ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

FINAL REPORT //

Updating and integrating LOCATE datasets and maps

Final Report // September 2022

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Disclaimer

This document is a final report.

The information contained herein is subject to change and does not commit the ESPON EGTC and the countries participating in the ESPON 2020 Cooperation Programme.

The final version of the report will be published as soon as approved.

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Abbreviations

CHP	Combined Heat and Power
DHC	District Heating and Cooling
DHW	Domestic Hot Water
MS	Member state of the European Union
NUTS	Nomenclature of Territorial Units for Statistics (from French: Nomenclature des unités territoriales statistiques)
PV	Photovoltaic

1 Introduction

Background and objectives of the research activity

The main objective of the previous SO1 activity "Territories and low-carbon economy" (LOCATE) was to provide evidence on the territorial dimension of implementing the low-carbon economy approach in different parts of Europe and different types of European regions and cities. The project gathered data for regions throughout the EU/Europe at the NUTS 3 level, related to energy consumption patterns and the potential to produce (and use) renewable energy sources. One part of the project focused on final energy consumption for space heating, domestic hot water and cooling in (1) residential buildings, (2) buildings of the private service sectors and (3) public buildings. While for each sector different approaches were applied to account for the peculiarities of all sectors of energy consumption, the common method was to apply regional dis-aggregation matrices to break down the energy consumption data on the NUTS 0 level to NUTS 3 regions. The details of this methodology can be found in the separate subchapters in the LOCATE scientific report (section 1.1.1 for final energy consumption and section 1.1.5 for the share of renewable energy in final energy consumption).

The main objective of the present activity is to update, map and analyse selected LOCATE indicators, if relevant by updating the methodologies used with the most recent methodological approaches and by col-lecting, transforming and harmonising relevant data, maps and indicators with the most recent information. Also, data gaps should be filled to cover as much as possible all regions involved in the ESPON 2020 Co-operation Programme (i.e. all EU member states, the UK and the ESPON Partner States). The data and metadata should be integrated into the ESPON 2020 Database. In addition, a short data analysis shall be conducted, and maps produced that shall be accompanied by short interpretations and key observations tailormade for policymakers and policy development. This data and map update is focusing on the earlier SO1 activity "Territories and low-carbon economy" (LOCATE).

- The following indicators are updated in this activity:
- Electricity generation by photovoltaic technology (in MWh)
- Electricity generation by wind onshore technology (in MWh)
- Final energy consumption for space heating, domestic hot water and cooling in buildings of the residential sector (in MWh)
- Final energy consumption for space heating, domestic hot water and cooling in buildings of the private service sector (in MWh)
- Final energy consumption for space heating, domestic hot water and cooling in buildings of the public sector (in MWh)
- Share of renewable energy carriers in final energy consumption for space heating, domestic hot water production and cooling in buildings of the residential sector (in %)
- Share of renewable energy carriers in final energy consumption for space heating, domestic hot water production and cooling in buildings of the private service sector (in %)
- Share of renewable energy carriers in final energy consumption for space heating, domestic hot water production and cooling in public buildings (in %)

Structure of the report

The report firstly presents the methodology used to build each set of maps, including the issues faced to fill out the gaps of missing data. Then it presents the results of the analysis of the territorial trends and their impacts related to energy consumption patterns and the potential to produce (and use) renewable energy sources in Europe and its regions. This is presented in the report by a set of maps. Finally, it provides all maps in Annex 1, and a selection of maps accompanied by a description and explanation following the structure of the online MapFinder in Annex 2.

2 List of Maps

Table 1: List of Maps created within this project, corresponding file name and set number

Map Number	File Name	Map Title	Set
1	Map 1_PhtElGnT_2002	Electricity generation by photovoltaic technology, 2002, [GWh]	1
2	Map 2_PhtElGnT_2012	Electricity generation by photovoltaic technology, 2012, [GWh]	1
3	Map 3_PhtElGnT_2018	Electricity generation by photovoltaic technology, 2018, [GWh]	1
4	Map 4_PhtElGnA_2002	Electricity generation by photovoltaic technology, 2002, [MWh/km2]	1
5	Map 5_PhtElGnA_2012	Electricity generation by photovoltaic technology, 2012, [MWh/km2]	1
6	Map 6_PhtElGnA_2018	Electricity generation by photovoltaic technology, 2018, [MWh/km2]	1
7	Map 7_ChangePhtElGnA_2002-2012	Change in electricity generation by photovoltaic technology, 2002-2012, [MWh/km2]	1
8	Map 8_ChangePhtElGnA_2012-2018	Change in electricity generation by photovoltaic technology, 2012-2018, [MWh/km2]	1
9	Map 9_WinElGnT_2002	Electricity generation by wind onshore technology, 2002, [GWh]	2
10	Map 10_WinElGnT_2012	Electricity generation by wind onshore technology, 2012, [GWh]	2
11	Map 11_WinElGnT_2018	Electricity generation by wind onshore technology, 2018, [GWh]	2
12	Map 12_WinElGnA_2002	Electricity generation by wind onshore technology, 2002, [MWh/km2]	2
13	Map 13_WinElGnA_2012	Electricity generation by wind onshore technology, 2012, [MWh/km2]	2
14	Map 14_WinElGnA_2018	Electricity generation by wind onshore technology, 2018, [MWh/km2]	2
15	Map 15_ChangeWinElGnA_2002-2012	Change in electricity generation by wind onshore technology, 2002-2012, [MWh/km2]	2
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20	Map 20_ChangeResHeatC_2002-2012	Residential buildings, 2002-2012, [MWh/cap], change in final energy consumption for space heating, hot water and cooling	3
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24	Map 24_PrivSHeatC_2018	Private service sector, 2018, [MWh/cap], final energy consumption for space heating, hot water and cooling	4
25	Map 25_ChangePrivSHeatC_2002-2012	Private service sector, 2002-2012, [MWh/cap], change in final energy consumption for space heating, hot water and cooling	4
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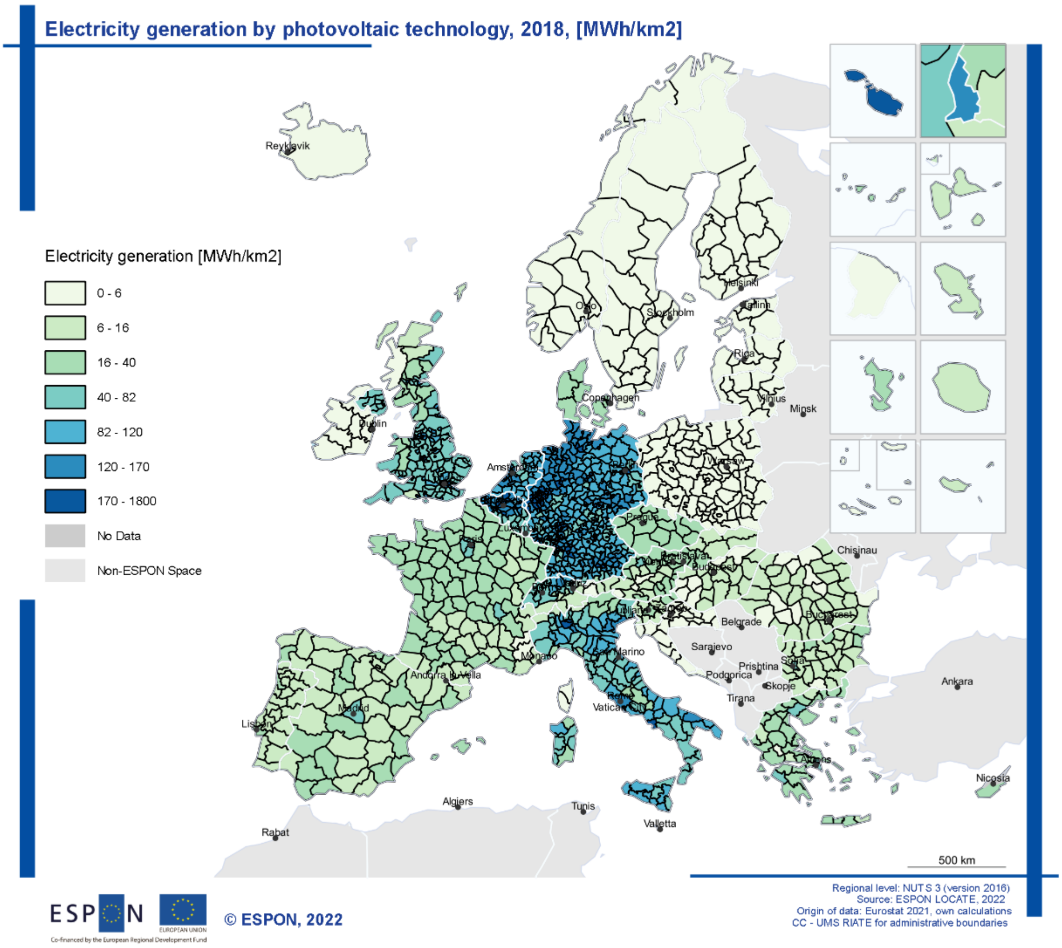
3 Methodology

