BuiltHub

Report on Data Visualisation (D4.5)

BuiltHub D4.5

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Disclaimer

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Executive Summary

The present report builds on the other project activities that identified and prepared indicators, especially Task 4.1. In the present report, we provide guidelines for the IT implementation and ideas for providing user-friendly visualizations in the BuiltHub platform.
This is a static document. However, the proposed functionalities for the web platform have the intention to make the user experience more dynamic and easier to understand. This report focuses on visualizations for the BuiltHub platform, especially for the thematic area **Energy consumption**.
In Section 1, different web-platform functionalities are introduced. These functionalities should serve as guidelines for the IT implementation in the BuiltHub platform. In Section 2, the visualizations are presented in factsheet format. Here, all the information related to each visualization is presented: graph title, graph type, exemplary visualization (not including all possible functionalities), functionalities that could be implemented, three short key messages about the graph, and a more detailed textual explanation of the graph. The last two aspects should enrich the platform's user experience and help the interpretation and understanding of the information provided in the graphs. The three "key messages" should be automatically generated by the platform using an algorithm programmed in the back end. On the other hand, the more detailed explanation requires expert knowledge. Therefore, it should be seen as a product provided by the platform additionally to the automatized messages (prefabricated text).
Complementary to this report, the project report on "Building sector indicators, definition, calculation, representation" (D4.1) presents the data-sources used to provide the visualizations. Also, the project report "Matrix, describing the available datasets and main data sources and type" (D4.2) presents detailed information about the Metadata of the datasets used.

1. Functionalities of the web-platform

To enrich the user experience while using the BuiltHub platform, we suggest implementing some functionalities in the platform. The main objective of these functionalities is to support the user on the interpretation and understanding of the visualizations (or graphs). These functionalities should also be supported by storylines, understood as the main “messages” that could by read from the graphs. With that, the platform user will be able to have an enriched experience.

1.1. Graph mask

In many of the visualizations, bar diagrams are proposed to compare information between all EU Member States. The idea of the graph masks is to equip those visualisations with a fixed “graph mask” that offers the user the ability to filter the data by the properties displayed. In essence, by graph masks we envision a template that every visualisation is based on and that is fixed regarding functionalities available to all templates, such as filtering, but flexible enough to be applied to different graph types.
The fixed graph mask helps the platform user to easily see if specific data is missing. In many graphs, when the data is missing, the information is hidden. However, the transparency of data gaps in this case could also help engaging stakeholders that may have certain information. Also, statistical analysis (section 1.3) can be part of a graph mask. If the user is looking for specific information, then further functionalities such as aggregation and filtering can be used. These will be explained in the next sections.

1.2. Bars with different width

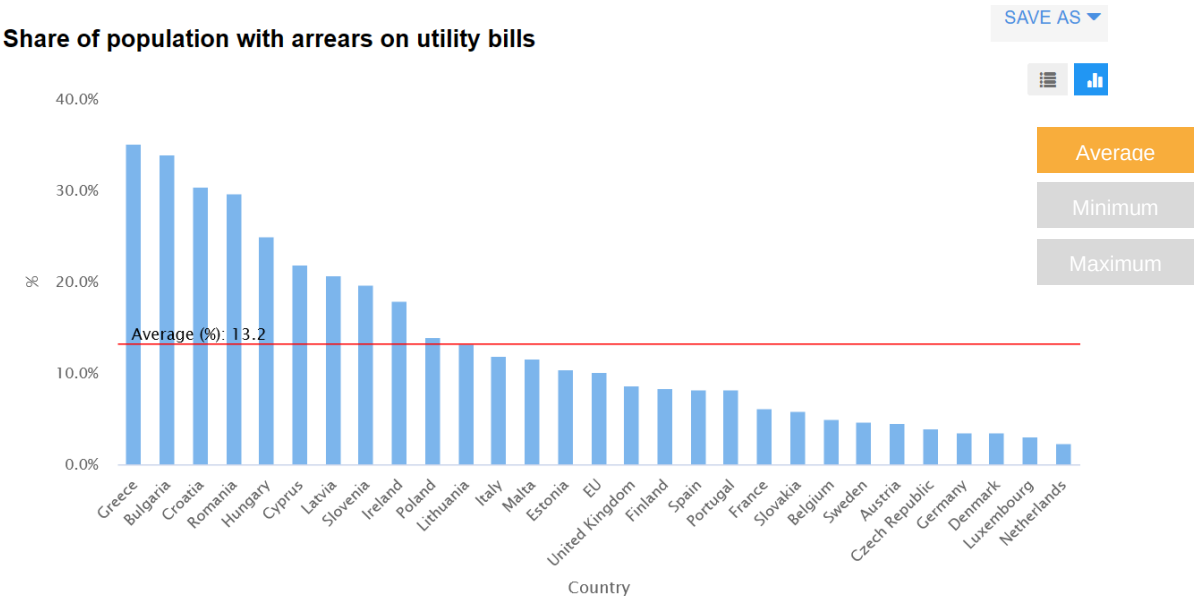
Also, in the bar diagrams, different bar width can be used to represent the information more visually. For example, in the Graph 3 the information of share of final energy consumption for each region is supported visually by the broader or narrower bar widths.

1.3. Statistical analysis and trend line

Using statistical indicators such as **minimum, maximum, average, weighted average,** etc. should help the platform user compare the visualized information and facilitate the analysis.
Therefore, when the dataset is uploaded to the BuiltHub platform, some statistical analysis should automatically be performed by the platform – as automatised data analytics. This information should be added as additional information and functionality of the graphs. It can also be combined with the possibility of activating (or disactivating) the statistical analysis through a button. The Figure 1[1] below shows an example on how to represent the average value, based on the BSO.

[1] Source: https://ec.europa.eu/energy/eu-buildings-datamapper_en

Figure 1 Exemplary presentation of statistical analysis

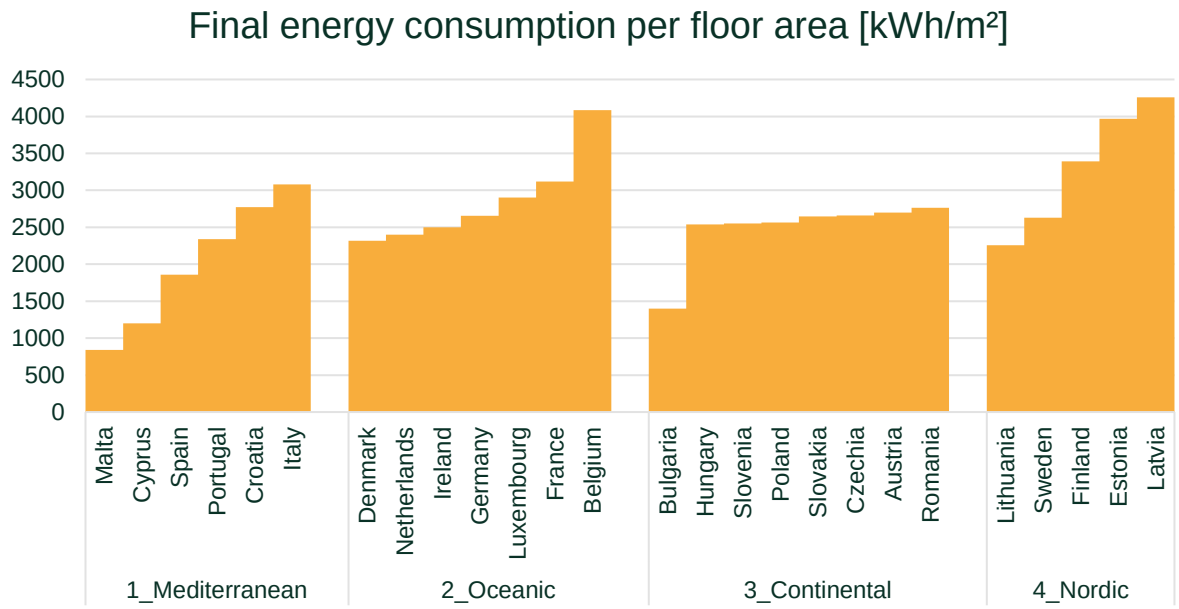


1.4. Sorting

When displaying the information, the platform user should be able to sort the displayed information in **increasing** or **decreasing** order. Additionally, the user can group the data according to predefined schemes, as explained in the next chapter 1.5, Table 1.

In the above, the information is shown in decreasing order. This kind of sorting can also be combined with other grouping strategies. In Figure 2, the graph is sorting the information in increasing order and grouping the countries by climate.

Figure 2 Exemplary presentation of combination of different functionalities



1.5. Grouping and clustering

To visualise messages clearly, in some of the graphs the data are organised in groups or in aggregated clusters[2]. Displaying data in groups helps to compare elements. For example, if we group countries by climate region a comparison of the energy consumption per square meter will be more meaningful than across different climate regions. Aggregation reduces the amount of information and helps visualizing weightings.
For example, in some graphs we decided to reduce the number of construction periods in a few higher-level visualisations as mapped in Table 1. The aggregated construction periods contain more weight and show a rougher but decluttered picture of the building stock structure.

Table 1 Aggregating construction periods

Construction periods in the Hotmaps dataset	Aggregated construction periods in some of our visualizations
1945-1969	1945-1979
1970-1979	
1980-1989	1980-1999
1990-1999	
2000-2010	2000-2010

To sort, compare, group and aggregate European countries we identified the following datasets that cluster EU member states by climate region, cultural region and based on their emission contributions.

[2] In this report we use grouping where each element is shown individually but next to comparable peer elements. We use clustering for aggregating elements into a cluster without showing each element individually.

Table 2 Clustering schemes based on climate region, cultural region and building stock emissions

Country for referencing in datasets	ID	Climate regions EPBD (2021)	Cultural regions P.Jordan 2005	Emission based McKinsey 2020
Cyprus	CY	1_Mediterranean	Southeastern	Southeast Europe
Greece	EL	1_Mediterranean	Southeastern	Southeast Europe
Croatia	HR	1_Mediterranean	Southeastern	Southeast Europe
Spain	ES	1_Mediterranean	Southern	Iberia
Italy	IT	1_Mediterranean	Southern	Italy
Malta	MT	1_Mediterranean	Southern	Italy
Portugal	PT	1_Mediterranean	Southern	Iberia
Germany	DE	2_Oceanic	Central	Germany
Luxembourg	LU	2_Oceanic	Central	Benelux
Denmark	DK	2_Oceanic	Northern	Nordics
Belgium	BE	2_Oceanic	Western	Benelux
France	FR	2_Oceanic	Western	France
Ireland	IE	2_Oceanic	Western	Ireland
Netherlands	NL	2_Oceanic	Western	Benelux
Austria	AT	3_Continental	Central	Other central Europe
Czechia	CZ	3_Continental	Central	Other central Europe
Hungary	HU	3_Continental	Central	Other central Europe
Poland	PL	3_Continental	Central	Poland
Slovakia	SK	3_Continental	Central	Other central Europe
Bulgaria	BG	3_Continental	Southeastern	Southeast Europe
Romania	RO	3_Continental	Southeastern	Southeast Europe
Slovenia	SI	3_Continental	Southeastern	Other central Europe
Estonia	EE	4_Nordic	Central	Nordics
Lithuania	LT	4_Nordic	Central	Nordics
Latvia	LV	4_Nordic	Central	Nordics
Finland	FI	4_Nordic	Northern	Nordics
Sweden	SE	4_Nordic	Northern	Nordics

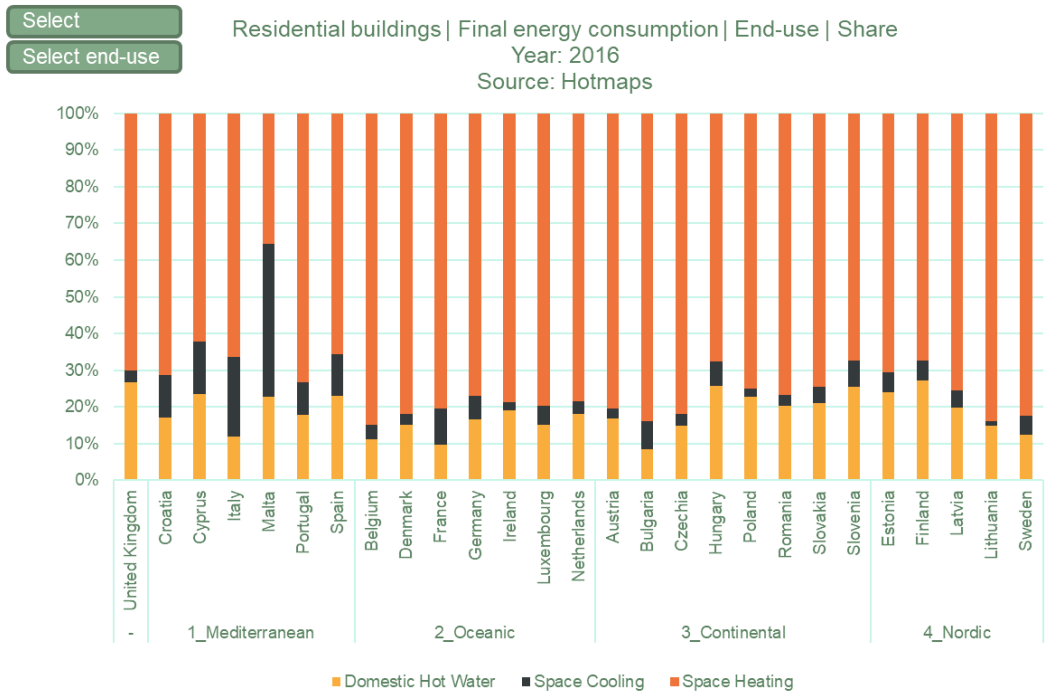
Also, different energy carriers could be grouped as proposed below. The energy carrier categories on the left side of the table are in line with the Eurostat categories.

Table 3 Aggregating energy carrier

Energy carrier	Aggregated energy carrier
Solid fossil fuel	Fossil fuels
Fossil oil and petroleum products	
Natural gas	
Electricity	Electricity
Heat	Heat
Renewables and biofuels	Renewables and biofuels
Other fuel n.e.c.	Others

1.6. Filtering and selecting specific information

Filters and selection of information is a well-established and easy to implement functionality. Some graphs in the BuiltHub platform should offer the platform user certain selections – for example, filtering out the “Space cooling” data if the user is mainly interested in “Space heating” and “Domestic hot water” data. The filter is an additional functionality. When initially loading the image, the Platform should show all available data, with the ability to select subgroups of data as indicated by the buttons on the top left: “select countries” and “select end-use”. Such filter options should be available for all graphs and therefore be included in the graph masks.

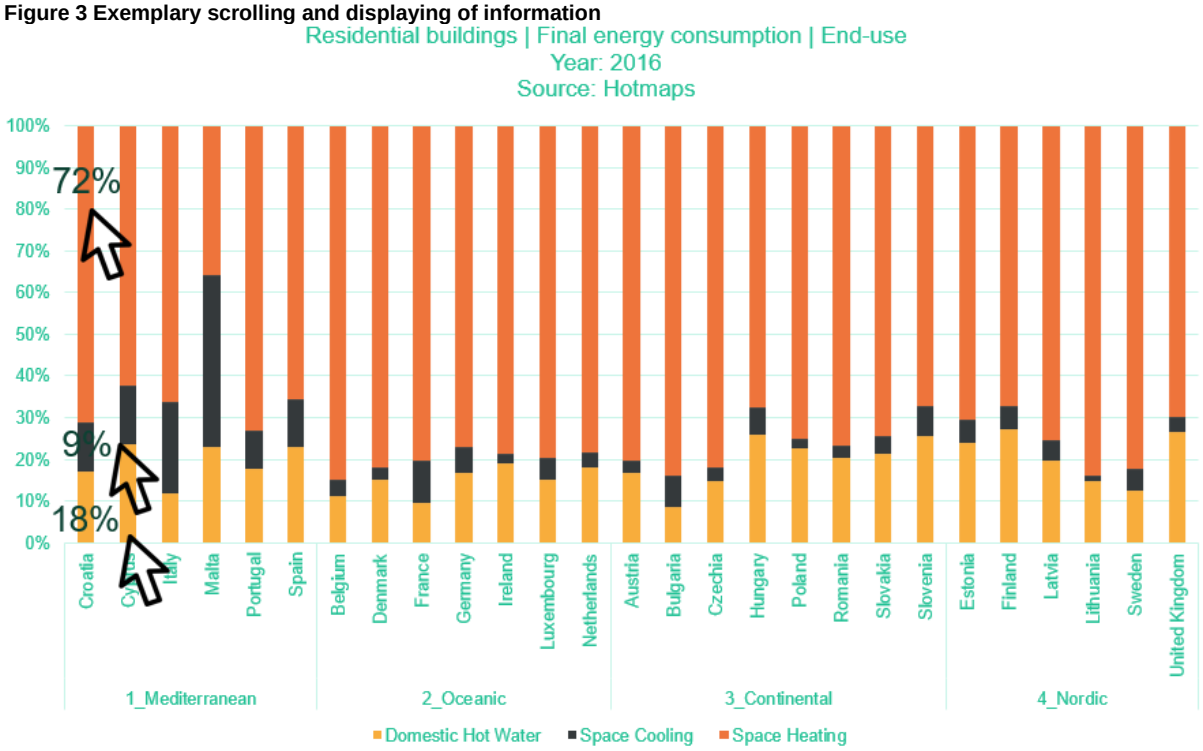


1.7. Display, scroll and show values

This functionality will help the platform user emphasize some aspects of the visualization. For example, making a specific information bigger, or showing values at “mouse-over” when scrolling through the graph. Figure 3 below

shows the functionality that consists of displaying the “value” of the graph by scrolling through it. It should help the platform user to read the values.

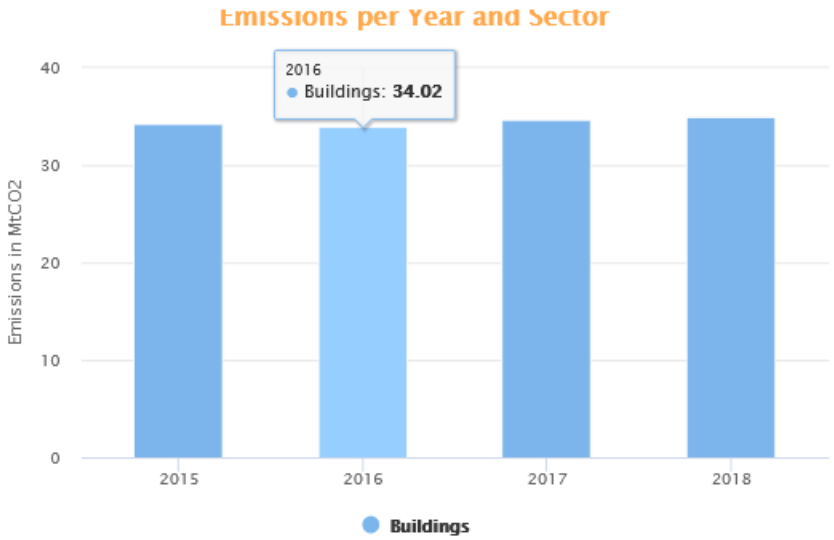
Figure 3 Exemplary scrolling and displaying of information



Platform implementation

When observing the implementation of the platform we see that the dashboards follow a similar structure that may be given by a template like the one we envisioned with the graph masks. We also see that filtering options are available, and average lines were implemented.

Interactive features are implemented with the frontend framework used: Knowage. It offers features such as mouseover and is implemented in all dashboards and graphs.



