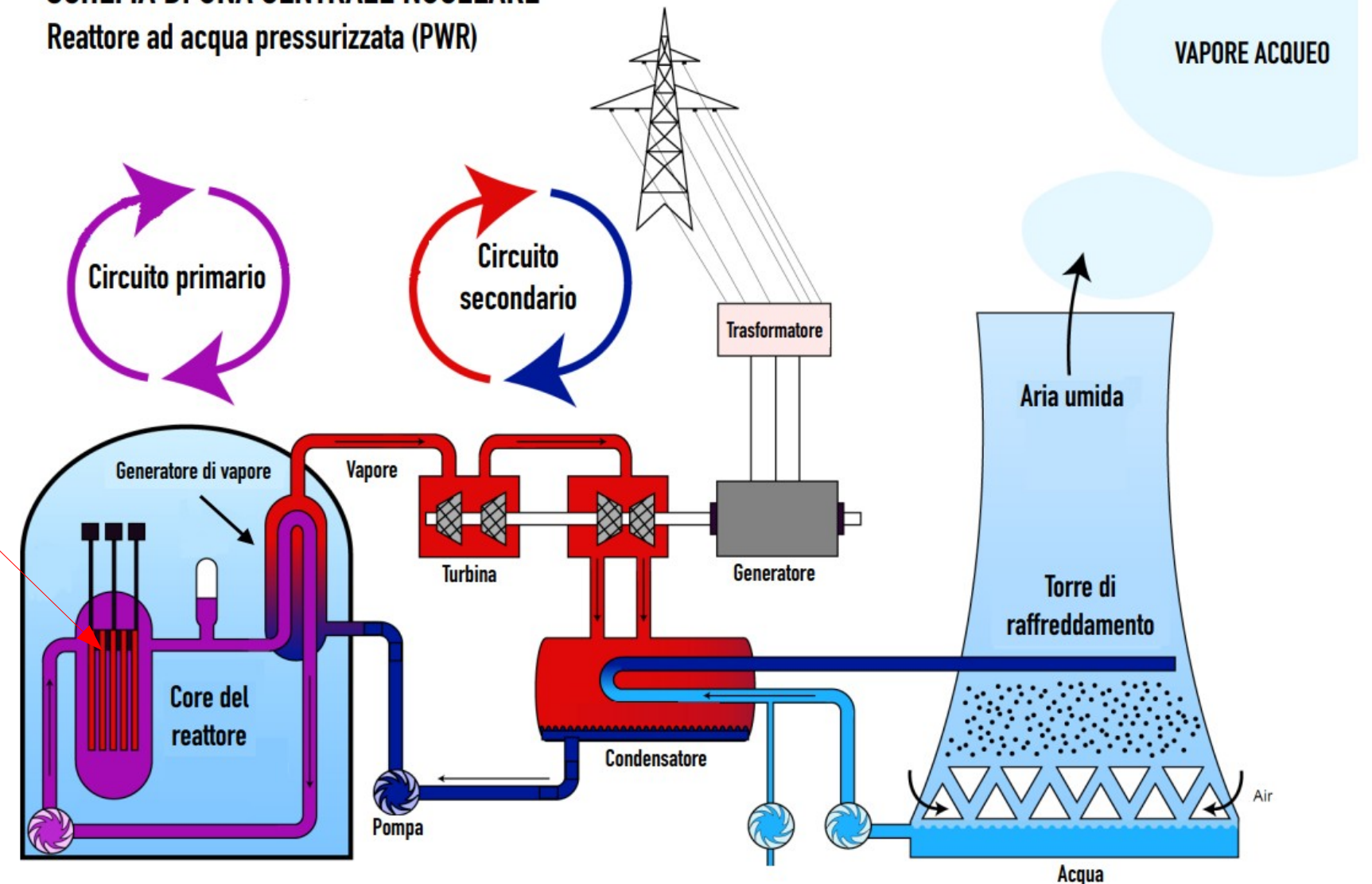
https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/210329-jrc-report-nuclear-energy-assessment_en.pdf
<https://nucleareeragione.org/2024/03/26/lenergia-nucleare-e-il-rapporto-jrc/>



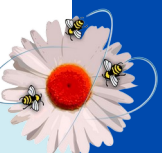
Energia nucleare cosa?



SCHEMA DI UNA CENTRALE NUCLEARE
Reattore ad acqua pressurizzata (PWR)



Il reattore nucleare non è altro
che un sofisticatissimo bollitore



Energia nucleare nel mondo

Status Reattori (febbraio 2025)