The objective of this chapter is to illustrate the methodological approach used to update the indicators and build the new maps.

3.1 Set 1: Electricity generation by photovoltaic technology (MWh and MWh/km2, 2002, 2012, 2018, and changes)

Data on photovoltaic electricity generation was provided by Eurostat (2022b) and Bundesamt für Energie (2022) for Switzerland. For Liechtenstein data were taken from LKW (2021). The data refers to the yearly total electricity generation by photovoltaic technology in MWh for the year 2018. In addition, population distribution (Eurostat, 2022a) and building footprint (Müller, 2018a) were used as auxiliary indicators. The data on electricity generation by photovoltaic technology of ESPON LOCATE (2018) for the years 2002 and 2012 was updated to fit the NUTS 2016 nomenclature.

Map 1 depicts the annual electricity generation by PV technologies per land area on the NUTS3 level in 2018.

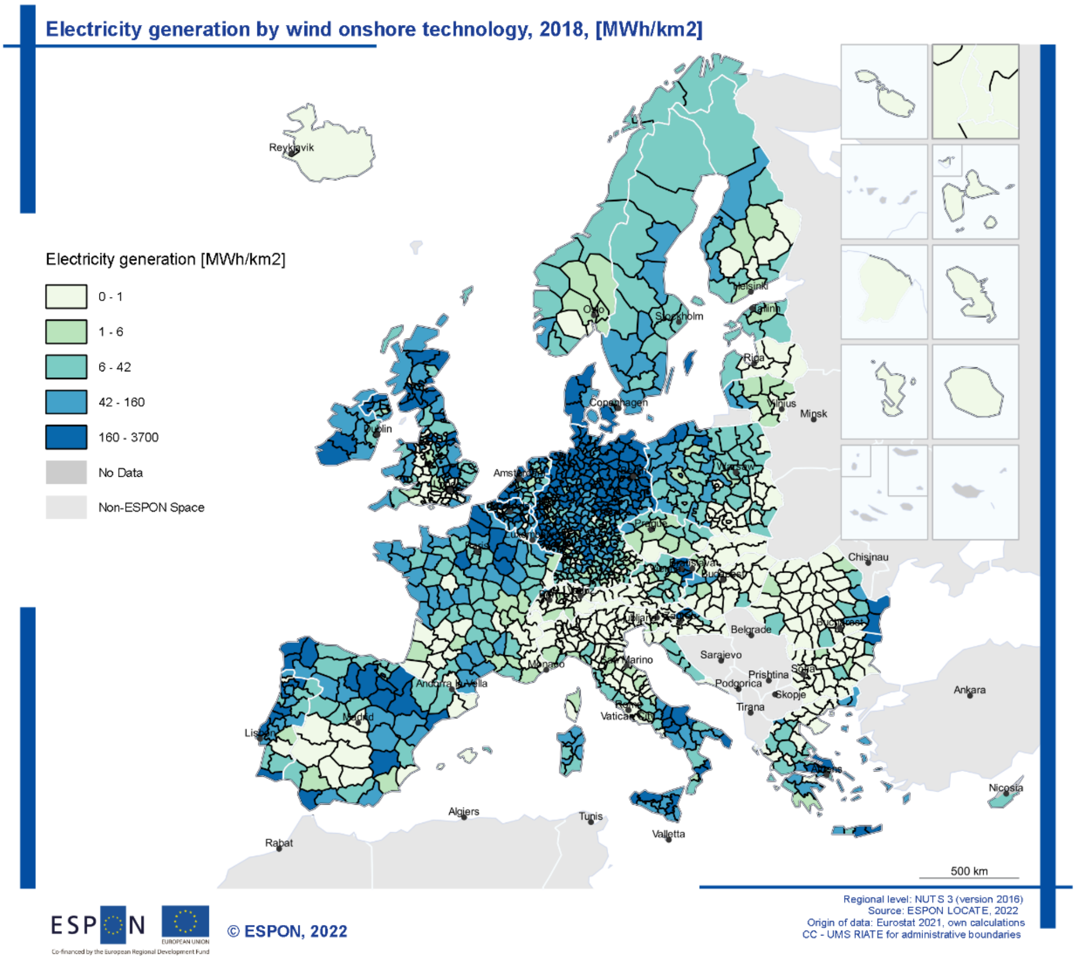


Map 1. Map of electricity generation by photovoltaic technology in 2018 [MWh/km²]

3.2 Set 2: Electricity generation by wind onshore technology (MWh and MWh/km2, 2002, 2012, 2018, changes)

Data on installed wind onshore capacities was provided by Wind Farm Database 2021 (The Wind Power, 2021). Data on wind onshore electricity generation was provided by Eurostat (2022b) and Bundesamt für Energie (2022) for Switzerland. As of 2021, no utility-scale wind power plant is operated in Liechtenstein. The data refers to the yearly total electricity generation by wind onshore technology in MWh and average full load hours for the year 2018 per country. In addition, the land-use classifications (CLC 2012) on the hectare level were used as auxiliary indicators. Here we considered only grid cells which belong to one of the following CLC-Code types (211 (non-irrigated arable land), 231 (pastures), 241 (annual crops associated with permanent crops), 242 (complex cultivation patterns), 243 (land principally occupied by agriculture, with significant areas of natural vegetation), 244 (agroforestry areas), 324 (transitional woodland-shrub) and 333 (sparsely vegetated areas). The data on electricity generation by wind onshore technology of ESPON LOCATE (2018) for the years 2002 and 2012 was updated to fit the NUTS 2016 nomenclature. Please keep in mind that the data availability of overseas territories of France, the Canary islands, the Azores and Madeira is particularly poor (including land-use classifications), which is partly the reason for the neglectable calculated electricity production by wind power plants in these regions. According to Maldonado (2016), Guadeloupe produces about 5% of its electricity consumption by wind power, for Martinique the share is 2% and 1% for Réunion. For Guadeloupe, this data results in 51 (2018) and 56 (2013) TWh of electricity from wind power, or 32 MWh/km².

