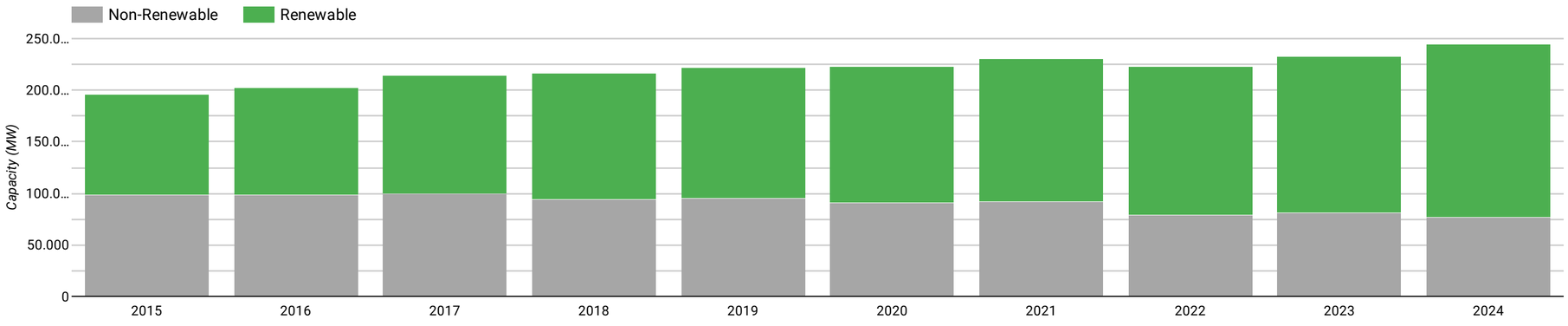
Installed generation capacity (2015-2024)

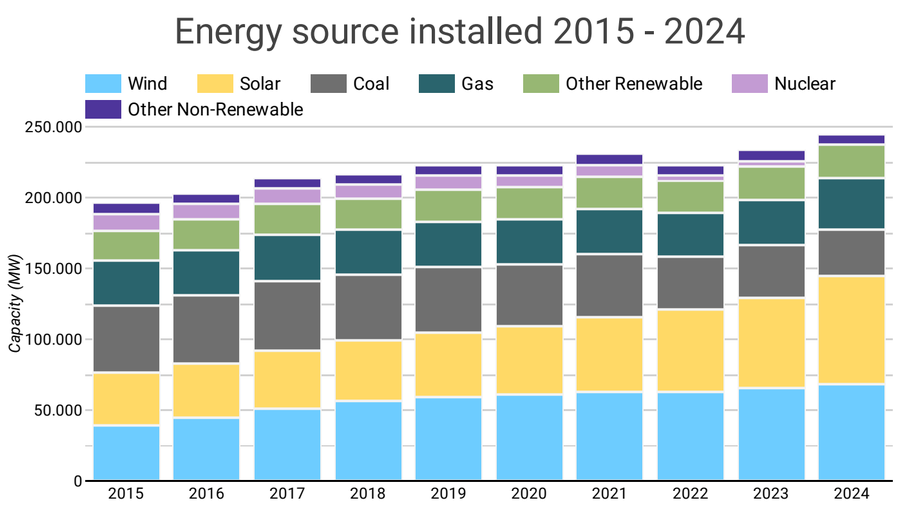
Installed capacity refers to the maximum ability of a plant to produce energy (MW). In the period considered, with data recorded every 1st January, the installed generation capacity *increased* from 200.000 MW to 270.000MW. It is interesting to note that, during the period analyzed, there was a gradual reduction in nuclear energy production, culminating in its *complete shutdown* on 15 April 2023.