2. Improvements and selection of visualisations

The first draft of the deliverable has provided work package 5 with designs for graphs. The second draft focuses on selecting graphs, reviewing some implementations, and providing improvement suggestions where needed.
The draft details improvement suggestions with respect to the current version of the platform as of March 21st 2023, for the following graphs:

- Graph 1 Final energy consumption by country
- Graph 3 Final energy consumption by construction period and climate region
- Graph 4 Final energy consumption by construction period and political region
- Graph 6 Final energy consumption per inhabitant and energy carrier
- Graph 7 Final energy consumption per inhabitant and energy carrier (share)
- Graph 8 Final energy consumption per inhabitant and energy carrier (filter Electricity)
- Graph 9 Final energy consumption per inhabitant by energy carrier (country comparison)
- Graph 21 Specific final energy consumption
- Graph 22 Specific final energy consumption and end-use
- Graph 23 Specific final energy consumption and end-use (share)

The report contains improvement suggestions for these graphs. In the next steps we will consider the suggestions and investigate whether they can be implemented in the platform.

3. Visualizing “Energy consumption” data

This chapter presents “**Factsheets of each visualization**” that can be presented in the BuiltHub platform. Here, the focus is on the “Energy Consumption” data. These visualizations are presented in a static way. But, when implemented together with the functionalities proposed in the chapter 1, they will enrich the user experience of the platform.
Additionally, it is proposed to add “Messages delivered from the graphs”. These messages should also support platform users to interpret the information on the graphs.
The 1-pager **Factsheets** contain the following information:

- Graph number
- Graph title
- Metadata (or additional information about the data)[3]
- Proposed visualization
- Functionalities that could be implemented
- 3 key messages from the graph
- Explanation about the messages from the graph

The next graphs are examples to show the data for the residential building sector. However, similar visualizations can also be provided for the non-residential building sector.

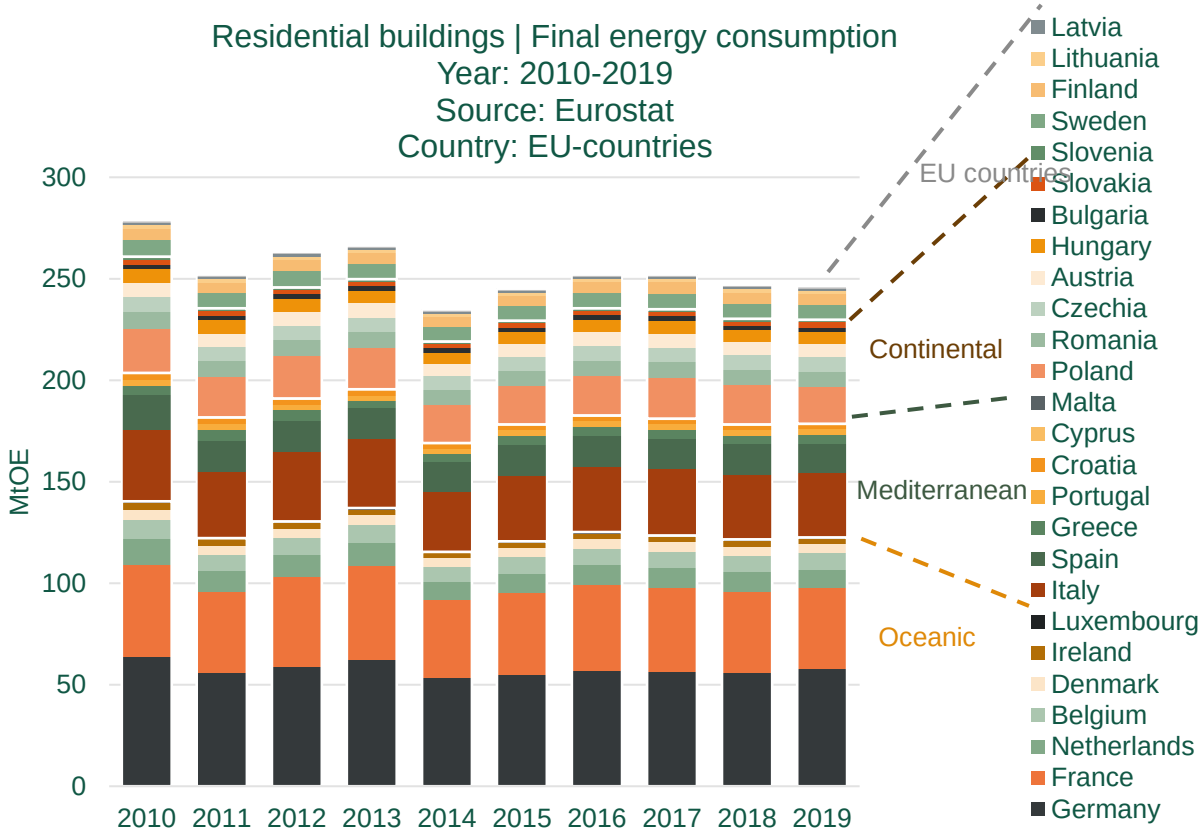
[3] More in detail presented in the project report “Matrix, describing the available datasets and main data sources and type” (D4.2)

3.1. Final energy consumption by country

These graphs show the final energy consumption (Terajoule) for residential buildings in all EU countries and climate regions and for different years (2010-2019).

Graph 1 Final energy consumption by country

Graph title: Final energy consumption – Residential buildings – Year
Metadata: Source Eurostat [FC_OTH_HH_E_SH + FC_OTH_HH_E_SC + FC_OTH_HH_E_WH + FC_OTH_HH_E_CK], Year 2010-2019
Proposed visualization: stacked graph (year)
Functionalities: 1) sorting by year; 2) scrolling through graph (display country or values)



Improvements suggested for implementing the graph in the platform

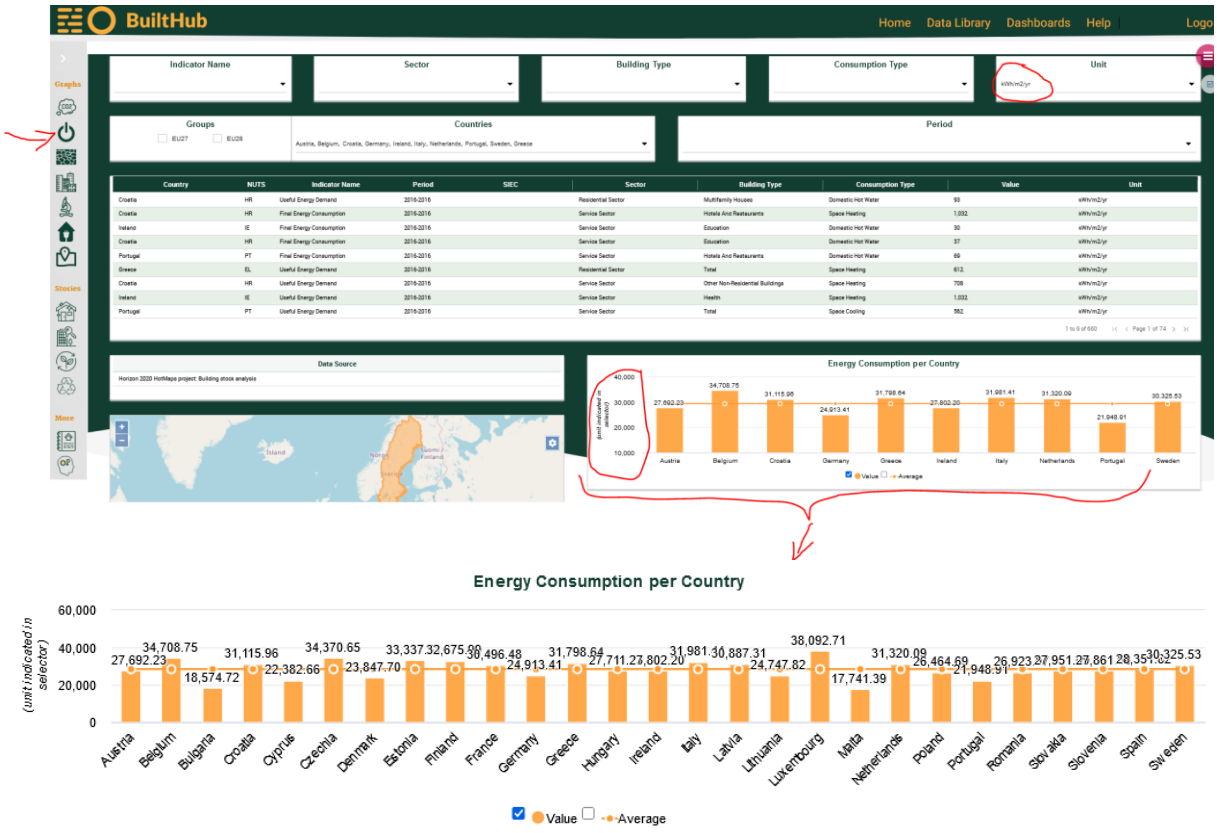
Concept

- The graph shows the contribution of all countries in stacked bars. This graph is meant to be interactive. When hovering over a country with the mouse, the other countries' colour saturation is supposed to be reduced so that this one country sticks out and the contribution of this country over time can be seen.

Readability

- Conversion to multiples of Wh (GWh, TWh, …) would be very useful to the user.
- It makes only sense to show the different countries – which are not readable when all are shown – if they can be filtered.
- Missing countries should be written as a note below, the short forms are not easily read.

Platform implementation in the Energy Dashboard

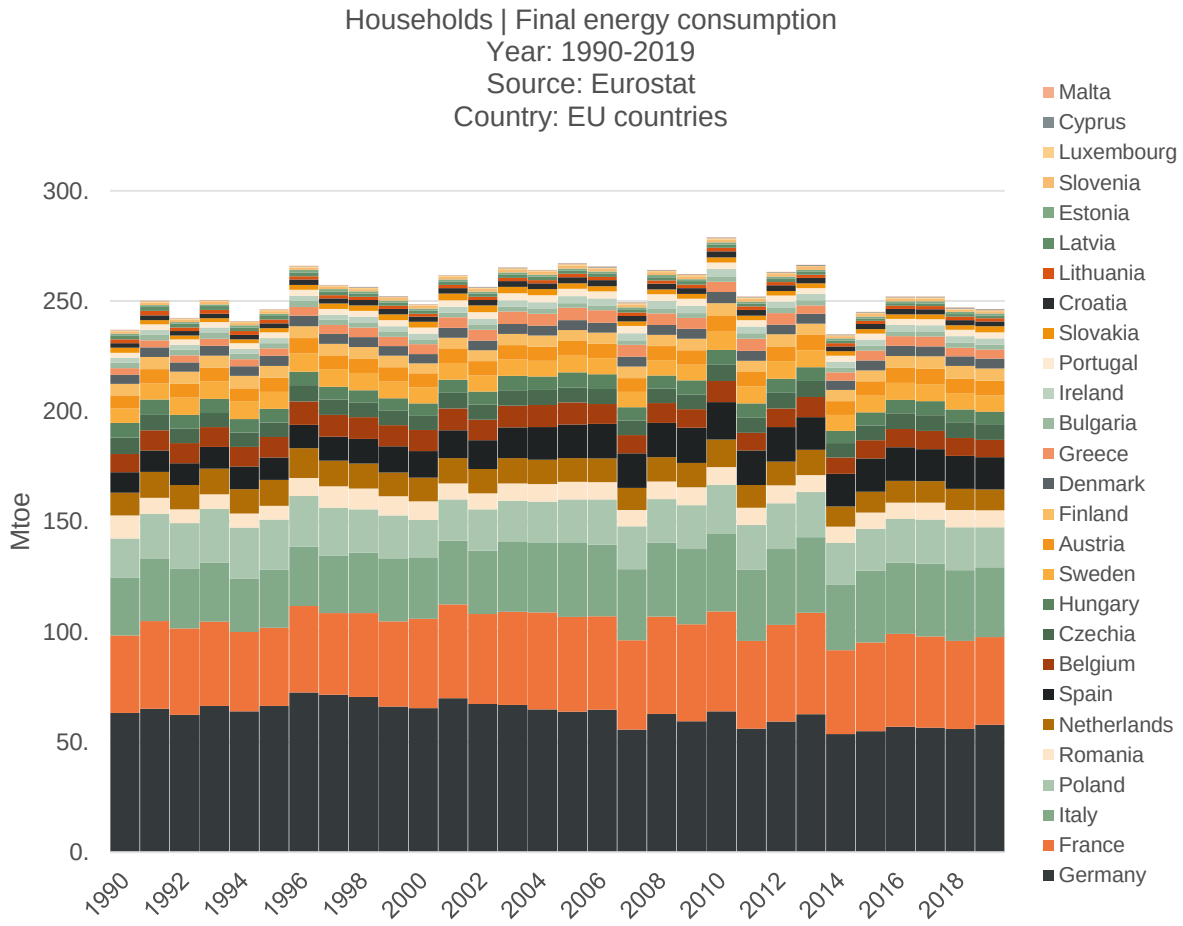


Dashboard 1 – Energy Dashboard

Improvement suggestions

The graph above has various problems.

- The graph above shows a "Value" (as bars) and an "Average" (as a line with markers). It is not clear to me what "Value" shows. It is clearly in a unit different from kWh/(m^2 yr) but does not represent the total energy consumption of a country either, as indicated by the title (otherwise, there would be much more difference, just because countries have completely different sizes).
  The unit kWh/(m^2 yr) should lead to values between 15k kWh/m^2yr and 40k kWh/m^2yr. It is possible that instead of averaging the values were added.
- When the "Average" is not selected, no line should be shown. The line seems to be perfectly horizontal. Maybe it is the average across all countries, but then there shouldn't be a marker per country, but just a line without markers and a single value.
- In case "Average" is selected along with "Value", you would need two y-axes with different scales.
- The y-axis should explicitly show the unit.
- When selecting the indicator, it should give more information, such as the data source and the limitations of the dataset.
- When multiple different units are selected, a warning should appear.



Key message from the graph

- Poland, Italy, France, and Germany are the countries with the highest contribution.

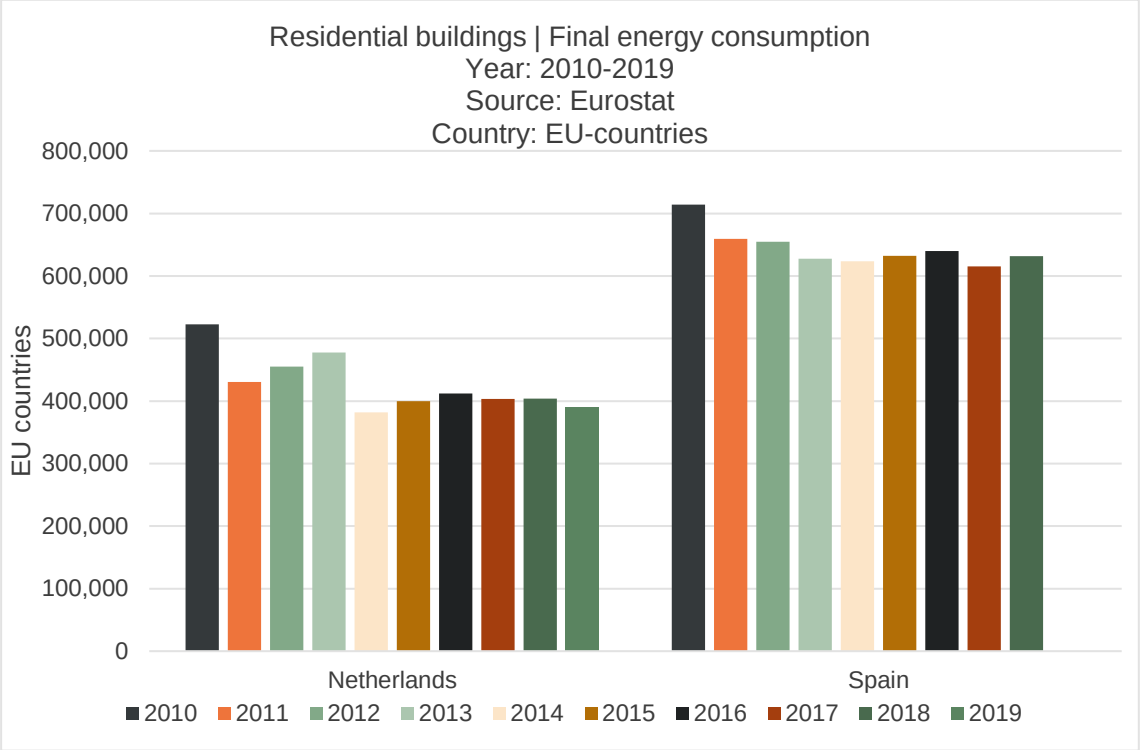
Note: the graph should be focused on space heating. However, in the platform implementation the energy use can be selected.

Explanation about the message from the graph

The graph shows the final energy consumption for households of European member states as far as they are recorded in Eurostat. From this graph we can learn that the total final energy consumption of households is about 250 Mtoe. We also identify the substantial contribution of Germany, France, Italy, Poland.

Graph 2 Final energy comparison (country comparison)

Graph title: Final energy consumption – Residential buildings – Country comparison – Year
Metadata: Source Eurostat, Year: 2010-2019
Proposed visualization: bar graphs (country)
Functionalities: 1) filter (country selection); 2) statistical analysis; 3) fixed graph mask



Three key messages from the graph

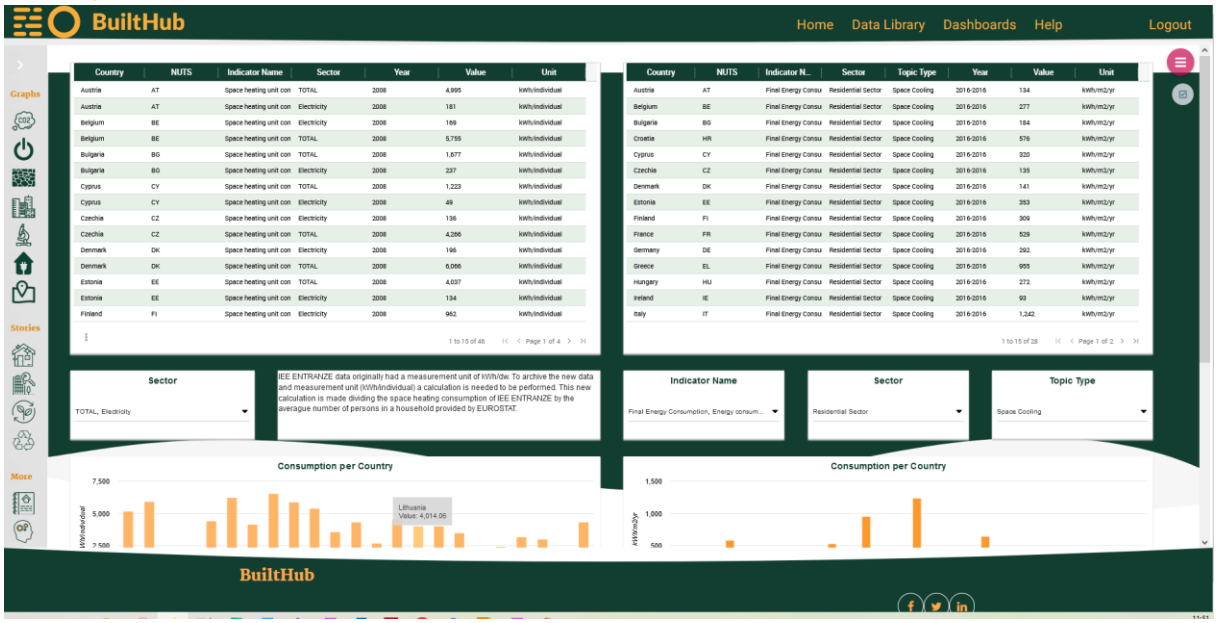
- Spain has higher final energy consumption than the Netherlands[4].
- 2010 is the year with highest energy consumption in both countries.
- 2014 is the year with lowest final energy consumption in the Netherlands, while 2017 is the year with lowest final energy consumption in Spain.