Map 2 depicts the annual electricity generation by onshore wind power per land area on the NUTS3 level in 2018.



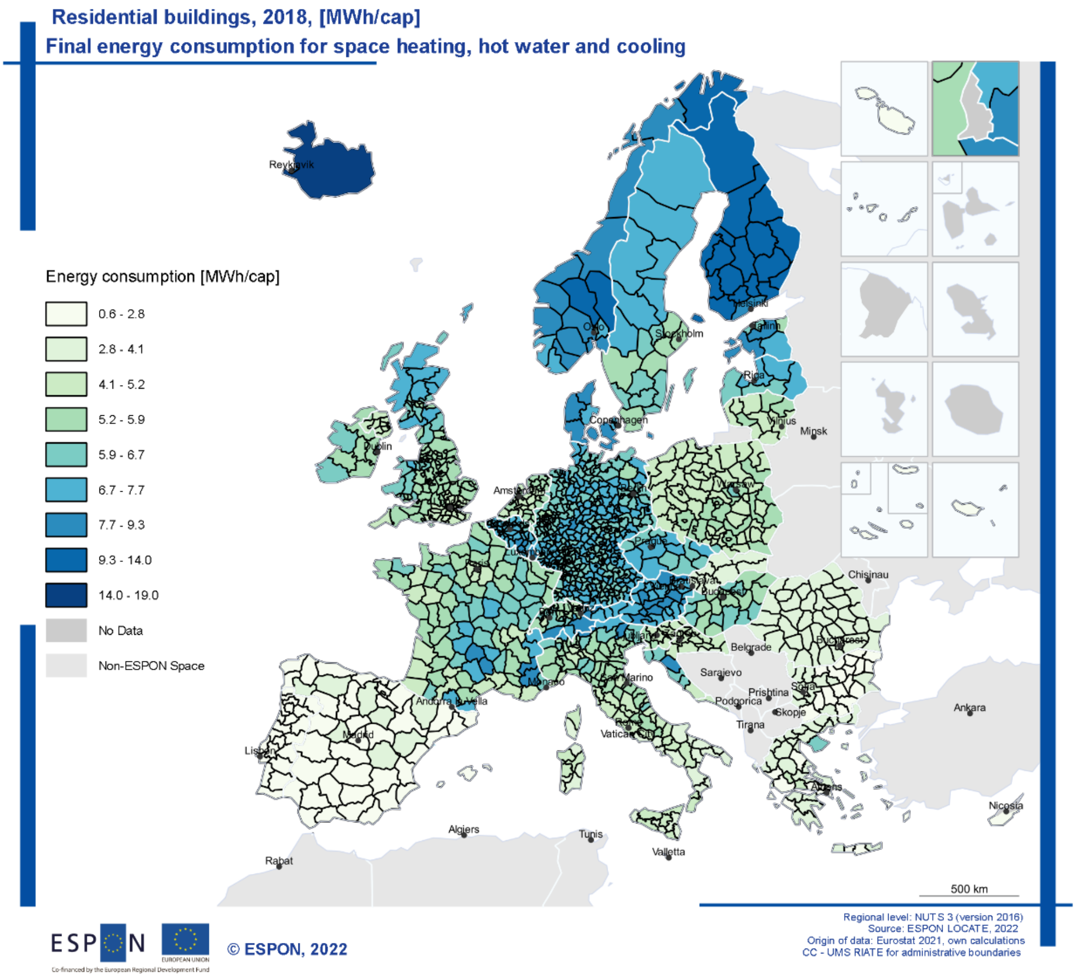
Map 2. Map of electricity generation by wind onshore technology in 2018 [MWh/km²]

3.3 Set 3: Final energy consumption for space heating, domestic hot water and cooling in buildings of the residential sector (MWh/capita, 2002, 2012, 2018, changes)

Data on the final energy consumption for heating and cooling on the NUTS 0 (country) level were provided by Eurostat (Eurostat, 2022c). Using the Energy balance sheets provided by Eurostat (April 2022 (Eurostat 2022d) edition, except for the United Kingdom, where the June 2021 (Euro-stat, 2021) version was used), a consistent data series for the energy consumption per energy carrier group was created for the period 2000 to 2019 (natural gas, oil, coal, district heating, electricity and renewable energy carriers). Missing data was extrapolated from time series of energy carrier consumption of at least five years. The energy carrier share of total energy demand was kept constant for missing years, where time series of four years or less was available. Where no data were available, the average share of all countries (weighted by the square root of the national consumption) was applied per energy carrier to the total sectoral demand of that energy carrier. For Switzerland, we draw on data provided by Prognos (2021). Liechtenstein does not have sector-specific energy consumption data. Taking into account the very different climate as well as different building construction practices and heritage in the oversea territories of France, we did not estimate the energy consumption for space heating and domestic hot water preparation.

The national energy consumption was broken down to the NUTS 3 level for the year 2012 by using the open data set of the Hotmaps project, which provides heat density maps on the hectare level for residential and non-residential buildings (Müller and Fallahnejad, 2018). The Hotmaps dataset is built with a top-down approach: starting from data at the country level (NUTS 0) and estimating data down to the hectare level using a series of regional indicators (Müller et al., 2019). The data refers to the total final energy consumption for space heating, hot water production and space cooling in residential buildings in megawatt hour per capita (MWh per capita) for the years 2002, 2012 and 2018. To estimate deviating developments in different NUTS 3 regions within a country for the energy consumption analysed here, the population growth (Eurostat, 2022a) was used as an indicator. For the conversion of the dataset with different NUTS 3 definitions (NUTS 2013, NUTS 2021 to NUTS 2016), data was resampled on the hectare level using the population layer of the Hotmaps project.

Map 3 shows the residential annual energy consumption per capita for space heating, domestic hot water preparation and space cooling on the NUTS3 level in 2018.