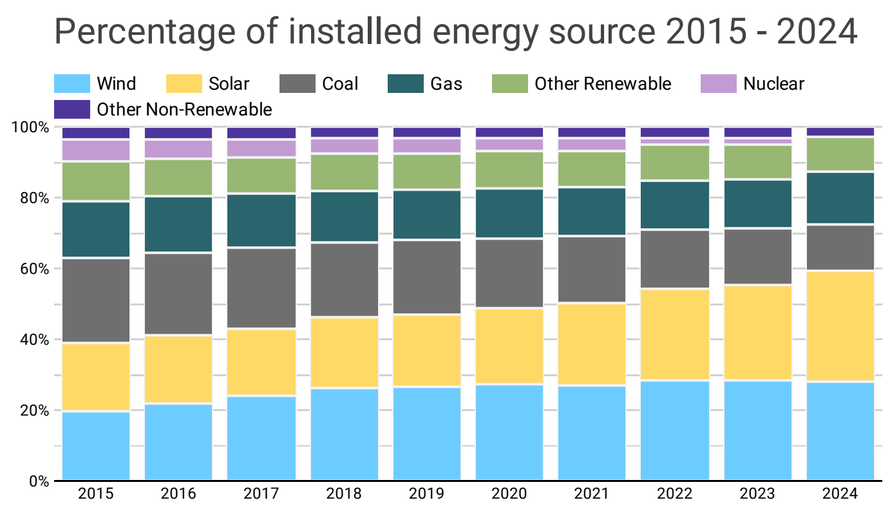
Installed capacity 2015 - 2024

Renewable capacity went from 97,462 to 168,446 MW (+72.86%). Meanwhile, generation capacity from **non-renewable** energy sources recorded a *decrease*: from 98,589 to 76,397 MW (-22.52%).

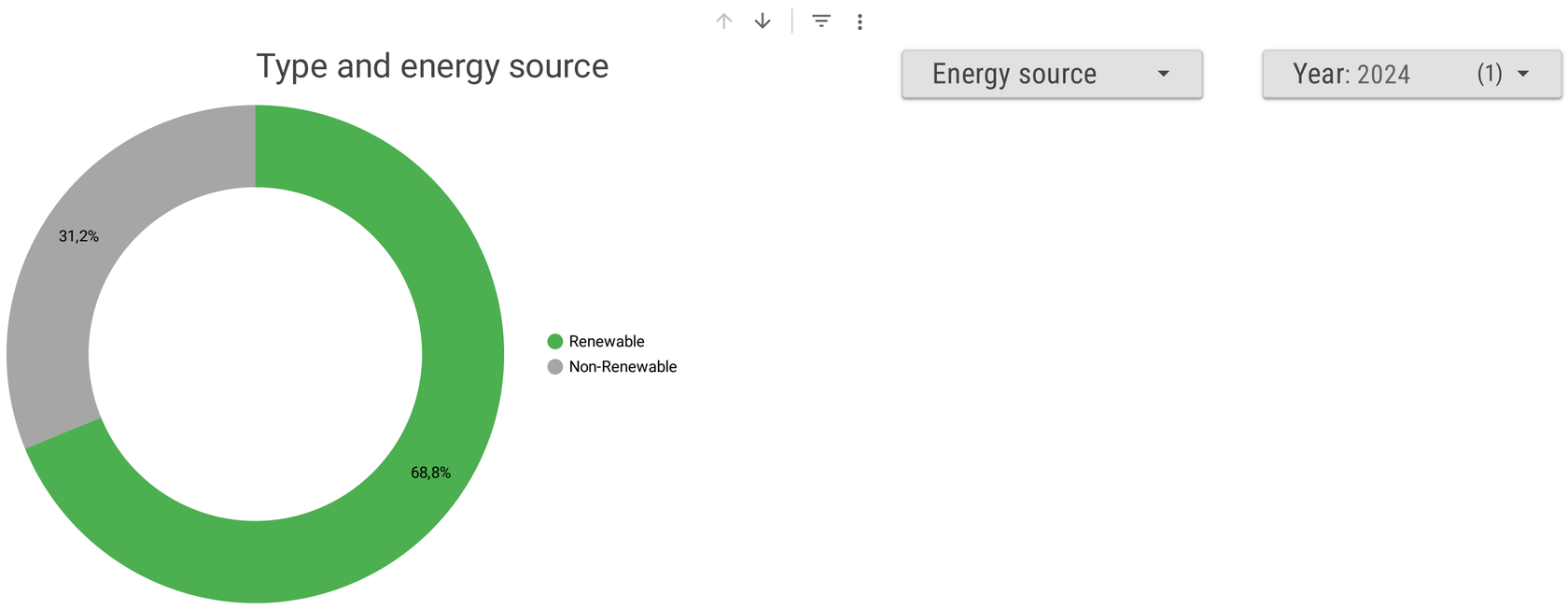


In the following graphs, we can observe in detail what was highlighted earlier. The amount of renewable energy, such as **solar** and **wind**, has *grown significantly* (especially **solar**). Additionally, a *reduction* in installed **coal** capacity can be observed, while, for **gas**, there has been an *increase* in absolute terms. However, its percentage share has *decreased* due to the significant growth in renewable energy installations.