Explanation about the messages from the graph

The graph shows two countries with a comparable amount of final energy consumption: the Netherlands and Spain. Although they are in different climate regions[5], both countries experienced a drop of energy consumption after 2010. In the following 2-3 years energy consumption increases in the Netherlands but remains constant in Spain. Both countries experience a rise in energy consumption between 2014 and 2016 with a decline after. All of the changes are relatively small, and a declining trend cannot be derived.

[4] Refer to graphs that consider other aspects, such as “Final energy consumption per inhabitants”.
[5] Compare Table 2 on page 9.

The comparison Dashboard



Dashboard 2 Comparison Dashboard

Improvement suggestions

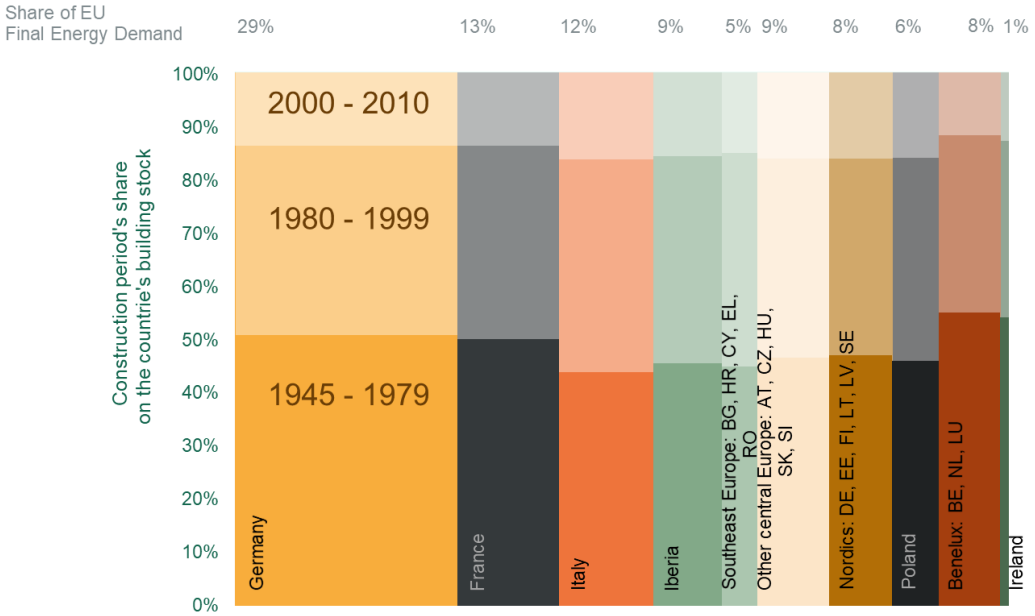
- Show all content on one screen, the chart cannot be displayed completely even when scrolling down.
- Indicate what parameters can actually be compared; there are two different lists of parameters that can be selected separately. I only found one pair of parameters that would make sense to compare. It is not clear what the basis for the parameter selection list on the left and on the right is. This would be good to understand as a start. Then it would be helpful for the user to suggest parameter-pairs that would make sense for comparison.
- Allow country comparison.
- Change icon for comparison dashboard.

3.2. Final energy consumption by groups

This graph shows the final energy consumption in all EU countries by climate region.

Graph 3 Final energy consumption by construction period and climate region

Graph title: Final energy consumption – Residential buildings – Construction period – Climate region
Metadata: Source Hotmaps, Year: 2016
Proposed visualization: stacked diagram (share)
Functionalities: 1) grouping and clustering; 2) sorting; 3) bars with different width



Three key messages from the graph

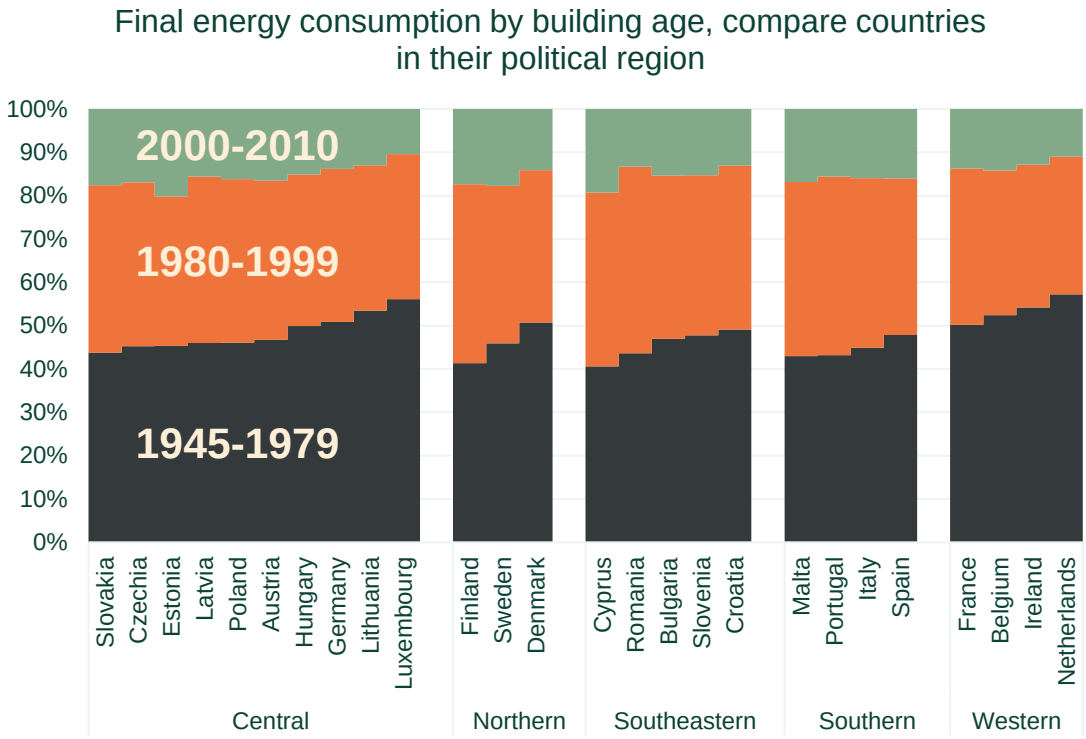
- Germany consumes 30% of all EU's final energy for heating, hot water, and cooling.
- Germany, France, and Italy together consume 54% of EU's final energy for heating, hot water, and cooling.
- In all groups/countries, the construction period 1945-1979 is the one that contributes most to the final energy consumption.

Messages delivered from the graph

Buildings in Germany consume about 30% of all final energy consumed for heating, hot water, and cooling in Europe. Half of this 30% is consumed in buildings built in the recovery period after the second world war between 1945 and 1979. Only a little more than 10% of the buildings were constructed after 2000 when energy considerations were manifested in the EPBD (Energy Performance of Buildings Directive). France and Italy consume about the same and together less than Germany, i.e., 25% of the European final energy for heating, cooling, and hot water in buildings. France and Germany have a building stock about the same age only topped regarding construction period 1945-1979 by Benelux with more than half of the buildings built before 1979.

Graph 4 Final energy consumption by construction period and political region

In this type of visualization, the absolute value is not on focus, but rather the share of final energy consumption between the different construction periods.
Graph title: Final energy consumption – Residential buildings – Construction period – Political region
Metadata: Source Hotmaps, Year: 2016
Proposed visualization: stacked diagram (share)
Functionalities: 1) scrolling through graph (display country or values); 3) grouping and clustering; 4) sorting



Three key messages from the graph

- The contribution of different construction periods to final energy consumption seems to be similarly distributed in all regions.
- In all regions, the final energy consumption of the oldest construction period 1945-1979 contributes between 40-60%.
- The newest buildings (constructed between 2000-2010) have the lowest share of final energy consumption in all regions.

Messages delivered from the graph

This visualization allows a cross-country (and cross-region) comparison between the share of final energy consumption of the different construction periods.

Improvement suggestions for the graph above (not implemented in the platform)

- A comment from the Workshop was that aggregation of the 5 periods to 3 periods is not helpful. So, if the graph would be implemented, all 5 periods should be shown.
- If implemented, the titles should be added in the chart.

3.3. Final energy consumption per inhabitant

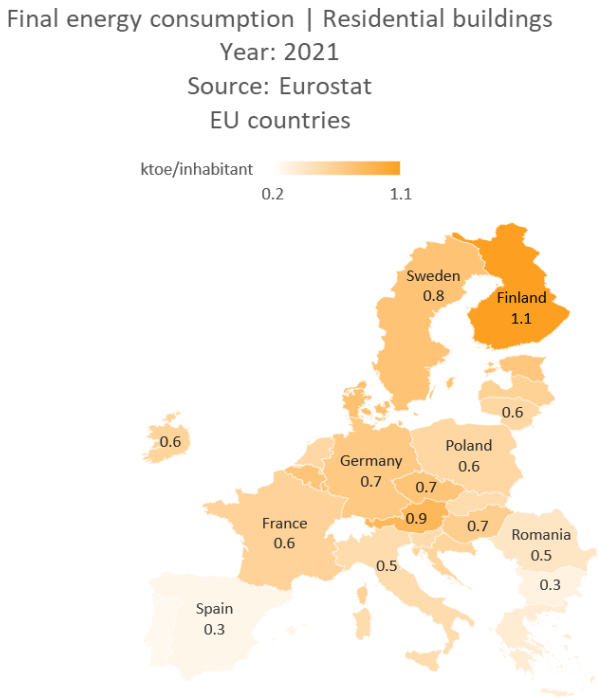
This graph shows the final energy consumption per inhabitant for year 2016 in all EU countries. This map focuses on cross-country comparison by location.

Graph 5 Final energy consumption per inhabitant

Graph title: Final energy consumption – Residential buildings – Per inhabitant
Metadata: Source Eurostat, Year: 2016
Proposed visualization: map
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) statistical analysis

Three key messages from the graph

- Luxembourg and Finland are the countries with highest final energy consumption per inhabitant.
- Romania, Malta, and Bulgaria are the countries with the lowest final energy consumption per inhabitant.
- Besides some exceptions, the final energy consumption per inhabitant seems to be higher in the colder climates, which also means that for the moment, energy consumption is more related to heating.

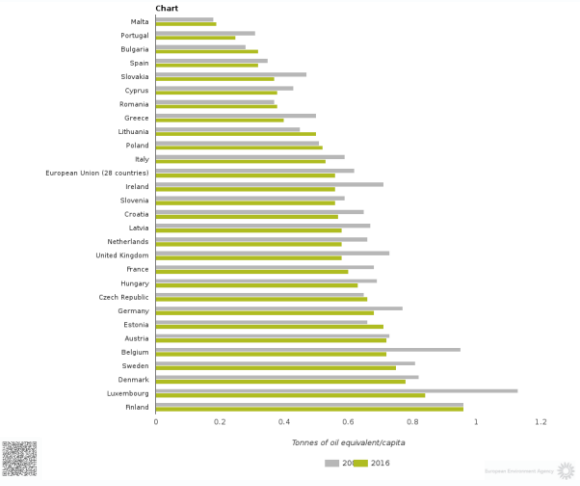


Explanation about the messages from the graph
This graph shows the different final energy consumption densities, which is the final energy consumption per inhabitant. From the colouring, we can observe different ranges of energy consumption per inhabitant, from 1.23 to 4.61 TOE/inhabitant: Luxembourg and Finland have the highest final energy consumption per inhabitant, followed by Austria, Belgium, and Sweden. The next group is composed by Sweden, Netherlands, Germany, and Ireland.

Improvements:

- The colour palette was improved to show darker orange for more consumption.
- For validation we compared our data with per capita data from EEA, see on the right.
- For validation we also double checked directly with Eurostat data for population (TPS00001) and Final consumption for energy use in households (TEN00124)

EEA data for validation:



https://www.eea.europa.eu/airs/2018/resource-efficiency-and-low-carbon-economy/household-energy-consumption

Graph 6 Final energy consumption per inhabitant and energy carrier

This visualization focuses on final energy consumption per energy carrier in all EU countries in relation with the population.

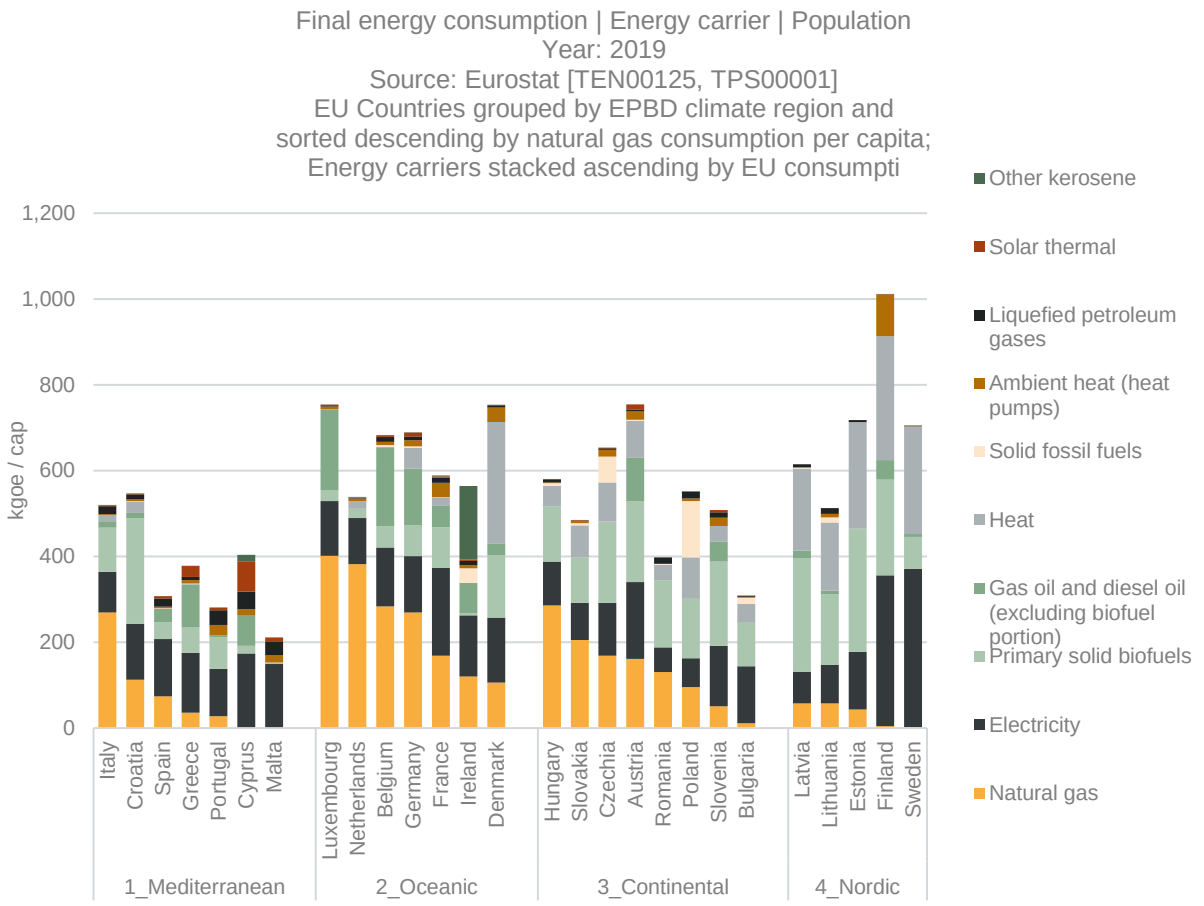
Graph title: Final energy consumption – Energy carrier – Population

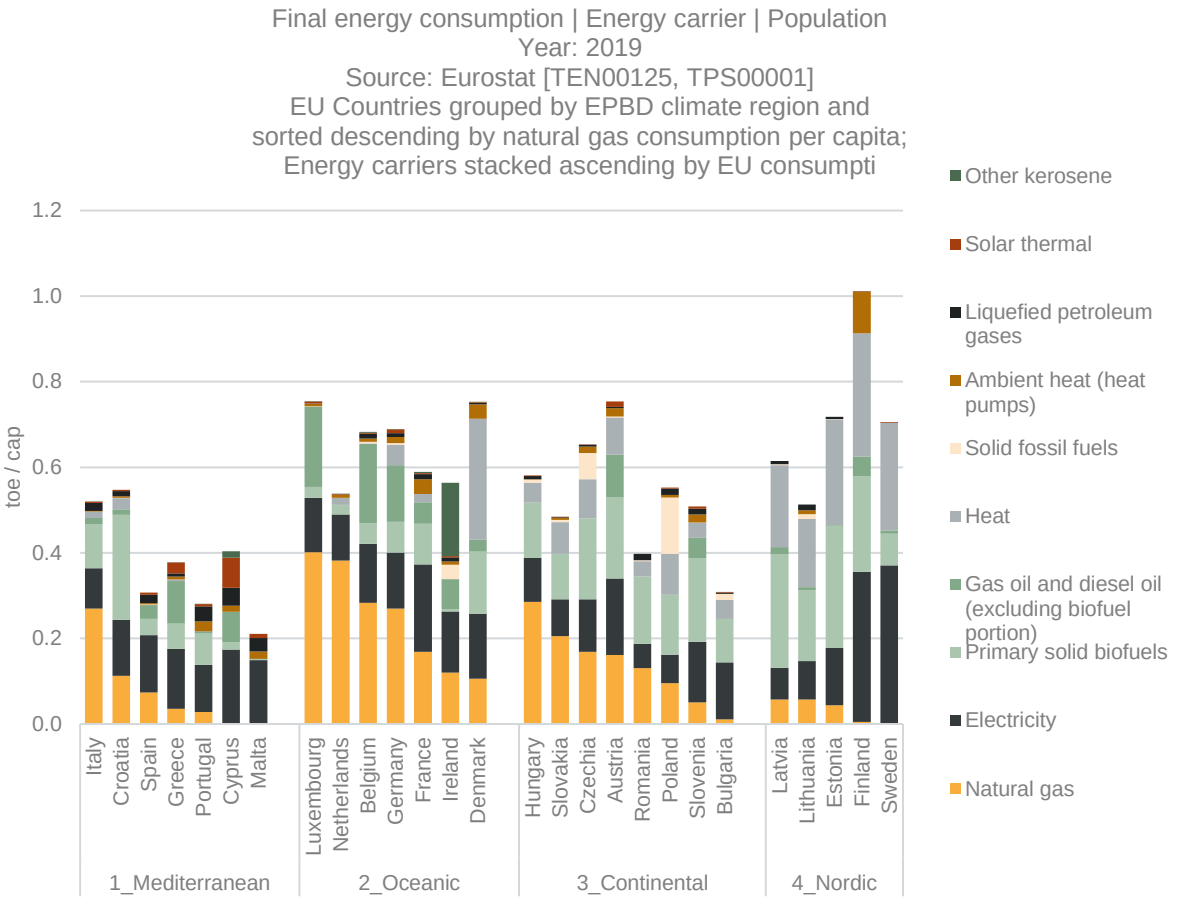
Metadata: Source Eurostat, Year: 2019

Proposed visualization: stacked diagram (country)

Functionalities:

1) scrolling through graph (display country or values);
2) fixed graph mask; 3) grouping and clustering; 4) bar with different width;
6) filters/selection;
7) statistical analysis and trends line





Improvements

- Validation with EEA and Eurostat data referred to in the description of the previous graph.
- Indicated sources more clearly.
- Indicated grouping and sorting.
- Transformed thousand tonnes of oil equivalent into kilograms of oil equivalent by multiplying by 1 million.

