

## H2020 Work Programme



# D2.5 – AVAILABLE DATABASES FOR SO WHAT ANALYSIS AND TOOL INTEGRATION

**Lead Contractor: RINA Consulting – RINA-C**

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## Abbreviations

**CHP:** Combined Heat and Power

**COP:** Coefficient of Performance

**DH:** District Heating

**DHCN:** District Heating and Cooling Networks

**EU:** European Union

**GHG:** Greenhouse Gas

**GIS:** Geographic Information System

**HP:** Heat Pump

**IPCC:** Intergovernmental Panel on Climate Change

**KPI:** Key Performance Indicator

**RES:** Renewable Energy Sources

**WH/C:** Waste Heat/Cold

**WHR:** Waste Heat Recovery

## Executive summary

This document represents deliverable D2.5 “Available databases for SO WHAT analysis and tool integration” and is prepared by RINA-C in the framework of T2.4 Definition and selection of scenarios. The purpose of the document is to identify and analyse which databases could be relevant for SO WHAT tool in light of the defined software architecture. The goal is also to identify whether data sources internal or external to the SO WHAT tool will be used to better understand how these data sources could be integrated during the software development phase.

The preparation of this document is informed by:

- The outcomes of WP1 activities where specific algorithms and databases to be integrated in the SO WHAT tool have been defined
- D2.2 “Modules Specifications and Update of Existing Tools” and D2.3 “Common IT framework specifications” describing the conceptual architecture of the SO WHAT tool

This deliverable will inform Task 2.3 by identifying the databases, their corresponding features, as well as data flows necessary in the SO WHAT tool. Then in Task 2.3 the desired functionalities of SO WHAT tool will be translated into the technical specification that will allow each piece of software and module to communicate and exchange data with each. All this information from WP2 will then allow the SO WHAT tool to be developed in WP4.

The main information reported in the present document is:

- A general overview of the SO WHAT tool briefly describing the architecture and the main features of the commercial and free version of the tool with reference to the databases; in addition, preliminary information about how data coming from different sources (i.e. from internal and external databases to the tool) will be managed;
- The analysis of databases that could be integrated within the SO WHAT tool to support its main functionalities. The databases analysis has been carried out according to the conceptual architecture of the software. Databases related to Manufacturing Module, Community Module and Decision Support Module have been identified and described in order to provide useful information about how they could be integrated in the SO WHAT tool.

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# 1 Introduction

## 1.1 Purpose and target group

This document represents deliverable D2.5 Available databases for SO WHAT analysis and tool integration and is prepared by RINA-C in the framework of T2.4 Definition and selection of scenarios.

The purpose of the document is to identify and analyse which database could be relevant for SO WHAT tool in light of the defined software architecture. The goal is also to identify whether data sources internal or external to the SO WHAT tool will be used to better understand how these data sources could be integrated during the software development phase.

## 1.2 Relation with other activities of the project

The preparation of this document is informed by:

- The outcomes of WP1 activities where specific algorithms and databases to be integrated in the SO WHAT tool have been defined
- D2.2 “Modules Specifications and Update of Existing Tools” and D2.3 “Common IT framework specifications” describing the conceptual architecture of the SO WHAT tool

This document will flow into Task 2.3 ‘Common IT framework and architecture’ where the functionalities of SO WHAT Tool will be translated into the technical specification that will allow each piece of software and module to communicate and exchange data with each. All this information from WP2 will then allow the SO WHAT tool to be developed in WP4.

## 1.3 Structure of Document

The present report is articulated in six chapters:

- Chapter 1 is dedicated to the introduction;
- Chapter 2 gives a general overview of the SO WHAT tool briefly describing architecture and the main features of the commercial and free version of the tool; in addition, preliminary information about how data coming from different sources (i.e. from internal and external databases to the tool) will be managed;
- Chapter 3 describes the methodology carried out for identifying and analysing the databases relevant for the SO WHAT tool;
- Chapter 4 is dedicated to the analysis of databases that could be integrated within the SO WHAT tool to support its main functionalities. The databases analysis has been carried out according to the conceptual architecture of the software. Databases related to Manufacturing Module, Community Module and Decision Support Module have been identified and described in order to provide useful information about how they could be integrated in the SO WHAT tool.
- Chapter 5 presents a summary of the identified and analysed tools;
- Chapter 6 summarizes the conclusions of the work carried out.