Map 3. Map of final energy consumption for space heating, DHW and space cooling in residential buildings in 2018 [MWh/capita]

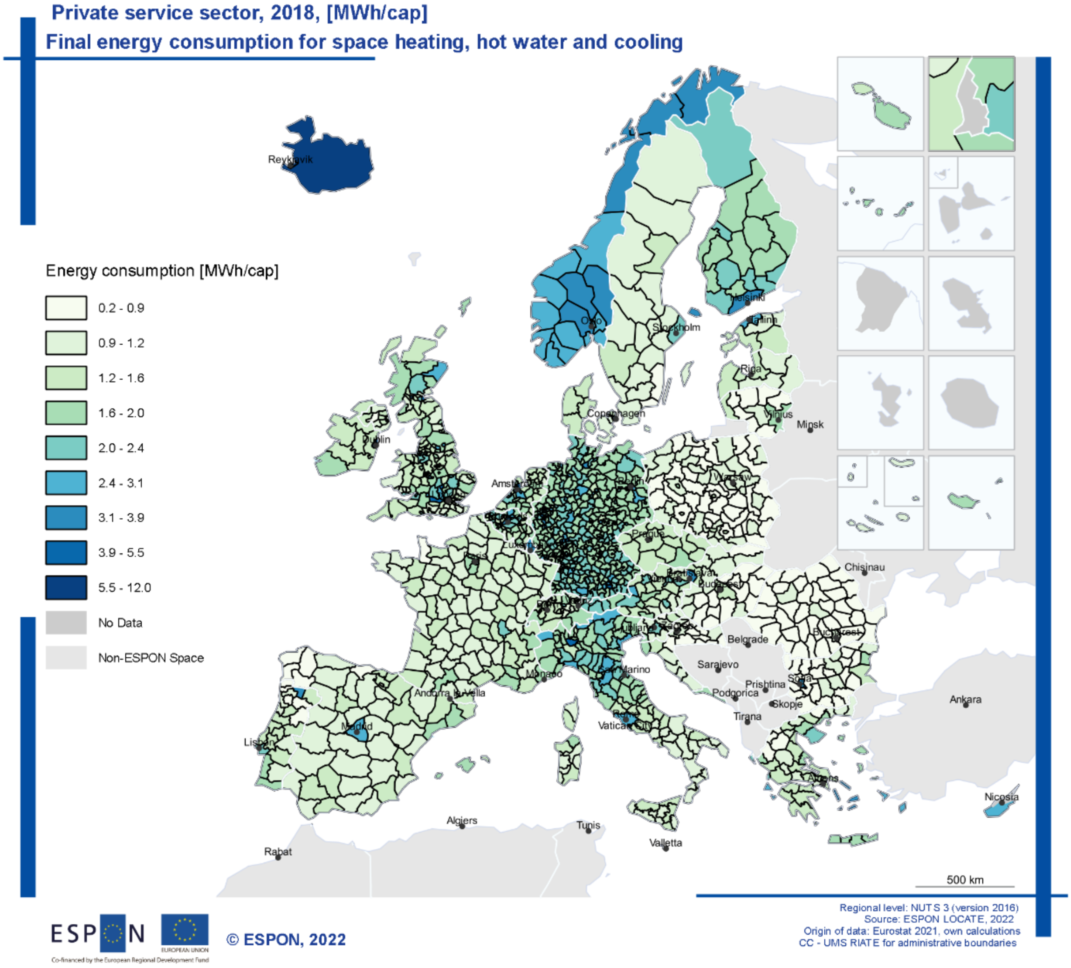
3.4 Set 4: Final energy consumption for space heating, domestic hot water and cooling in buildings of the private service sectors and public buildings (MWh/capita, 2002, 2012, 2018, changes)

For non-residential buildings, the national demand for space heating, DHW and cooling as well as the share of energy carriers (2012) were built on own data sets. The share of total sectoral energy consumption per energy carrier, used for space heating, DHW and cooling was kept constant. Using the Energy balance sheets provided by Eurostat (April 2022 edition (Eurostat, 2022d), except for the United Kingdom, where the June 2021 version (Eurostat, 2021) was used), a consistent data series for the energy consumption per energy carrier group was created for the period 2000 to 2019 (natural gas, oil, coal, district heating, electricity and renewable energy carriers). For Switzerland, we used national statistics on the energy demand of the service sector per energy carrier (Bundesamt für Energie, 2022a) and applied for each energy carrier the European average share that is used for space conditioning and domestic hot water preparation. Again, no data are available for Liechtenstein. As for the residential sector, we were not able to estimate the energy consumption in the oversea territories of France. For Switzerland, we draw on data provided by Prognos (2021).

The national energy consumption was broken down to the NUTS 3 level for the year 2012 by using the open data set of the Hotmaps project, which provides heat density maps on the hectare level for residential and non-residential buildings (Müller and Fallahnejad, 2018b). The Hotmaps dataset is built with a top-down approach: starting from data at the country level (NUTS 0) and estimating data down to the hectare level using a series of regional indicators (Müller et al., 2019).

The data refers to the total final energy consumption for space heating, hot water production and space cooling in residential buildings in megawatt hour per capita (MWh per capita) for the years 2002, 2012 and 2018. To estimate deviating developments in different NUTS 3 regions within a country for the energy consumption analysed here, the population growth (Eurostat, 2022a) was used as an indicator. To differentiate between public and private service sectors, the country-specific share published by Schremmer et al. (2018) within the Territories and low-carbon economy (ESPON LOCATE) project was used. For the conversion of the dataset with different NUTS 3 definitions (NUTS 2013, NUTS 2021 into NUTS 2016 version), the data on the hectare level was resampled using the population layer of the Hotmaps project (Müller, 2018b).

Map 4 shows the annual energy consumption per capita for space heating, domestic hot water preparation and space cooling in buildings of the private service sector on the NUTS3 level in 2018.



Map 4. Map of final energy consumption for space heating, DHW and space cooling in buildings of the private service sector in 2018 [MWh/capita]

3.5 Set 5: Share of renewable energy carriers in final energy consumption for space heating, domestic hot water production and cooling in buildings of the residential sector (in %, 2002, 2012, 2018, changes)

