Interreg Alpine Space

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CERVINO

CERVINO
Creating an EneRgy data exchange and VIsualizatioN tOol for the alps

Report D1.1.1

Lead Partner: Regional Agency for Infrastructure development, building Renovation and Energy of Liguria – IRE spa (Lead partner)

Activity 1.1 – Reshaping, upgrading, and improving the existing Energy Survey structure based on the lessons learned
Leader Organization: Eurac Research

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Preface

The EUSALP (EU Strategy for the Alpine Region) Action Group 9 (AG9) promotes energy efficiency and encourages the production and utilization of renewable energy sources in the EUSALP macro-region[1]. To define, implement, and monitor the effectiveness of energy policies, reliable energy data are required. For this purpose, AG9 developed the Energy Survey to collect regional and national energy data in the EUSALP territory. The Energy was implemented in 2017 and updated in 2019.

Now, the CERVINO (*Creating an EneRgy data exchange and VIsualizatioN tOol for the alps*) project[2] aims to facilitate energy data exchange within the Alpine territory to support decision-making by setting up a reliable system to collect, manage, update, and use energy data.

This report describes all the activities performed in Activity 1.1 of CERVINO: "Reshaping, upgrading and improving the existing Energy Survey structure based on the lessons learned". Taking EUSALP AG9's previous Energy Survey as a starting point, the A1.1 aimed at:

- Identifying the previous Survey's strengths and weaknesses, also based on the experience gained when conducting it.
- Drafting a new set of information and data requirements for the reshaped Energy Survey.
- Setting up the methodology for data collection and provide instructions to ensure data homogenization and consistency.

AG9 members and other stakeholders have been involved at different stages of A1.1 for dedicated questionnaires and meetings to provide feedback and input.

The report is structured as follow:

- Chapter 1: Analysis of the previous Energy Survey.
- Chapter 2: Discussion of the short questionnaire submitted to project observers and active EUSALP AG9 members to collect information on current systems in place in some regions to collect energy data.
- Chapter 3: Description of the process to select which energy data will be included in the reshaped Energy Survey.
- Chapter 4: Compilation instruction for the data collection interface, to be integrated in the "CERVINO Alpine Energy Data Platform" (Activity 1.2).

[1] https://www.alpine-region.eu/
[2] https://www.alpine-space.eu/project/cervino/

Executive Summary

Reliable energy data are the basis for decision-makers to define, implement, and monitor the effectiveness of energy policies. To implement a well-informed energy strategy for the EUSALP macro-region that responds to the needs and challenges of the territory, Action Group 9 developed the Energy Survey to collect regional and national energy data, as well as medium and long-term policy goals defined by the functional units in the EUSALP territory.

In this context, the CERVINO (*Creating an EneRgy data exchange and VIsualizatioN tOol for the alps*) project is focused on facilitating energy data exchange within the Alpine territory to support the decision-making process. This will be done by setting-up a stable and reliable system that will enable better collection, management, update, and use of energy data. CERVINO will leverage the above mentioned EUSALP Energy Survey, implemented in 2017 and updated in 2019 (performed in the framework of AlpGov – *Implementing Alpine Governance Mechanisms of the European Strategy for the Alpine region* – Interreg Alpine Space project).

This first report describes the development of the reshaped Energy Survey, including analysis of previous Energy Survey versions, new data requirements, and compilation instructions for the data collection interface to ensure data homogenization and consistency.

The report describes all the activities performed in Activity 1.1 of CERVINO: "Reshaping, upgrading and improving the existing Energy Survey structure based on the lessons learned". Taking EUSALP AG9's previous Energy Survey as a starting point, the A1.1 aimed at:

- Identifying the previous Survey's strengths and weaknesses, also based on the experience gained when conducting it.
- Drafting a new set of information and data requirements for the reshaped Energy Survey.
- Setting up the methodology for data collection and provide instructions to ensure data homogenization and consistency.

AG9 members and other stakeholders have been involved at different stages of A1.1 for dedicated questionnaires and meetings to provide feedback and input.

In Chapter 1, we present the analysis of the previous Energy Survey and of its update (2017 and 2019). Main results suggest that selected indicators for the new version of the Energy Survey should give priority to those for which the level of data availability is high. Moreover, the number of requested indicators should be limited to enhance the participation of all the EUSALP regions in the survey.

In Chapter 2, systems currently used to collect energy data in some EUSALP regions are investigated. To do that, a short questionnaire was submitted to project observers and active EUSALP AG9 members. Results are not representative (few answers), but they provide useful insight regarding the variability in the type of collected data and gathering processes.

In Chapter 3, selected data which will be included in the reshaped Energy Survey are presented. These data cover all the main relevant topics in the energy sector with a specific focus on the use of renewable resources.

In Chapter 4, instructions regarding the data collection interface are provided. The interface will be integrated in the "CERVINO Alpine Energy Data Platform" (Activity 1.2).

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1 | Analysis of previous Energy Survey

The Alpine Space is characterized by important energy flows between regions. These energy flows can benefit from cross-border energy projects, which in turn can significantly contribute to achieve the European Union (EU) goal of being CO_2 neutral by 2050. However, a necessary basis for the creation of joint energy projects is the availability of relevant, reliable, and updated cross-regional energy data. The EUSALP Energy Survey was designed to address this issue.

The aim of the EUSALP Energy Survey was to collect valuable information on the energy status quo to monitor and evaluate the energy situation and the potential for renewable energy sources in the Alpine Space. The survey results could inform stakeholders and decision makers in the definition, implementation, and monitoring of the effectiveness of energy policies and projects promoting the energy transition progress in the Alpine region. Moreover, the survey could also help in the identification of potential areas for energy innovation and investment in the Alpine region.

The first EUSALP Energy Survey took place in 2017. The survey was sent to 50 entities: 1 EU country (Slovenia), 1 non-EU country (Liechtenstein), 22 EU regions, Provinces or Ländern (9 Austrian, 8 Italian, 3 French and 2 German), and 26 Swiss cantons (Bisello, et al., 2018). The English version of the Survey was made accessible online by using the tool Survey Monkey. The Survey consisted of twenty-nine open questions organized in 7 sections.

In 2019, the EUSALP Energy Survey was reorganized to gain updated energy data and new insights for policy measures and investment priorities in the EUSALP territory (Bisello, et al., 2019). The survey was sent to twenty-five entities (the same of the previous Survey but considering Switzerland as a whole). The information was collected with an online questionnaire, this time using the tool Opinio. Compared to the Energy Survey 2017, more detailed data were requested on renewable energy sources (RES) in the transport sector, RES installed capacity, and heat pumps contribution in the heating and cooling (H&C) sector. Moreover, regional energy consumption was divided by the reference sector (industry, transport, residential, services, agriculture/forestry, fishing, energy branch, other).

The CERVINO project is built on the results of these two relevant works to improve the Energy Survey structure and develop a user-friendly energy data management tool. Thanks to the experience gained in conducting and updating the previous Energy Surveys, the new survey is designed to make the collection of energy data and the entire data management process more efficient, reliable, and cost-effective. To identify the strengths and weaknesses of the previous surveys, a detailed analysis of the results gained in 2017 and 2019 was conducted, considering the following points to evaluate:

- **Data availability**: the percentage of provided values for each category and region.
- **Missing data**: the proportion of values set at zero, not available values, and missing data for each category.
- **Data source**: the proportion of national and regional statistics as data source for each category and region.

1.1 Data Availability

As a first step, the availability of data on energy statistics for the EUSALP regions was evaluated. To do so, Eurac Research considered the percentage of questions that received a valid answered by the EUSALP regions in the previous Energy Survey. Note that, in this case, an answer was considered *valid* only if a numeric quantity (different from zero) was provided. Values set at zero, not available data, and missing answers were all considered as missing data (see Section 1.2 for further details).

On average, regions were able to provide valid data for almost 50% of the required indicators. However, the percentage of valid values presents a large variability across regions, with values ranging from as low as 20% up to 85%. The percentage of provided values by each region is presented in Figure 1. It is important to note that some regions (Switzerland, Veneto, Tirol, Steiermark, Oberösterreich, and Wien – indicated with a yellow dot in Figure 1) required manual data collection and input by Eurac Research.

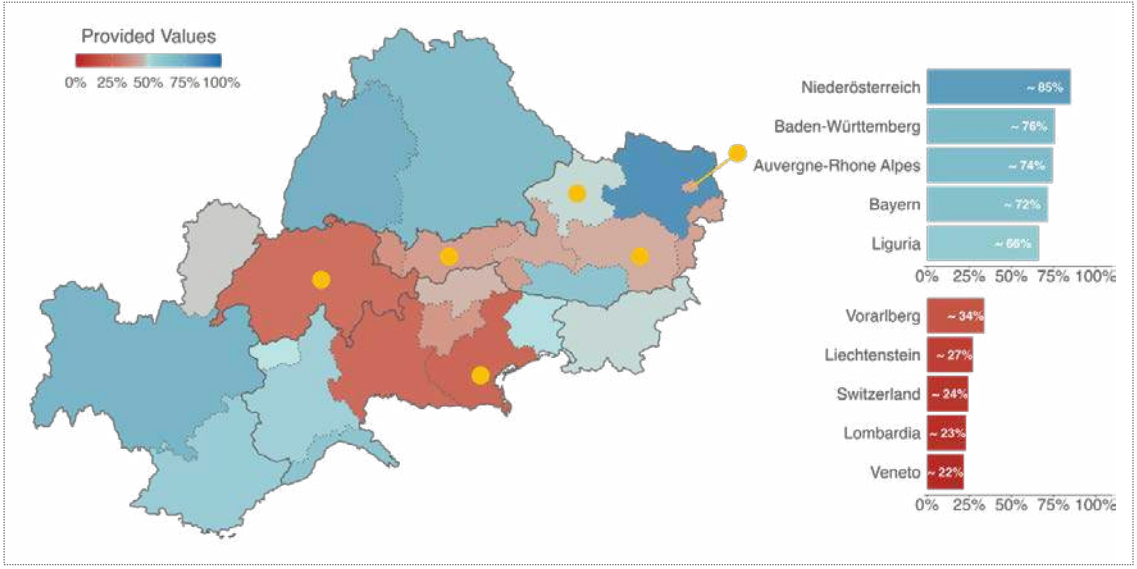

Figure 1. Percentages of provided values to the previous EUSALP Energy Survey by region. Regions indicated by a yellow dot required manual data collection and input by EURAC. Source: EURAC elaboration.

Overall, both French and German regions were able to provide most of the required values. Instead, a different pattern was observed for Austria, Italy, and Slovenia, where data availability varies considerably depending on the specific region. Finally, Liechtenstein and Switzerland were among the regions providing the least amount of data.