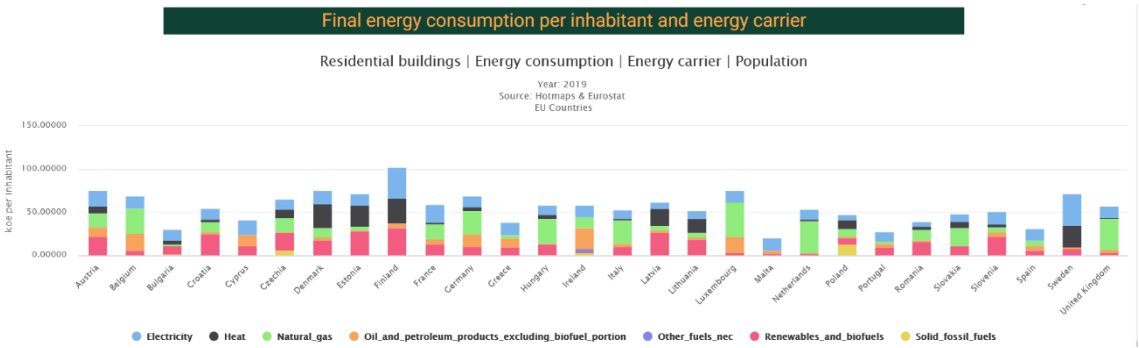
Three key messages from the graph

- Finland, Luxembourg, Denmark, and Austria have the highest final energy consumption per inhabitant in the EU.
- Heat consumption per inhabitant in Finland is the highest in the EU, followed by Denmark, Sweden, and Estonia.
- Malta, Romania, and Bulgaria have the lowest final energy consumption per inhabitant.

Messages delivered from the graph

Buildings in Luxembourg and Finland have the highest energy consumption per inhabitant in the EU, followed by Sweden, Austria, Belgium, Netherlands, and Germany. The graph shows also that electricity consumption per inhabitant in Finland and Sweden is very high, as well as oil and products consumption per inhabitant in Luxembourg.

The Renovation Dashboard



Dashboard 3 Renovation dashboard

Improvement suggestions

- The “Renovation Dashboard” should be renamed to “Energy Consumption Visualizations”.
- Title: Energy consumption data source is Hotmaps; population data source is Eurostat.
- Design: Bars can be wider.
- Readability: group countries by climate region and sort by total value.

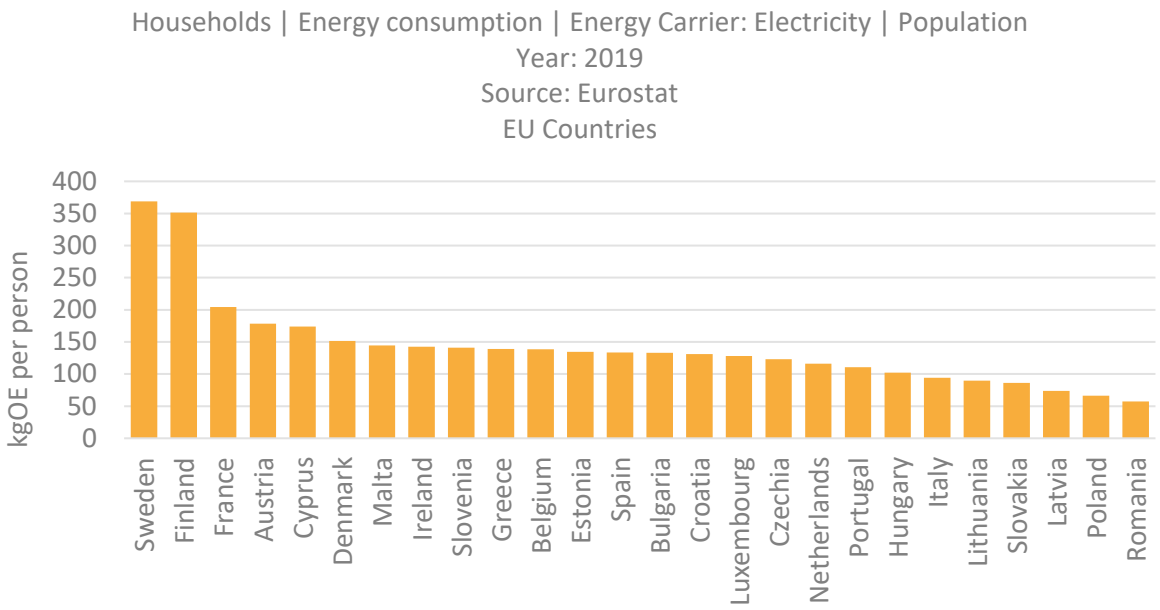
Graph 7 - Final energy consumption per inhabitant and energy carrier (share)

This graph was replaced by Graph 15.

Graph 8 Final energy consumption per inhabitant and energy carrier (filter Electricity)

This visualization is an example of Graph 4 with energy carrier filter (Electricity) for all EU countries.
Graph title: Final electricity *(energy carrier filter)* consumption – Population

Metadata: Source Eurostat, Year: 2019
Proposed visualization: bar diagram (country)
Functionalities:
1) scrolling through graph (display country or values);
2) fixed graph mask;
3) grouping and clustering;
4) bar different width;
6) filters/selection;
7) statistical analysis and trends line



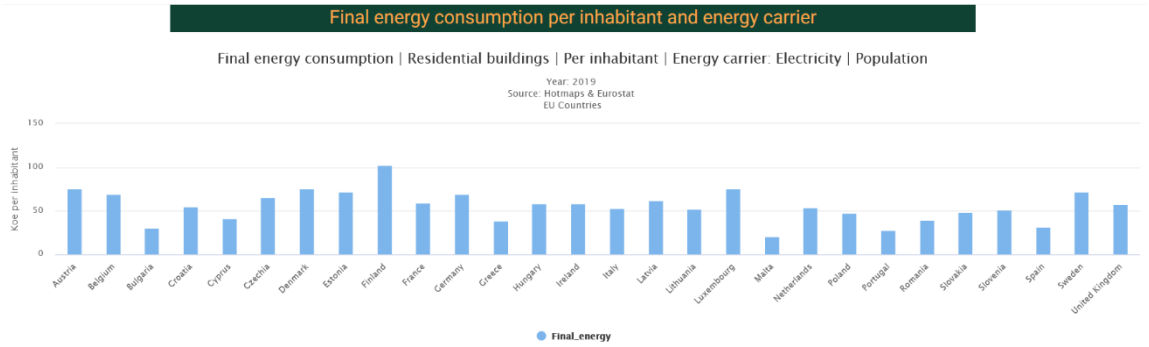
Three key messages from the graph

- Finland is the country with highest electricity consumption per inhabitant.
- Most of the countries have a similar electricity consumption per inhabitant.
- Romania has lowest electricity consumption per inhabitant.
-

Messages delivered from the graph

This visualization allows a cross-country comparison of electricity consumption per inhabitant. For example, Finland has the highest electricity consumption per inhabitant in the EU, followed by Sweden, Luxembourg, Austria, and Belgium. The rest of countries have a similar consumption in electricity.

The Renovation Dashboard



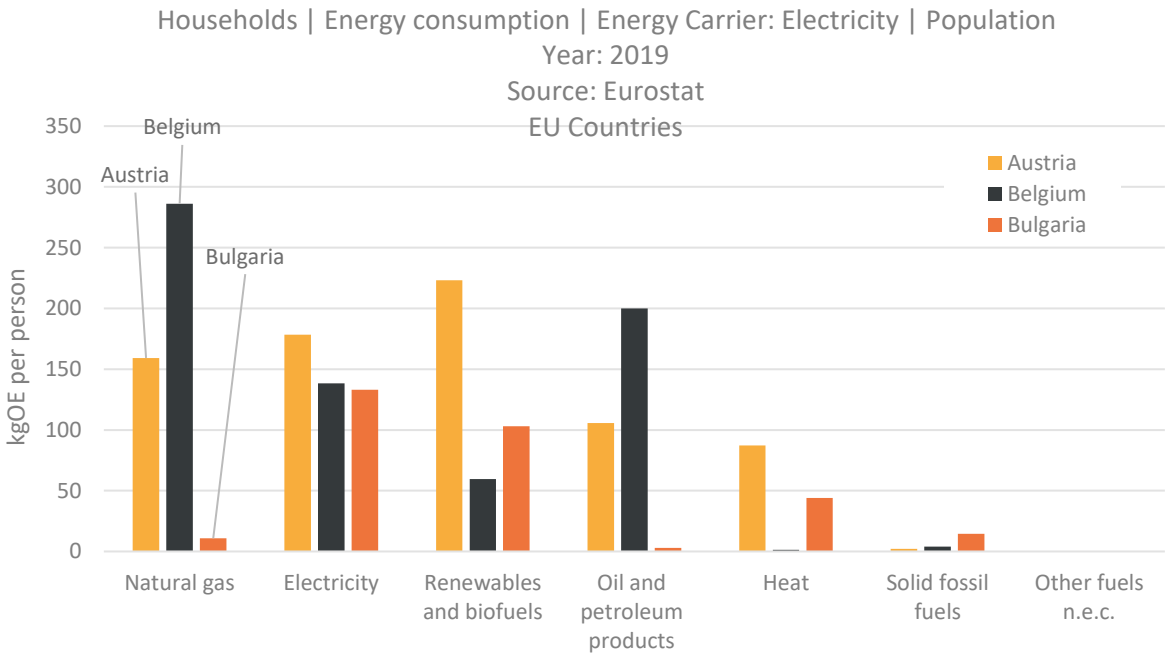
Dashboard 4 in the renovation dashboard > graph 8 Electricity consumption per inhabitant and energy carrier

Improvement suggestions

- Possibility to filter for specific bars would be a useful feature for all stacked bar charts, it makes a visual comparison among countries easier.
- As the implementation does not have a filter but only shows Electricity, the Heading should say “Electricity consumption …”.
- Content: Electricity data source is Hotmaps; population data source is Eurostat.
- Design: Bars can be wider, drop the legend.
- Readability: countries can be grouped by climate region and sorted by value.

Graph 9 Final energy consumption per inhabitant by energy carrier (country comparison)

Similar to the previous one, this visualization is an example of Graph 4 but with countries filter (Austria, Belgium and Bulgaria), where the final energy consumption is depicted per inhabitant and energy carrier.
Graph title: Final energy consumption – Energy carrier – Population
Metadata: Source Eurostat, Year: 2019
Proposed visualization: bar diagram (energy carrier)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



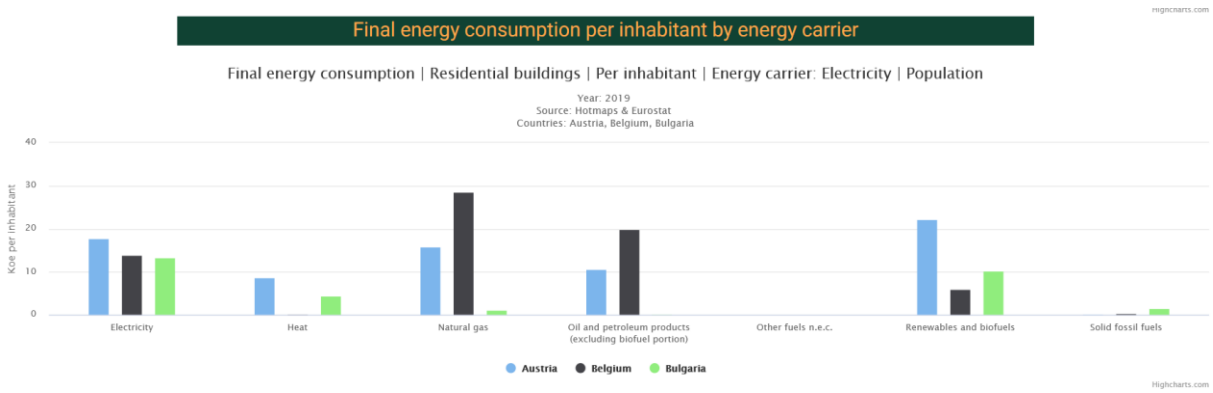
Three key messages from the graph

- Electricity consumption per inhabitant is similar in the three countries.
- Heat consumption per inhabitant is higher in Austria, while Belgium has the highest natural gas consumption per capita.
- Renewables and biofuels consumption per inhabitant is higher in Austria.

Messages delivered from the graph

This visualization allows a comparison of the consumption per inhabitant in the different energy carriers of some selected countries, making comparison easy. Bulgaria has the highest consumption in renewables per inhabitant.

The Renovation Dashboard



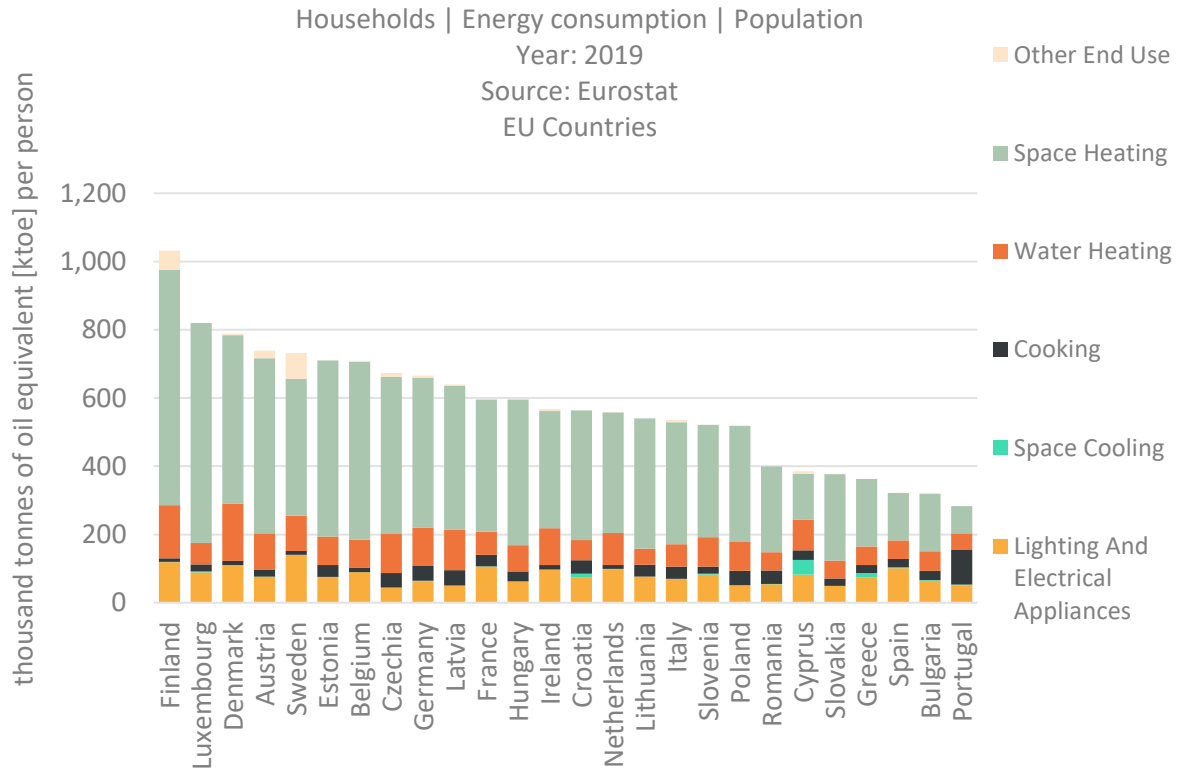
Dashboard 5 in the renovation dashboard. We find the energy consumption for Austria, Belgium, and Bulgaria.

Improvement suggestions

- Heading should say “Final energy consumption per inhabitant by energy carrier – country comparison”.
- Content: Electricity data source is Hotmaps; population data source is Eurostat.
- Readability: countries can be grouped by climate region and sorted by value.

Graph 10 Final energy consumption per inhabitant by end-use (country comparison)

This visualization focuses on final energy consumption per energy end-use in all EU countries in relation with the population in each EU country.
Graph title: Final energy consumption – End-use – Households – Population
Metadata: Source Eurostat, Year: 2019
Proposed visualization: stacked diagram (country)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

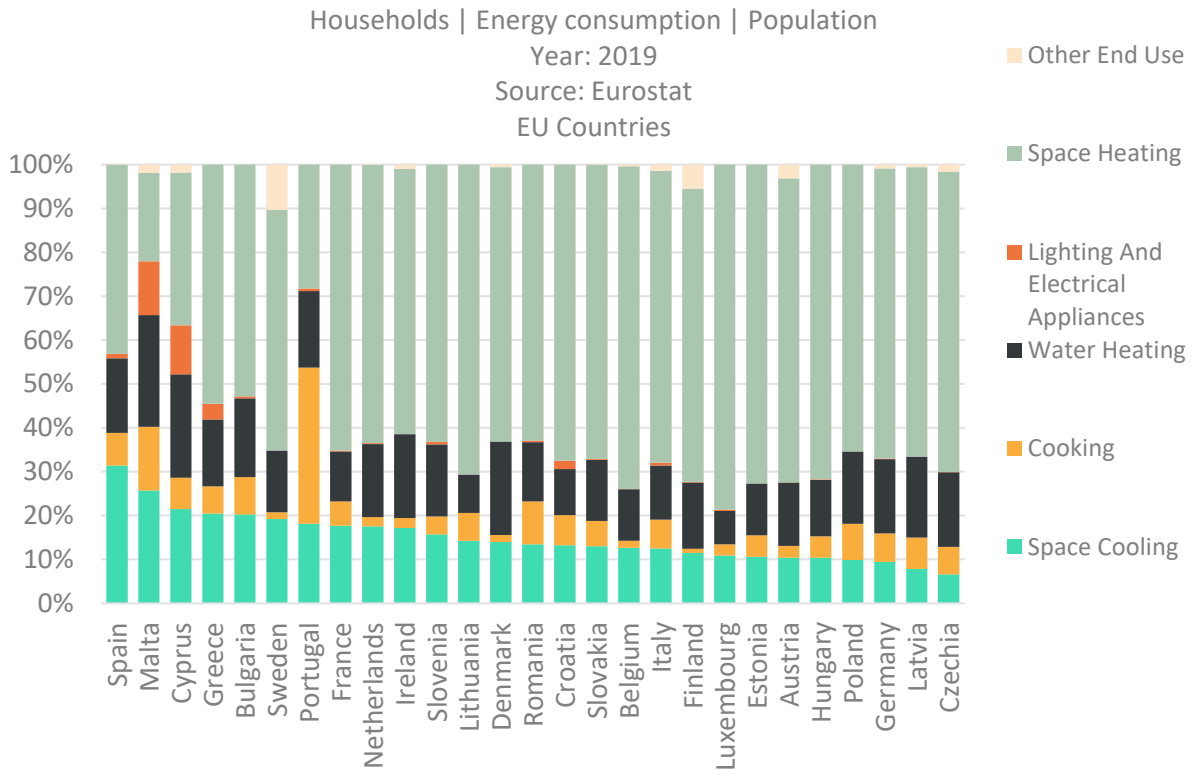
- Space heating is the energy end-use with the highest consumption per inhabitant across the countries.
- Water heating and cooking end-uses have a similar consumption per inhabitant for all countries.
- Malta has the lowest total energy consumption for all end-uses per inhabitant, while Finland has the highest.

Messages delivered from the graph

This graph highlights that the highest energy end-use consumption per inhabitant is on space heating for all EU countries.

Graph 11 Final energy consumption per inhabitant by end-use (country comparison) (share)

This visualization focuses on the share of energy uses in final energy consumption in relation with the population in each EU country.
Graph title: Final energy consumption – Residential buildings – End-use – Population – Share
Metadata: Source Eurostat, Year: 2018
Proposed visualization: stacked diagram (share)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

- The highest share on energy consumption per inhabitant is on space heating in almost all the countries.
- Malta has the lowest share in space heating in energy consumption per inhabitant, and in general, Malta has the most distributed end-use energy consumptions.
- The highest share on water heating from energy consumption per inhabitant is in Denmark and Finland, while the highest share for cooking end-use energy consumption is in Portugal.