In attività: **416 in 31 Paesi**

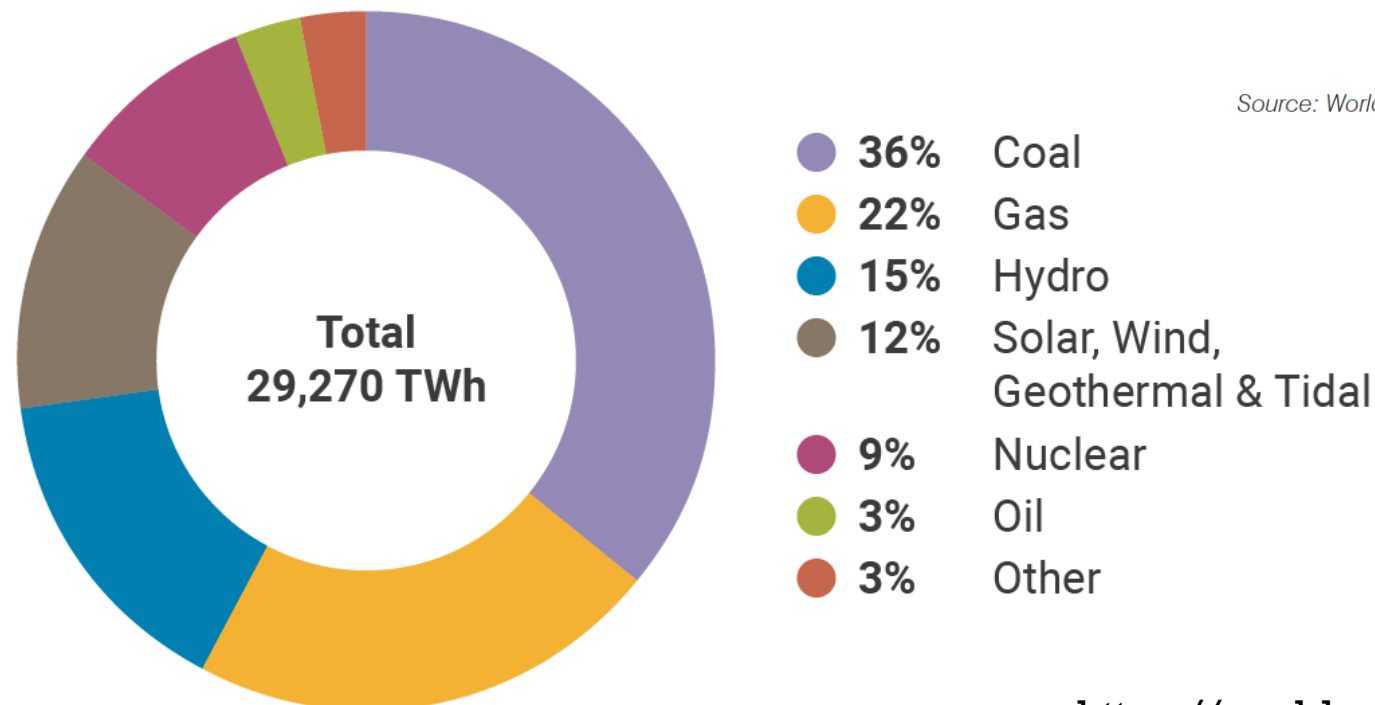
Sospesi: 23

In costruzione: **65 in 15 Paesi**

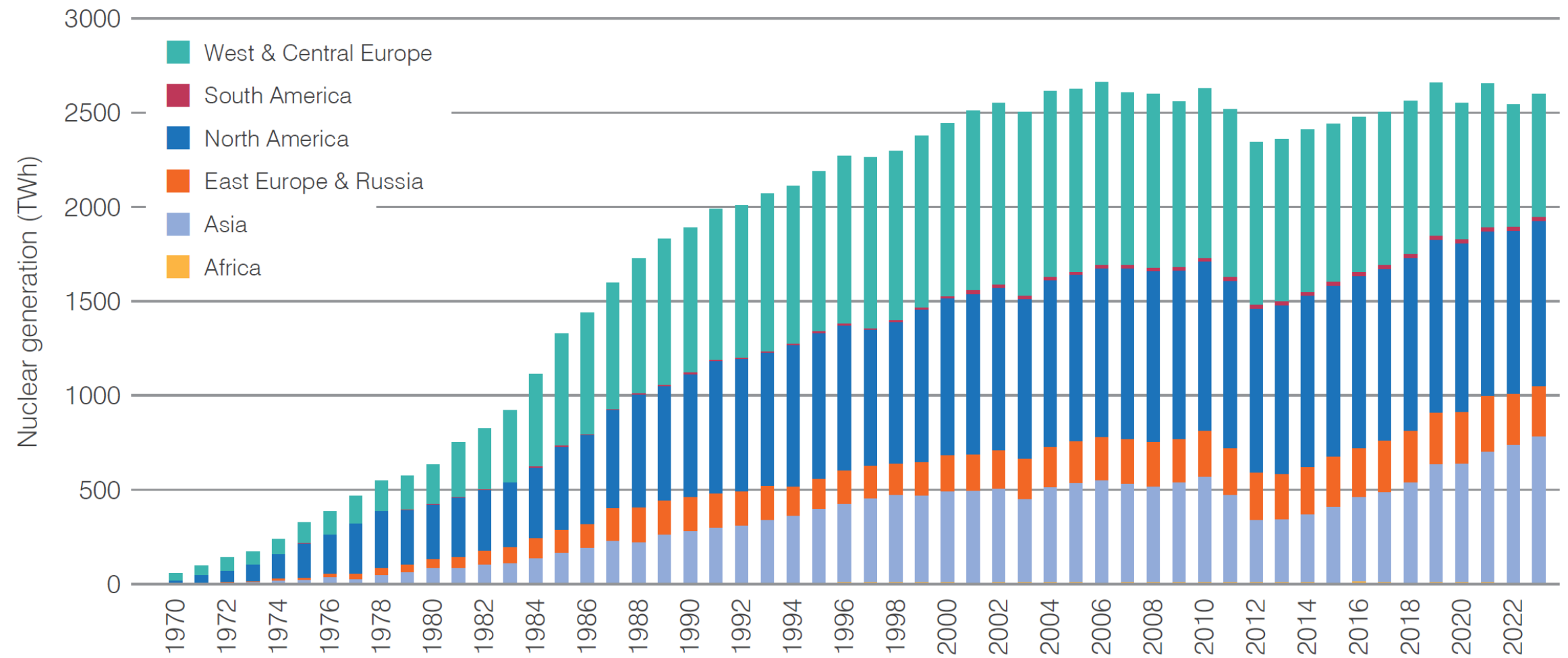
Pianificati: **86 in 16 Paesi**

Proposti: **344 in 27 Paesi**

(di cui nuovi arrivati: Ghana, Kazakhstan, Polonia, Arabia Saudita, Uzbekistan)



Source: IEA



Source: World Nuclear Association and IAEA Power Reactor Information Service (PRIS)

<https://world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx>
<https://world-nuclear.org/information-library/facts-and-figures/world-nuclear-power-reactors-and-uranium-requireme.aspx>



Perchè l'energia nucleare può essere (parte del)la soluzione?

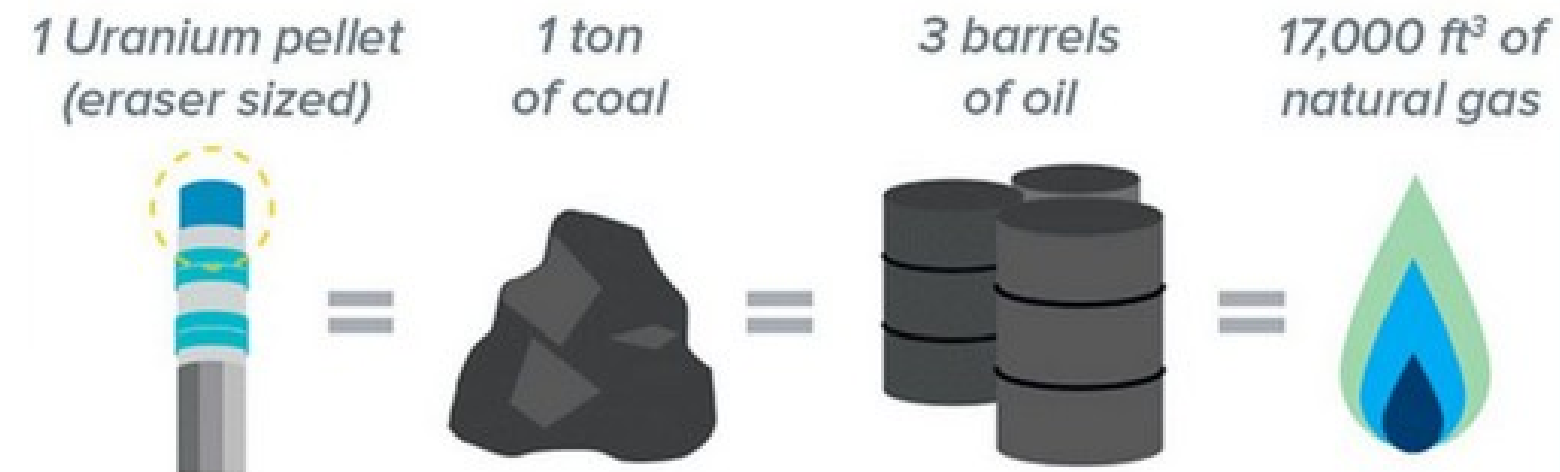
1) No emissione di gas serra o altri inquinanti