To understand in more detail the availability of data on energy statistics, we considered the percentages of valid data provided according to the specific category of the EUSALP Energy Survey for each region (see Figure 2). The results indicate how data availability differs among categories and similar patterns emerge among regions. In general, the following points can be highlighted:

- Data regarding the general energy balance (e.g., primary production, energy import/export, final energy consumption, etc.), the electricity production from renewables (i.e., hydropower, wind, and solar photovoltaic), and the gross final consumption from renewables were available in all regions for most indicators (except for few cases).

- The availability of data regarding the gross final consumption from fossil fuels, the final energy consumption by sector, and the heat and the electricity production from fossil fuels and biomass varied considerably among regions. Only French and German regions covered these indicators consistently.
- Data regarding heat pumps (i.e., heat production and installed capacity of different type of heat pumps) were not available for almost all EUSALP regions.

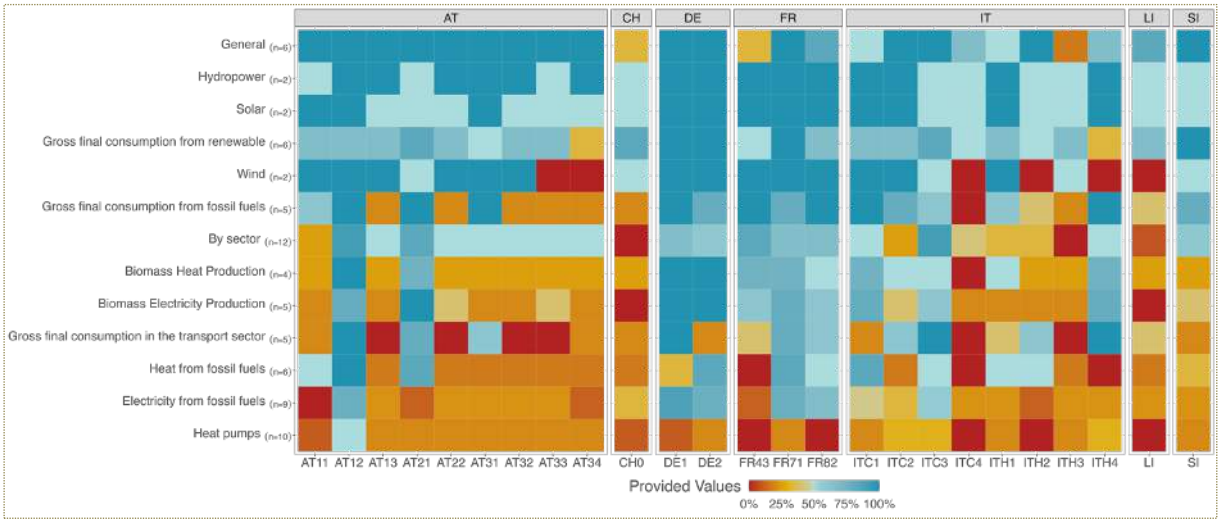

Figure 2. Percentages of provided values to the previous EUSALP Energy Survey for each category by region. The number of indicators within each category is reported within brackets. Region codes are reported in Table 7 of Annex I. Source: EURAC elaboration.

Evaluating the different level of data availability according to the specific category and the different regions is important for the design of the reshaped Energy Survey. In the selection of indicators to be included in the new version of the Energy Survey, priority should be given to those that demonstrate high levels of data availability across the majority of regions. Furthermore, the percentage of data provided may reflect not only the actual availability of data, but also indicates the degree of cooperation of the region in the survey. Thus, to enhance the participation of all the EUSALP regions in the survey, the number of requested indicators should be limited.

1.2 Missing Data

In the previous survey, regions were required to insert the value '-999' to indicate when the value for a specific indicator was not available and to specify the value '0' when the measured value was truly zero. However, this method failed to work due to the presence of a large percentage of missing values. Missing values are difficult to interpret as it is not possible to understand whether they indicate that the value for that specific indicator is truly zero, the indicator is not measured by the region, or the person who compiled the survey forgot to insert the answer.

The percentages of answers with valid values, zero values, '-999' values (not available), and missing values are presented for each category in Figure 3. Except for few categories, the percentage of missing data ranges from more than 20% to almost 40%. Data regarding heat pumps had the highest levels of missing data with more than 50%.

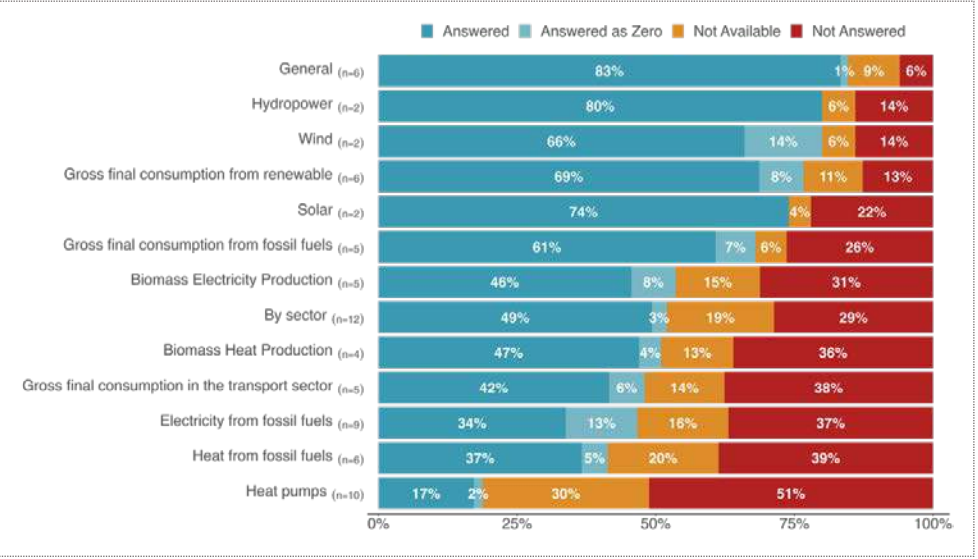

Figure 3. Percentages of valid answers, zero values, not available data, and missing data responses according to the different categories. The number of indicators within each category is reported within brackets. Source: EURAC elaboration.

In Figure 4, the percentages of answers with valid values, zero values, '-999' (not available) values, and missing values are presented for the top-10 and the bottom-10 indicators in terms of data availability. These results confirm the previous findings: indicators with low levels of missing values belong to the category of general energy balance, electricity production from renewables, or gross final consumption from renewables; indicators with high levels of missing values belong to the category heat pumps. There are also some interesting exceptions, for example, the low levels of missing values for the energy consumption in the transport sector and the high level of missing values for the energy consumption in the fishing sector.

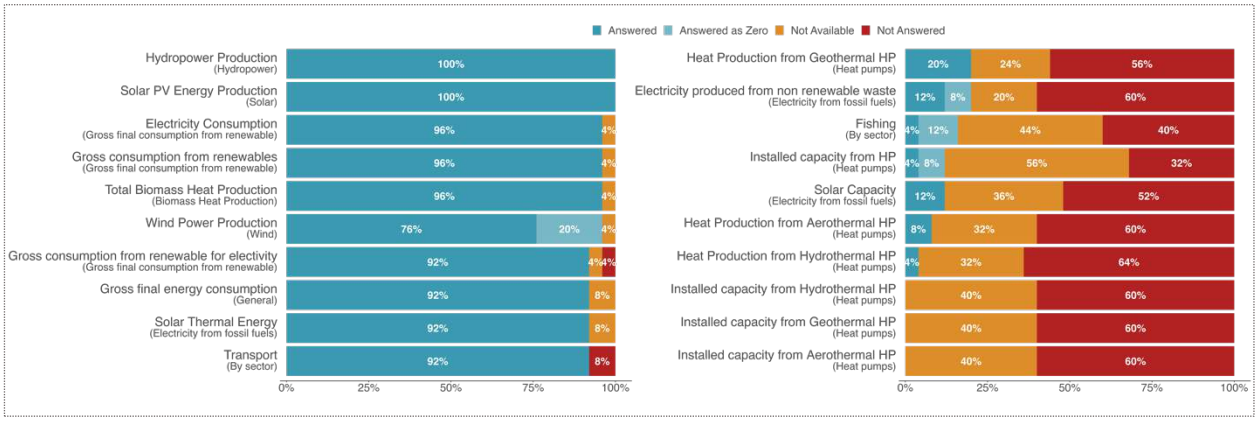

Figure 4. Percentages of valid answers, zero values, not available data, and missing data responses for the top-10 and bottom-10 indicators. Category of each indicator is reported within parenthesis. Source: EURAC elaboration.

The presence of missing values clearly affected the quality and interpretability of the overall results of the Energy Survey. An accurate selection of the required indicators and an accurate design of the data collection procedure are required to minimize the issue of missing data in the reshaped EUSALP Energy Survey.

1.3 Data Source

Knowing the data source of the provided values is important to assess the data quality. High-quality data are measured at the regional level as they provide values that accurately represent the specific region of interest. On the other hand, low-quality data provide a rough estimate of the regional values and are usually derived from national values (or other aggregated levels), for example by dividing an aggregated value by the regional population. This leads to less accurate data that may not be representative for the specific region of interest.

In the previous Energy Survey, regions could specify whether the provided data were obtained from "National statistics", "Local statistics", "Locally collected data" or "Own estimation". The percentages of data coming from different data sources are presented for each category in Figure 5. The distribution of values is similar among categories. The heat pumps category has the highest percentage of data obtained from national statistics (almost 80%), whereas the final consumption in the transport sector has the highest combined percentage of local statistics and regional estimation (almost 50%).