Messages delivered from the graph

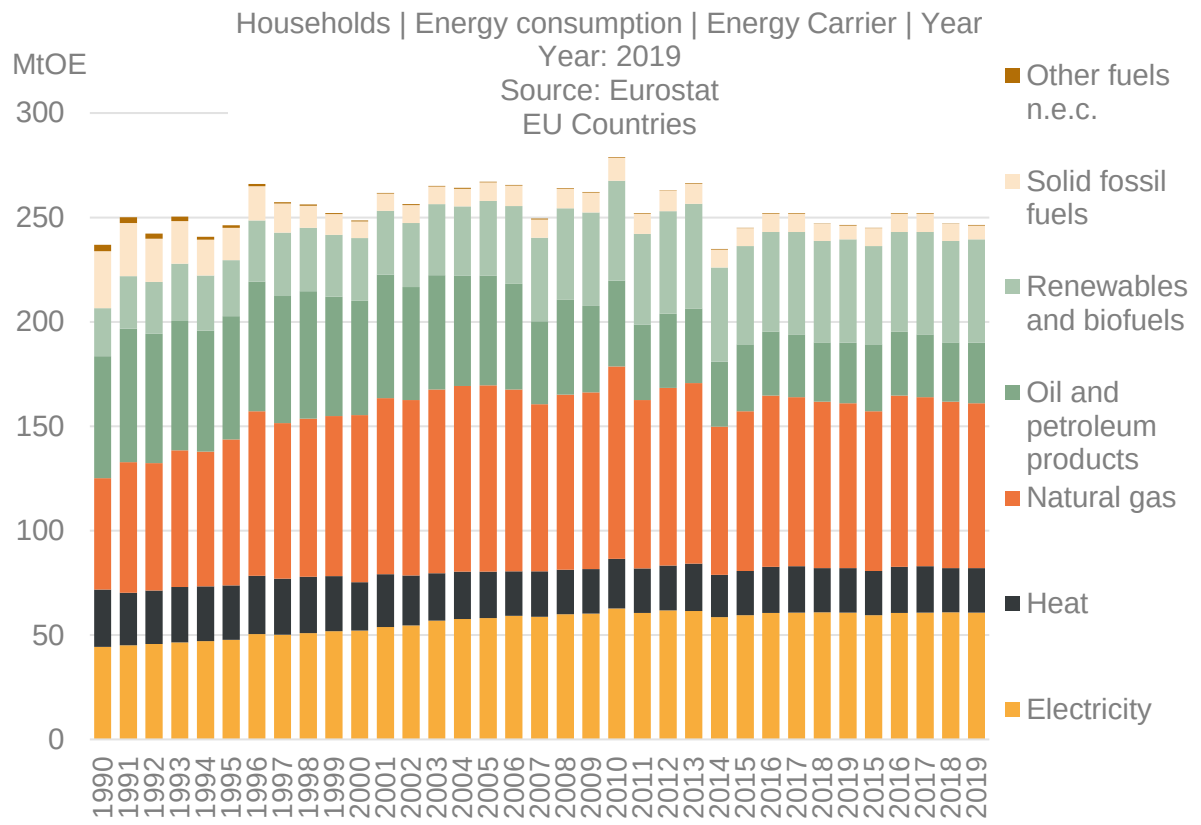
This visualization allows a cross-country comparison between the share of final energy consumption per inhabitant of the different end-uses.

3.4. Final energy consumption by energy carrier

These graphs show the final energy consumption for residential buildings at EU level and in each EU-country divided by energy carrier (solid fossil fuels, renewables and biofuels, other fuels not elsewhere classified, fossil oil and petroleum products, natural gas, heat, and electricity), as evolution across different years or in a specific year.

Graph 12 Final energy consumption in households by energy carrier and by year

In this type of visualization, the absolute value is not on focus, but rather the share of final energy consumption between the different construction periods.
Graph title: Final energy consumption – Residential buildings – Energy carrier
Metadata: Source Eurostat, Year: 2010-2021
Proposed visualization: stacked diagram (year)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

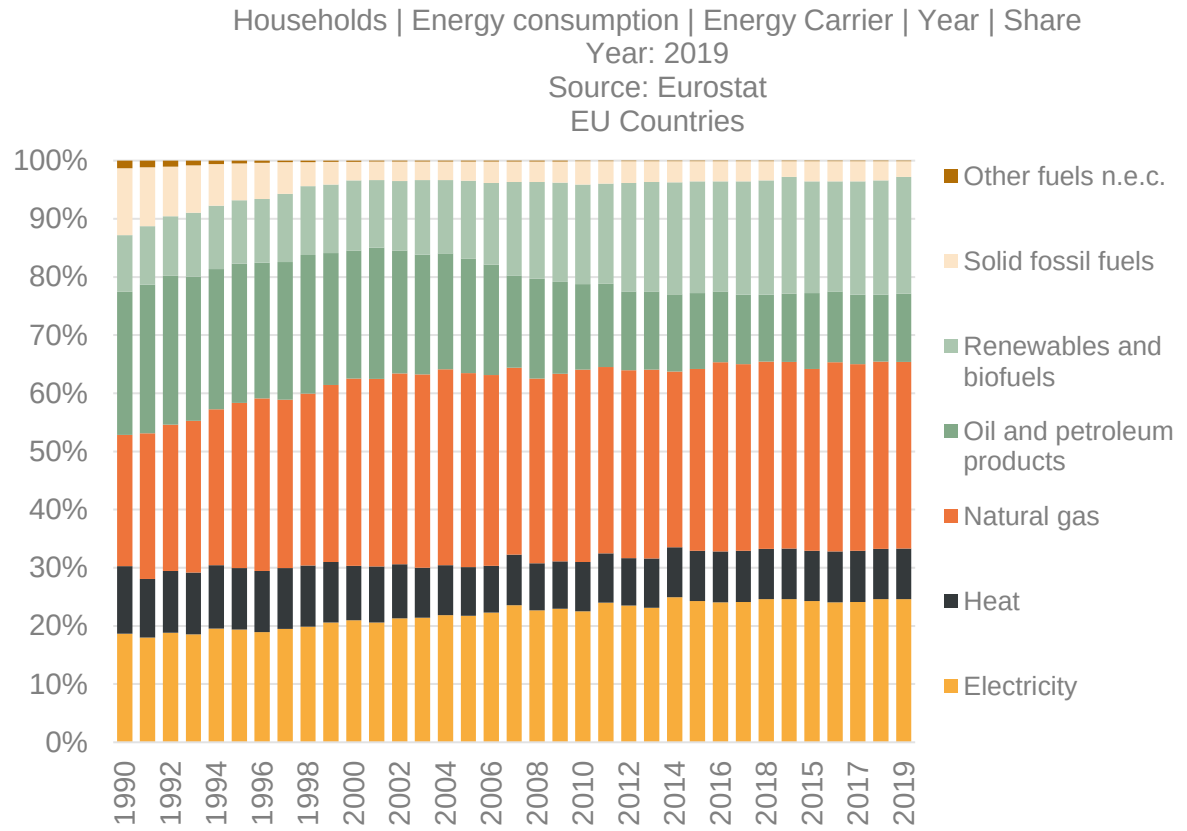
- Over the whole period (2010-2021) the final energy consumption varied around 250 Mtoe, with the lowest consumption in 1990 and the highest in 2016.
- Natural gas and electricity consumption are gradually increasing over time.

Messages delivered from the graph

The total (as sum of all energy carriers) energy consumption in the EU is about stable. In this type of visualization, the focus is on the total final energy consumption by energy carrier across the years at EU level, in case the user is more interested in evolution and EU values as a whole.

Graph 13 Final energy consumption in households by energy carrier and by year (share)

In this type of visualization, the absolute value is not on focus, but rather the share of final energy consumption per energy carrier across the years at EU level.
Graph title: Final energy consumption – Residential buildings – Energy carrier – Share - Year
Metadata: Source Eurostat, Year: 2010-2021
Proposed visualization: stacked diagram (share)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

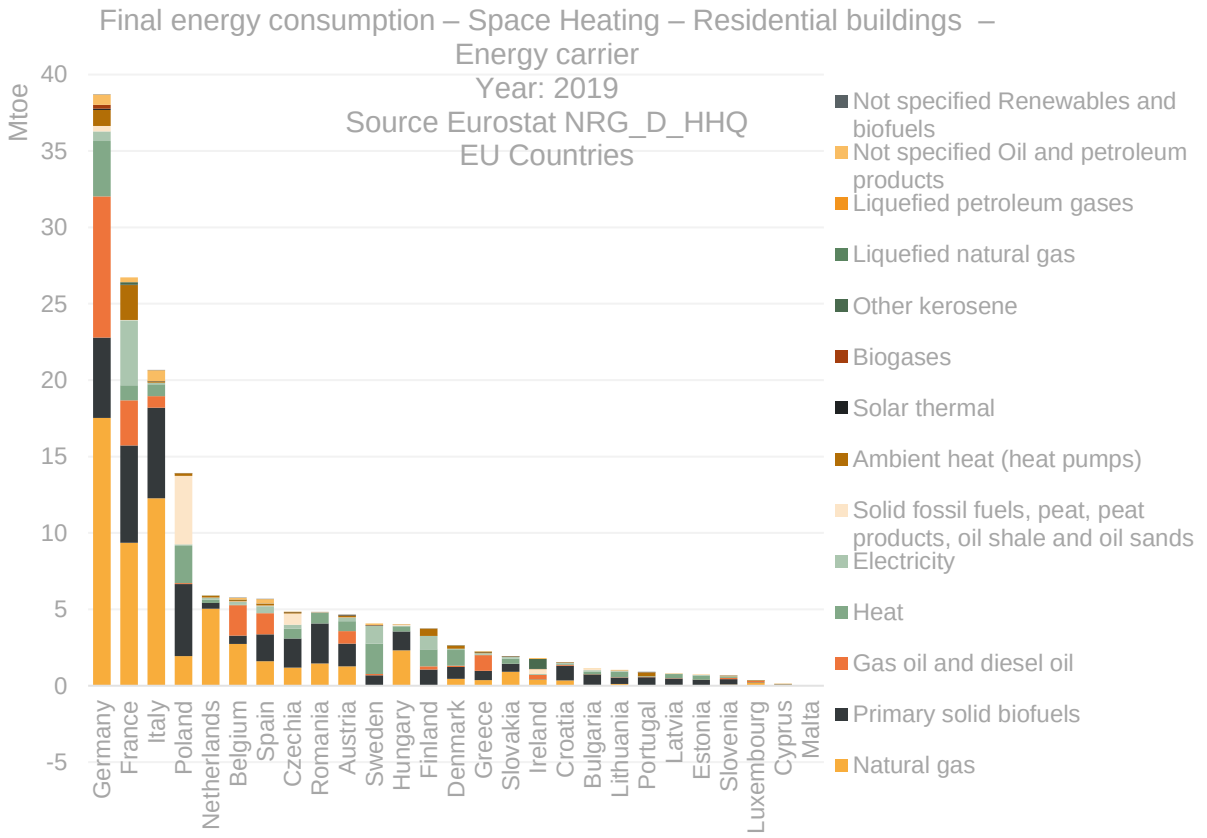
- Oil and petroleum products are the energy carriers most consumed over the years in the EU.
- Electricity consumption increased gradually during the period.
- Renewable energy also increases.

Messages delivered from the graph

While the use of renewable energy is increasing, it by far does not cover a dominant share of the final energy consumption in households. The dominant energy carriers in the 1900s were oil and gas, and gas has grown to dominate.

Graph 14 Final energy consumption for space heating by energy carrier and country, for one year

This visualization focuses on the final energy consumption per energy carrier for a certain year in each EU country, in case the user is interested in the absolute value.
Graph title: Final energy consumption – Residential buildings – Energy carrier – Country
Metadata: Source Eurostat **NRG_D_HHQ**, Year: 2019
Proposed visualization: stacked diagram (country)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

- Germany has the highest final energy consumption in 2019, with around 39 Mtoe, followed by France, Italy, and Poland.
- Malta has the lowest final energy consumption, with about 21 ktoe.
- Overall, the energy carrier providing most of the space heating according to Eurostat reporting is natural gas, followed by primary solid biofuels, and gas oil and diesel oil.

Messages delivered from the graph

It shows a great difference between the energy consumption across countries, since some are bigger in area and more populated than others. Natural gas is the most consumed energy carrier in most countries, followed by electricity.

Graph 15 Final energy consumption for space heating by energy carrier and country, for one year (share)

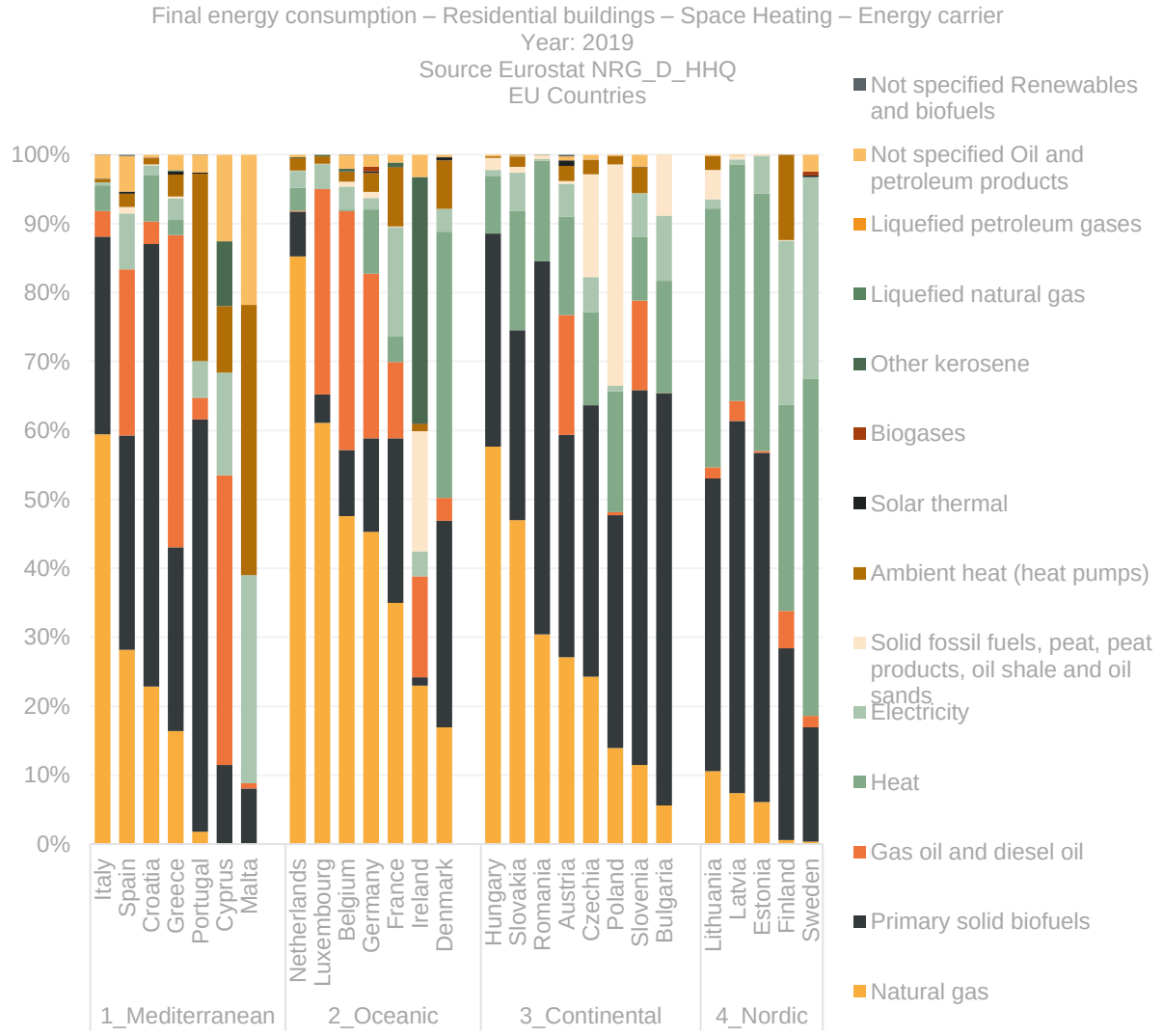
This visualization focuses on the share of final energy consumption per energy carrier for a certain year in the EU countries.

Graph title: Final energy consumption – Residential buildings – Energy carrier – Country

Metadata: Source Eurostat, Year: 2019

Proposed visualization: stacked diagram (share)

Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



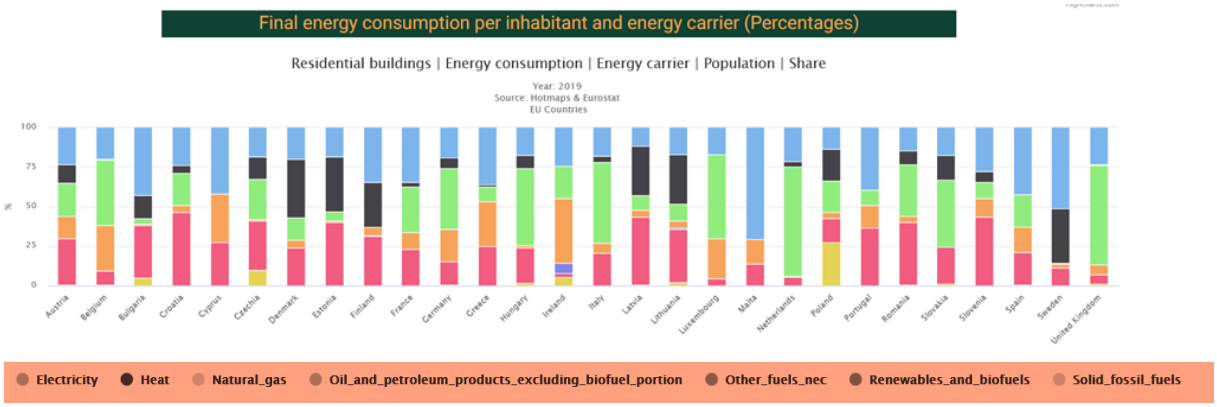
Three key messages from the graph

- The share of final energy consumption in 2019 varies across countries.
- For most countries the highest energy consumption share is either electricity, natural gas, or renewables.
- The lowest share of energy consumption is provided by solid fossil fuels and heat.
- Hungary has the highest share in final energy consumption in 2019 in solid fossil fuels carrier, while Luxembourg has the highest share in final energy consumption for oil and petroleum products.

Messages delivered from the graph

This visualization allows a cross-country comparison of the share of the energy carriers on final energy consumption in 2019.