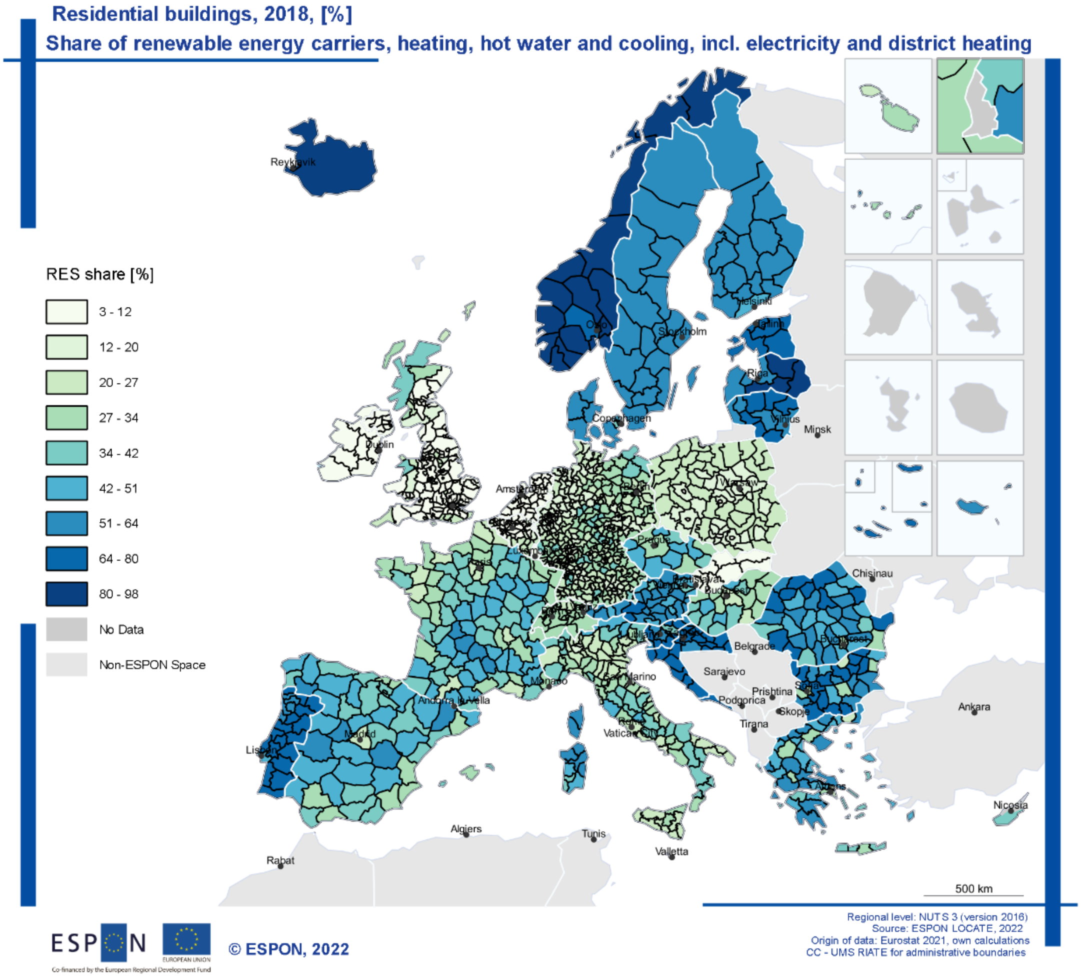
Data on the final energy consumption for heating and cooling on the NUTS 0 (country) level were taken from Eurostat (Eurostat, 2022a). Using the Energy balance sheets provided by Eurostat (April 2022 edition (Eurostat, 2022b), except for the United Kingdom, where the June 2021 version (Eurostat, 2021) was used), a consistent data series for the energy consumption per energy carrier group was created for the period 2000 to 2019 (natural gas, oil, coal, district heating, electricity and renewable energy carriers). Missing data was extrapolated from time series of energy carrier consumption of at least five years. Where time series of four years or less was available, the energy carrier share of total energy demand was kept constant for missing years. Where no data were available, the average share of all countries (weighted by the square root of the national consumption) was applied per energy carrier to the total sectoral demand of that energy carrier. A dataset was built for non-residential buildings for the national demand for space heating, DHW and cooling as well as the share of energy carriers (2012). The share of the total sectoral energy consumption per energy carrier used for space heating, DHW and cooling was kept constant. We were not able to estimate the share of renewable energy carriers in the oversea French territories.

The national share of energy carriers was broken down to the NUTS 3 level for the year 2012 by considering the potential availability of energy carriers within the different NUTS 3 regions. The possible availability of natural gas was estimated as a proximity function to the distance to the European gas transport infrastructure. More on that approach is discussed in (Schremmer et al. 2018). The availability of district heating uses the energy demand for space heating and domestic hot water preparation based on the Hotmaps heat density maps (Müller and Fallahnejad, 2018a, 2018b) on the hectare level in those hectare cells, for which the Heat Roadmap Europe Peta 4.3 indicates that a district heating network exists (Persson et al., 2018) with a weight of 80% and the installed CHP capacity in 2016 (as used by Schremmer et al., 2018) within the different NUTS 3 region with a weight of 20% (100% for those countries, which are not included in the Peta 4.3). The availability or usage of oil, renewables (mostly biogenic energy carriers in most countries) and coal were estimated depending on the degree of urbanisation. This reflects the higher utilisation of these energy carriers in more rural areas. The share of urbanisation for each NUTS 3 region was given as an attribute of the NUTS 3 spatial layer provided by Eurostat. In the case of renewable energy carriers and coal, an availability indicator of 50% was given to rural areas, and 20% to urban areas. Oil use was estimated at 80% for rural and 60% for urban areas. Electricity was given an availability weight of 80% for all areas. For each NUTS 3 region, the possible supply options were calculated and scaled the availability up, if either a single region scored a total availability indicator for all energy carriers of less than 200% or if the total country weight utilisation potential for a given energy carrier did not reach at least 125% of national consumption of that energy carrier group.

In consecutive steps, the energy consumption of each energy carrier was assigned to each region according to the availability indicator of that energy carrier compared to the other energy carriers by ensuring that the total consumption of all energy carriers aligns with the total energy demand in each region and that the total energy demand per energy carrier in all regions meets the national consumption of each energy carrier for space heating, domestic hot water preparation and air conditioning in the corresponding year. The share of renewable energy for electricity and district heat production was calculated based on the share of renewable fuel input into the different types of electricity and district heat supply types and their corresponding heat and electricity output, as stated according to the Energy Balances provided by Eurostat for each year and country (Eurostat, 2021; Eurostat, 2022d). With this methodology, the seasonal change in the renewable energy share was neglected, especially for electricity production, imports and exports and in the case of CHP production, we give the same weight to electricity and district heat, not considering different efficiency factors.

The data refers to the share of renewable energy carriers in total final energy consumption for space heating, hot water production and space cooling in residential buildings in percentage (%) for the years 2002, 2012 and 2018. To estimate deviating developments in different NUTS 3 regions within a country for the energy consumption analysed here, the population growth was used as an indicator. For the conversion of the dataset with different NUTS 3 definitions (NUTS 2013, NUTS 2021 into NUTS 2016), data was resampled on the hectare level using the population layer provided by the Hotmaps project (Müller, 2018b).

Map 5 shows the annual energy consumption per capita for space heating, domestic hot water preparation and space cooling in buildings of the private service sector on the NUTS3 level in 2018.



Map 5. Map of share of renewable energy carriers for space heating, DHW and space cooling in buildings in the residential sector in 2018 [MWh/capita]

3.6 Issues

Data was not always available for all countries. This especially holds for energy data at the regional level. Therefore the data provided within this report are based on a statistical top-down approach using representative indicators rather than on measured bottom-up data.

Where data was not available or could not be estimated, the region was indicated as “No Data.” Furthermore, inconsistencies between different data sources arose for the definitions of the following NUTS 2016 regions: FRH02, NO061, NO062, PL842 and PL843.

4 Analysis of the territorial trends: energy consumption patterns and potential for renewable energy sources

In the update of the above-mentioned energy indicators and development of the relative maps, some trends emerged concerning energy consumption patterns and the potential for the production and use of renewable energy sources. Topic-specific map interpretations are listed below.