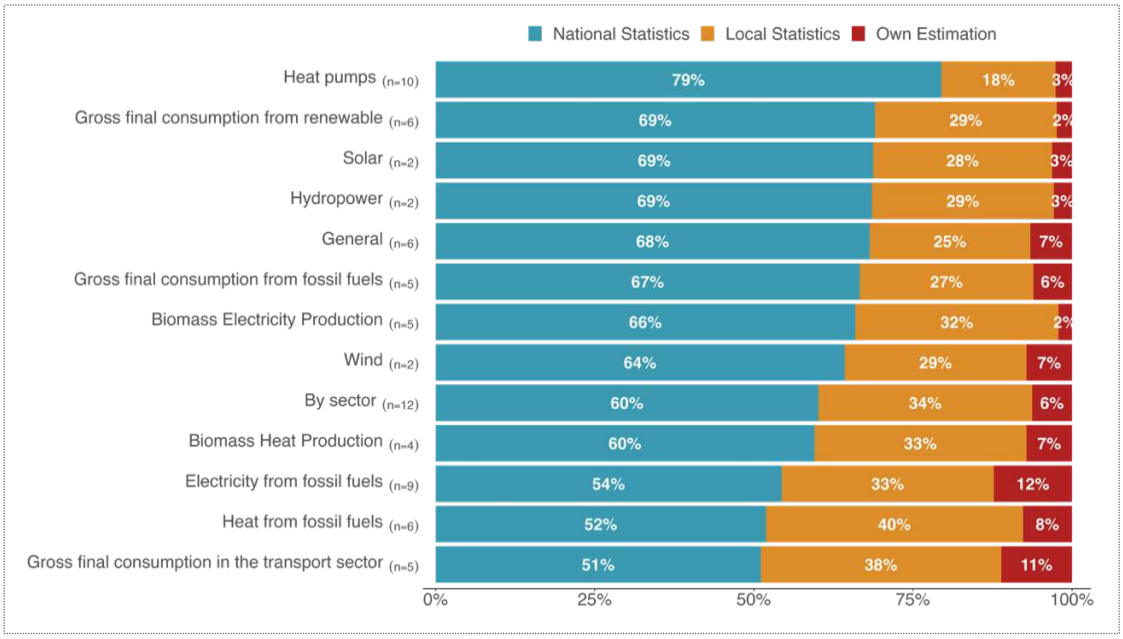

Figure 5. Data sources percentages according to the different categories: national statistics, local statistics (including also locally collected data), own estimation. The number of indicators within each category is reported within brackets. Source: EURAC elaboration.

To analyze with more detail the data sources of provided data on energy statistics, Eurac Research considered the percentage of data coming from different data sources according to the specific category of the Energy Survey for each region (see Figure 6). The results show how data sources differ

more among regions rather than among categories. Note that the white color indicates missing values for the type of data source. In general, it is possible to highlight the following points:

- Austrian regions relied almost exclusively on national statistics, except for few categories in some regions. The same is also true for Lichtenstein and Slovenia (that indeed are included as whole countries in EUSALP).
- Italian regions show a great variability in the level of national statistics. Some regions relied almost exclusively on regional statistics, other regions relied on national statistics, and some other regions have a mix of the two data sources.
- French regions relied almost exclusively on regional statistics, apart from few categories in some regions.
- Only limited information was available for German regions, suggesting the use of regional statistics.
- No information was provided by Switzerland.

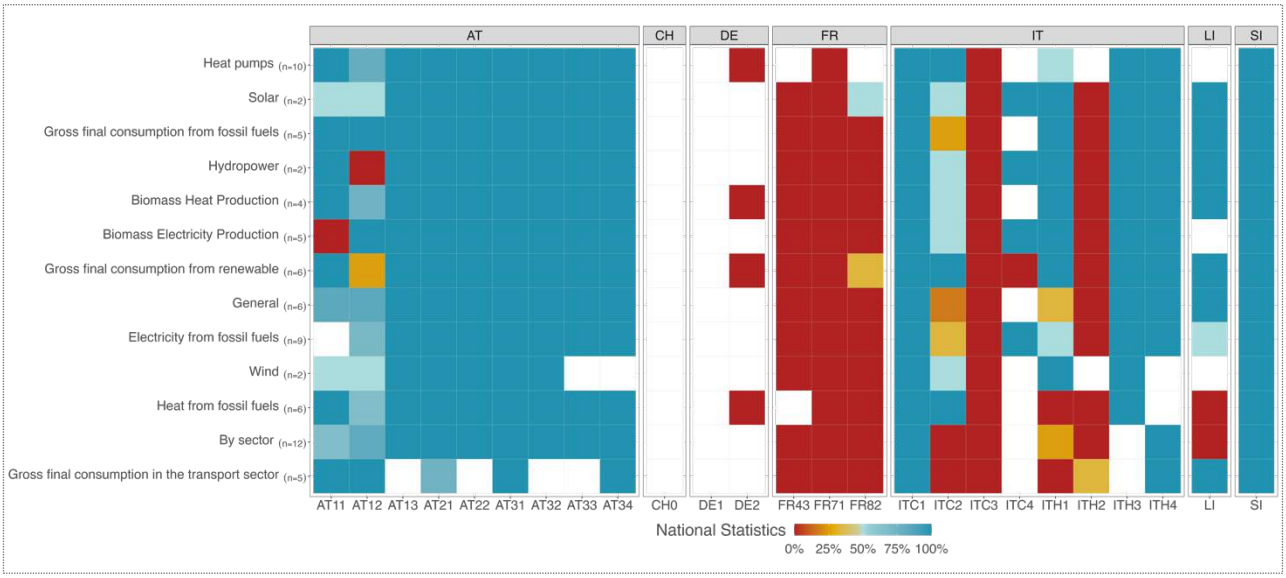

Figure 6. Percentages of data from national statistics for each category by region. The number of indicators within each category is reported within brackets. White color indicates missing values for the type of data source. Region codes are reported in Table 7 of Annex I. Source: EURAC elaboration.

Even if the previous Energy Survey allowed to specify the data source for the provided values, this information is not sufficient to assess the quality of the data. In fact, although one could consider with a certain degree of confidence that regional statistics (and own estimation) are high quality data and that national statistics provide a lower level of quality, this was not clearly stated in the previous surveys. As already pointed out, the source of the data (regional or national institute) is not a truly relevant element to assess the data quality. A much more important aspect is that the data accurately represent or not the specific region and they are not derived from aggregated values (national or other levels). This difference is related to the granularity of the measured value rather than the source of the

data. This aspect will be clarified in the design of the new survey to allow a clearer evaluation of the quality of the data.

1.4 Overview Results

Overall, the analysis of the previous EUSALP Energy Survey and of its update (in 2017 and 2019) highlighted the following relevant issues:

- The indicators selected for the new version of the Energy Survey should give priority to those for which the level of data availability is high, and their number should be limited to enhance the participation of all the EUSALP regions in the survey.
- The design of the collection procedure should minimize the issue of missing data allowing to clearly differentiate among zero values and not available values.
- Information regarding the data sources of the provided values should allow to clearly assess the quality of the data.

Addressing these limits is crucial for the improvement of the reshaped Energy Survey in the framework of CERVINO project.

2 | Questionnaire on current systems to collect energy data

A short questionnaire on the current ways of collection and storage of energy data was sent to project observers and AG9 members (9 reference persons). This survey aimed at setting a starting point for the development for the reshaped Energy Survey, considering the status quo of some EUSALP regions in terms of adopted systems for energy data collection, currently energy (and related) data collected, etc. This questionnaire also gave the opportunity to ask about interesting data to be potentially included in the reshaped Energy Survey and feedback on the last Energy Survey.

The following questions were included in the questionnaire:

1) Which kind of system/tool do you use for storing energy data at regional level?
(*xls or csv format, internal database, digital platform, other – please specify*)

2) Are these stored data or data platform accessible to external users?
(*NO, YES, YES but after approval, other*)

3) Are you sharing these stored data with one or more entities?
(*NO, YES: European or national statistical offices, YES: other regional offices, other – please specify*)

4) Which temporal resolution have the collected data?
(*Monthly, annual, bi-annual, other*)

5) Which kind of energy data do you collect?
(*The list of categories of data collected with the Energy Survey in 2019 was provided*)

6) Do you currently collect other kind of energy-related data, e.g., GHG emissions?
(*Open question*)

7) Which new data do you think would be useful to collect with the "reshaped" Energy Survey thanks to the CERVINO project?
(*Open question*)

8) Please point out brief pros and cons of the last Energy Survey (2019) considering both the used tool/system and the requested data.
(*Open question*)

9) Are you interested in being involved in the working group set up within the CERVINO project?
(*open question*)

The main outputs from the 5 filled questionnaires are reported below.

The responses to question 1, regarding the current system/tool used for storing data at regional level, show how most participants (80%) make use of spreadsheet or csv files to store energy data. Only one region declared to store data by using only an internal database, whereas 40% of the participants make a combined use of spreadsheet or csv files with internal databases or digital platforms (see Figure 7).

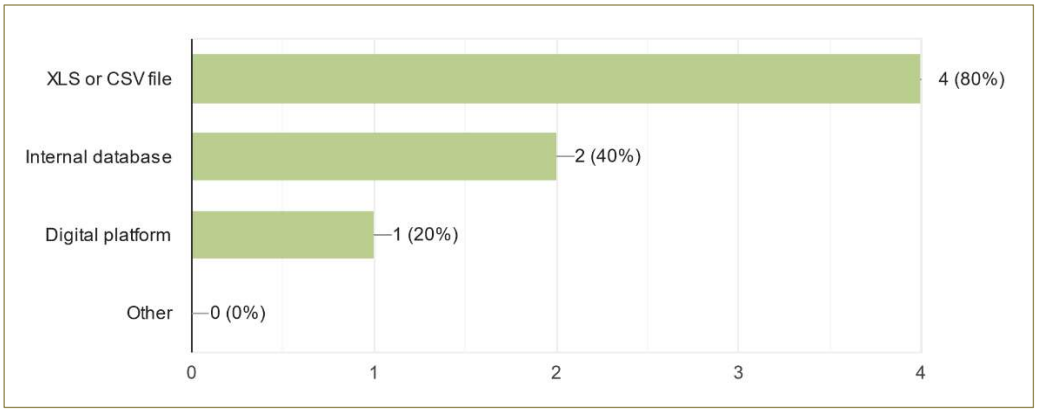

Figure 7. Current system used for storing data at regional level. Source: EURAC elaboration from Google form.

Regarding the accessibility of the stored data by external users (question 2; see Figure 8) most of the respondents declared that the data collected are not accessible for external users (40%) or accessible only after approval (40%), whilst one participant indicated the "other" option, but did not provide further information about the specific accessibility system in use.

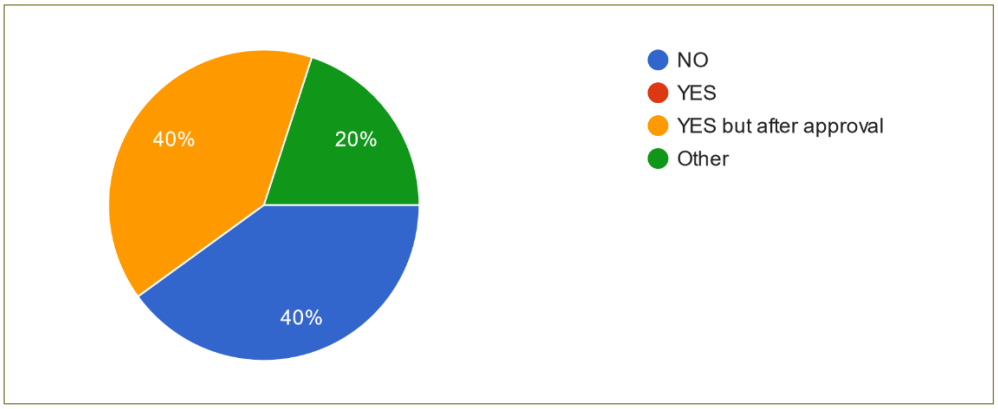

Figure 8. Accessibility of the stored data by external users ($n_{responses}$ = 5). Source: EURAC elaboration from Google form.