## 2 SO WHAT TOOL – General overview

Two different versions of the SO WHAT will be released: a commercial and a free version. Both will offer the user the ability to understand the potential for waste heat/cooling recovery and use at Manufacturing and Community levels. However, the Free Version will be available online, while the Commercial Version will be a mix of online and desktop based and likely downloaded using a license. Both tools have similar functionalities at a high level, albeit at different scales of user interaction and detail of results. A detailed explanation of the functions and software architecture of the SO WHAT Tool is contained in D2.2 and D2.3, however below is a brief summary.

For both versions, the Manufacturing and Community modules, the end-user will access the software via a web portal that enables them to:

- Conduct project setup and user access
- View 3D maps and select buildings/ communities to model
- Input data required to building energy assessment
- Use the Decision Support Module for the Scenario, KPIs, Target setting and Results Visualisation and Analysis via the KPI panel and Dashboards.

A key difference between the two versions is the amount of data input required from the user and the subsequent simulations that it enables. The Free version will ask the user for minimal data and will use relational databases to lookup industry energy profiles and potential waste heat recovery technologies, whereas the Commercial version will need to user to input a larger amount of information in order to organise all industrial process related data into create 'Rough Cut Profiles' to create for industrial process energy flows and to conduct a detailed simulations at a Community level.

Other differences between the versions are the level of simulation available at community level and also the ability to have more detailed energy demand and potential supply mapping.

The Free version of the SO WHAT tool will be a tool that the from the Industrial users' point of view, the user initially engages with to understand the waste heat and cooling potential in the facility, and whether there is a viable way to use this at a community level. If the User feels it is worth moving further, then they will be encouraged to access the full Commercial software.

From the Municipality perspective, the user could be interested to understand the potential waste heat/cooling solutions and potential areas to supply heat and/or demand heat from, as well as areas for integrating waste heat/cooling with Renewable Energy technologies.

From the ESCO perspective, the user will be interested to recognise which solutions relating to waste heat/cooling in a community would best suit the business models thy under.

The end-user for the Commercial version of the SO WHAT Tool is an expert from one of the user groups (Industrial, Municipality, or ESCO).

The conceptual architectures of both versions of SO WHAT tool are presented in the following block diagrams. As shown, both versions are structured in 4 modules: Manufacturing, Community and Decision Support and Database Module.