The following pie chart allows for a detailed analysis, year by year, of all the energy sources available, starting from the grouping by source type. In the previous graphs, groupings were made to ensure better visual clarity. However, thanks to the "drill-down" function, it is possible to view: the type of source; the energy sources; and all the others energy sources that were previously grouped.



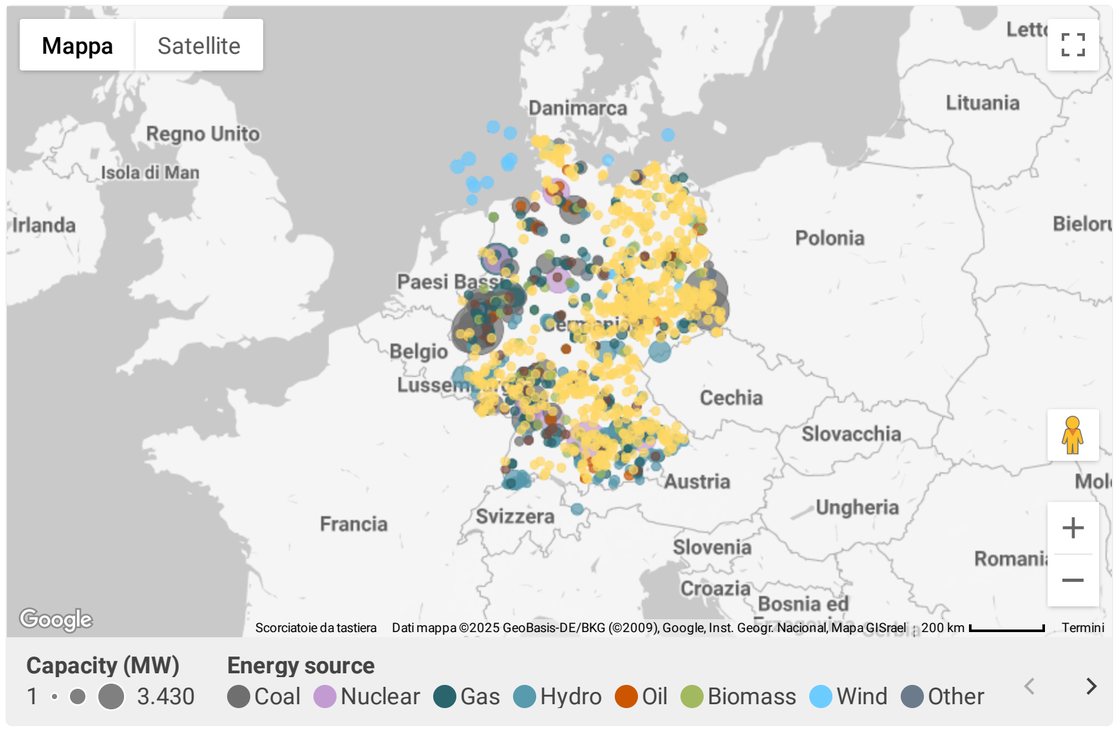
Filters

- Type of source
  - Renewable
  - Non-Renewable
- Energy source
  - Coal
  - Gas
  - Nuclear
  - Other Non-Renewable
  - Other Renewable
  - Solar
  - Wind
- Year
  - 2024
  - 2023
  - 2022
  - 2021
  - 2020
  - 2019
  - 2018
  - 2017
  - 2016
  - 2015