Responses to question 3 (see Figure 9) show how four participants out of five share the stored data with other entities; three of them affirmed to share the data with other regional offices and only one with other European or National statistical office. Only one region claimed not to share the energy data collected.

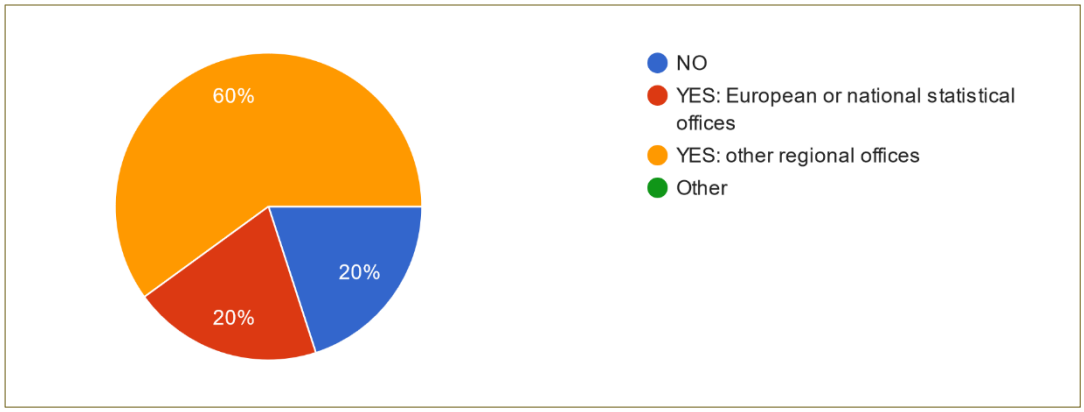

Figure 9. Current sharing of collected energy data with other entities ($n_{responses}$ = 5). Source: EURAC elaboration from Google form.

Question 4 investigates the temporal resolution of collected energy data by the different regions (see Figure 10). The majority of participants (60%) confirmed the annual frequency of data collection; one region declared to collect energy data monthly and the remaining one selected the "other" option; however, no specific information is provided.

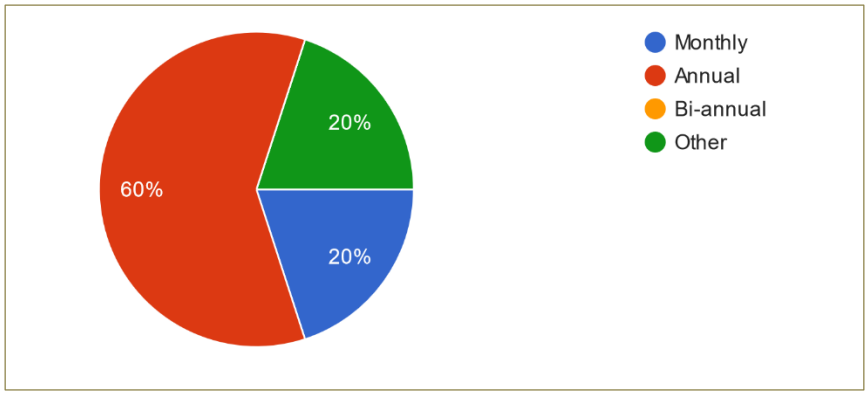

Figure 10. Temporal resolution of collected energy data ($n_{responses}$ = 5). Source: EURAC elaboration from Google form.

Question 5 required the participants to identify the data currently collected at regional level among a provided list of data built on the main categories included in the previous Energy Survey 2019. The main objective was to identify data items that are not collected or available by one or more region.

Interesting insights emerge from the surveyed people in relation to specific data categories (see Figure 11): only 4 categories of data out of 11 appear to be collected by all the participants regions. Primary energy production results to be collected only by the 40% of respondents; data regarding Heat Production and related detail with respect to the source appear to be collected only in the 50% of the participants regions, and the same applies to the Electricity Production's item; whereas data about Electricity Production by source seems to be available for 4 respondents out of 5.

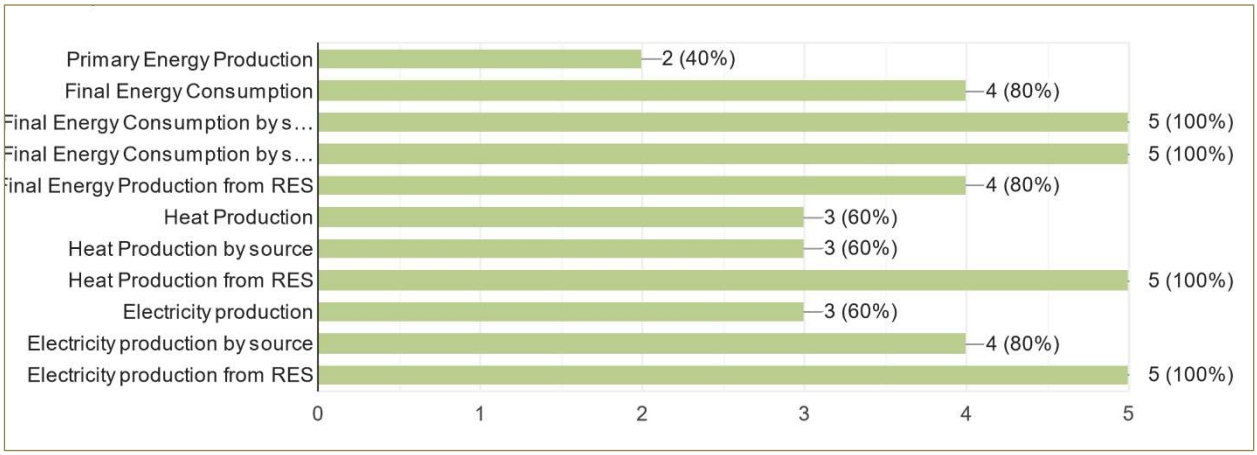

Figure 11. Energy data currently collected at regional level. Source: EURAC elaboration from Google form.

The last two questions aimed at gaining insights about other kind of energy-related data currently collected in the regions (question 6) and getting suggestions about "new" data they would like to see in the re-shaped Energy Survey (question 7). Responses about other energy-related data are listed below:

- *"GHG emissions".*
- *"Translation of consumption data into GHG emissions for SECAP (Sustainable Energy and Climate Action Plan) at municipality level".*
- *"CO_2 emissions calculated from energy data".*
- *"Not directly, but there are synergies between the collection of energy data for the Regional Energy balance and the inventory of air polluting emissions carried out by the environment department of the region".*

Insights provided in relation to "new" data to be collected with the reshaped Energy Survey are reported below:

- *"Energy flows among Alpine Space regions".*
- *"Data by source for each sector (currently requested only for transport; other sectors could be useful)".*
- *"Installed storage capacity, hydrogen production and production capacity, biomass sustainable retrievable potential".*
- *"Biomass consumption, heat pumps production, electromobility consumption".*
- *"Recovery of energy byproducts, carbon storage".*

3 | Energy data requested in the reshaped Energy Survey

Considering the answers to the brief questionnaire presented in the previous section, and after a consultation phase among the project partners, the final set of indicators related to energy data was defined. These indicators will be included in the reshaped Energy Survey that will be submitted within the CERVINO project starting from June 2023.

Starting from the list of indicators collected in the previous Energy Survey, the project consortium discussed the possibility to have a group of "core" data (essential for comparing energy profiles among EUSALP regions) and a group of "additional" data that will add useful information to the core ones while not being fundamental. When filling the survey, only the provision of "core" data will be mandatory, whereas the provision of "additional" data will be optional. The decision of subdividing indicators into these two groups will allow to overcome the issues identified in the previous version of the Energy Survey (see Section 1.2). Specifically:

- The issue related to missing data will be limited by forcing to provide values (or select the non-availability option, please see Section 4) for all the "core" data.
- The list of "core" data includes a limited number of indicators. Indicators are selected according to their relevance considering the data availability (both present and future). This will allow not only to overcome the issue related to not available data but also to reduce the amount of effort required to complete the survey enhancing the participation of all EUSALP regions.
- The list of "additional" data includes optional indicators providing more in-depth insights on certain energy topics. While the provision of data for the additional indicators is not mandatory, including them in the Energy Survey ensures that this information is not overlooked in regions where data are available. Not all regions are expected to provide information for these indicators.

The reshaped Energy Survey has been structured in the following categories:

1. **Energy Balance**. Overview of the region's energy situation (flow and use of energy within a region).
2. **Gross Final Energy Consumption**. Gross final energy consumption of the region, divided by different energy sources.
3. **Gross Electricity Production**. Detailed overview of the primary sources used to produce electricity in the region.
4. **Gross Energy Production for H&C**. Detailed overview of the primary sources used for heating and cooling in the region.
5. **Final Energy Consumption**. Final energy consumption of the region, divided by different sectors.

6. **Energy Transition**. Emerging trends in the regional energy sector related to the energy transition.

Moreover, within each category indicators related to the same topic are grouped into subcategories. In the following sections, the agreed structure of the reshaped Energy Survey is represented.

3.1 Energy Balance

This category provides a comprehensive overview of the regional energy situation considering flow and use of energy within the region. The selected indicators are presented in Table 1. All indicators are considered "core" data and no "additional" data is included.

Table 1: Energy Balance indicators. Source: EURAC elaboration

category	subcategory	core data	additional data
Energy balance	Energy balance	Primary production	
		Energy imports	
		Energy exports	
		Gross inland energy consumption	
		Final energy consumption	
		Gross final energy consumption	

3.2 Gross Final Energy Consumption

This category focuses on the gross final energy consumption of the region, divided by different energy sources. The selected indicators are presented in Table 2. Subcategories cover the final energy consumption from fossil fuels, renewables, electricity, nuclear, other sources, and the consumption in the energy transport sector. Most indicators are "core" data with "additional" data providing further details on the renewables and the transport sector.