The Renovation Dashboard



Dashboard 6 The renovation dashboard

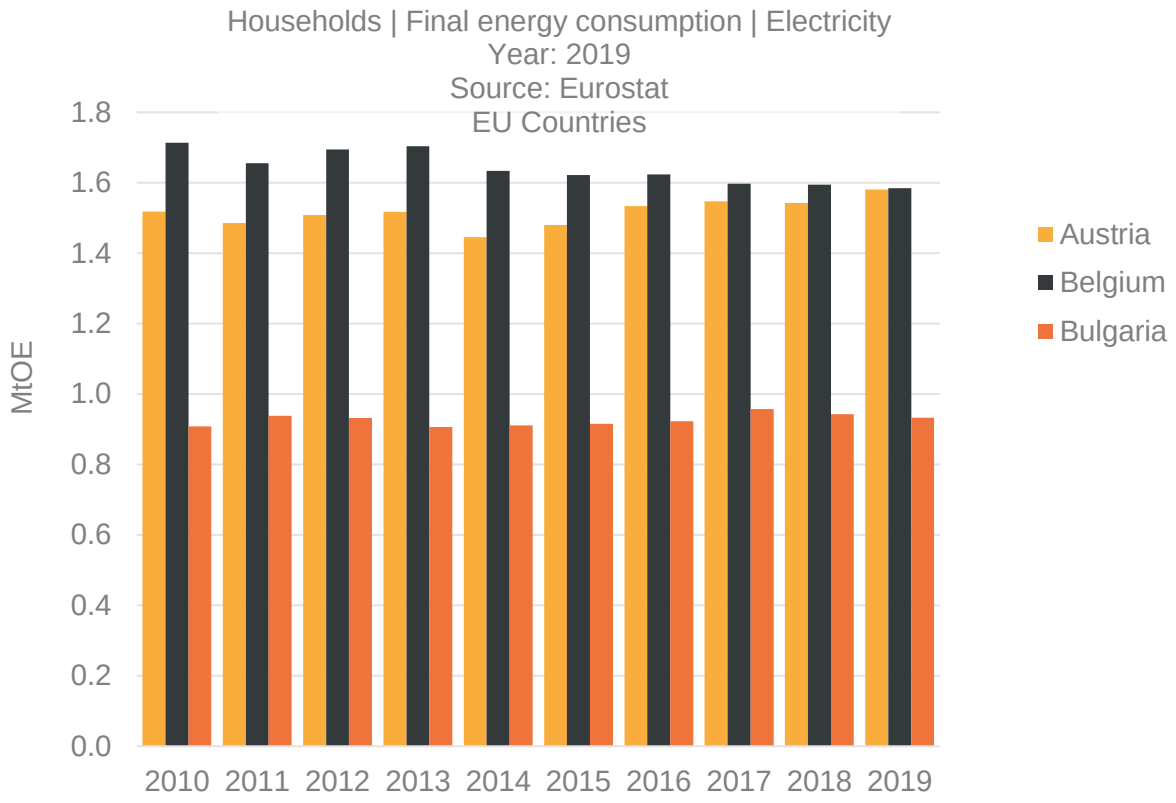
Improvement suggestions

- Content: Energy consumption data source is Hotmaps; population data source is Eurostat.
- Add a legend!
- Design: make bars wider.
- Readability: sort countries descending by natural gas share.

Graph 16 Final energy consumption in households selected energy carrier (country comparison by year)

This graph shows a combination of

Graph 13 and Graph 14, and the application of **filter/selection** functionality. This visualization focuses on final energy consumption with an energy carrier filter across the years, and few countries being selected.
Graph title: Final electricity (*energy carrier filter*) consumption – Year
Metadata: Source Eurostat, Year: 2010-2021
Proposed visualization: bar diagram
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

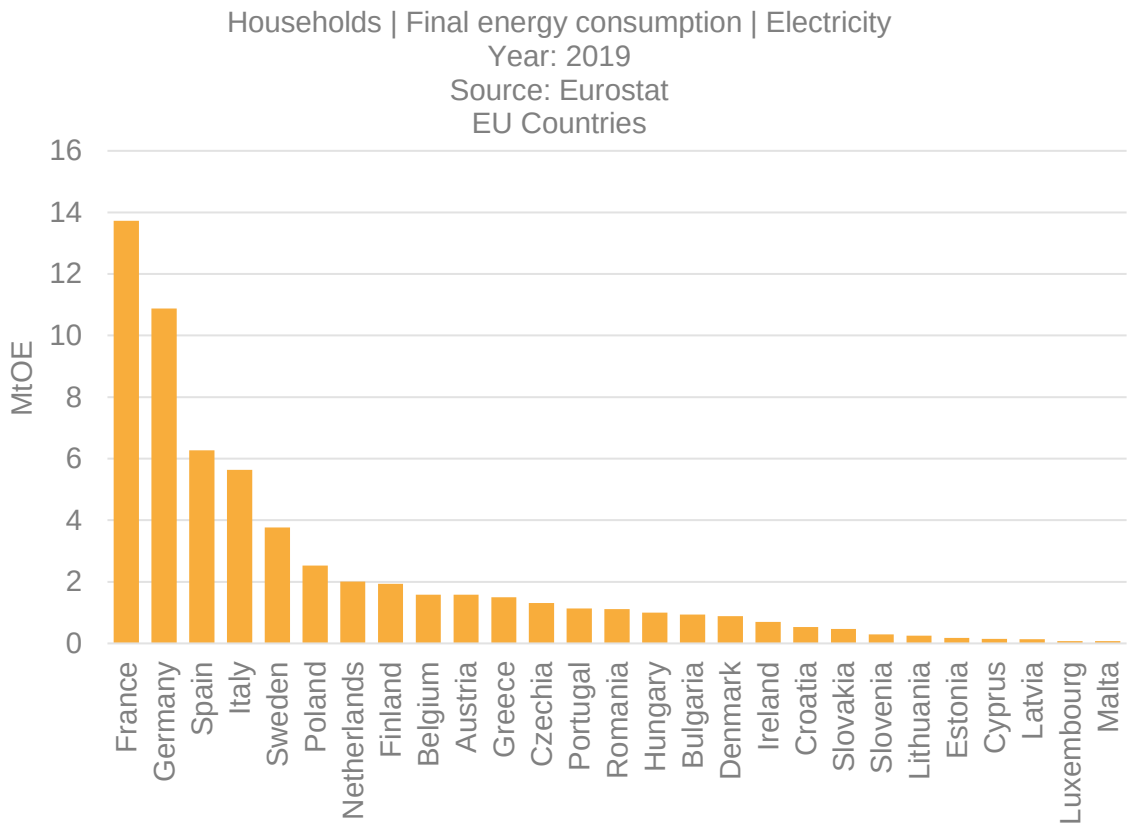
- From years 2010 – 2019, the electricity consumption in Belgium was higher than that of Austria, and much higher than that of Bulgaria.
- The electricity consumption in Austria is slowly increasing over the years.
- The electricity consumption in Belgium is about stable in the recent years, starting a little decrease.

Messages delivered from the graph

This visualization focuses on the final energy consumption by energy carrier across the years focusing on specific countries in case the user is most interested in their evolution.

Graph 17 Final energy consumption in households for selected energy carrier (country comparison)

This visualization is an example of Graph 14 but with energy carrier filter (Electricity).
Graph title: Final electricity (filtered energy carrier) consumption
Metadata: Source Eurostat, Year: 2019
Proposed visualization: bar diagram (country)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

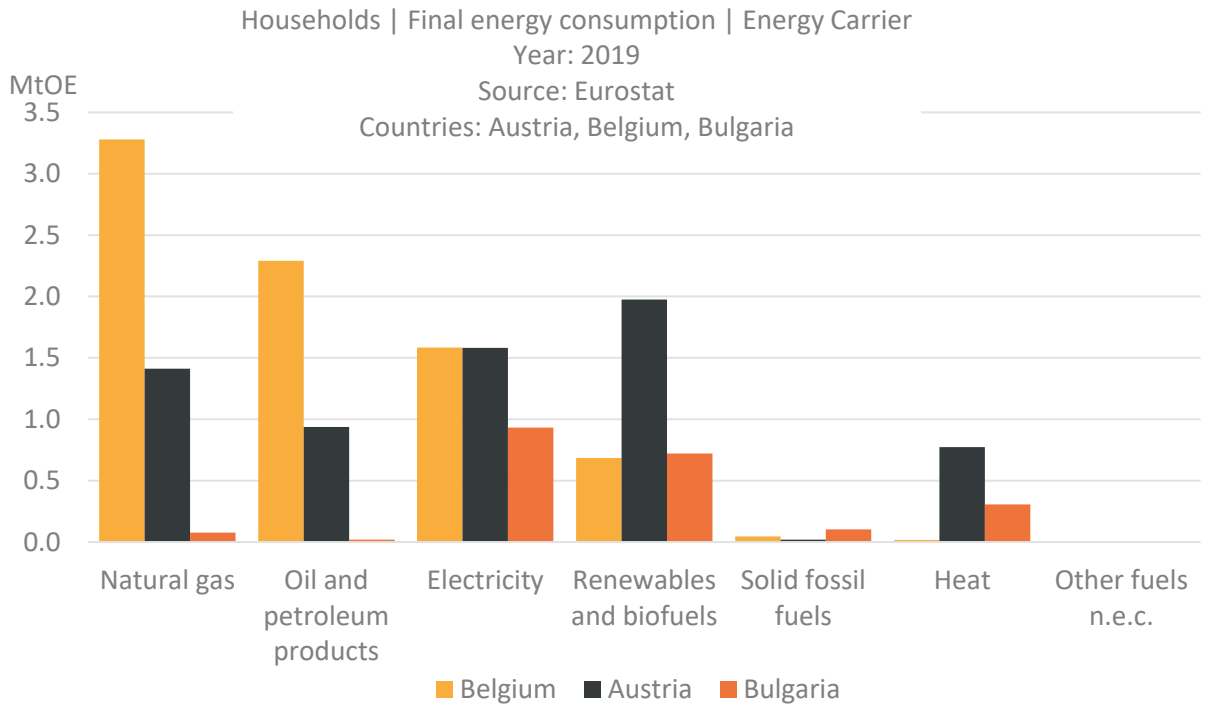
- France, Germany, Spain, and Italy have the highest electricity consumption in 2019 in the EU.
- Malta has the lowest electricity consumption in 2019, followed by Luxembourg, Latvia, and Cyprus.
- Electricity consumption is related with the countries' size and population.

Messages delivered from the graph

It shows the electricity consumption in the EU countries, which is generally higher in the most populated ones (Germany, France, Spain, and Italy).

Graph 18 Final energy consumption in households by energy carrier for selected countries

Like the previous one, this visualization is an example of Graph 14 but with countries filter (Austria, Belgium and Bulgaria), in case the user is more interested in the final energy consumption by energy carrier for a certain year in some specific countries.
Graph title: Final energy consumption – Energy carrier
Metadata: Source Eurostat, Year: 2019
Proposed visualization: bar diagram (energy carrier)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

- Natural gas consumption in 2019 is much higher in Belgium.
- Among the selected countries, natural gas consumption is highest in Belgium, while heat consumption is highest in Austria.
- The consumption of renewables in Austria is the highest among the three countries.
-

Messages delivered from the graph

This visualization allows comparison of the consumption in the different energy carriers for a certain year (2019) of few countries, making comparison easy. Bulgaria has generally the lowest consumption in every energy carrier, with some notable exceptions.

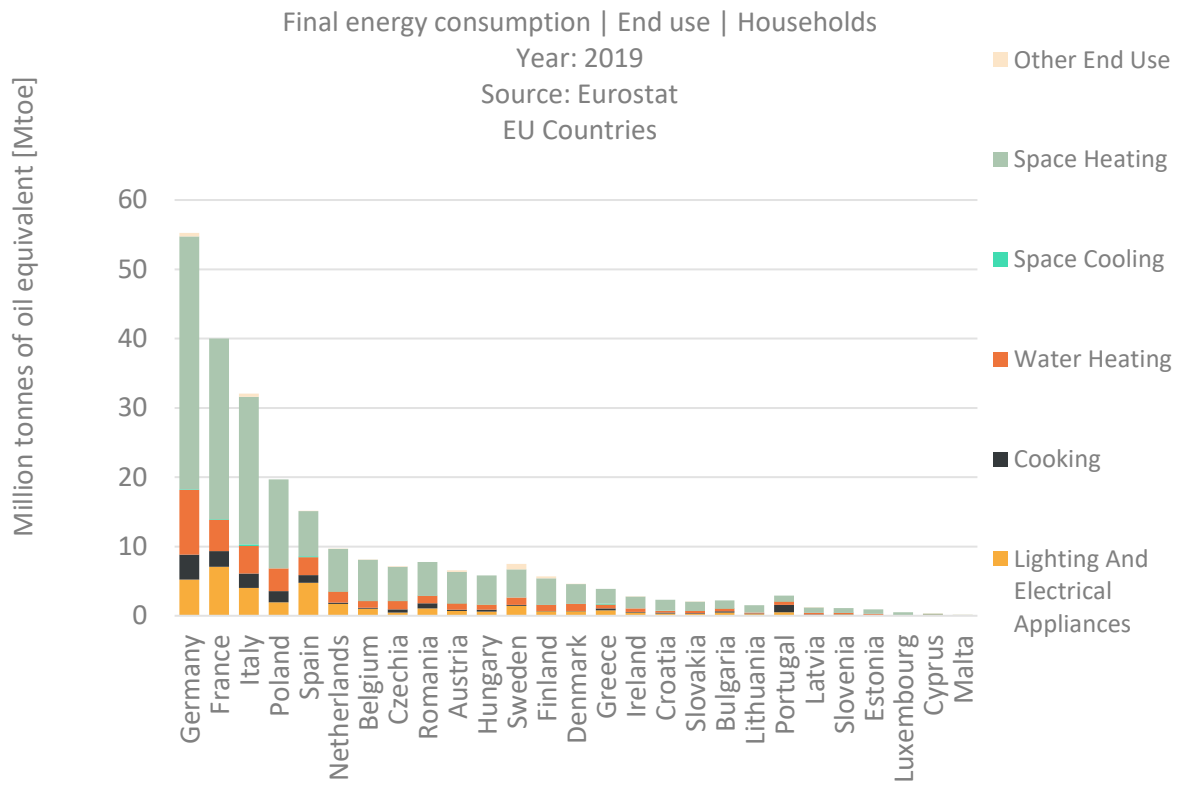
3.5. Final energy consumption by end-use

These graphs show the final energy consumption for residential buildings at in the EU countries divided by energy use (space heating, water heating, cooking, lighting and electrical appliances, other end use), in a specific year.

Graph 19 Final energy consumption by end-use country comparison for one year and several end-uses

This visualization focuses on the final energy consumption per end-use in the EU countries.
Graph title: Final energy consumption – End-use - Households

Metadata: Source Eurostat, Year: 2019
Proposed visualization: stacked diagram (country)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

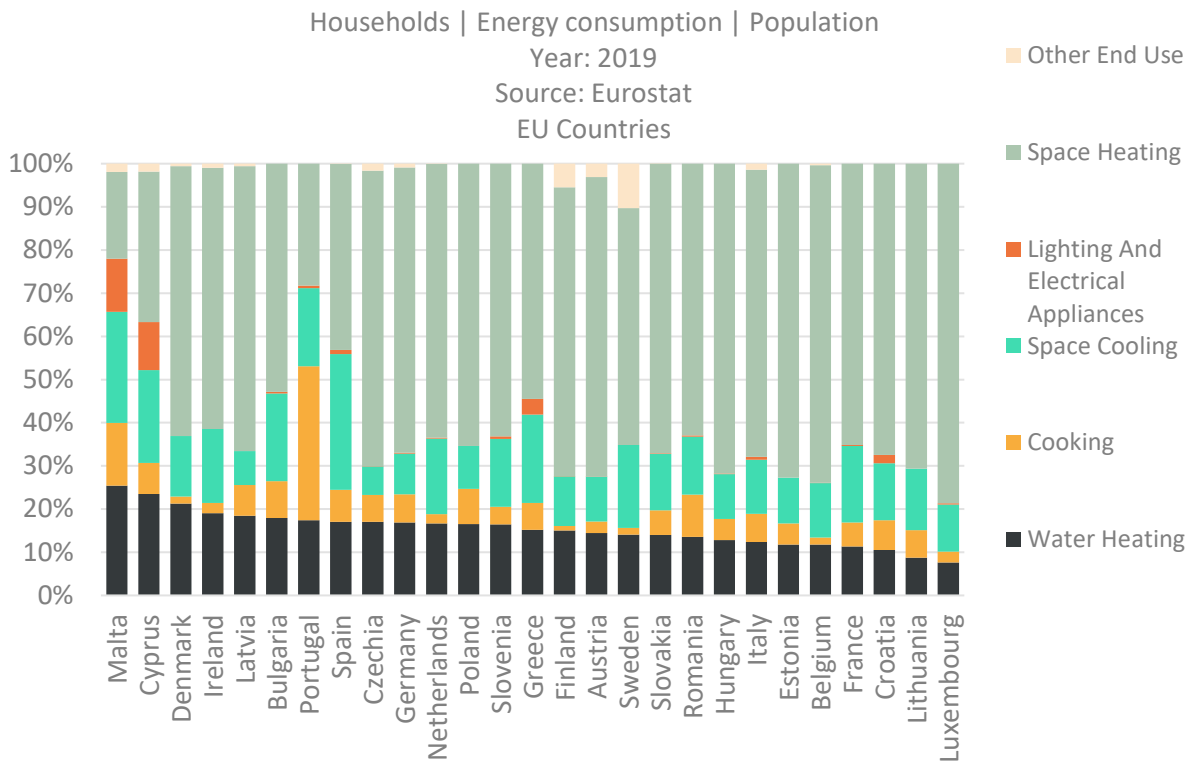
- Germany, France, and Italy have the highest total energy consumption for all end uses in 2019.
- Space heating is the energy end-use with the highest consumption for all countries.
- Malta has the lowest total energy consumption for all end-uses in 2019.

Messages delivered from the graph

This graph highlights that the highest energy consumption for the end-uses in 2018 is higher in the most populated countries. It shows also that the most energy-consuming end-use for all countries is space heating.

Graph 20 Final energy consumption by end-use country comparison for one year and many end-uses

This visualization focuses on the share of final energy consumption per energy end-use in the different countries.
Graph title: Final energy consumption – End-use – Households – Share
Metadata: Source Eurostat, Year: 2019
Proposed visualization: stacked diagram (share)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

- Space heating is the highest share in energy consumption in 2019 in most of the countries.
- Malta has the lowest share of space heating in energy consumption in 2019, and in general, Malta is the country with most different shares in the energy end-uses consumption, followed by Portugal, Cyprus, and Spain (seems climate-related).
- The highest share of water heating in energy consumption in 2019 is in Malta and Cyprus, while the highest share for cooking end-use is in Portugal, and the highest share for cooling is in Spain.

Messages delivered from the graph

This visualization allows a cross-country comparison between the share of final energy consumption in 2019 of the different end-uses.

3.6. Specific final energy consumption (per floor area)

Graph 21 Specific final energy consumption

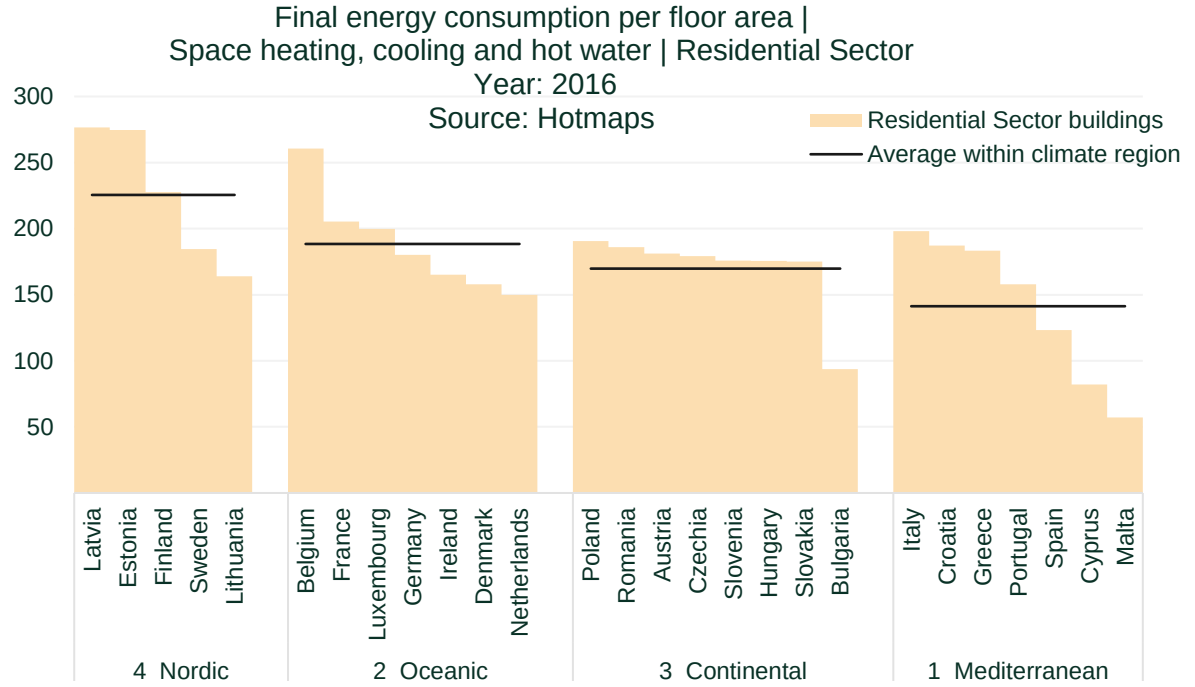
This graph shows the final energy consumption per floor area (kWh/m²*yr) for residential buildings in all EU countries. This graph focuses on a **cross-country** comparison. Therefore, all EU countries are represented. Additionally, the countries are clustered by climate region (according to the EPBD 2021, compare Table 2 on page 9).