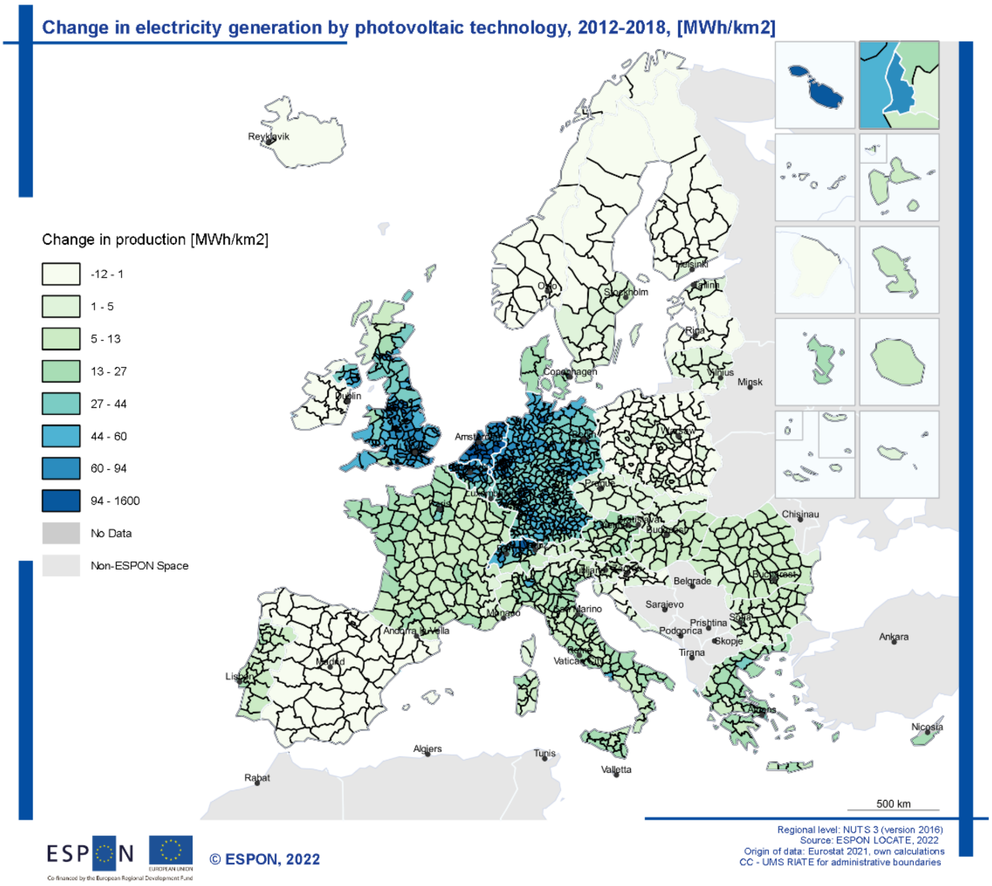
4.1 Set 1: Electricity generation by photovoltaic technology (GWh and MWh/km2, 2002, 2012, 2018, and changes)

Looking at the map, urban regions in western and central Europe show the highest electricity generation per km² by photovoltaic technology, against rural regions in South-Eastern Europe, which register the lowest values. Many regions still neglect this technology despite their high solar potential.

Between 2012 and 2018, the largest increase in electricity generated by photovoltaics took place in the United Kingdom, Germany, France, and the Netherlands. The only country showing a decrease in photovoltaic electricity generation was Slovenia, where the electricity generated by photovoltaic technology in 2018 was 41 GWh lower than in 2012. The smallest increase between 2012 and 2018 took place in Albania, Latvia, and Serbia. The label “No Data” indicates regions where data was not available or could not be estimated.

Considering the power generation by PV technology per km² per region as shown in Map 6, regions in Germany, Italy, the United Kingdom, Belgium, Greece, the Netherlands and Switzerland have to be counted as the most developed ones.

Map 6 indicates the increase in electricity production by PV technologies between 2012 and 2018 on the NUTS 3 level.



Map 6 Map increase in electricity production by PV technologies between 2012 and 2018 [MWh/km²]

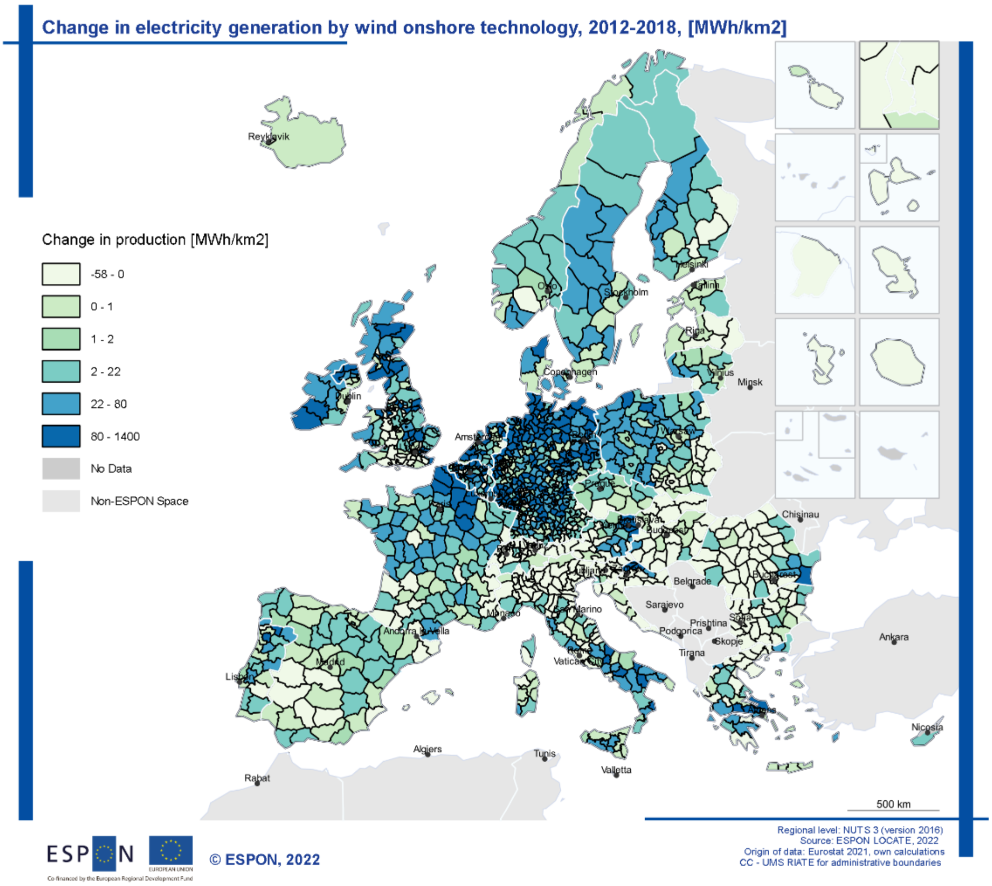
4.2 Set 2: Electricity generation by wind onshore technology (GWh and MWh/km2, 2002, 2012, 2018, changes)

Looking at the map, Germany, the United Kingdom, Spain, and France had the greatest generation by wind onshore technology in 2018. The highest electricity generation per km² by wind onshore was registered in the same countries along with regions in Portugal, Austria, the Netherlands and Belgium. Due to regulations on the minimum distance of wind turbines from settlement areas, the lowest values are found in urban regions. This technology is still neglected in several regions despite high potentials.

Between 2012 and 2018, the largest increase in electricity generated from wind onshore took place in Germany, the United Kingdom, and France. The only country showing a decrease in wind electricity generation was Hungary, where the electricity generated by wind onshore in 2018 was 163 GWh lower than in 2012. No change took place in Slovakia. The smallest increases between 2012 and 2018 took place in Slovenia, Latvia and Iceland. The label "No Data" indicates regions where data was not available or could not be estimated, such as the Canary islands, the Azores and Madeira.

Considering the power generation by wind onshore technology per km² per region as shown in Map 7, regions in Germany, the United Kingdom, Spain, Portugal, Austria, the Netherlands and Belgium show the highest electricity generation by wind onshore technology per total area.

Map 7 indicates the increase in electricity production by onshore wind technologies between 2012 and 2018 on the NUTS 3 level.