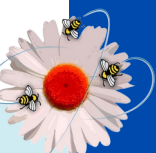
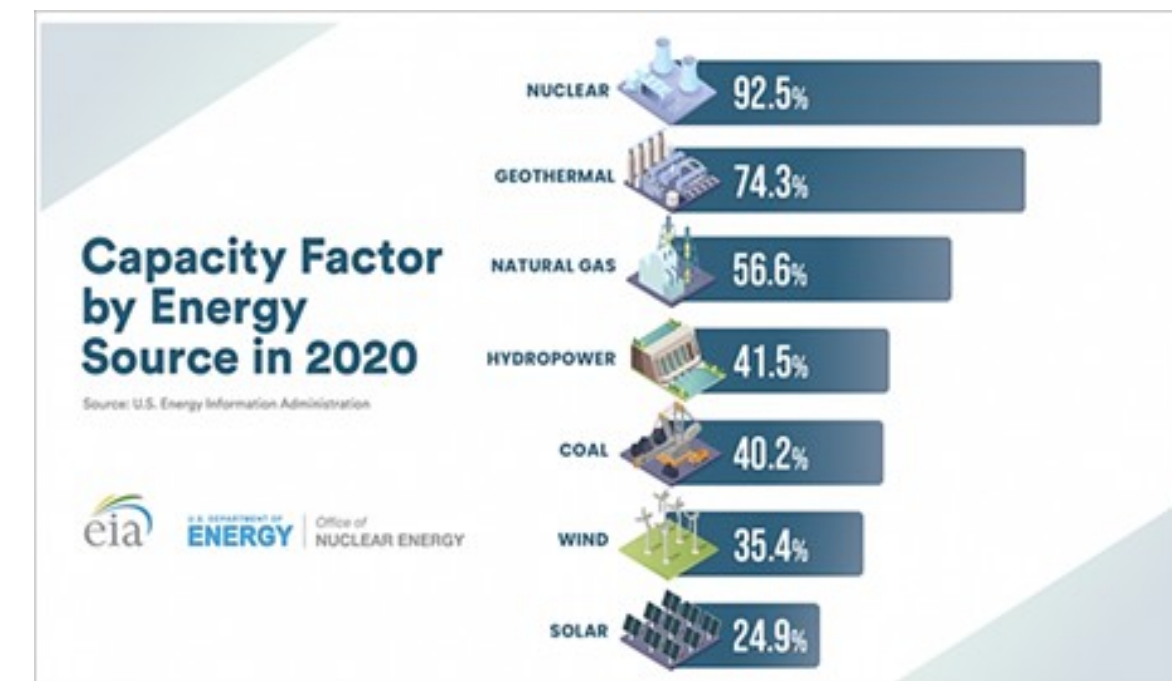
2) Basso impatto ambientale (materiali, suolo, acqua...)



3) Elevata densità energetica



4) Produzione costante



La falsa dicotomia



Primo pannello solare al silicio:
Bell Labs., 1954

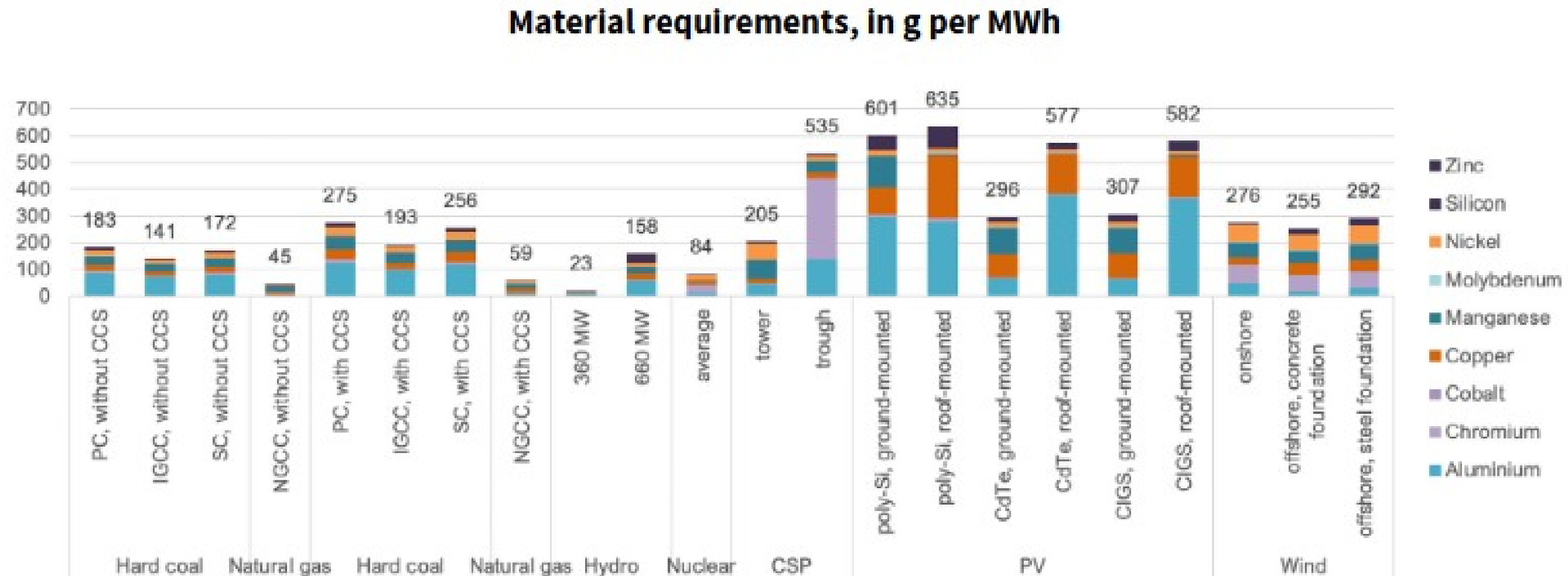


Prima centrale nucleare ad essere
connessa alla rete elettrica:
Obninsk, Unione Sovietica, 1954



Impatto ambientale - 1

Figure 46 Lifecycle requirements of select materials for electricity technologies, in g per MWh.