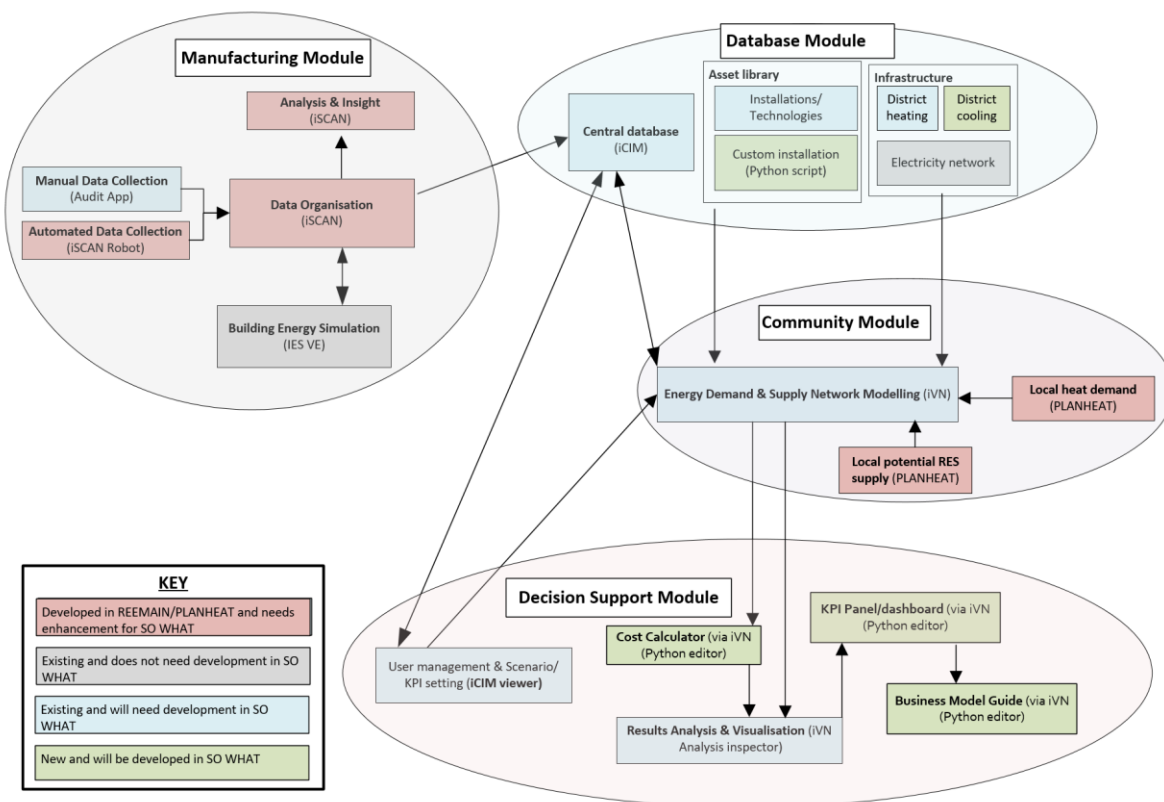


Figure 1: SO WHAT commercial tool – Conceptual software architecture

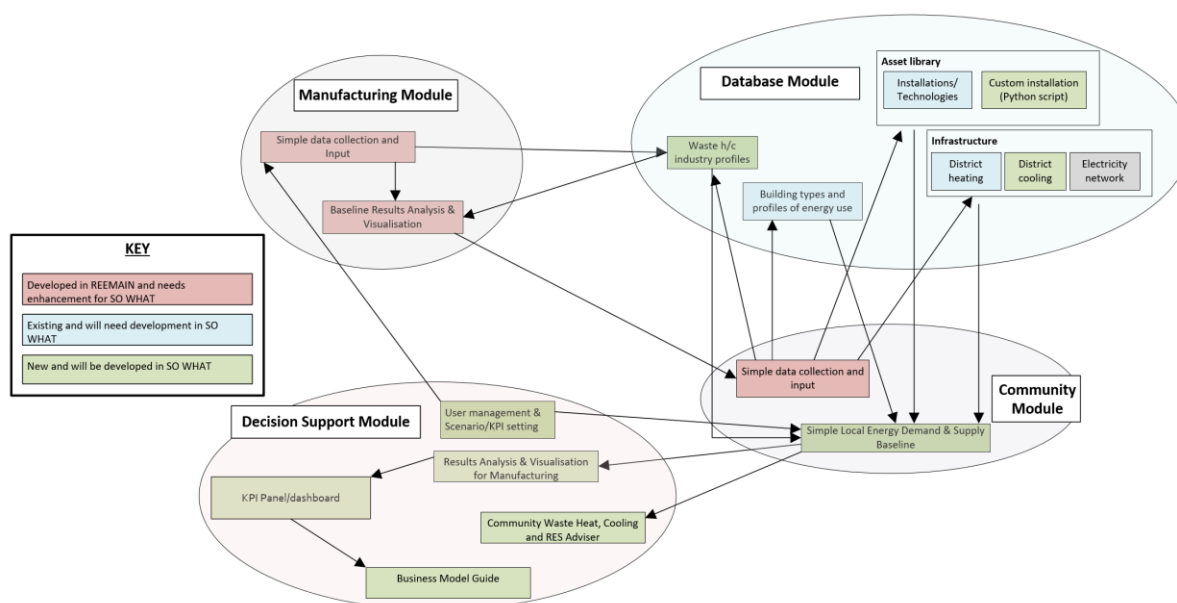


Figure 2: SO WHAT free tool – Conceptual software architecture

As seen in the diagrams, the tool is divided into Manufacturing, Community and Database Modules.