Map 7. Map increase in electricity production by onshore wind technologies between 2012 and 2018 [MWh/km²]

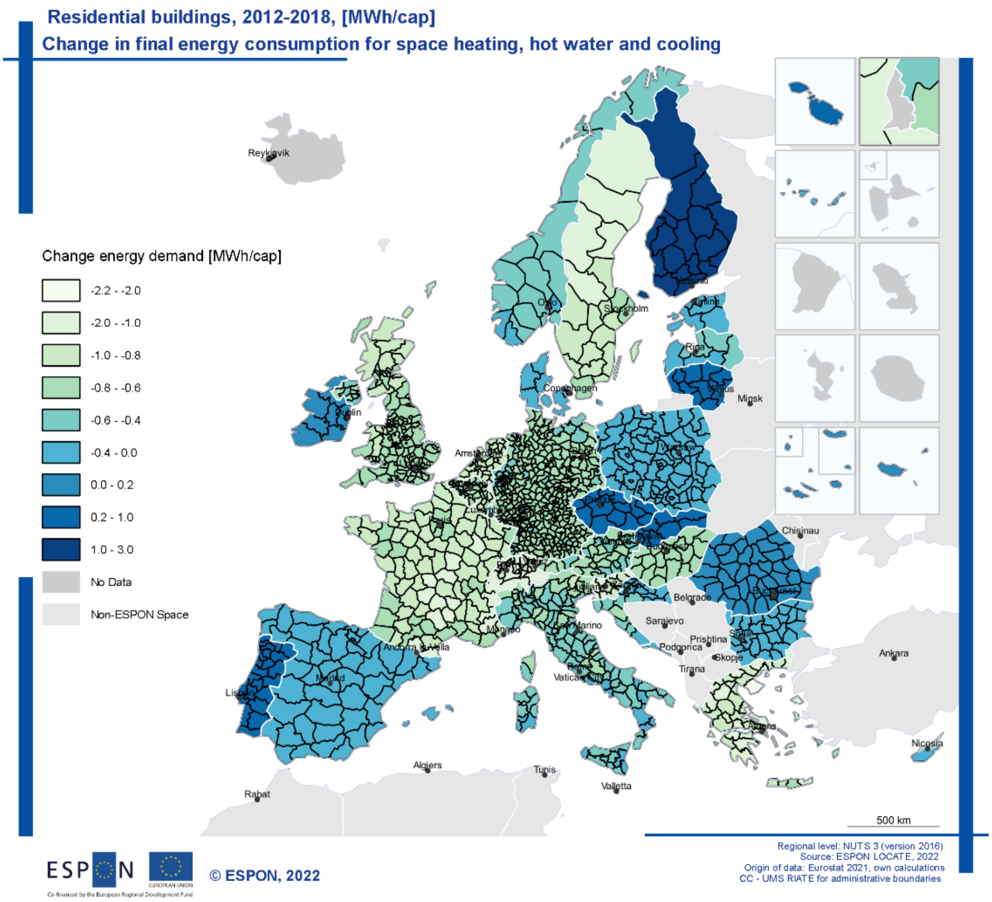
4.3 Set 3: Final energy consumption for space heating, domestic hot water and cooling in buildings of the residential sector (MWh/capita, 2002, 2012, 2018, changes)

Looking at the maps, the northern regions show the highest final energy consumption per capita for space heating, domestic hot water and space cooling in the residential sector, while the southern and eastern regions show the lowest values.

Between 2012 and 2018, an increase in final energy consumption per capita for heating, cooling, and domestic hot water took place at the northern, eastern, and western margins of the Union: Iceland, Finland, Portugal, the Czech Republic, Slovakia, and Lithuania. In the same period, the largest decrease took place in France, Slovenia, Sweden, Greece, the United Kingdom and the Netherlands. The tendency of final energy consumption in MWh/cap seen in the first observation period (2002-2012) was mostly confirmed in the second period (2012-2018): regions with growing consumption kept growing (Czech Republic, Finland, Iceland) and the other way round (the United Kingdom, France, the Netherlands). However, further analysis is needed to disaggregate the impact of demographic development (very diversified across regions), efficiency improvements, and service indicators such as floor area per capita.

The maps show a lower energy consumption per capita in the metropolitan areas due to a higher share of multi-family houses compared to rural areas. This calls for spatial policies regarding the settlement densities and type of new building construction. The label “No Data” indicates regions where data was not available or could not be estimated.

Map 8 shows a lower energy consumption per capita in metropolitan areas due to a higher share of multi-family houses compared to rural areas. This calls for spatial policies regarding the settlement densities and type of new building construction.



Map 8. Change in energy consumption in residential buildings between 2012 and 2018 [MWh/capita]

4.4 Set 4: Final energy consumption for space heating, domestic hot water and cooling in buildings of the private service sectors and public sector (MWh/capita, 2002, 2012, 2018, changes)

Looking at the maps, the highest final energy consumption per capita for space heating, domestic hot water and space cooling can be seen in Iceland, Norway, Finland, Germany and the alpine regions of Austria and Italy, in metropolitan areas for private services as well as in central Europe for public services. The lowest values can be seen in the eastern and southern regions.

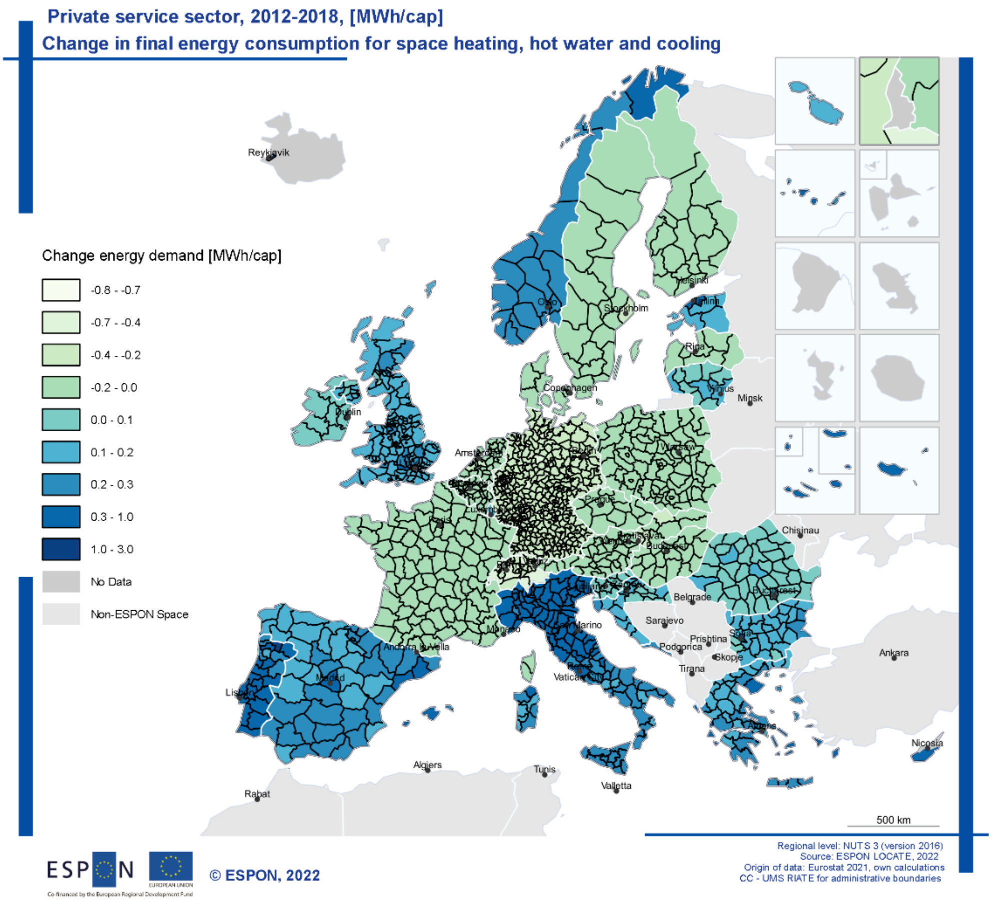
Between 2012 and 2018, both private and public services saw a strong increase in energy demand per capita for heating and cooling in Iceland, Norway, Italy, Spain, and Portugal and a strong decrease in Germany, more moderate in the rest of central Europe. On the one hand, building codes, standards and regulatory frameworks need to be strengthened accordingly and specifically for the service sector. On the other hand, the development shows that the trend is also strongly triggered by economic growth and that a decoupling of economic growth and energy consumption has not yet occurred in this sector.