Power plant location 2018

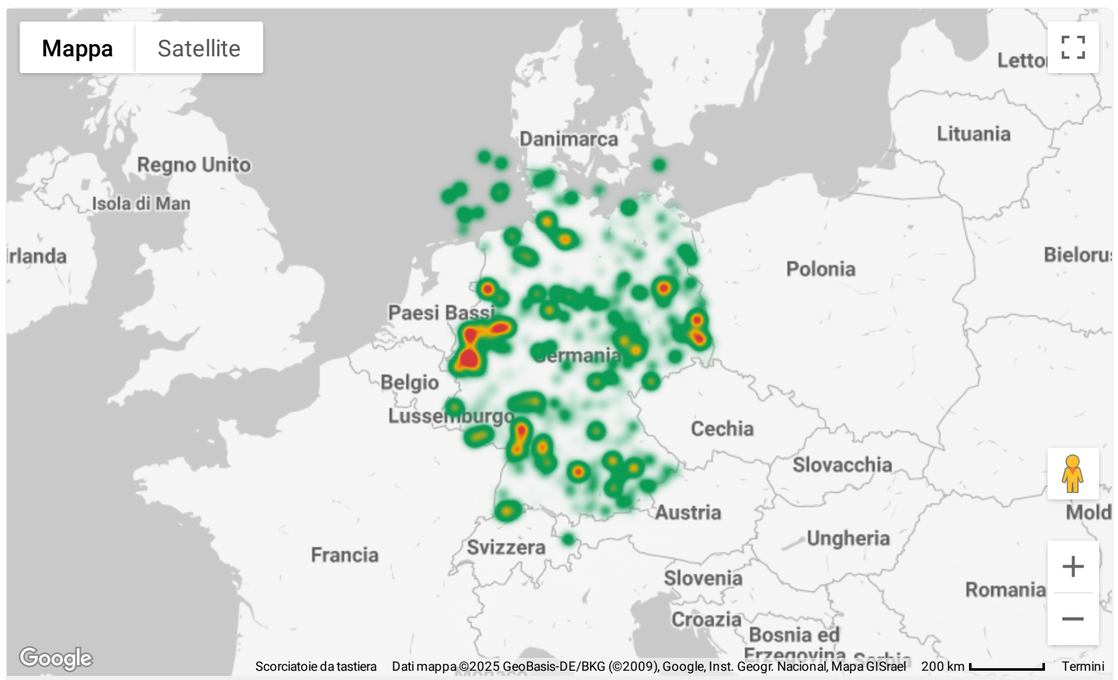
This visualization illustrates the geographical distribution of energy production plants in Germany. The maps highlight both the locations of individual facilities and the areas with the highest concentration. In total, 1309 power plants are displayed for the year 2018. You can switch to the 'Satellite Map' view to examine individual plants from above or use 'Street View' to explore the facilities at ground level.

German power plant location 2018



In this map, using the 'Satellite Map' view, we observe the following patterns:

- **Hydro:** Predominantly located in the central and southern regions, where the terrain is mountainous.
- **Wind:** Found in the eastern regions (onshore) and in the North Sea (offshore).
- **Solar:** Concentrated mainly in the south and east, while the western regions have significantly lower density.
- **Coal, oil, waste, biomass** & **gas:** Spread evenly across the country.
- **Nuclear:** Primarily concentrated in the south and northwest.



This map highlights the areas in Germany with the highest concentration of energy production plants. **Larger plants**, such as those powered by **coal**, **gas**, and **oil** (also the most polluting), are generally located near borders with neighboring countries. No distinct location patterns are observed for **smaller plants**, as they tend to have lower energy capacities and are widely distributed.

Filters

Type of source
Renewable
Non-Renewable

Energy source	Number of plan...
Biomass	53
Coal	96
Gas	180
Hydro	112
Nuclear	7
Oil	24
Other	11
Solar	735
Waste	66
Wind	25

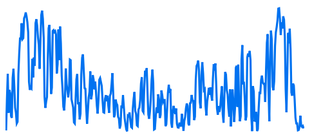
Energy produced 2023

The energy produced, unlike installed capacity, represents the energy actually generated by a specific source. Variations are momentary, but for simplicity and clarity of visualization, we have reported the data on a daily basis.
In general, it can be observed that energy production is *higher* during the winter period, likely due to increased energy consumption.
Additionally, the *interruption* of nuclear energy production is noticeable.