The Manufacturing module will allow modelling the industrial process in order to show potential waste heat and cooling that can be further utilised within the facility or in the local community. In the free version, the user will fill in a questionnaire regarding the site (industry type, size, location, processes, energy profile, energy consumption etc) which will then be mapped to specific pre-defined and simulated industrial buildings and processes. For the Commercial version, more detailed data will be required and entered software that will enable an improved profile of each process to occur and a more detailed view of energy flows and waste heat/cooling potential will be given.

For the Manufacturing user to understand what can be done with their waste heat/cooling, there will be a connection to the Database module which will house all of the technical and economic data for specific technologies that can be simulated. The Free tool will have basic data and simulation capabilities, whereas the Commercial version will be more advanced. As well as technologies, this module will also contain infrastructure details, the Waste Heat /Cooling Profiles and the Building Types and Profiles.

For the Community user, in the free version, whilst the user will be able to view their area and buildings in 3D, they will only be able to simulate a basic local energy demand and supply baseline, and they will also be restricted to a simple guide of the most appropriate technologies to use and potential business models. However, the Commercial version will give the full capacities to the user to model the electric and thermal grid including waste heat and cooling and renewable energy systems to show detailed:

- Local forecasted demand for heating and cooling
- How waste heat/cooling can be used in the community
- Potential of locally available RES sources can to be integrated with W H/C

- Cost-effective scenarios

The Decision Support Module is the module which brings together all of the results relating the different ways that an industry or community could utilise waste heat/cooling from industry and summarise these into Key performance Indicators (KPIs) that can be visualised and understood by expert and non-expert users. It will be online and available to both free and commercial users, with different visualisation and functionality depending on which version used. As part of the Commercial version, there will also be a section allowing the user to rank different technologies and scenario depending on their needs, and also a detailed business model guide.

## 2.1 Managing data inside and outside SO WHAT tool

The SO WHAT tool will manage different types of data from the following sources:

- Data coming from the user
- Data retrieved from sensors (monitoring infrastructure related to iSCAN)
- Default/support data for covering possible lack of data from end user perspective plus facilitate the user experience in using the tool; this default/support data could come from different sources (i.e. from an external database or from ad-hoc databases created in the project).
- Data created by the tool for the specific use case created by the user

Data will be managed through:

- SO WHAT Database module (i.e. inside SO WHAT tool);
- Whenever necessary and possible, the connection to external data sources will be implemented through APIs (i.e. outside SO WHAT tool).
- Connection with iSCAN

### 3 Databases analysis – Methodology

As mentioned in the introduction the purpose of this document is to identify and analyse databases relevant for SO WHAT tool. Considering such a purpose, each module composing the SO WHAT tool has been analysed in terms of main functionalities and related relevant databases have been identified.

The databases analysis has been carried out according to the conceptual architecture of the software. Databases related to Manufacturing Module, Community Module and Decision Support Module have been identified and described in order to provide useful information about how they could be integrated in the SO WHAT tool.

Chapter 5 reports a summary of the analysis carried out, characterizing each database according to the template presented in Table 1.

*Table 1: Example of template for database characterization*

No.	SO WHAT Module of relevance	Database name	Database description	Database provider	Possible integration with WHAT Tool
1		PVGIS	<i>It includes data about solar energy availability for the entire Europe on an hourly, monthly and yearly basis</i>	JRC External database	<i>Connection between SO WHAT tool and PVGIS via API</i>

## 4 Databases analysis

### 4.1 Databases related to Manufacturing Module

#### 4.1.1 Data about energy audit at the industrial site

Data about industrial site will be collected from:

- User for the free version of the SO WHAT tool, lower detail – e.g. industry type, size, location, processes, energy profile, energy consumption, etc.
- User or automatically for the commercial version of the SO WHAT tool, with an increased level of detail in order to provide more complete and reliable outputs

This data will be stored in the database module of the SO WHAT tool.

#### 4.1.2 Profiles for estimating industrial processes consumption

The commercial version of the SO WHAT tool will post process the aggregated energy data collected from a specific industrial site via the iSCAN software. This software serves to enable aggregated energy data from a factory to be broken down and organised into profiles and channels so that it can be allocated to specific process/machinery. The database module of the SO WHAT tool will include the required pre-defined profiles for performing the aforementioned data break down.