Table 2. Gross Final Energy Consumption indicators. Source: EURAC elaboration.

category	subcategory	core data	additional data
Gross final energy consumption	From fossil fuels	Gross consumption from fossil fuels - Total	
			From solid fuels (coal)
			From oil
			From gas
			From non-renewable waste
	From renewables	Gross consumption from renewables - Total	
			For electricity
			For heating and cooling (H&C)
			For transport

	From electricity	Gross consumption from electricity	
	From nuclear	Gross consumption from nuclear	
	From others	Gross consumption from other sources	
	In the transport sector	Gross consumption for transport - Total	
			Oil
			Natural gas
			Renewables

3.3 Gross Electricity Production

This category focuses on the gross electricity production and the sources of this production. The selected indicators are presented in Table 3. Subcategories cover the primary sources used to produce electricity in the region: fossil fuels, renewables (considering also installed capacity), nuclear, and other sources. Most indicators are "core" data with "additional" data providing further details on the specific fossil fuel used and biomass type.

Table 3. Gross Electricity Production indicators. Source: EURAC elaboration.

category	subcategory	core data	additional data
Gross electricity production	From fossil fuels	Electricity from fossil fuels - Total	
			Coal
			Oil
			Gas
			Non-renewable waste
	From renewables	Electricity from biomass - Total	
			Biogas
			Biofuels
			Bioliquids
			Solid biomass
		Electricity from hydropower	
		Electricity from wind power	
		Electricity from solar PV	
		Electricity from other renewables	
	Installed capacity for electricity from renewables	Hydropower capacity	
		Wind power capacity	
		Solar PV capacity	
	From nuclear	Electricity from nuclear Energy	
	From others	Electricity from other sources	

3.4 Gross Energy Production for H&C

This category focuses on the gross energy production for heating and cooling of the region, divided according to the different energy sources. The selected indicators are presented in Table 4. Subcategories cover the primary sources used for heating and cooling in the region: fossil fuels, renewables (considering also installed capacity), and other sources. Only part of the indicators are "core" data with "additional" data providing further details on the specific fossil fuel used, biomass type, and heat pump type.

Table 4. Gross Energy Production for H&C indicators. Source: EURAC elaboration.

category	subcategory	core data	additional data
Gross energy production for H&C	From fossil fuels	H&C from fossil fuels - Total	
			Coal
			Oil
			Gas
			Non-renewable waste
	From renewables	H&C from biomass - Total	
			Biogas
			Biofuels
			Bioliquids
			Solid biomass
		H&C from heat pumps - Total	
			H&C from geothermal HP
			H&C from aerothermal HP
			H&C from hydrothermal HP
		H&C from solar thermal	
		H&C from other renewables	
	Installed capacity for H&C from renewables	H&C installed capacity for heat pumps - Total	
			From geothermal HP
			From aerothermal HP
			From hydrothermal HP
		H&C installed capacity for solar thermal	
	From others	H&C from other sources	

3.5 Final Energy Consumption

This category considers the final energy consumption of the region according to the different sectors. The selected indicators are presented in Table 5. Most indicators are "core" data with "additional" data providing further details on the transport sector.

Table 5. Final Energy Consumption indicators. Source: EURAC elaboration.

category	subcategory	core data	additional data
Final energy consumption	By sector	Consumption of transport - Total	
			Road
			Rail
			Aviation
			Other
		Consumption of industry	
		Consumption of residential	
		Consumption of services	
		Consumption of agriculture/forestry	
		Consumption of fishing	
		Consumption of the energy branch	
		Consumption of other sectors	

3.6 Energy Transition

This category focuses on emerging trends in the regional energy sector related to the energy transition. The selected indicators are presented in Table 6. Subcategories cover information on hydrogen production and source, energy communities, and e-mobility. All indicators are "core" data because, although they may not be available now, they are expected to become more relevant in the next future.

Table 6. Energy Transition indicators. Source: EURAC elaboration.

category	subcategory	core data	additional data
Energy transition	Hydrogen production by source	Green hydrogen production	
		Grey hydrogen production	
		Blue hydrogen production	
	Energy communities	Energy source(s)	
		Energy capacity of plants - total	
		Number of members	
	E-mobility	Charging points for e/H vehicles - number	
		Private e/H vehicles - number	
		Public e/H vehicles - number	

4 | Compilation instruction for the data collection interface

Considering all the points highlighted in the analysis of previous Energy Surveys, in the questionnaire on current systems to collect energy data, and after the consultation phase among the project partners to define the final set of energy data, EURAC decided to develop a web-based platform to collect data from the different regions within the Alpine territory. Having a tailor-made application allows to set-up a stable and reliable system that can be modified afterwards in the case of further updates on the Energy Survey. This means that the platform will also have a persistence layer to store energy data, so the participants of the Energy Surveys can add or modify their information at any time. Also, a web-based platform will permit to access to the previous, current, and future Energy Surveys with any device and with any web browser.

4.1 Platform registration and Log-in

Credentials used to access the platforms will be provided by Eurac Research to the regions participating in the Energy Survey. For each region, an account will be created to access the platform and insert the data for the associated region. Note that the same account can be used by multiple users from the same to insert the data. Alternatively, multiple accounts for the same region can be created but such accounts will access the same data.

The platform starts with a login interface where users are required to insert their credentials (see Figure 12). In case of a forgotten password, users can require a new password by clicking on the "Forgot password?" option and follow the instructions. An email will be sent with the link to set the new password. After logging in, users can access the platform for the data collection.

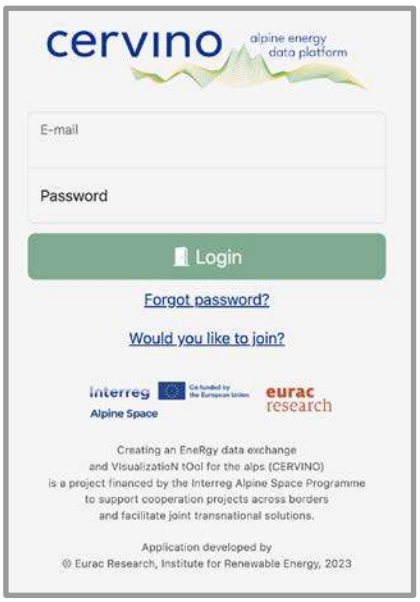

Figure 12. Login to the web-based platform to collect energy data from different regions in the Alpine territory. Source: EURAC elaboration.

4.2 Modalities for data collection

The initial page of the platform is presented in Figure 13. The top navigation bar allows users to select the modality for the data collection. Two different options are available:

- *"By category"* (default option, see Section 4.2.1). Data for multiple indicators are collected for the same selected year.
- *"By year"* (see Section 4.2.2). Data for multiple years are collected for the same selected indicator.

In addition to the modalities for data collection, users can find two further sections in the top navigation bar:

- *"Support"*. This allows users to report their feedback regarding the platform. Moreover, the link to the privacy policy is provided.
- *"Account"*. This allows users to modify their settings, such as contact information and password.

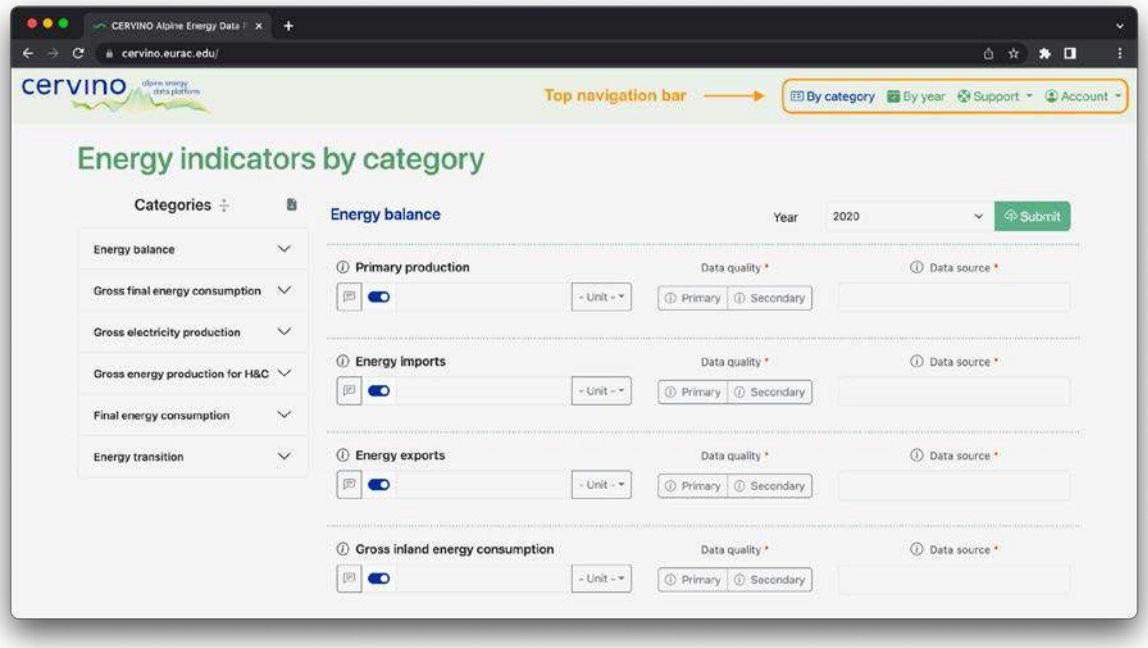

Figure 13. Platform initial page with top navigation bar to select modality for the data collection. The default modality is "By category". Source: EURAC elaboration.

4.2.1 Data collection by category

The default data collection modality is *"By category"*. This modality allows inserting data regarding all the indicators of a specific category at the same time for a selected reference year. As indicated in Figure 14, users can select the desired category of indicators using the menu on the left and select the reference year from the list on the top-right side of the page. Currently, available reference years range from 2018 to 2021.

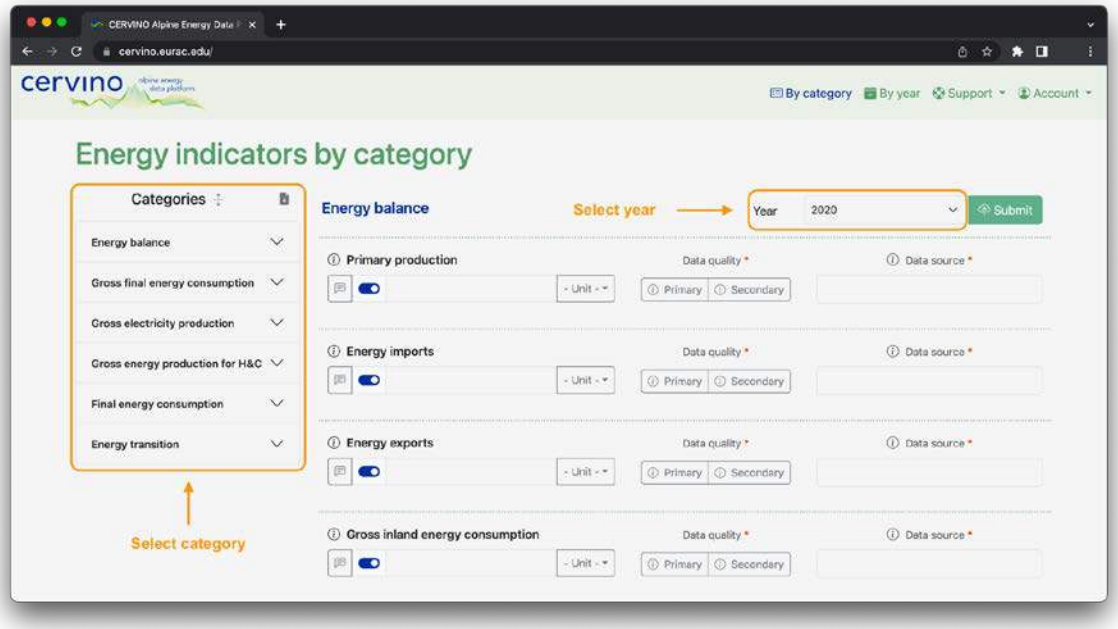

Figure 14. Compilation of energy indicators associated to a selected category and for a selected year. Users can select the category and then, they can select the year from a list. Source: EURAC elaboration.