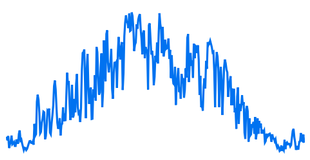
Trend of the main energy sources 2023

Total MWh 2023
461,0 Mln

Fossil MWh 2023
170,9 Mln



Solar MWh 2023
55,7 Mln

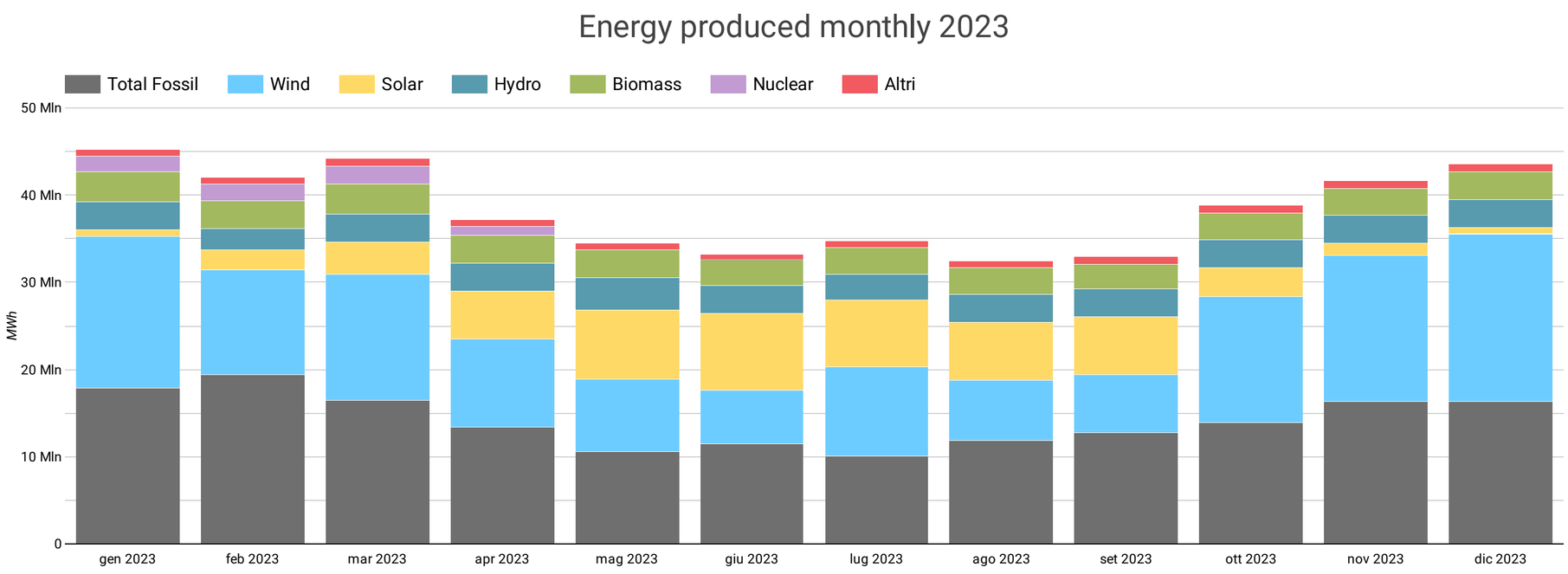


Wind MWh 2023
142,3 Mln

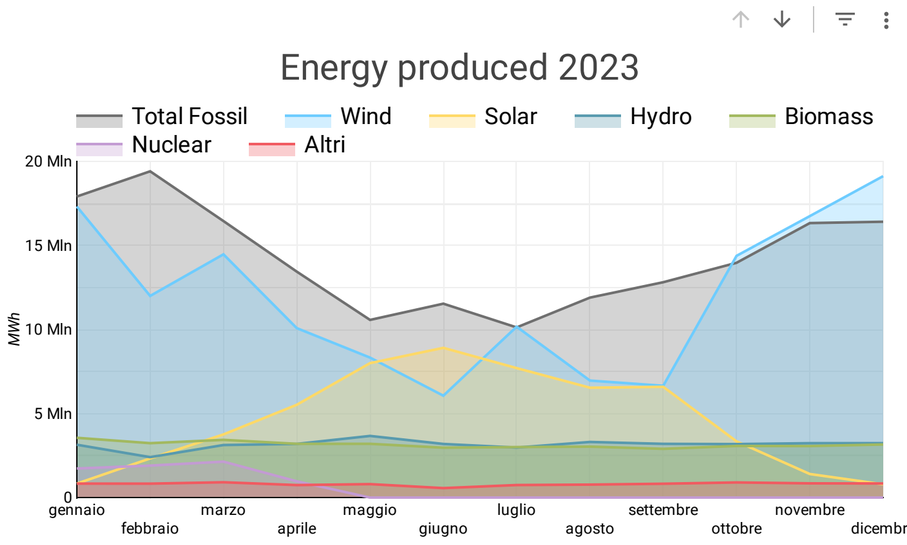
Nuclear MWh 2023
6,7 Mln

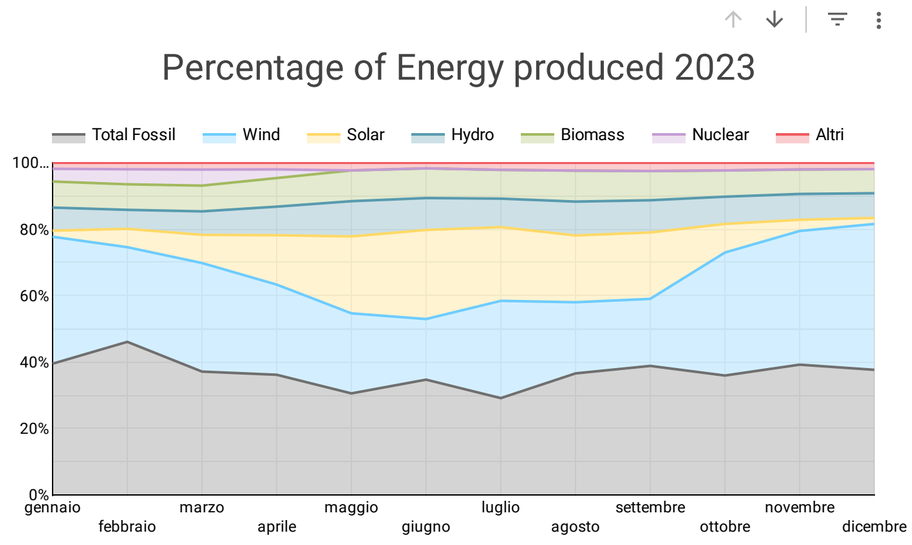
Energy produced 2023

In this first graph, we can observe the amount of energy produced month by month. It can be noted that **fossil fuels** show an almost *constant* production throughout the year, with a *reduction* during the summer periods. **Wind** energy generates a significant amount of energy during the *winter* and autumn months, while **solar** energy peaks in production during the *summer* months. The amount of energy produced by **biomass**, on the other hand, remains more or less *constant* throughout the year.



In the following graphs, we can observe the previous results in greater detail. Thanks to the "drill-down" function on both graphs, it is possible to analyze the amount of energy produced day by day. This visualization is very important because it allows us to note that, although the amount of energy produced from **renewable** sources is high on a monthly basis, there are *entire days* scattered throughout the year when energy from **fossil fuels** is the most produced. This phenomenon is due to the intermittency of renewable sources.