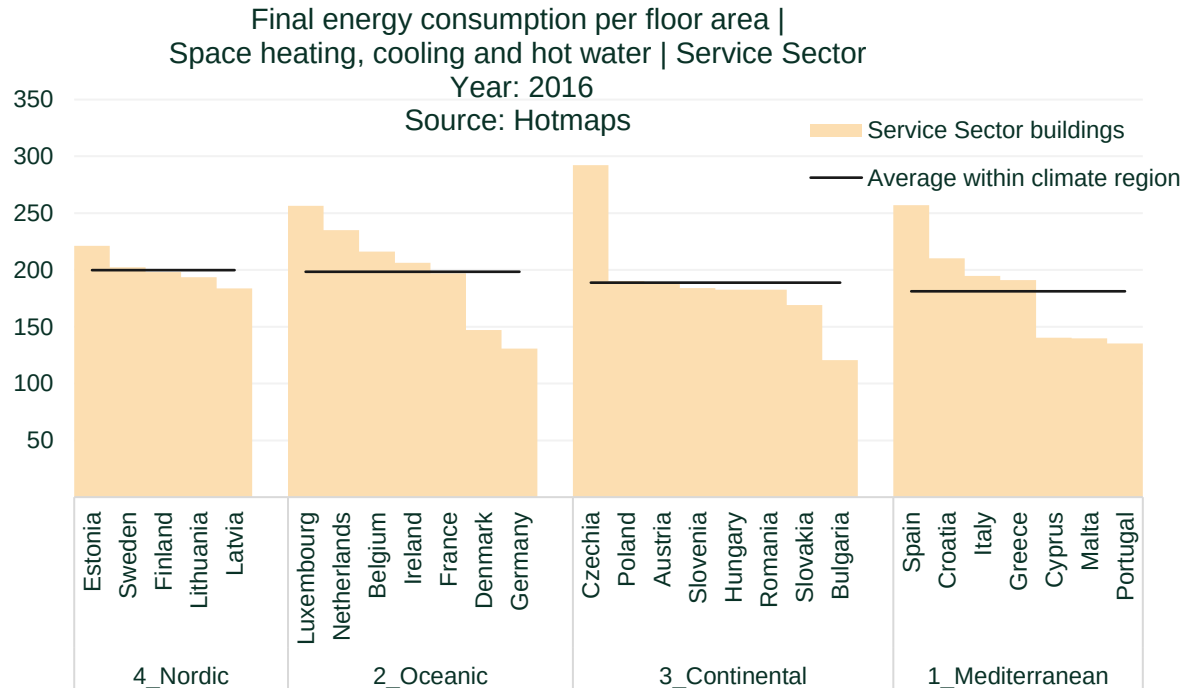
Graph title: Final energy consumption – Residential buildings – Floor area

Metadata: Source Hotmaps, Year: 2016

Proposed visualization: stacked diagram (increasing / clustered by climate region)

Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) filters/selection; 5) statistical analysis and trends line; 6) sorting





Three key messages from the graph

- The graph shows, which country is leading within their climate peer group[6] regarding the energy efficiency in buildings for the residential sectors and service sector.
- The different order of countries in the two graphs shows that in some countries residential buildings are more advanced and in other countries service buildings are more advanced, compared to the climate region counterparts.
- Latvia and Belgium are the countries with highest final energy consumption per floor area, while Malta is the lowest between all countries.
- In the different climate regions, Nordic and Mediterranean are the climate region with the highest difference between the countries.
- Countries with highest final energy consumption in their climate region area Italy, Belgium, Romania and Latvia.

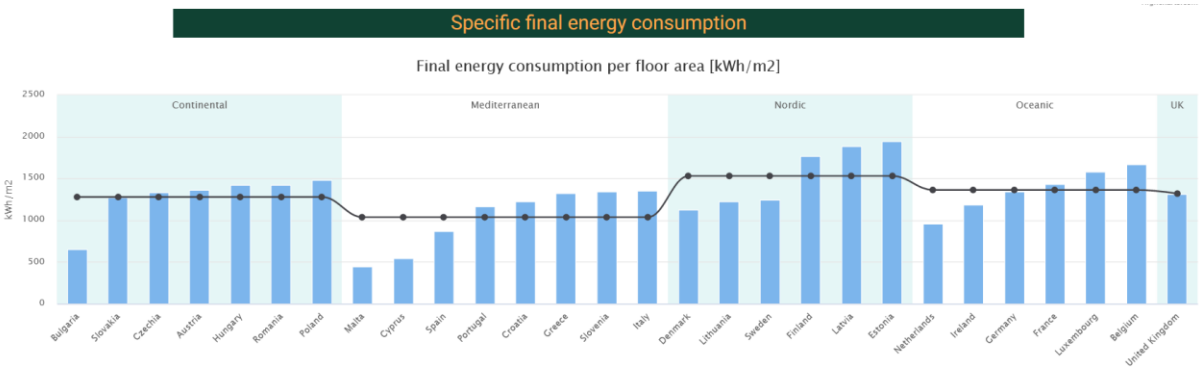
Potential improvements

- Calculating average and median considering the population size of the countries as a weighting factor.

Messages delivered from the graph:

For example: The Mediterranean group seems to be very diverse. Comparisons should be done with cautious attention to the context. In the continental group the variance is very low, countries seem to be well-comparable except for Bulgaria.

The Renovation Dashboard



Dashboard 7 renovation dashboard > graph 21 Specific final energy consumption per floor area

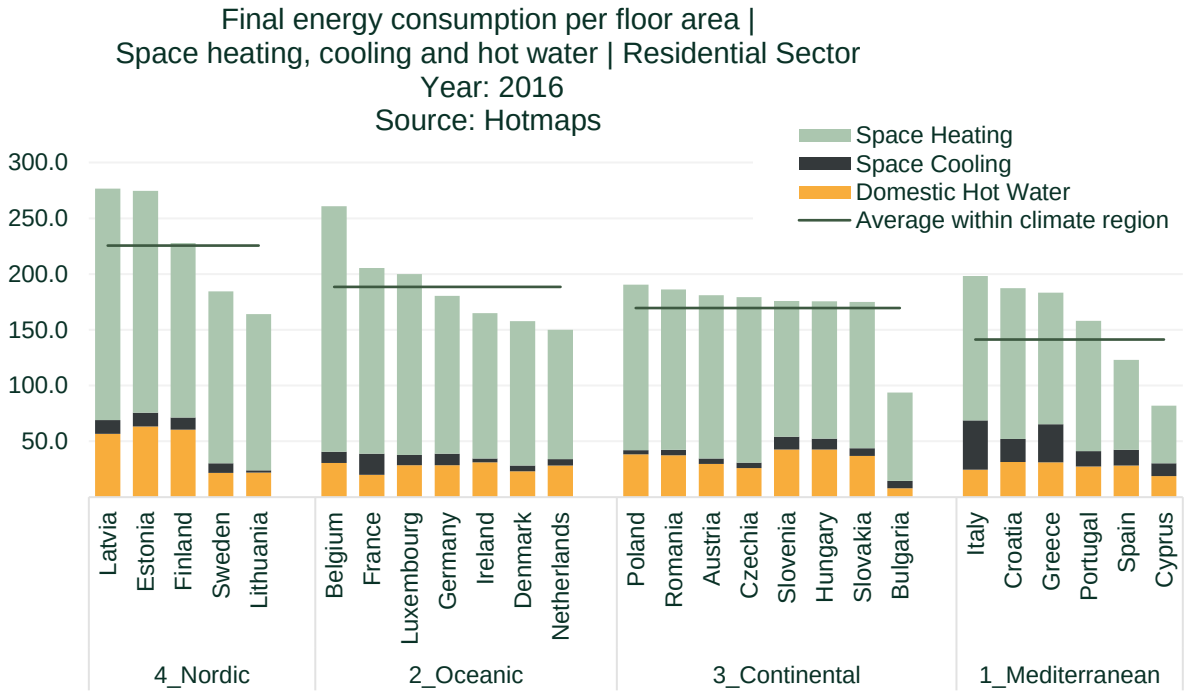
Improvement suggestions

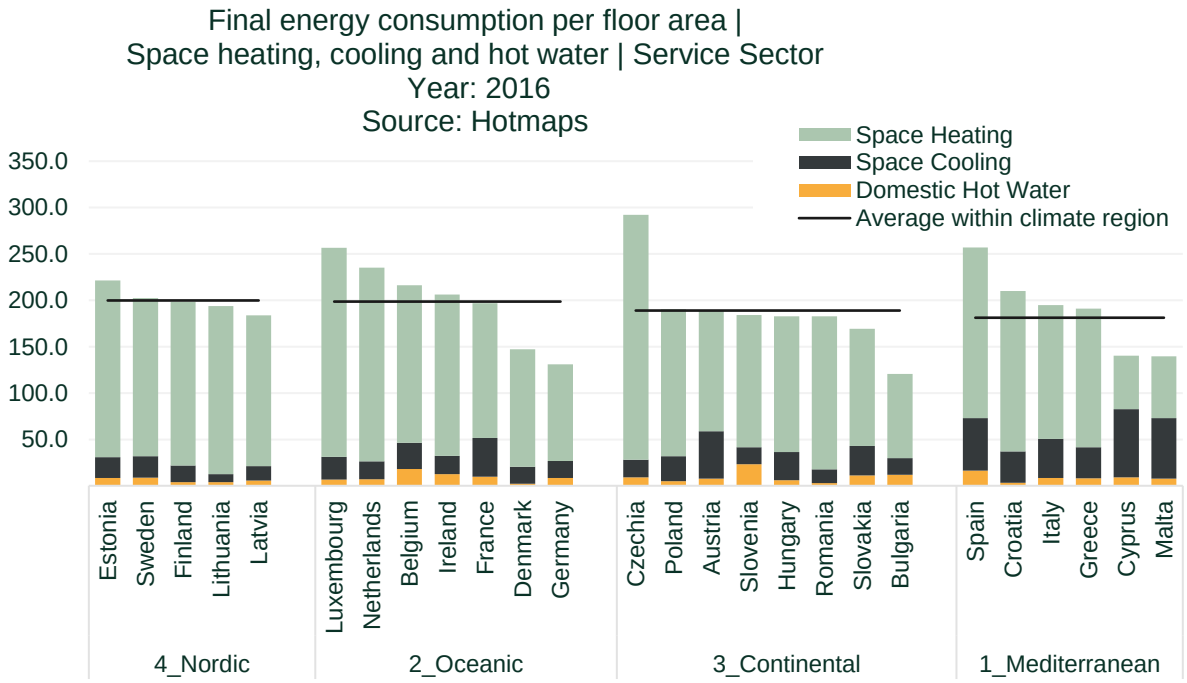
- Update title as above to show data source and year.
- Average line: Use dashes instead of dots and do not connect them, i.e., do not connect the regions.
- The values need to be averaged instead of summed up, but the energy uses need to be summed, see in the chart above.

[6] According to EPBD climate regions

Graph 22 Specific final energy consumption and end-use [Ina/Ece]

This graph shows the final energy consumption per floor area (kWh/m²*yr) for residential buildings in all EU countries divided by end-uses (Space Heating, Space cooling and Domestic Hot Water). This graph focuses on a **cross-country** comparison. Therefore, all EU countries are represented. Additionally, the countries are clustered by climate region (according to the EPBD 2021, compare Table 2 on page 9).
Graph title: Final energy consumption – Residential buildings – Floor area – End-use
Metadata: Source Hotmaps, Year: 2016
Proposed visualization: stacked diagram (climate region)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) filters/selection; 5) statistical analysis and trends line; 6) sorting; 7) statistical analysis and trends line

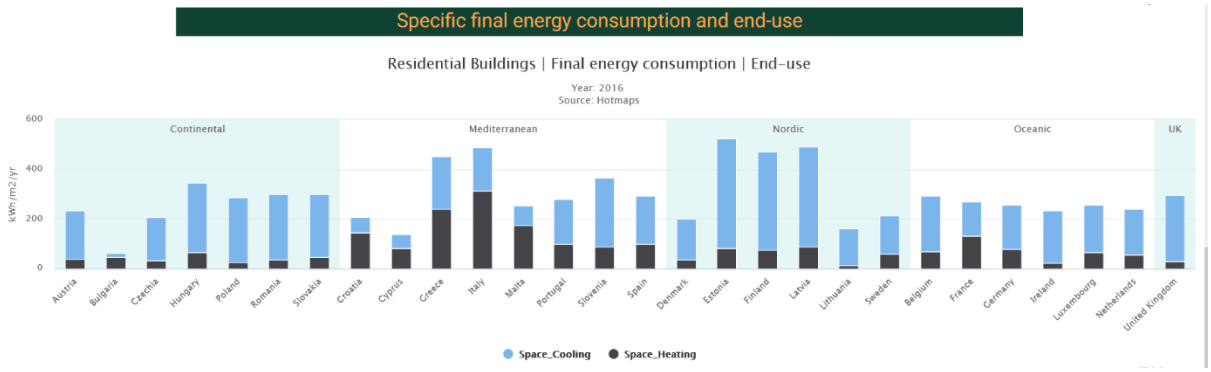




Three key messages from the graph

- The different order of the countries shows that in some countries residential buildings are more advanced and in other countries service buildings are more advanced, compared to the climate region counterparts.
- The highest final energy consumption is for space heating, followed by domestic hot water then space cooling.
- *Belgium* is the country with highest specific energy consumption for space heating.
- *Malta* is the country with lowest specific energy consumption for space heating.

The Renovation Dashboard



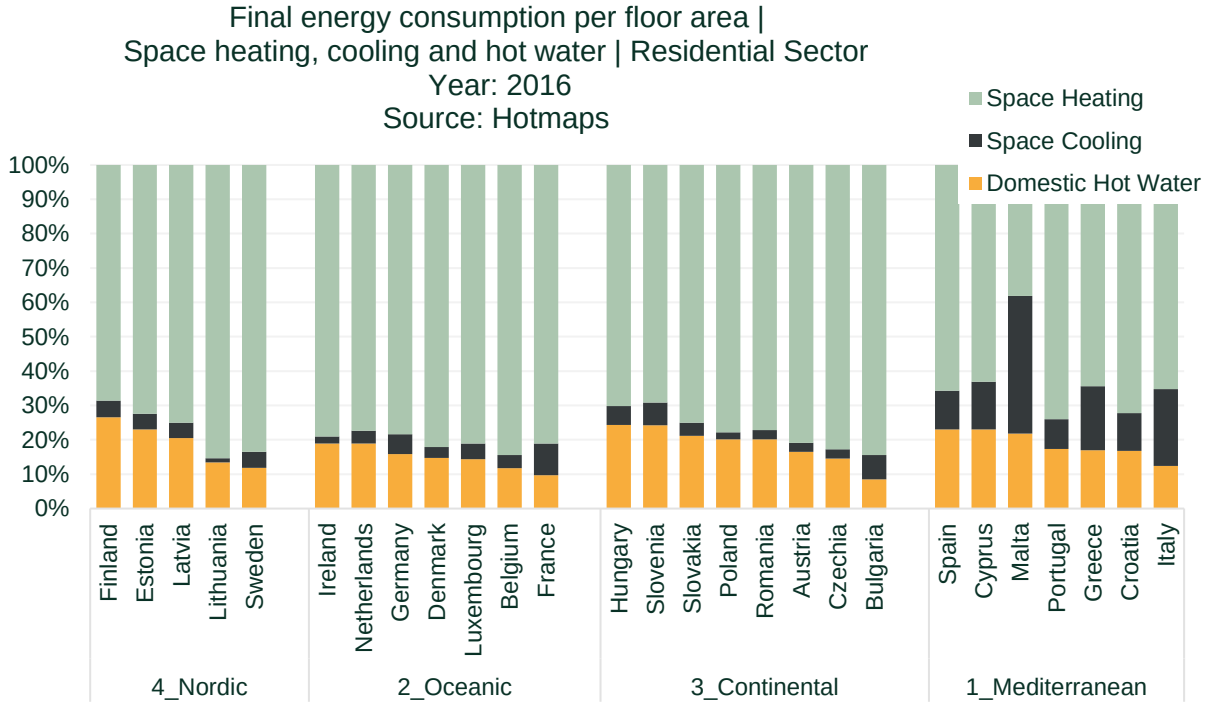
Dashboard 8 renovation dashboard > graph 22 Specific final energy consumption and end-use

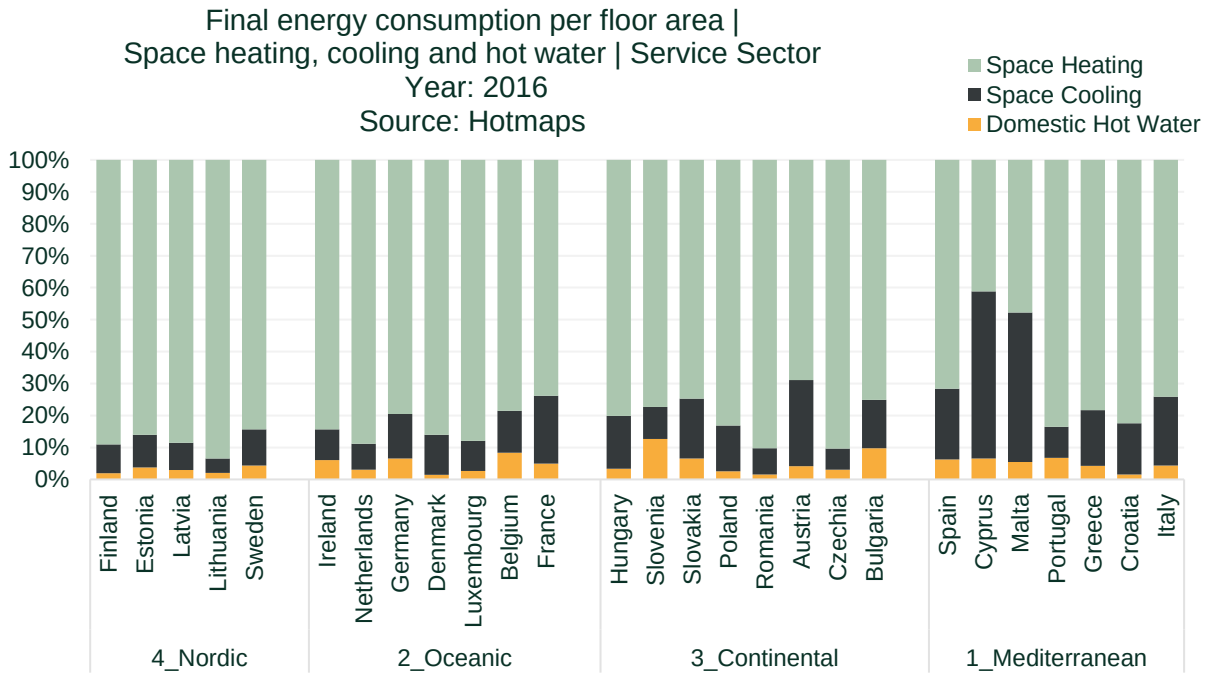
Improvement suggestions

- Content: There should not be more cooling need in the Nordics than in the Mediterranean, please check legend (the other way around or even hot water).
- The countries within a region should be sorted by space heating value or total value.