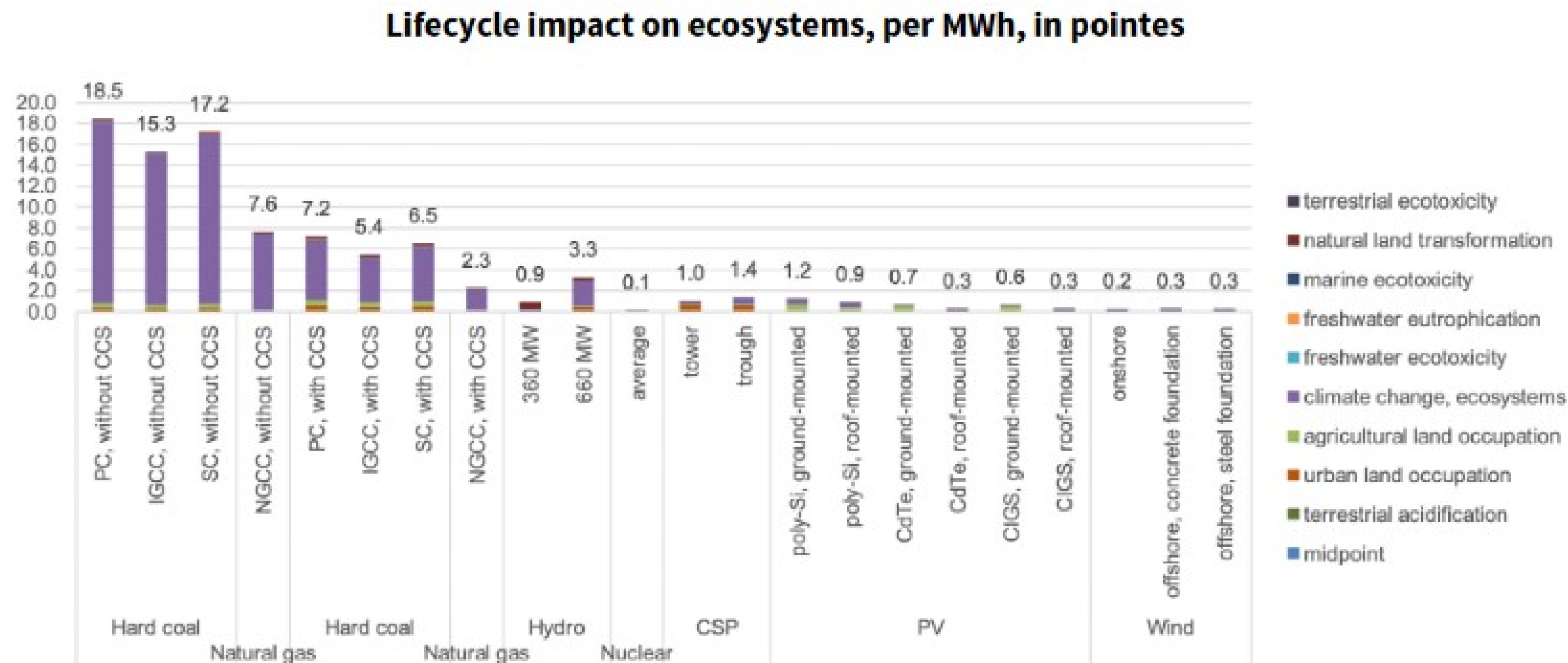


https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf



Impatto ambientale - 2

Figure 48 Lifecycle impacts on ecosystems, in points, including climate change.
Note on unit: 1 point is equivalent to the impacts (in species-year) of 1 person (globally) over one year.



https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf

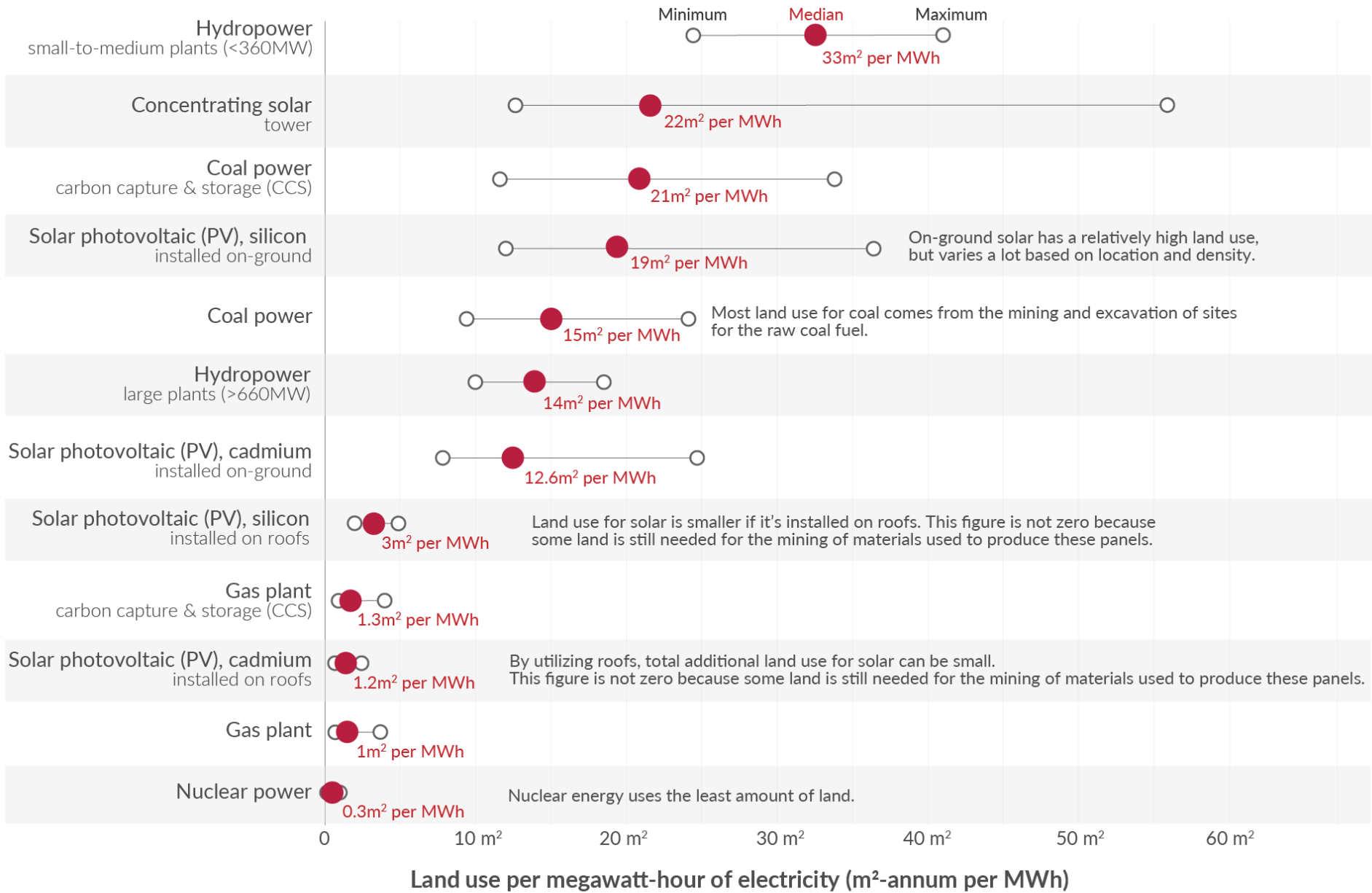


Impatto ambientale - 3

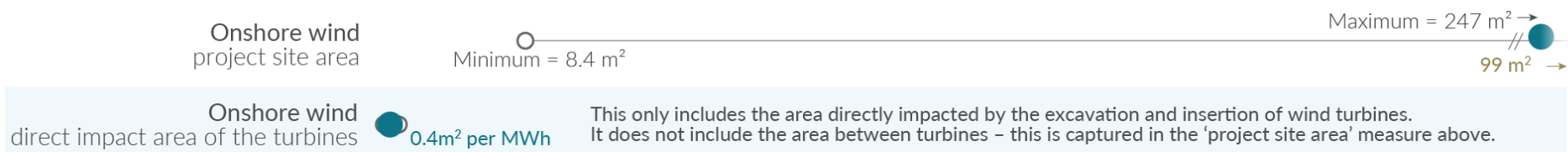
Land use of energy sources per unit of electricity

Our World
in Data

Land use is based on life-cycle assessment; this means it does not only account for the land of the energy plant itself but also land used for the mining of materials used for its construction, fuel inputs, decommissioning, and the handling of waste.