The following gauge allows us to observe the *median* value of energy efficiency, that is, how much each source is used compared to its installed capacity (as described earlier). We chose to use the median instead of the average to present a value that is not influenced by either the production peaks of **fossil fuels** or those of **renewables**.
By selecting all the energy sources from the filters you get the *total efficiency*.

WARNING regarding nuclear energy! Including this source will skew the values after April 16 (the date when production is zero).

Filters

- Type of source
  - Renewable
  - Non-Renewable
- Energy source
  - Biomass
  - Geothermal
  - Hydro
  - Nuclear
  - Other
  - Other renewable
  - Solar
  - Total Fossil
  - Waste
  - Wind

1 gen 2023 - 31 dic 2023

CO2 Emitted & Other Stats 2015, 2023

We decided to compare the *two opposite periods we analyzed*. Specifically, we aimed to examine the differences in KgCO2 emissions from energy production during a time of significant investment in renewable resources (€155 billion). To be coherent with the data we used before (and how they were obtained), we calculated the KgCO2 emissions ourselves using the "Total Life Cycle" data from the National Renewable Energy Laboratory.

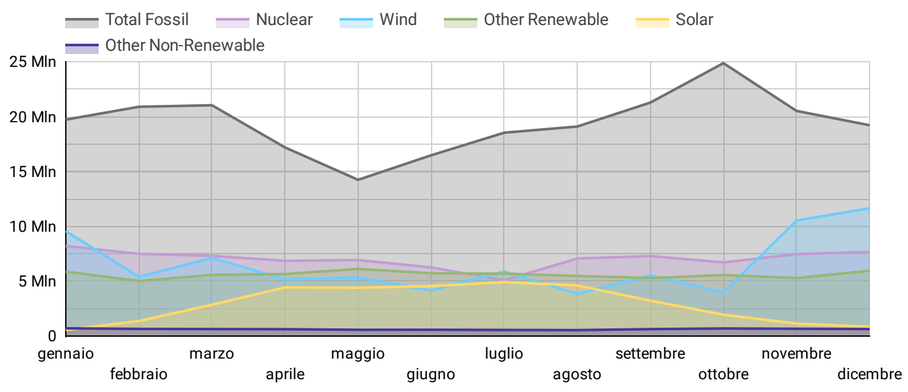
Energy Generated 2015, 2023

To introduce this chapter on CO2, we start by comparing the key contributor to emissions: *energy generation*. A clear trend is the reduction in **fossil fuel**-based energy, especially in summer months, leading to lower emissions—largely thanks to increased solar energy production. **Wind** power generation has also grown consistently year-round.