4.2.2 Data collection by year

The modality *"By year"* allows inserting data for the selected indicator for multiple years at the same time. As indicated in Figure 15, users can select the desired category of indicators using the menu on the left and select the specific indicator from the list on the top of the page.

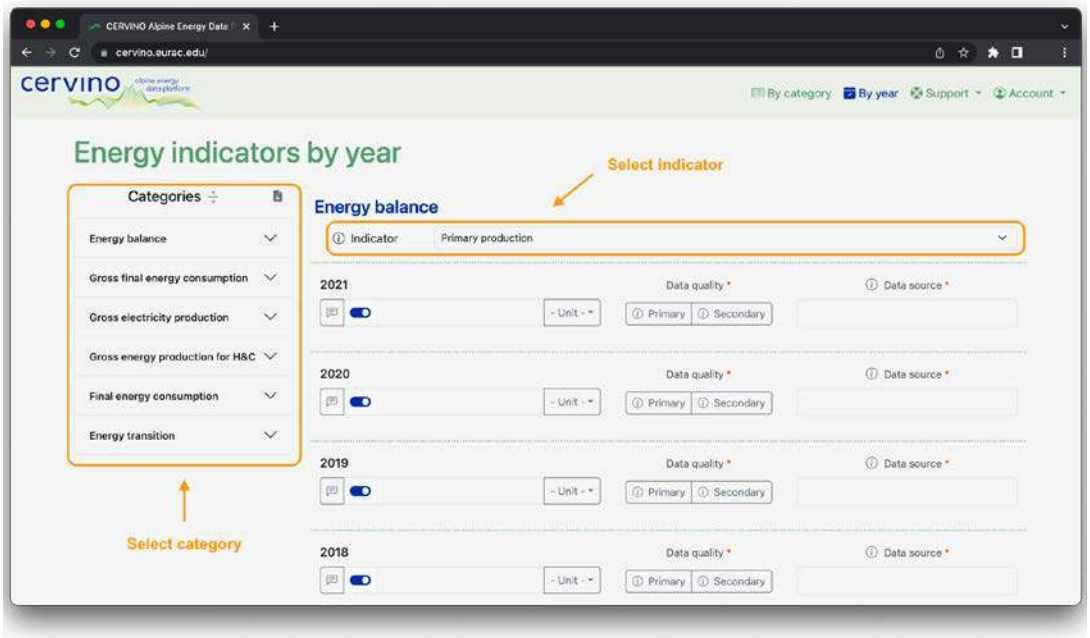

Figure 15. Compilation of a specific energy indicator for all the available years. Users can change the category and then, they can select the indicator from a list. Source: EURAC elaboration.

4.3 Indicator information

Independently from the selected modality to provide data, each energy indicator requires a set of values to be filled in (see Figure 16).

Figure 16. Required information for an energy indicator. Source: EURAC elaboration.

i. *The value of the indicator*. For most indicators this will be a numerical value indicating, for instance, the amount of energy or production capacity. For some indicators (e.g., energy sources of energy communities), the value can be a text description.
ii. *The unit of measure.* When applicable, users need to select the unit of measure associated with the numerical value from a list of different possibilities. Note that it is possible to select only one unit of measurement.
iii. *Data quality*. To overcome the issue related to the assessment on data sources highlighted in previous sections, the user can choose the quality of data for the energy indicator, which can be classified as:
    - *Primary*, or accurate values (measured or estimated) at regional level. The source of data (regional or national institute) is not relevant if the indicator accurately represents the region, and it is not derived from aggregated values (national or other levels).
    - *Secondary*, or rough estimate of regional values that derive from national values (or other aggregate levels), e.g., by dividing it by the regional population. This leads to less accurate data that may not be representative for the region.
iv. *Data source.* Users also need to provide the source of the data, for instance, the name of the regional or national institution in charge of measuring or estimating the indicator, an external link to the web page where the data is available, etc.

Users are required to fill in all four fields for each indicator. Figure 17 provides an example of an indicator with all the required information.

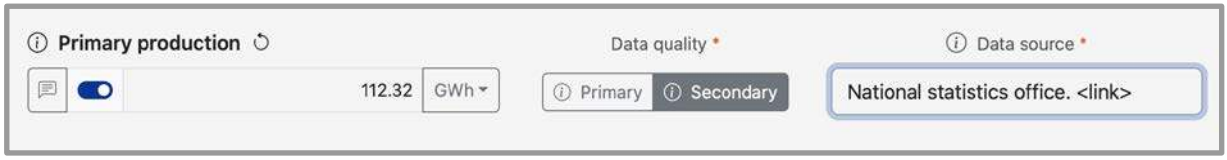

Figure 17. Energy indicator with complete information. Source: EURAC elaboration.

When data are not available, users can disable the indicator using the switching button on the left side (see Figure 18). This switching button allows the users to select only those indicators for which data are available and to disable those that cannot be completed due to missing values. In this way, we avoid constraining users to insert negative values to indicate that the value of a specific indicator is not available.

Figure 18. Switching button to enable and disable indicators. Users can disable the indicator in the case the data is not available. Source: EURAC elaboration.

Moreover, users can add comments providing further details and information for each indicator. To add a comment, users need to click the button on the left side (see Figure 19). Note that comments are always available, regardless of the status of the indicator (enabled or disabled).

Figure 19. Regardless of the status of the indicator (enabled or disabled), comments are always available to specify more details about the indicator. Source: EURAC elaboration.

In the case of invalid values (e.g., text where numeric values are required), the box will automatically turn red, also displaying an issue icon (see Figure 20). Users need to insert all valid values to allow submitting the survey for a reference year (see Section 4.4).

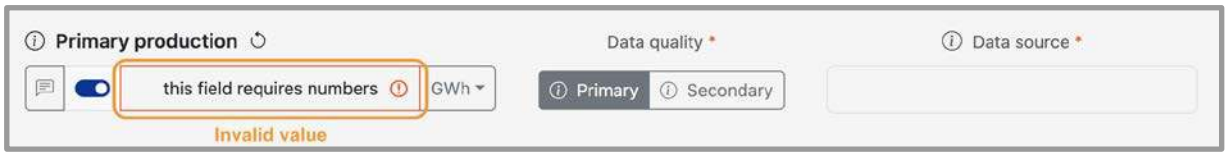

Figure 20. In the case of invalid values (e.g., text instead of numeric values), the platform will automatically prompt the user. Source: EURAC elaboration.

Finally, users can find further information about the indicators and the required data by moving the mouse pointer over the info icons (see Figure 21). In some cases, it is also possible to click the info icon next to the name of the indicator to show detailed information about it. By doing so, the platform will open a side box on the left with more details (see Figure 22).

Figure 21. By moving the mouse pointer over the info icon, the platform will provide further information about the required data. Source: EURAC elaboration.

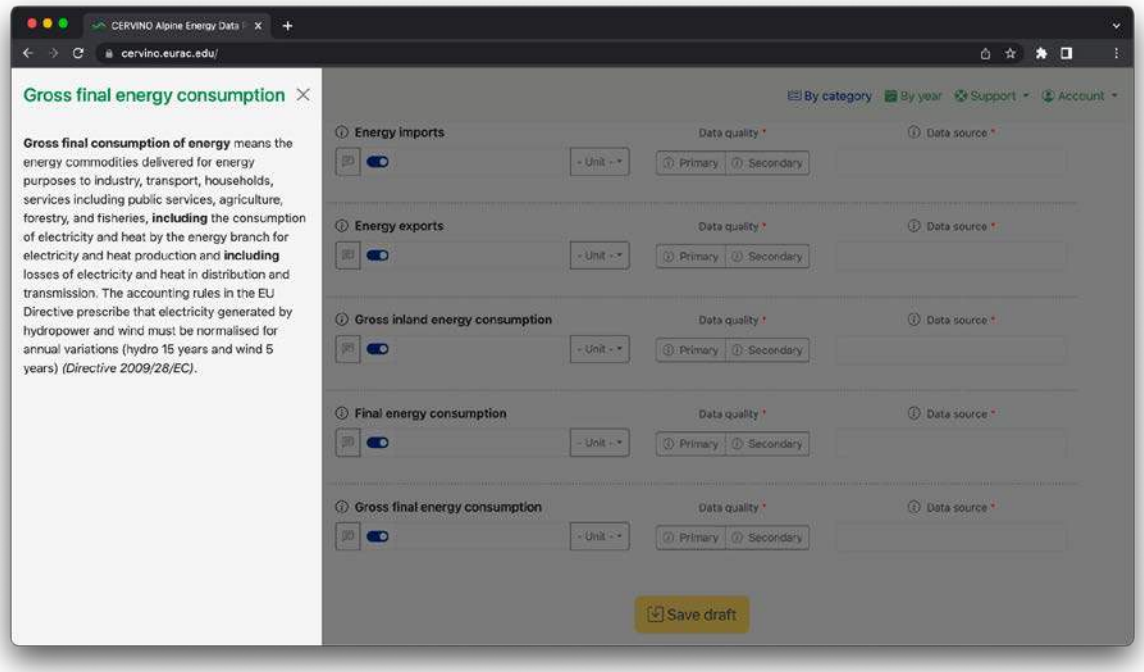

Figure 22. Clicking on the icon next to the name of the indicator, the platform will open a side box on the left with detailed information about the indicator. Source: EURAC elaboration.

To download the full list of indicators and description, click the icon on the left of the Category menu (see Figure 23).