The land use of onshore wind can be measured in several ways, and is distinctly different from land use of other energy technologies. Land between wind turbines can be used for other purposes (such as farming), which is not the case for other energy sources. The spacing of turbines, and the context of the site means land use is highly variable.



Note Capacity factors are taken into account for each technology which adjusts for intermittency. Land use of energy storage is not included since the quantity of storage depends on the composition of the electricity mix.
Source: UNECE (2021). Lifecycle Assessment of Electricity Generation Options. United Nations Economic Commission for Europe for all data except wind. Wind land use calculated by the author.
See OurWorldinData.org/land-use-per-energy-source for more research on this topic. Licensed under CC-BY by the author Hannah Ritchie.



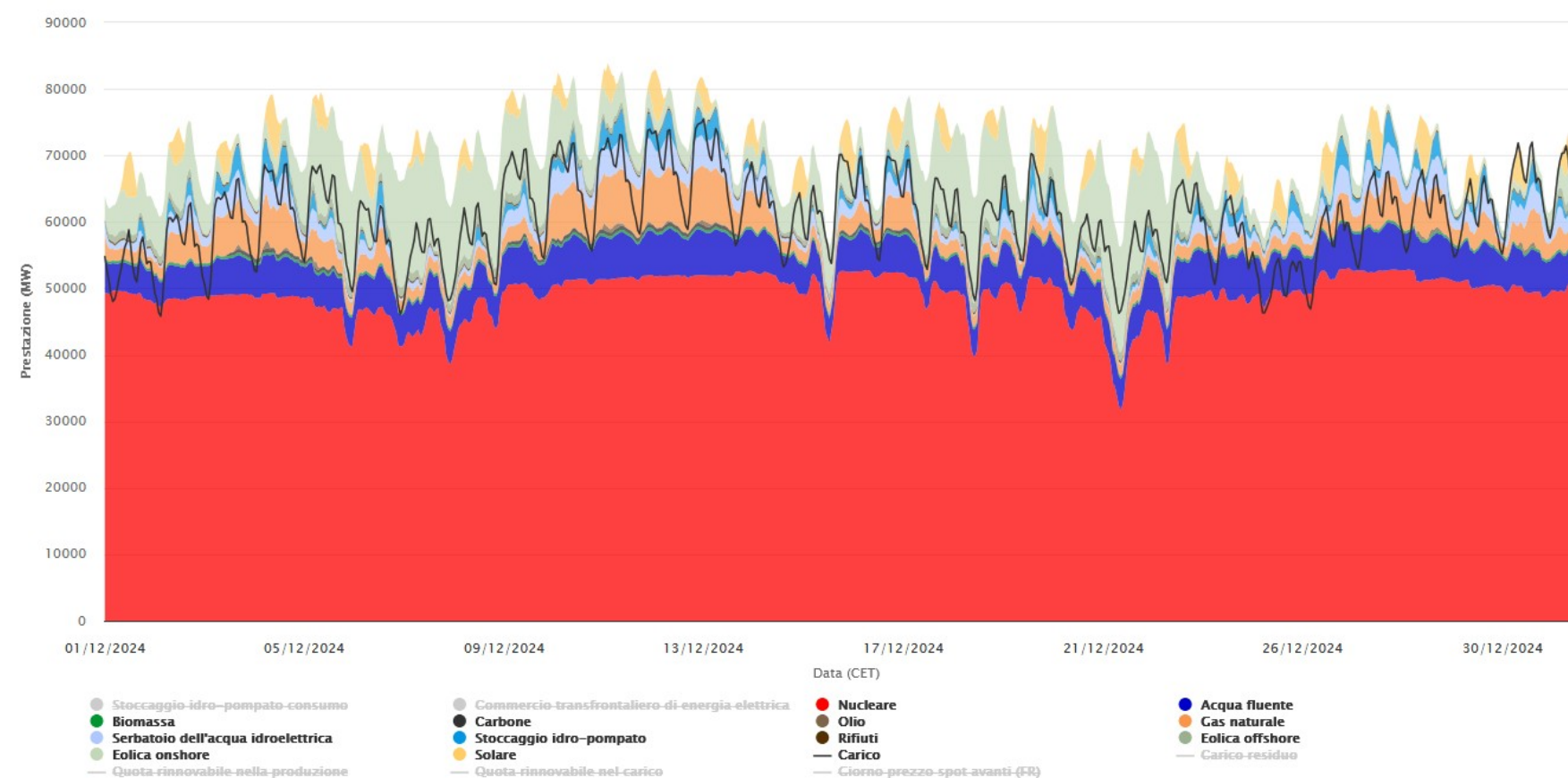
Alla ricerca del giusto mix

Francia

Una produzione di baseload basata su una fonti affidabile (il nucleare), che garantisce un output costante. Lunghi periodi di sovra-produzione e relativa esportazione di elettricità