Graph 23 Specific final energy consumption and building-related end-use (share)

In this type of visualization, the absolute value is not on focus, but rather the share of final energy consumption between the different end-uses.
Graph title: Final energy consumption –Residential buildings – Floor area - End-use
Metadata: Source Hotmaps, Year: 2016
Proposed visualization: stacked diagram (share)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line





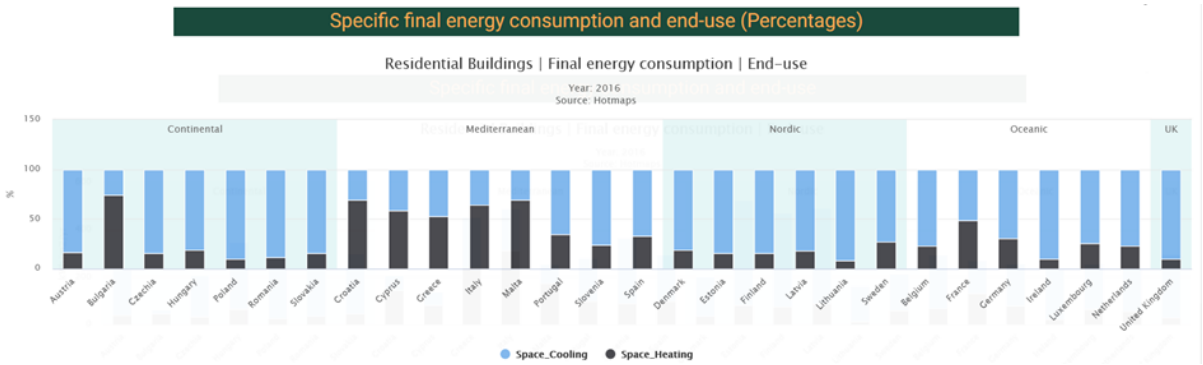
Three key messages from the graph

- In service sector more energy is used for cooling than for residential buildings. High shares in cooling can be observed in France and Austria.
- In residential buildings more energy is used for hot water than in service sector. Although there is some variation within the climate peer groups there are no notable high or low final energy shares for domestic hot water.
- Except for Malta and Cyprus, the final energy share for space heating in residential buildings varies between 68%-87%.
- Mediterranean countries have a tendency of high share of space cooling with respect to the other climate regions (15-21), however it is not only related to the climate region, as other countries have similar cooling shares, for example Bulgaria (21%), Slovakia (15%), Slovenia (14%), Germany (13%), and Ireland (13%).
- Malta and Cyprus have significantly high energy shares of space cooling in the service sector of about 47 and 40%.

Messages delivered from the graph

This graph is complementary to the previous one, and shows the different shares per end-use.

The Renovation Dashboard



Dashboard 9 renovation dashboard > graph 23 Specific final energy consumption and end-use (share)

Improvement suggestions

- Content: It is impossible that there is more cooling need in the Nordics than in the Mediterranean, please check legend (the other way around, or even hot water).
- The countries within a region should be sorted by space heating share.

Graph 24 Specific final energy consumption for a selected building type

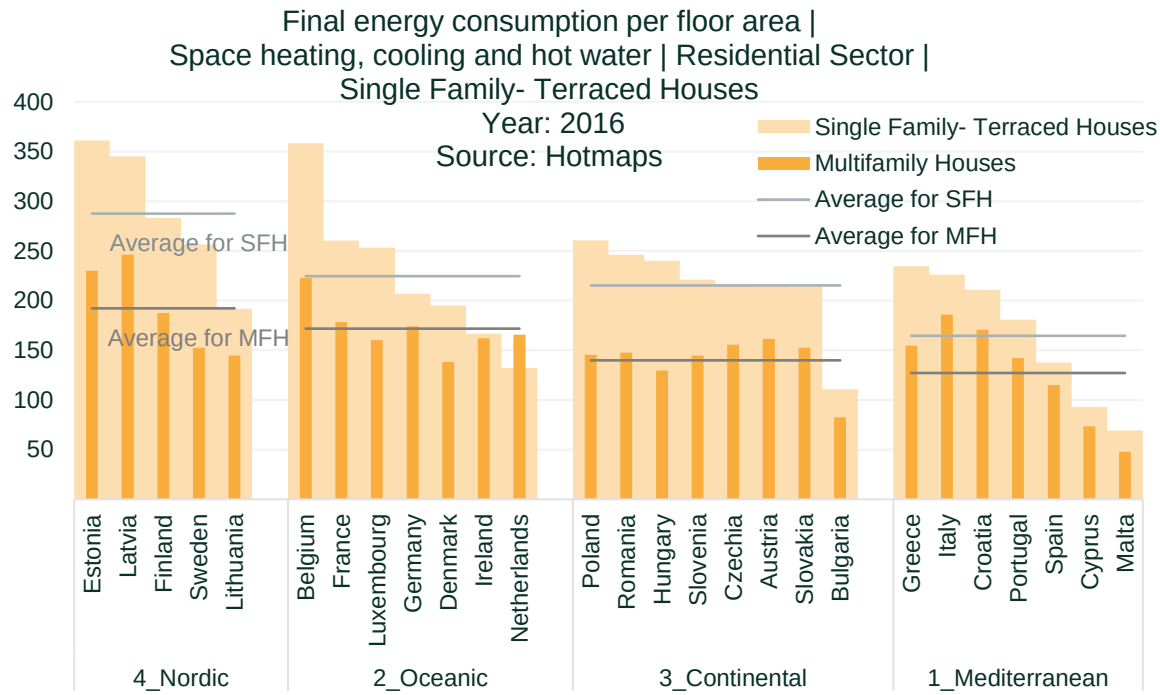
These graphs show the final energy consumption per floor area for residential and service sector buildings for all EU countries for the selected building type (single family, multifamily, and apartment blocks). This graph focuses on a cross-country comparison within a group that is supposed to have comparable climatic conditions. Therefore, the countries are clustered by climate region (according to the EPBD 2021). In this visualization, the absolute value is in focus.

Graph title: Final energy consumption per floor area | Space heating, cooling and hot water | Residential sector | Single Family – Terraced Houses

Metadata: Source Hotmaps, Year: 2016

Proposed visualization: diagram with columns and lines for average and median values within peer climate group (country)

Functionalities: 1) scrolling through graph (display country or values); 2) grouping according to climate region and sorting by value within the groups; 3) filters/selection: switching between different building types; 4) statistical analysis: lines for average and median values within peer climate group (country)



Three key messages from the graph

- Notably, in Belgium single and multi-family buildings have a high final energy consumption per m² for space heating, cooling and hot water compared to other countries with oceanic climate. The final energy demand is like the nordic country Estonia.
- For both building types, Bulgaria reports a very low energy consumption comparable with Cyprus.
- For most countries, multi-family buildings consume less energy for space heating, cooling, and hot water than single family buildings.

Graph 25 Specific final energy consumption and building type (share)

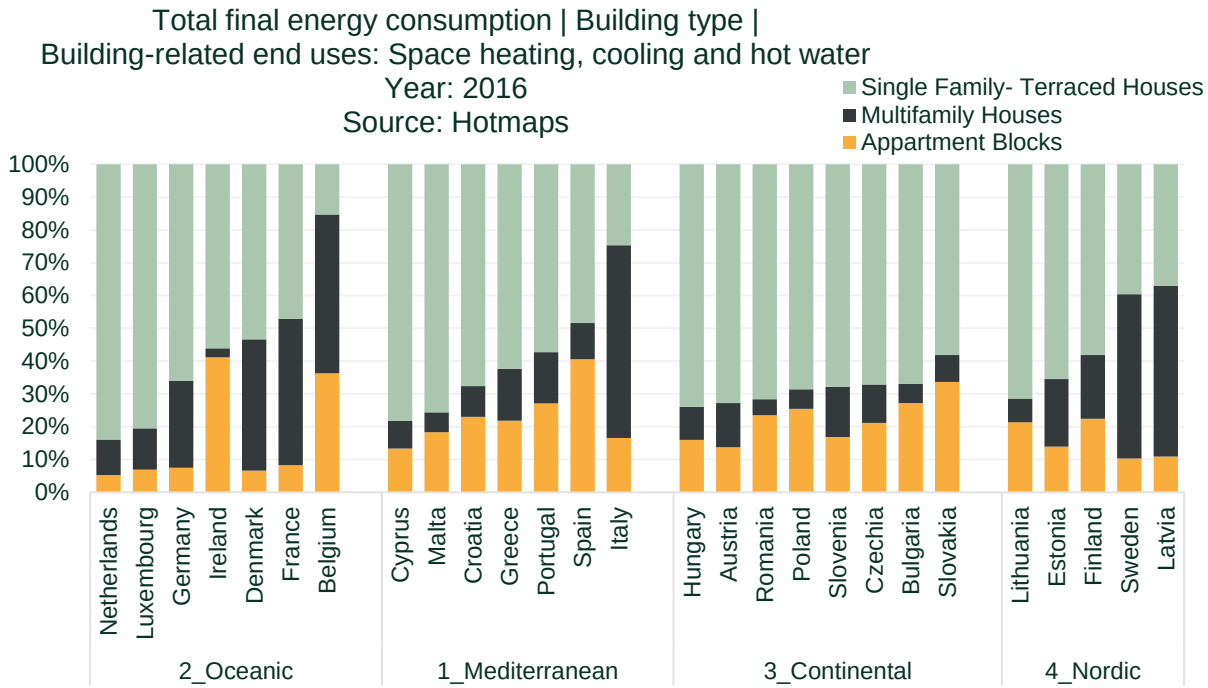
In this type of visualization, the absolute value is not on focus, but rather the share of final energy consumption between the building types.

Graph title: Final energy consumption – Residential buildings – Building Type – Share

Metadata: Source Hotmaps, Year: 2016

Proposed visualization: stacked diagram (share)

Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

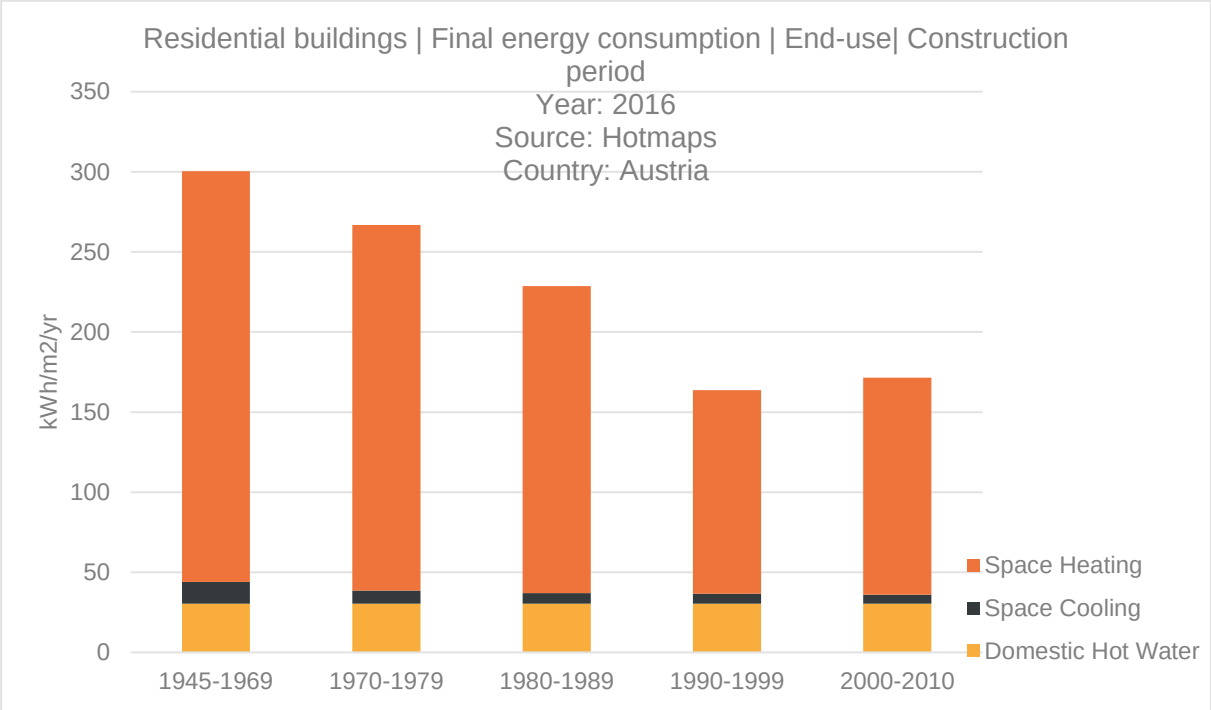
- The lowest share in final energy in Single Family Terraced houses, i.e., for space heating, cooling, and hot water, is consumed in Belgium, followed by Italy, Latvia, and Sweden.
- It is notable that the share of apartment blocks versus multi-family houses is high in Ireland, Belgium, and Spain.
- This graph would give the policy maker an idea which share of building-related energy is addressed when approaching decision makers for different types of buildings.

Messages delivered from the graph

This graph shows the share of final energy consumption between different building types. This information may be relevant to understand which building types should, for example, undergo building renovations or energy efficiency measures. In this graph, it can be seen a common trend between all EU countries, and no country-specific picture.

Graph 26 Specific final energy consumption, end-use and construction period (country comparison)

This graph shows the final energy consumption for residential buildings in each EU countries divided by end-uses (space heating, space cooling, and domestic hot water) and construction period. This graph focuses on a country specific information. Therefore, one EU-country is represented, here as an example Austria.
Graph title: Final energy consumption – Residential buildings – Floor area – Construction type – End-use
Metadata: Source Hotmaps, Year: 2016
Proposed visualization: stacked diagram (construction period)
Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

- Space heating consumption decreased by about 45% from buildings constructed in 1945-1969 to buildings constructed 1990-1999.
- There is a slight increase on the space heating consumption between the construction periods of 1990-1999 and 2000-2010.
- Domestic hot water consumption is basically equal for all construction periods.

Messages delivered from the graph

In this graph the user can see specific information for a country. Also, a relation between final energy consumption of the end-use and construction period can be provided. Space heating is still the highest specific energy consumption in buildings, independent of the construction periods. Between the construction periods a consumption decrease can be observed. Space cooling is not as relevant as space heating and domestic hot water.

Graph 27 Specific final energy consumption, end-use and building type (country comparison)

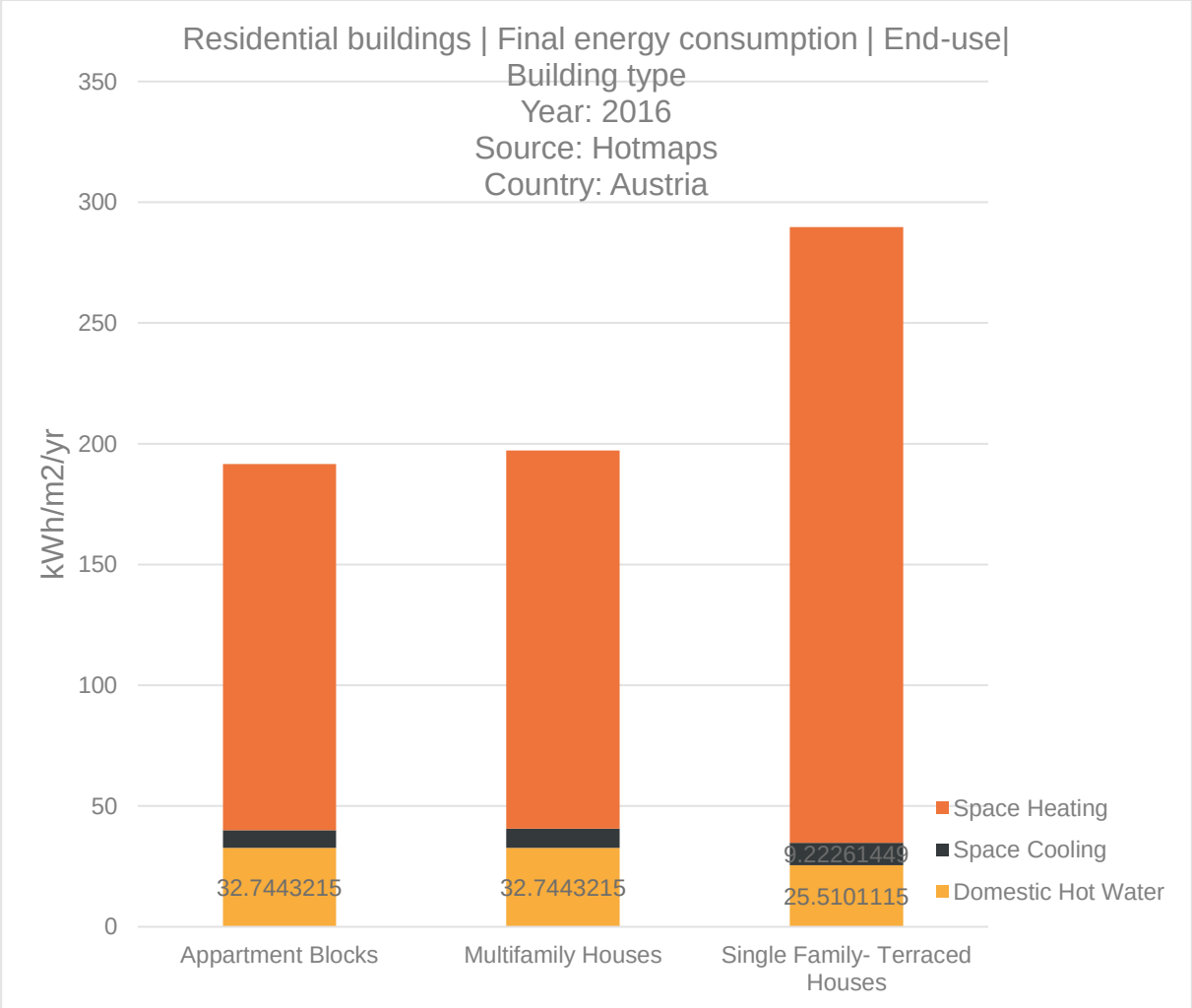
This type of visualization focuses on crossing different information about end-use and building type for a specific country.

Graph title: Final energy consumption – Residential buildings – Floor area – Building Type – End-use

Metadata: Source Hotmaps, Year: 2016

Proposed visualization: stacked diagram (building type)

Functionalities: 1) scrolling through graph (display country or values); 2) fixed graph mask; 3) grouping and clustering; 4) bar with different width; 6) filters/selection; 7) statistical analysis and trends line



Three key messages from the graph

- Single family houses have higher final consumption for space heating then the other building types – about 250 kWh/m²yr.
- Domestic hot water consumption is about the same for all building type – about 30 kWh/m²yr.
- Space cooling is more or less the same for all building type – about 10 kWh/m²yr.

Messages delivered from the graph

In this graph the user can see specific information for a country. Also, a relation between final energy consumption of the end-use and building type can be provided. Space heating is still the highest specific energy consumption in buildings, independent of the building type. Between the building types, single-family houses are the ones with the highest consumption, likely because of their geometry.

4. Conclusion

The visualisations presented demonstrate that visualisations developed to focus on a specific topic or angle bring additional value to the user. The implementation of such focussed visualisation in comparison to generic visualisations is still a manual process that depends on knowledge of the data and their dependencies. These focussed visualisations help the user to gain deeper insight into the meaning of the data while the generic visualisations such as in the first four dashboards of the platform can deliver an overview. Focussed visualisations can be developed for other indicators to help the user understand the magnitudes, the compositions, and the relevant comparisons the data can provide.

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