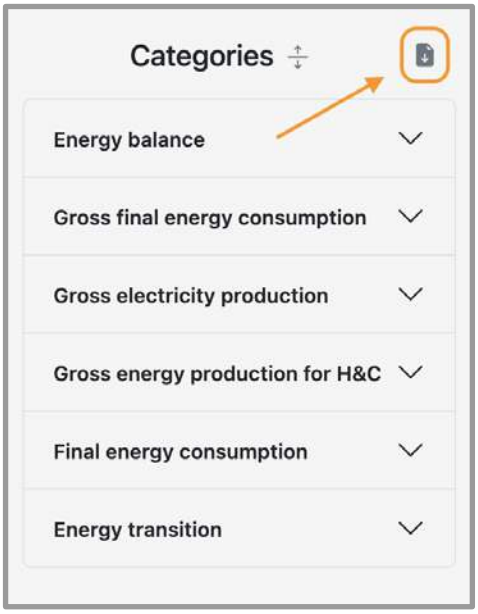

Figure 23. Clicking on the icon next to the Category menu to download the full list of indicators and description. Source: EURAC elaboration.

4.3.1 "Core" and "additional" data

The survey includes "core" indicators and "additional" indicators to provide in-depth insights on certain energy topics. "Core" indicators are mandatory and therefore, they are already enabled at the beginning of the survey. Note that this does not mean that users are forced to provide a value for them as it is always possible to disable them when a particular value is not available. On the contrary, "additional" data are disabled by default. When values for "additional" indicators are available for a region, users can enable them and insert all the required data.

Whenever a "core" indicator has also a list of "additional" or optional indicators to provide in-depth insights on certain energy topics, they will be grouped as a list. In the case of "By category" data collection modality, the "core" indicator is presented at the top of the list, while related "additional" indicators are listed afterwards in *italic* (see Figure 24). In the case of "By year" data collection modality, "core" and "additional" indicators are grouped in the list and, again, the "core" indicator comes first, while related "additional" indicators are listed afterwards (see Figure 25).

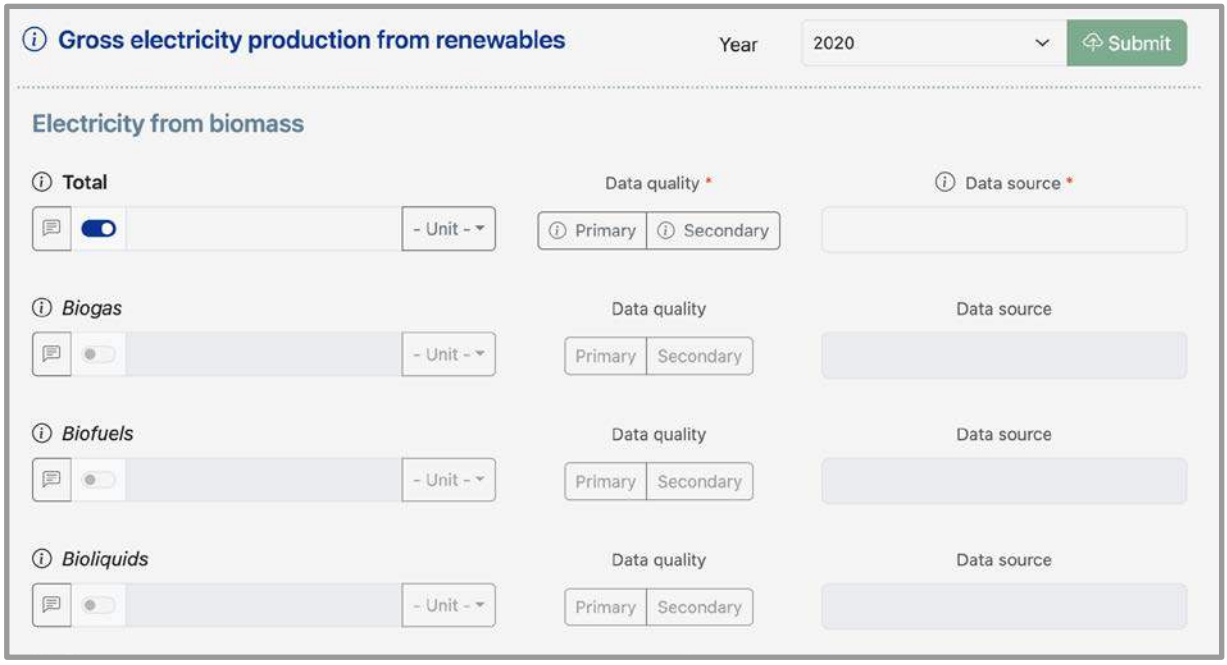

Figure 24. List of "core" and "additional" in the "By category" data collection modality. The first indicator is the "core" one, then the "additional" indicators are listed afterwards in italic.
Note that "additional" indicators are disabled by default. Source: EURAC elaboration.

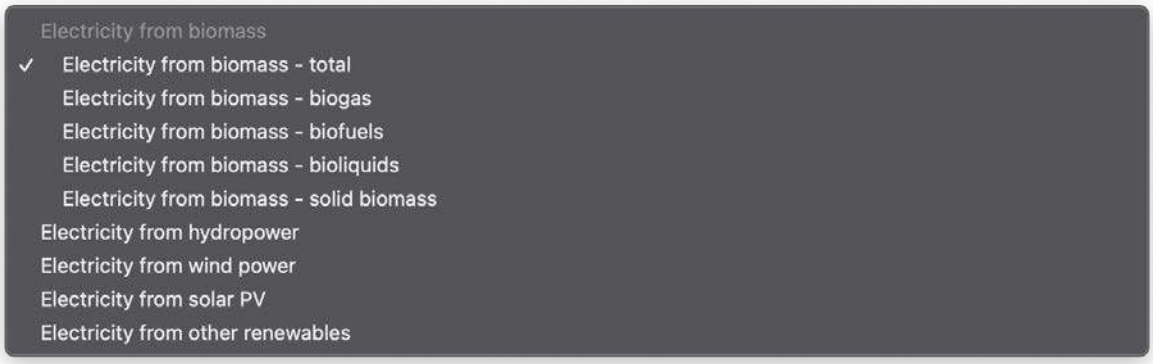

Figure 25. List of "core" and "additional" in the "By year" data collection modality. The first indicator is the "core" one, then the "additional" indicators are listed afterwards. Source: EURAC elaboration.

4.4 Save and submit

After inserting new details for some of the indicators, users need to click the "Save draft" button at the bottom of the page to save the changes. Subsequently, once all indicators have been completed (or disabled), users can click on "Submit" at the top-right side of the page to send all their responses to the survey (see Figure 26).

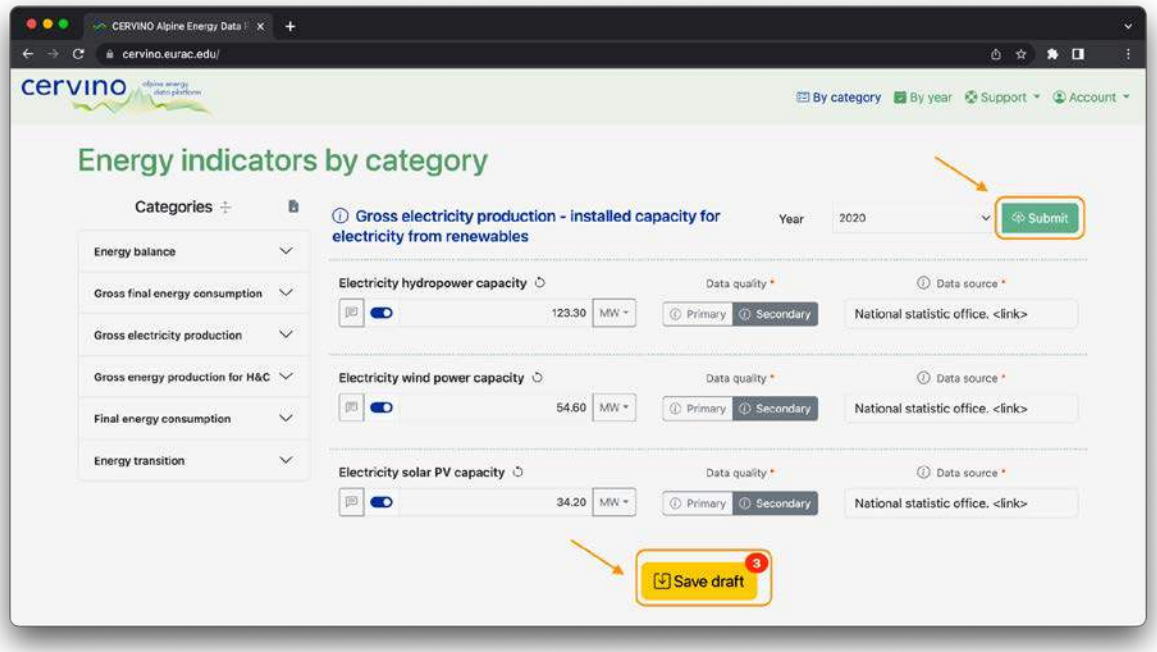

Figure 26. Save draft" button is used to save current changes. "Submit" button is used to send all the responses to the survey. Source: EURAC elaboration.

Note that it will be possible to submit a survey for a specific year only once all the enabled indicators are complete (i.e., with correct value, and with selected unit of measure, data quality, and data source). Alternatively, indicators without values must be disabled. The category menu on the left side displays a grey dot if all indicators for each group of indicators are correctly completed (or disabled) and a red dot if there are uncompleted indicators due to missing values (see Figure 27).

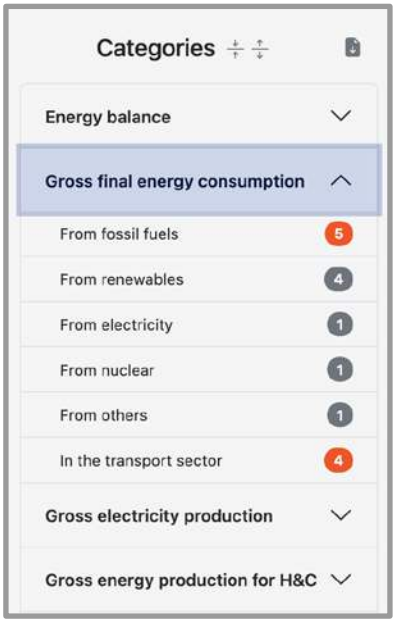

Figure 27. For each group of indicators, the category menu displays a grey dot if all indicators are correctly completed (or disabled) and a red dot if there are uncompleted indicators or other issues. Source: EURAC elaboration.

5 | References

Bisello, A. et al., 2018. *EUSALP Energy Survey 2017 - Report, https://www.alpine-region.eu/file/2445/download?token=Ly-gLBN9.*

Bisello, A. et al., 2019. *EUSALP Energy Survey Update 2019 - Report, https://www.alpine-region.eu/file/5904/download?token=iqEkmGre.*

Figures

Tables

Annex I - EUSALP regions' codes

Table 7. EUSALP regions' codes. Source: EURAC elaboration.