Produzione pubblica netta di energia elettrica in Francia in Dicembre 2024

Dati originali ENTSO-E

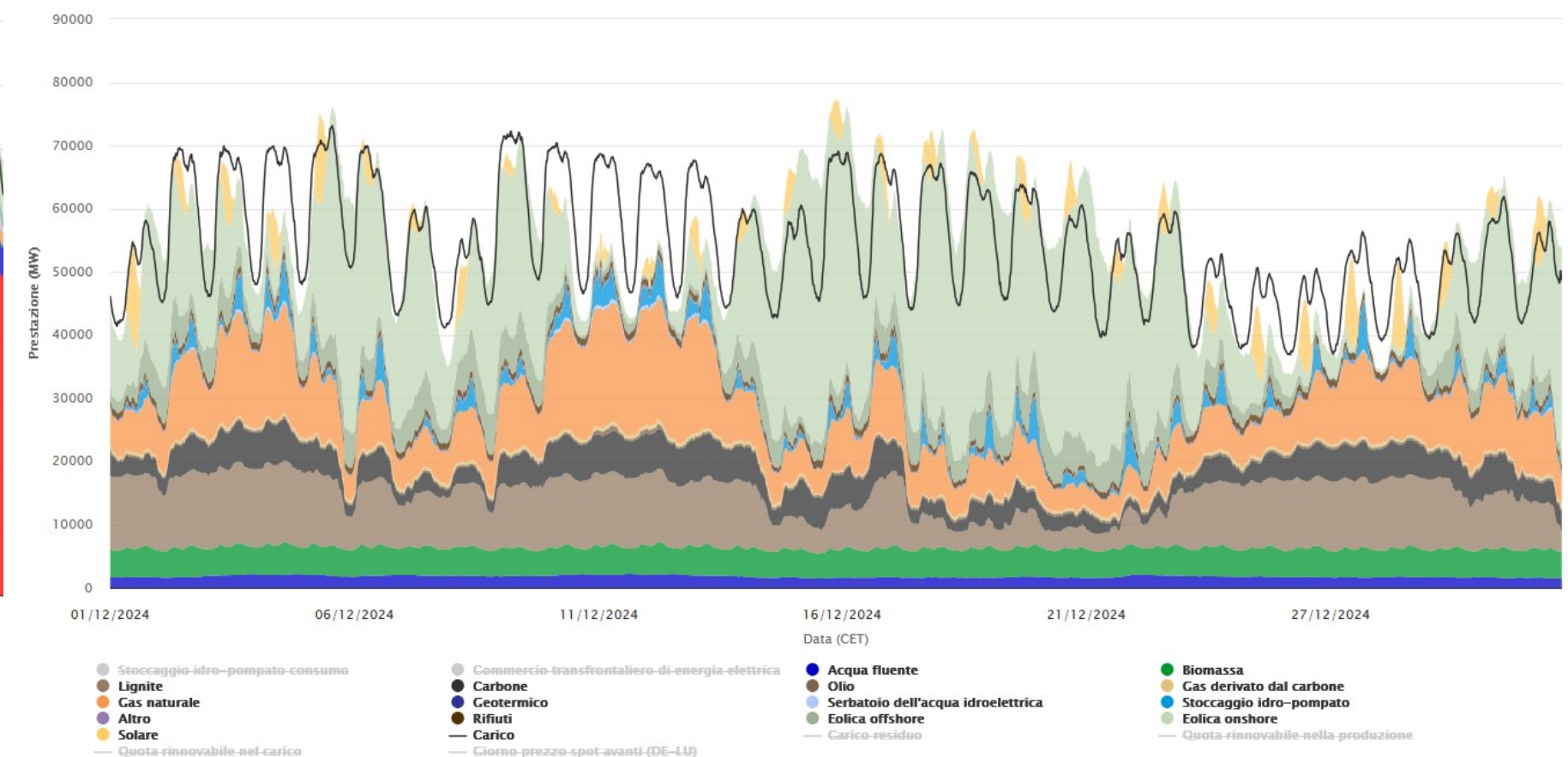


Germania

La grande variabilità delle fonti rinnovabili è compensata dal gas e dall'import/export. Una dipendenza ancora marcata dal carbone

Produzione pubblica netta di energia elettrica in Germania in Dicembre 2024

Valori corretti energeticamente



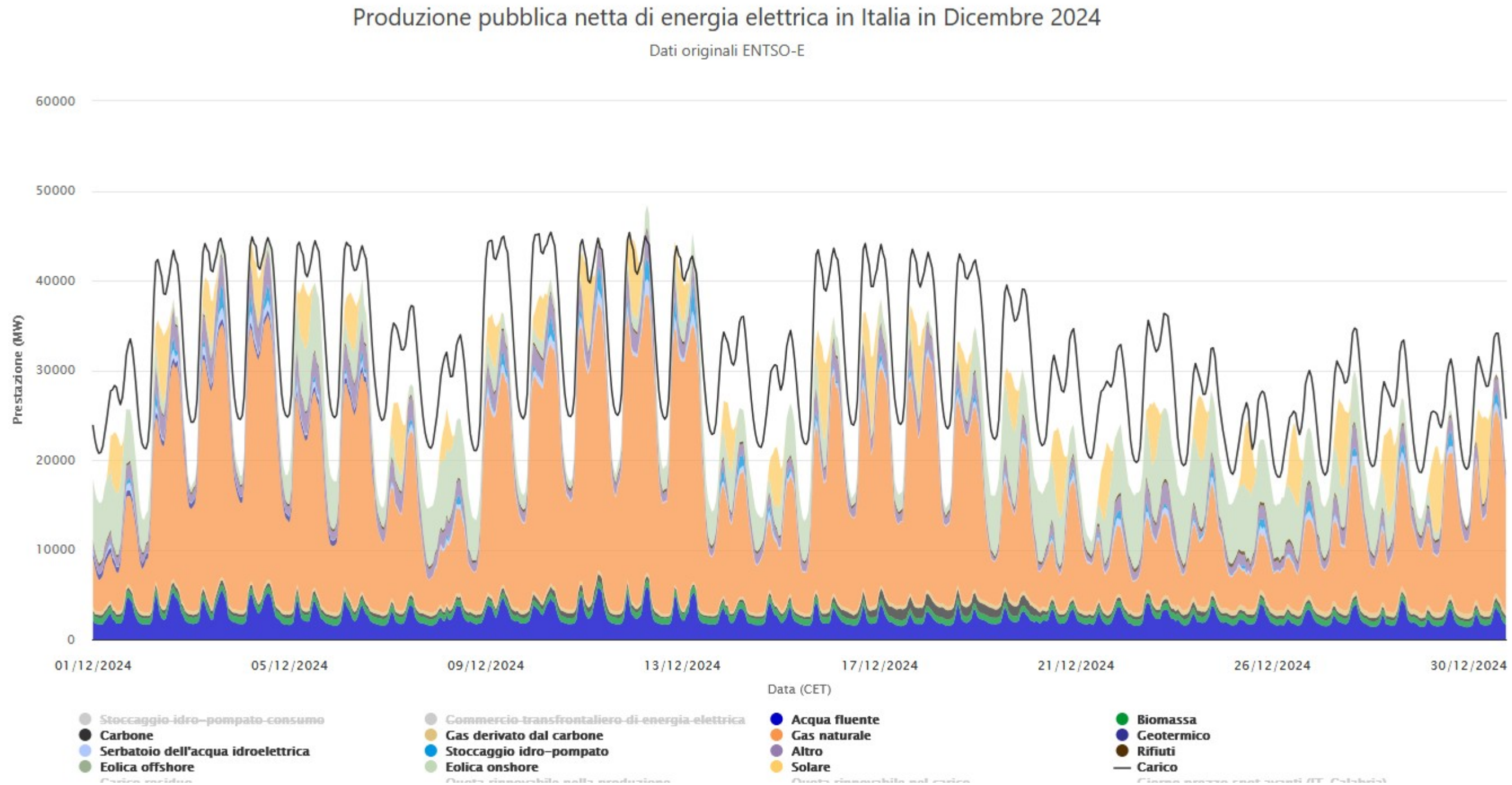
<https://www.energy-charts.info>



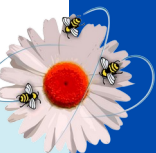
Alla ricerca del giusto mix

Italia

Una parte rilevante del fabbisogno è garantito dalle importazioni (ovvero ANCHE dall'energia nucleare prodotta nei paesi limitrofi). Forte dipendenza dal gas.