#### 4.1.3 Pre-defined and pre-simulated industrial buildings and processes for simplified estimation of waste heat and cooling per industry and country

in the free version of the SO WHAT tool pre-defined and pre-simulated industrial buildings and processes will be stored within the Database module to provide the user with estimations of waste heat and cooling potential. The SO WHAT consortium has investigated waste heat and cooling potential per industry (Iron & Steel, Chemical & Petrochemical, Non-ferrous Metals, Non-metallic Minerals, Food & Tobacco, Paper, Pulp & Print, Wood & Wood Products, Textile & Leather and Other Industry) and country. Two different methods have been used to calculate the waste heat potential in the EU both producing comparable results. Method 1 is a top down calculation that estimates heat use and waste heat from national and industry studies and applies these over the EU using calculated national energy intensity factors. Method 2 is a bottom up calculation that estimates energy surplus output from industries based on the technologies they employ and then calculates the waste heat potential for each industry and applies this to industry energy consumption data for each country. Both methods make broad assumptions that key studies from a single country can be applied across the EU. This is sensible for an overall calculation such as this but takes little account of local differences in industry practice.

#### 4.1.4 Industrial processes and machinery database connected to data input about industrial site

For both the commercial and free version of the SO WHAT tool, the Database Module will include a “catalogue” of processes and machinery to characterize their energy consumption and accomplish the audit phase foreseen by the Manufacturing Module.

#### 4.1.5 Technologies to Recover and Reuse Waste Heat/Cooling within the Factory

In order to simulate the impact of different technologies available to recover and reuse waste heat/cooling at a factory level, there will need to be a database containing all of the technical and economic data for such technologies. As part of D1.9, the University of Birmingham has developed a techno economic database of industrial w h/c recovery technologies (D1.9 – Techno-economic database of industrial w h/c recovery technologies and modelling algorithms). Performance parameters and costs related to each of the technologies presented in Figure 3 have been collected.

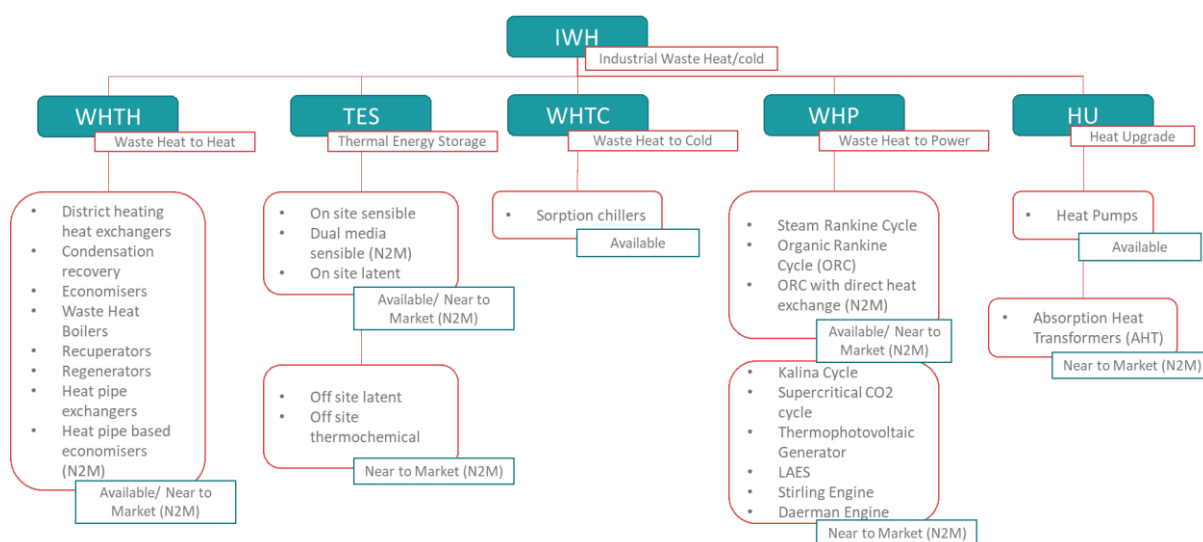


Figure 3: SO WHAT Tool - WH/C technologies

Where IES already has the ability to model these technologies within its existing software (such as Boilers, Sorption Chillers, Organic Rankine Cycle, Heat Pumps) the data from D1.9 will be added into the existing database within IES software. Where IES does not have the existing capability to model technologies, and especially when they are near to market, the database will be compatible with Python script so that they can be run with the software supplementary to the existing options. This database will be integrated within the Database Module of the SO WHAT tool to support the functionalities of the Manufacturing Module, and allow the user to simulate scenarios for exploiting available w h/c and to view the results in the Decision Support Module.