Code	Region
Austria	
AT11	Burgenland
AT12	Niederösterreich
AT13	Wien
AT21	Kärnten
AT22	Steiermark
AT31	Oberösterreich
AT32	Salzburg
AT33	Tirol
AT34	Vorarlberg
Switzerland	
CH0	Switzerland
Germany	
DE1	Baden-Württemberg
DE2	Bayern
France	
FR43	Franche-Comté
FR71	Auvergne-Rhone Alpes
FR82	PACA
Italy	
ITC1	Piemonte
ITC2	Valle d'Aosta
ITC3	Liguria
ITC4	Lombardia
ITH1	Provincia Autonoma di Bolzano
ITH2	Provincia Autonoma di Trento
ITH3	Veneto
ITH4	Friuli Venezia Giulia
Liechtenstein	
LI	Liechtenstein
Slovenia	
SI	Slovenia

Annex II - Indicators' definitions

For the purposes of this Deliverable and the Alpine Energy Data Platform, the following definitions apply:

"**Primary production**" of energy is any extraction of energy products in a usable form from natural sources. This occurs either when natural sources are exploited (for example, in coal mines, crude oil fields, hydro power plants) or in the fabrication of biofuels. Transforming energy from one form into another, such as electricity or heat generation in thermal power plants (where primary energy sources are burned), or coke production in coke ovens, is not primary production (EUROSTAT Energy Glossary).

"**Energy imports**" represent all entries into the national territory excluding transit quantities. However, if electricity transits through a country, the amount is reported as both an import and an export. Data reflect amounts having crossed the national territorial boundaries, whether customs clearance has taken place or not. Quantities of crude oil and products imported under processing agreements (i.e., refining on account) are included. Petroleum products imported directly by the petrochemical industry should be included (EUROSTAT Energy Balance Guideline 2019).

"**Energy exports**" represent all exits from the national territory excluding transit quantities. However, if electricity transits through a country, the amount is reported as both an import and an export. Data reflect amounts having crossed the national territorial boundaries, whether customs clearance has taken place or not. Quantities of crude oil and products exported under processing agreements (i.e., refining on account) are included. Petroleum products exported directly by the petrochemical industry should be included (EUROSTAT Energy Balance Guideline 2019).

"**Gross inland energy consumption**" is the total energy demand of a country or region. It represents the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration. Gross inland energy consumption **includes**:

- consumption by the energy sector itself,
- distribution and transformation losses,
- final energy consumption by end users,
- "statistical differences" (not already captured in the figures on primary energy consumption and final energy consumption).

Gross inland consumption **does not include** energy (fuel oil) provided to international maritime bunkers. It is calculated as follows: **primary production + recovered & recycled products + imports – export + variations of stocks – bunkers** (EUROSTAT Energy Glossary).

"**Final energy consumption**" is the total energy consumed by end users, such as households, industry, and agriculture. It is the energy which reaches the final consumer's door. It **excludes** energy used by the energy sector, including for deliveries, and transformation. It also **excludes** fuel transformed in the

electrical power stations of industrial auto-producers and coke transformed into blast-furnace gas where this is not part of overall industrial consumption but of the transformation sector. Final energy consumption in "households, services, etc." **covers** quantities consumed by private households, commerce, public administration, services, agriculture, and fisheries (EUROSTAT Energy Glossary). This quantity is relevant for measuring the energy consumption at the final place of energy use and for comparing it to the Europe targets. For example, in Directive 2012/27/EU the "Percentage of savings" is calculated using these values of 2005 and its forecast for 2020 targets; the Europe 2020 target was reached when this value reaches the level of 20% (EUSALP Energy Survey, 2019).

"**Gross final consumption of energy**" means the energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry, and fisheries, **including** the consumption of electricity and heat by the energy branch for electricity and heat production, and **including** losses of electricity and heat in distribution and transmission. The accounting rules in the EU Directive prescribe that electricity generated by hydropower and wind must be normalised for annual variations (hydro 15 years and wind 5 years) (Directive 2009/28/EC).

"**Coal**" (Solid Fossil Fuels): Anthracite, Coking coal, Other bituminous coal, Sub-bituminous coal Lignite / Brown Coal, Patent Fuels, Coke oven coke, Gas coke, Coal tar, BKB, Peat, Peat products, Oil shale & oil sands (EUSALP Energy Survey, 2019).

"**Gas**": Natural gas, Coke oven gas, Blast furnace gas, Gasworks gas, Other recovered gas (EUSALP Energy Survey, 2019).

"**Oil**": Crude oil, Natural Gas Liquids, Refinery Feedstocks, Additives / Oxygenates, Other Hydrocarb. (w/o bio), Refinery gas, Ethane, LPG, Motor Gasoline (w/o bio), Aviation Gasoline, Gasoline Type Jet Fuel, Kerosene Type Jet Fuel, Other Kerosene, Naphtha, Gas/Diesel Oil (w/obio), Fuel Oil, White spirit and SBP, Lubricants, Bitumen, Petroleum Coke, Paraffin Waxes, Other Products (EUSALP Energy Survey, 2019).

"**Non-renewable waste**": Industrial waste and Non-renewable municipal waste (EUSALP Energy Survey, 2019).

"**Gross final energy consumption from renewable**" is the amount of renewable energy consumed for electricity, heating and cooling, and transport (EUSALP Energy Survey, 2019).

"**Renewable energy sources**" are energy sources that replenish (or renew) themselves naturally. Renewables can be used for electricity and derived heat production. Mainly sources for derived heat production are solar thermal, biomass, geothermal and heat pumps. Heat pumps can be used by individual households as well as at larger scale in industry and in commercial and public services. Energy flows related to heat pumps used for cooling are excluded, only heat pumps used for heating (hot water) are included. For more details on methodology and related calculation principles, please see Commission Decision 2013/114/EU (notified under document C(2013) 1082) (EUSALP Energy Survey, 2019).

"**Gross final energy consumption from electricity**" is equal to the **import + stock changes – export** of electricity. The figure does not consider the production of electricity from fuels within the region (EUSALP Energy Survey, 2019).

"**Gross final energy consumption from nuclear**" means the total amount of energy consumption from nuclear sources (EUSALP Energy Survey, 2019).

"**Gross electricity production**" (or gross electricity generation) is the total amount of electrical energy produced by transforming other forms of energy, for example nuclear or wind power (EUROSTAT Energy Glossary).

"**Biomass**" is organic, non-fossil material of biological origin (plants and animals) used as a raw material for production of biofuels. It can also be called biomass feedstock or energy crops. It includes a wide range of materials harvested from nature or biological portions of waste. The most typical example is wood (firewood, wood residues, wood waste, tree branches, stump, wood pellets, ...), which is the largest biomass energy source. Other examples of biomass are grass, bamboo, corn, sugarcane, animal waste, sewage sludge and algae (EUROSTAT Energy Glossary). Biomass - organic material of non-fossil origin, including organic waste - can be converted into bioenergy through combustion, either directly or via derived products. Examples of derived products from waste streams include waste oil into biodiesel, animal manure and organic household waste into biogas and plant or plant waste products into biofuel. The following materials can be used in the generation of bioenergy:

- wood and wood waste;
- the organic part of municipal solid waste;
- the organic part of industrial waste;
- sewage;
- manure;
- crop plants and plants by products of food production.

Biomass, particularly woody biomass, can be directly combusted to generate heat and/or electricity. Only sustainable biofuels and bioliquids should be taken into account as renewable energies eligible for the accounting of the share. The split between sustainable and non-sustainable biofuels and bioliquids does not exist in the traditional system of energy statistics and is also not covered in EUROSTAT energy balances. Sustainable biofuels and bioliquids are those compliant with Articles 17 and 18 of Directive 2009/28/EC (EUSALP Energy Survey, 2019).

"**Biogas**" is a gas composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass or by thermal processes from biomass, including biomass in waste. In energy statistics, biogas is a product aggregate equal to the sum of landfill gas, sewage sludge gas, other biogases from anaerobic digestion and biogases from thermal processes (EUROSTAT Energy Glossary).

"**Biofuels**" means liquid or gaseous fuel for transport produced from biomass (Renewable Energy Directive 2018/2001).

"**Bioliquids**" include all liquid fuels of natural origin (e.g., produced from biomass and/or the biodegradable fraction of waste), suitable to be blended with or replace liquid fuels from fossil origin. In energy statistics, liquid biofuels are a product aggregate equal to the sum of biogasoline, biodiesel, bio jet kerosene and other liquid biofuels (EUROSTAT Energy Glossary).

"**Solid biomass**" means not liquid or gaseous fuel for energy purposes produced from biomass.

"**Electricity from hydropower**" is the quantity of electricity generated by all hydropower plants, excluding production from pumped storage units using water that has previously been pumped uphill (Directive 2009/28/EC).

"**Installed capacity**" refers to the maximum amount of electricity or heat that an energy plant can produce under specific conditions, designated by the manufacturer.

"**Gross energy production for H&C from renewable sources**" shall be calculated as the quantity of district heating and cooling produced in a local administrative unit from renewable sources, plus the consumption of other energy from renewable sources in industry, households, services, agriculture, forestry, and fisheries, for heating, cooling, and processing purposes. The quantity of heat to be considered as energy from renewable sources shall be calculated in accordance with the methodology laid down in Annex VII of the Directive 2009/28/EC (EUSALP Energy Survey, 2019).

"**Aerothermal energy**" means energy stored in the form of heat in the ambient air (Renewable Energy Directive 2018/2001).

"**Geothermal energy**" means energy stored in the form of heat beneath the surface of solid earth (Renewable Energy Directive 2018/2001).

"**Hydrothermal energy**" means energy stored in the form of heat in surface water (Renewable Energy Directive 2018/2001).

"**Final energy consumption by the energy branch**" refers to the consumption by the energy sector itself, including losses for distribution and transformation.

"**Grey Hydrogen Production**" refers to the production of hydrogen from natural gas and coal (EPRS - European Parliamentary Research Service).

"**Green Hydrogen Production**" refers to the production of hydrogen by electrolysis of water with renewable electricity (EPRS - European Parliamentary Research Service).

"**Blue Hydrogen Production**" refers to the production of hydrogen through the same production processes as grey hydrogen when CO_2 is captured and stored permanently (EPRS - European Parliamentary Research Service).

A "**Renewable Energy Community**" is a legal entities (a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity; (b) the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities; (c) the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits (Directive 2018/2001).

"E- mobility" refers to clean and efficient transport, using electric vehicles, powered either by batteries or by hydrogen fuel cells (JRC – Joint Research Centre).