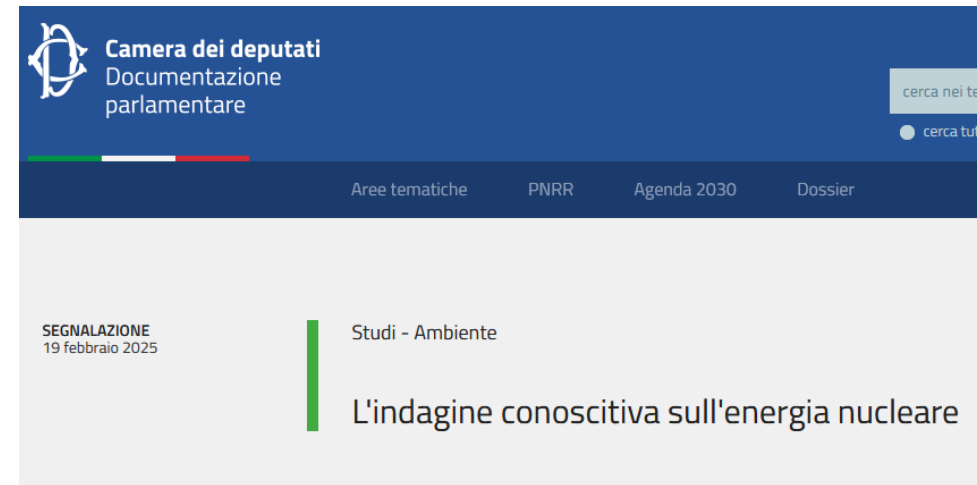
<https://www.energy-charts.info>



Italia: eppur si muove?



Audizioni parlamentari e indagini conoscitive



INDAGINE CONOSCITIVA

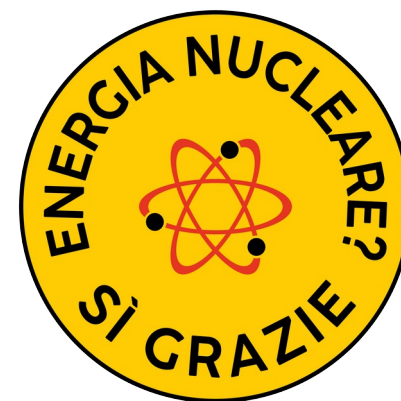
sul ruolo dell'energia nucleare nella transizione energetica e nel processo di decarbonizzazione

https://temi.camera.it/leg19/post/OCD15_15063/l-indagine-conoscitiva-sull-energia-nucleare.html

Walter Ambrosini – Docente di Impianti Nucleari, Università di Pisa
Giuseppe Benedetto – Presidente della Fondazione Luigi Einaudi
Carlo Calenda – Segretario di Azione
Piercamillo Falasca – Direttore de L'Europeista
Patrizia Feletig – Giornalista e saggista
Davide Giacalone – Direttore de La Ragione, Vicepresidente Fondazione Luigi Einaudi
Matteo Hallissey – Segretario di Radicali Italiani
Stefano Monti – Presidente di Associazione Italiana Nucleare
Aurora Pinto – Content Creator Giovani Blu (e socia del Comitato Nucleare e Ragione)
Marco Ricotti – Docente di Impianti Nucleari, Politecnico di Milano
Nora Brigid Righini – Studentessa, Comitato Nazionale di Radicali Italiani
Luca Romano – Fisico, divulgatore scientifico, L'Avvocato dell'Atomo
Chicco Testa – Dirigente d'azienda, giornalista e saggista
Monica Tommasi – Presidente degli Amici della Terra
Pierluigi Totaro – Presidente del Comitato Nucleare e Ragione
Giuseppe Zollino – Docente di Tecnica ed Economia dell'Energia e Impianti Nucleari responsabile Energia e Ambiente di Azione

<https://firmereferendum.giustizia.it/referendum/open/dettaglio-open/1500004>

Proposta di legge di iniziativa popolare



72840 firme

MASE: Piattaforma Nazionale per il Nucleare Sostenibile



Home / Comunicati Stampa / Al MASE la prima riunione della Piattaforma Nazionale per un Nucleare Sostenibile

Al MASE la prima riunione della Piattaforma Nazionale per un Nucleare Sostenibile



Il Ministro Pichetto: "Valutare nuove tecnologie sicure del nucleare innovativo come Small Modular Reactor (SMR) e reattori nucleari di quarta generazione (AMR)."

Roma, 21 settembre - Si è svolta oggi al Ministero dell'ambiente e della sicurezza energetica la prima riunione della **Piattaforma Nazionale per un Nucleare Sostenibile (PNNS)**. L'incontro, presieduto dal Ministro Gilberto Pichetto Fratin, ha visto la partecipazione dei principali Enti pubblici di ricerca, di esponenti del mondo delle Università, di associazioni scientifiche, di soggetti pubblici operanti nel settore della sicurezza nucleare e del decommissioning, nonché di imprese che hanno già in essere programmi di investimento nel settore nucleare, nella produzione di componenti e impianti e nelle applicazioni mediche nel settore nucleare.

DDL Delega approvato dal CdM 28/2/2025



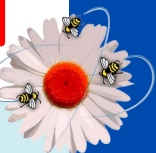
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Nucleare sostenibile: MASE, il Consiglio dei Ministri approva la delega