The data does not provide evidence that the public service sector performed significantly better than the private service buildings, although specific policies for improving the energy performance of public buildings are in place. Thus, the efforts for improving the energy performance of public buildings need to be further enhanced.

While the consumption per capita in residential buildings in metropolitan areas tends to be lower than in other regions, for service buildings it is the other way round, due to the higher concentration of economic activities. This asks for specific measures to address the growth and energy performance of service buildings in these areas.

Overall, the data support the conclusion that the development of energy consumption in this sector in the observation periods is not in line with policy targets set in the fit-for-55 package.

Map 10 indicates the change in final energy consumption for space heating, hot water and space cooling in private service buildings between 2012 and 2018 on the NUTS 3 level.



Map 9. Change in energy consumption in buildings of the private service sector between 2012 and 2018 [MWh/capita]

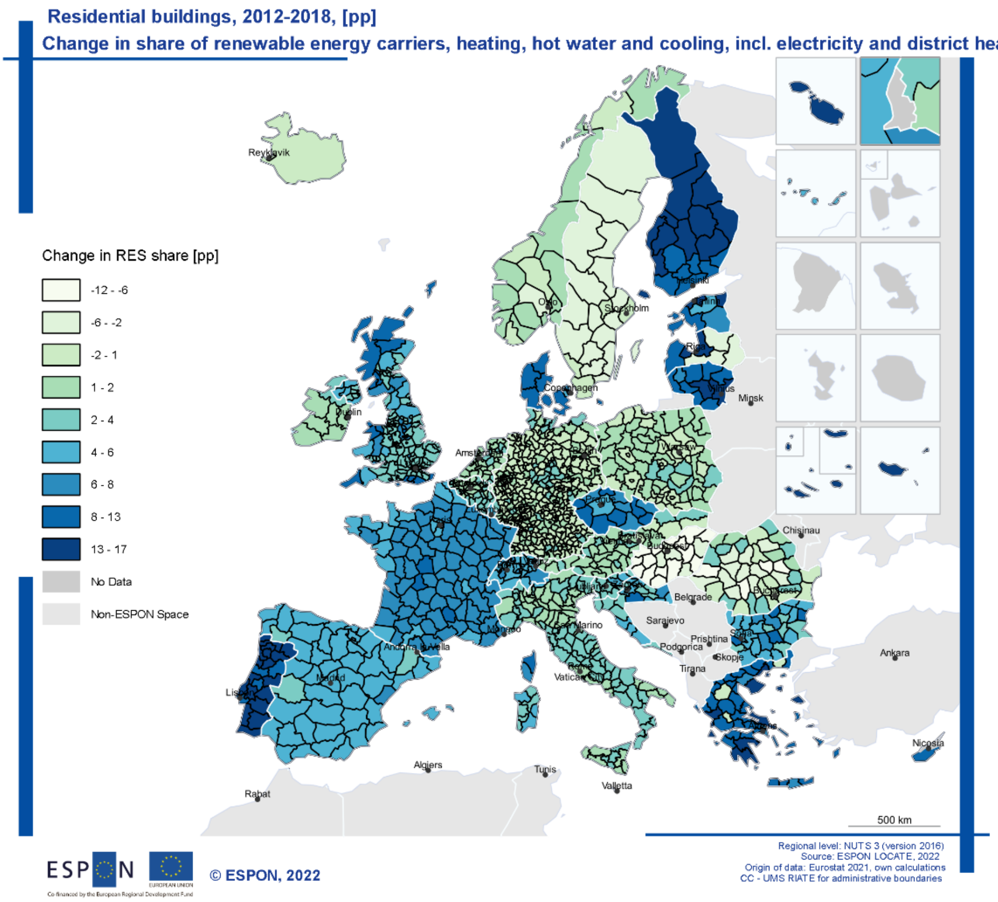
4.5 Set 5: Share of renewable energy carriers in final energy consumption for space heating, domestic hot water production and cooling in buildings of the residential sector (in %, 2002, 2012, 2018, changes)

Looking at the maps, the highest share of renewable energy carriers in final energy consumption for space heating, domestic hot water and space cooling can be seen in Iceland, Portugal, Scandinavian and Baltic regions, with the highest results by far in the residential sector, followed by private and public services.

Between 2012 and 2018, the residential sector shows the greatest increase in the share of renewable energy in heating and cooling final energy demand in Finland, Lithuania, Portugal, Greece, and Denmark, while in the service sector, strong increases took place in Portugal, Italy, and Greece. A decrease in the share of renewable energy in final energy consumption for space heating, domestic hot water and space cooling was registered in Norway, Finland and the Czech Republic. Where data was not available or could not be estimated, the region was indicated as “No Data”.

Only a few areas and countries have shown significant progress in both observed periods (2002-2012; 2012-2018), in particular Finland, Denmark, Portugal and parts of Scotland. Most regions show differences in the pace at which renewables in residential buildings have increased. These differences cannot be explained by the status of RES development in a certain area, nor by the related RES potentials.

Map 10 indicates the increasing share of renewable energy carriers for space heating, domestic hot water preparation and space cooling in residential buildings between 2012 and 2018 on the NUTS 3 level.



Map 10. Change in the share of renewable energy carriers for space heating, domestic hot water preparation and space cooling in residential buildings between 2012 and 2018 [MWh/capita]

5 Conclusions

The work done to update the energy indicators and develop the relative maps shows that there is room for improvement concerning the availability of complete and up-to-date energy data both for generation from renewable energy sources and disaggregated consumption.

The analysis of the maps shows also that the decarbonization process is progressing at a different pace across Europe. Some regions show greater improvements in electricity generation from renewable energy sources and a reduction in energy consumption for heating and cooling, mostly thanks to the increase in heating and cooling systems. However, other regions lag behind and much more should be done to advance the decarbonisation of the power system and the heating and cooling sector, including further integration of decentralized production from intermittent sources and reduction of demand thanks to building thermal renovations.

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7 List of Annexes

Annexe 1, All maps

Annexe 2, Selection of maps accompanied by a description and explanation following the structure of the online MapFinder

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