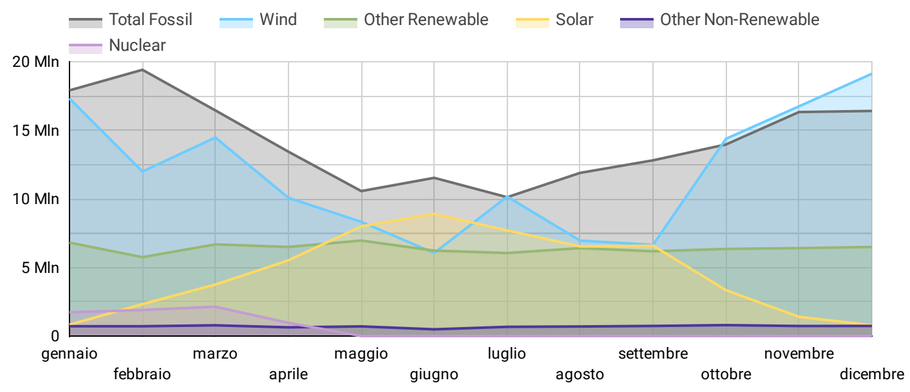
Use the 'Drill down' function to view data day by day and the 'Zoom' tool to focus on specific periods, enabling deeper insights.

Type emission source | Energy source

Generation 2015



Generation 2023



CO2 Emitted 2015, 2023

These charts show that CO2 emissions have *generally decreased across all months of the year*, as highlighted in the line chart. However, the 'Drill down' function reveals daily fluctuations, with some winter days in 2023 showing higher emissions than in 2015, often due to low **wind** power generation.

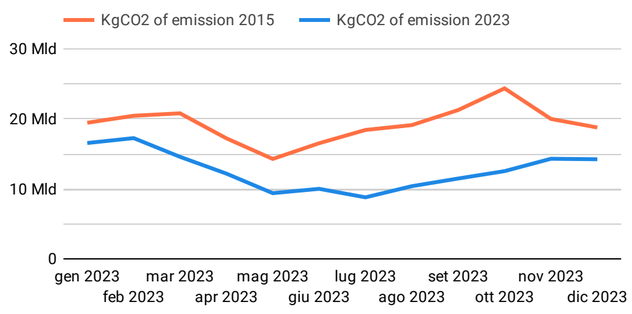
Use the 'Zoom' function to explore these trends in the earlier "Generation" graphs.

KgCO2 emitted 2015	KgCO2 emitted 2023	Difference between 2015-2023
231 Mld	152 Mld	-79 Mld

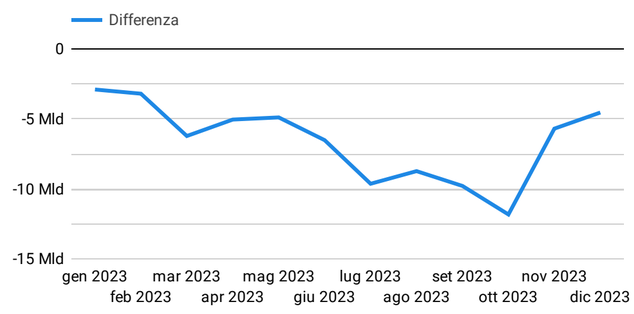
Total Life Cycle data

Source	Lifecycle KgCO2e/MWh
Coal	1001
Oil	840
Gas	486
Biomass	52
Photovolta…	43

CO2 Emitted

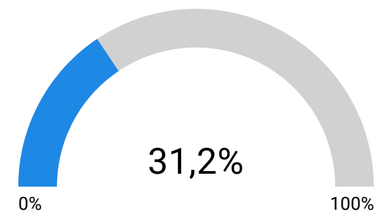


Difference CO2 (2015, 2023)