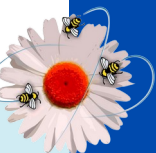
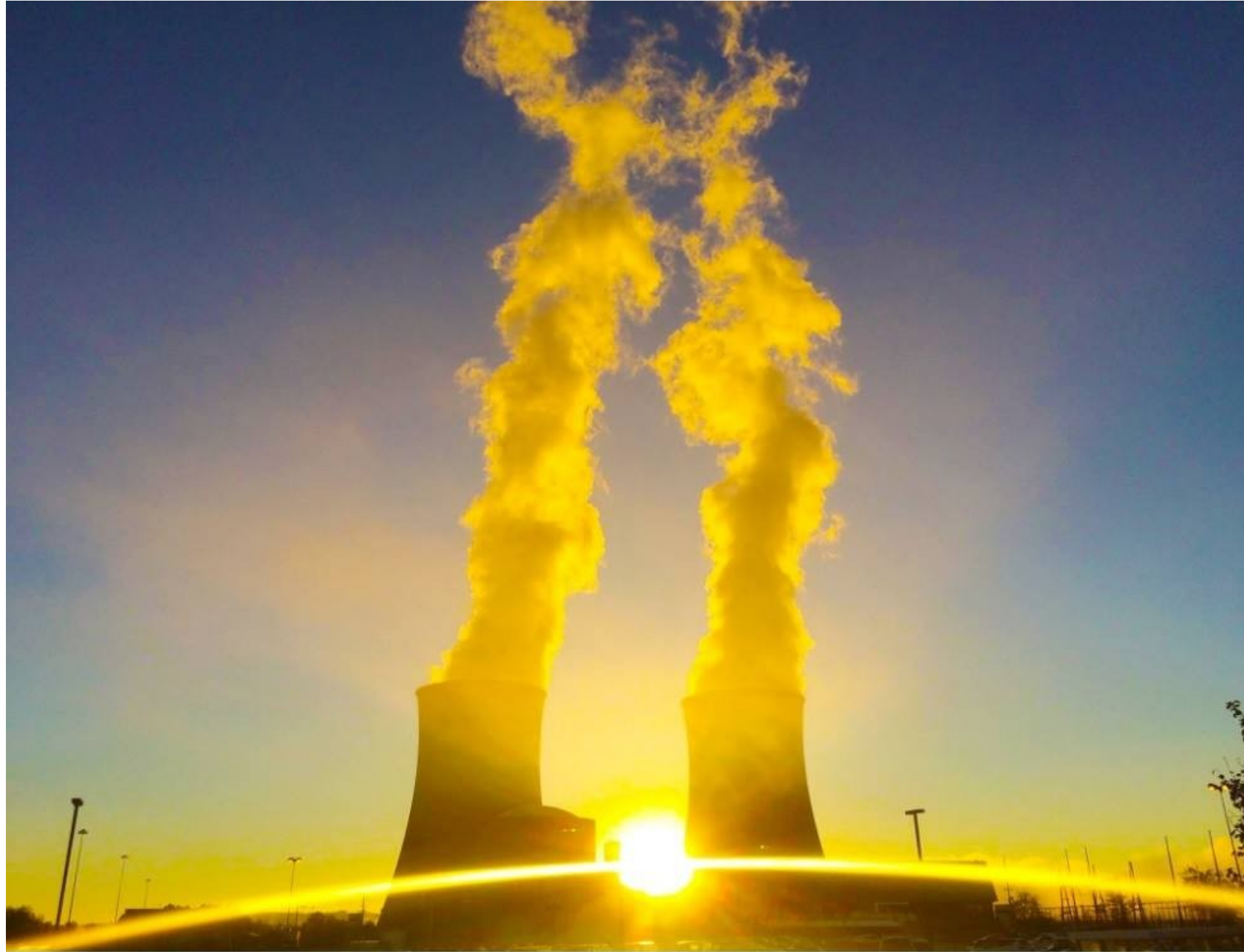


Obiettivo disciplinare la produzione di energia attraverso i nuovi moduli, lo smantellamento delle vecchie centrali, la gestione di rifiuti e combustibile esaurito, ricerca e sviluppo su energia da fusione, riorganizzazione competenze e funzioni. Il ministro Pichetto: "Così l'Italia pronta ad affrontare le sfide del futuro".

Roma, 28 febbraio - Su proposta del Ministro Gilberto Pichetto, il Consiglio dei Ministri ha approvato un disegno di legge per conferire una delega all'Esecutivo sul nuovo nucleare sostenibile. «Con il nucleare di ultima generazione insieme alle rinnovabili - spiega il ministro Pichetto - saremo



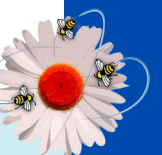
Una nuova alba per l'energia nucleare?



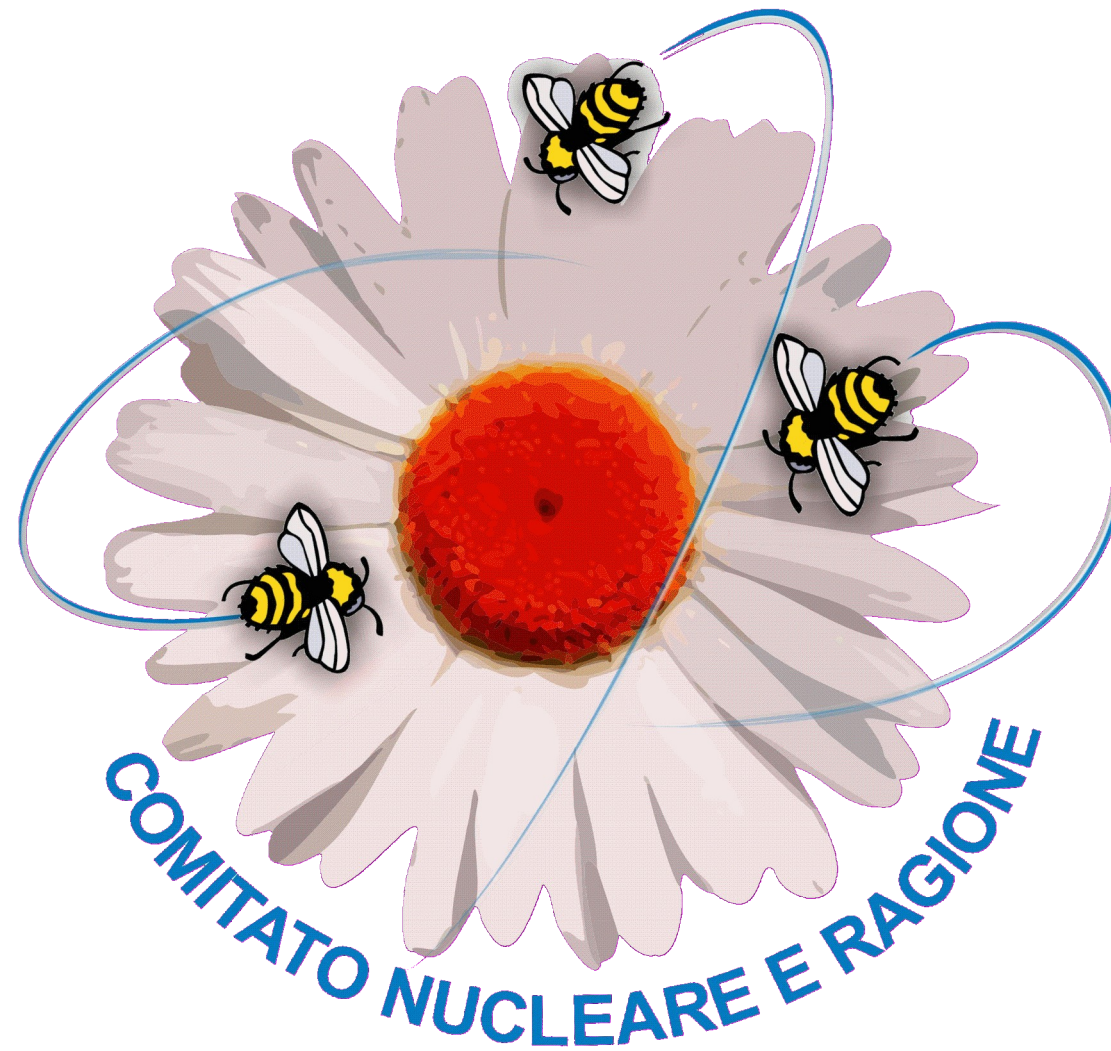
L'ostacolo culturale



La sfida culturale



Grazie!



<https://nucleareeragione.org>
info@nucleareeragione.org