1 gen 2023 - 31 dic 2023

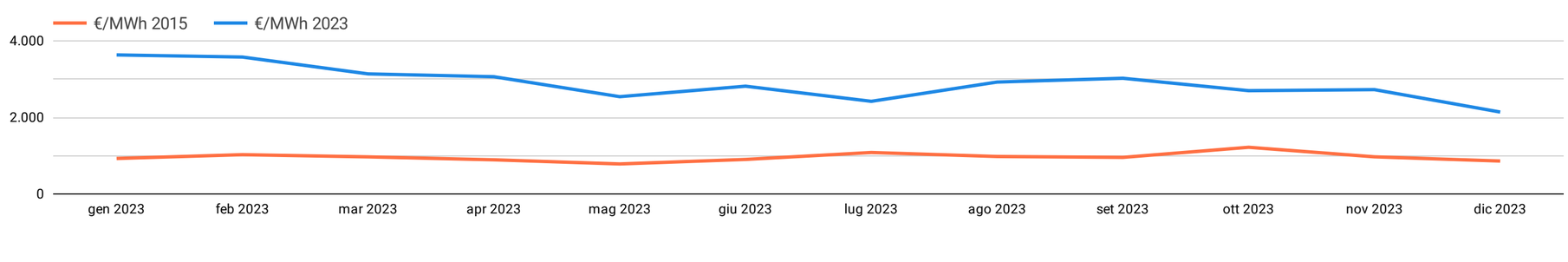
Average decrease 2023



Spot cost and Average Carbon Cost 2015, 2023

The spot cost (€/MWh), which represents the wholesale energy price excluding taxes and charges, is on average higher in 2023 than in 2015. Using the 'Drill down' function, we can see specific trends: in 2023, the spot cost drops during prolonged periods of **wind** power generation. However, **solar** installations did *not lower* summer prices. Notably, there are two days in 2023 when the *spot cost is negative*. While this may seem beneficial for consumers, it poses challenges for energy producers and suppliers.

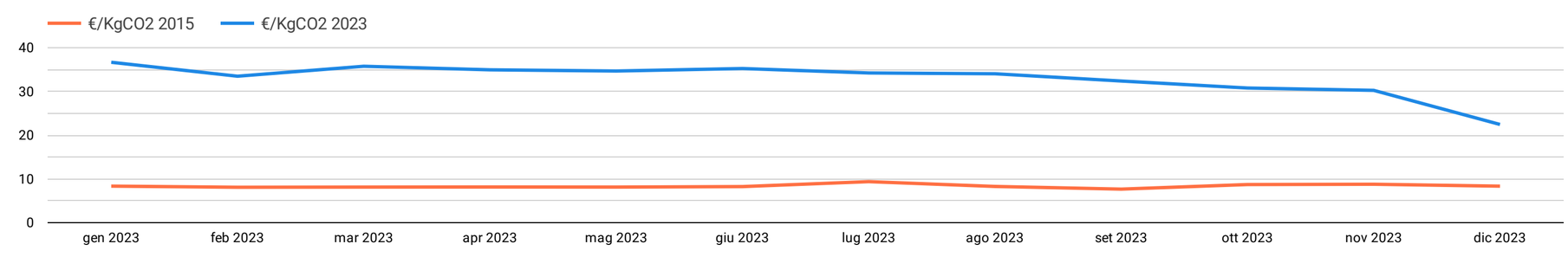
Spot cost 2015, 2023



We can calculate the 'average carbon cost' (€/KgCO2), which represents the economic cost of the energy system for each kilogram of CO2 emitted. A *low value* may indicate a cheaper but carbon-intensive system, while a *high value* suggests the opposite.

Using the 'Zoom' function, you can compare the spot cost and CO2 emissions by analyzing the "energy generation" charts.

Average Carbon Cost 2015, 2023



Carbon intensity of the economy 2015, 2023

During the analyzed period, Germany's GDP *increased*, reflecting progress toward energy neutrality—a trend already evident in the previous sections through *reduced* emissions and cleaner energy generation.
The following chart further illustrates this: the 'carbon intensity of the economy' (KgCO2/$) measures CO2 emissions per unit of economic value. The *lower* average values in 2023 indicate a *stronger and cleaner* economy.

GDP 2015	GDP 2023
3,73 Bln	4,46 Bln

Carbon Intensity of the Economy 2015, 2023