## 4.2 Databases related to Community Module

### 4.2.1 Databases for H&C demand mapping

The SO WHAT tool and specifically the Community Module could be provided with algorithms for mapping H&C demand at local level. Two different approaches could be implemented: top down and bottom up approach.

#### Top down approach for Mapping H&C demand

The assessment is based on the following input data:

- Final energy consumption of the area of interest;
- Information/assumptions about technologies installed in the area of interest;
- Spatial indicators (i.e. Cadastre data - e.g. for a city, the boundaries of the municipality are to be used as input data - LAU2 level of the territorial units for statistics, formerly known as NUTS level 5 - Population density, Employment density, Land use).

#### Bottom-up approach for mapping H&C demand

The assessment is based on the following input data:

- Information at building level (e.g. footprint area, year of construction, use, height)
- Heating & Cooling degree days

For both approaches, in case of lack of input data, default values coming from EU databases can be adopted. Some of the relevant databases that could be used as reference for SO WHAT tool are described in the following sections.

##### 4.2.1.1 Heat RoadMap Europe – Data set for Heating and Cooling Demand

In the framework of the project Heat RoadMap Europe, the 2015 heating and cooling profiles for all EU28 member states (for residential, tertiary and industrial sectors) have been estimated and a specific data set has been developed. The dataset is available in the format of Excel spreadsheets (publically available and downloadable at the following link: [https://heatroadmap.eu/wp-content/uploads/2018/09/HRE4-Exchange-Template-WP3\\_v22b\\_website.xlsx](https://heatroadmap.eu/wp-content/uploads/2018/09/HRE4-Exchange-Template-WP3_v22b_website.xlsx)). These data set could be downloaded and linked to the Database Module of the SO WHAT tool and made available for Community Module calculations for what it concerns the top down approach for mapping H+DHW & C demand (data aggregated at national level can be used and scaled down according to the population of the city of interest).

##### 4.2.1.2 European Building Stock Database

The EU Building Stock Observatory (BSO) was established in 2016 as part of the Clean energy for all Europeans package and aims to provide a better understanding of the energy performance of the building sector through reliable, consistent and comparable data <https://ec.europa.eu/energy/en/eu-buildings-database>. Statistics about technical buildings systems for space heating, space cooling and water heating is available for European Countries and for different years. The available data set are downloadable in csv format. These data set could be linked to the Database Module of the SO WHAT tool and made available for Community Module calculations for what it concerns the top down approach for mapping H+DHW & C demand.

##### 4.2.1.3 Odyssee database for energy consumption

The Odyssee database (<http://www.indicators.odyssee-mure.eu/energy-efficiency-database.html>) contains detailed energy consumption by end-use and their drivers as well as energy efficiency and CO<sub>2</sub> related indicators. Latest available data is providing by national representatives, such as energy agencies or statistical organization, from all EU countries as well as Norway, Switzerland and Serbia. Main features are:

- Advanced data request and analysis interface
- Unlimited exports to Excel
- Numerous indicators for energy efficiency and CO<sub>2</sub>



- Continuous updates with the latest data
- Annual time series
- Detailed energy consumption data by sector and end-use
- CO<sub>2</sub> emissions (direct and indirect)

The access is free for all EU Ministries, Concerted Action EED, EED Committee Members and EU universities and research centers for non-commercial uses and via subscription for other users.

#### 4.2.1.4 Spatial indicators for creating H&C maps

To create maps representing the distribution of H&C demand, spatial indicators are needed.

##### Population density

Population density map 2013 at the 50m resolution (in .asc format) is currently available on the PLANHEAT tool database (open source). This dataset could be linked to the Database Module of the SO WHAT tool and made available for Community Module to create maps of H&C demand distribution.

##### Employment density

Map with the distribution of the number of employees in the services sector at the 50m resolution (in .asc format). This dataset could be linked to the Database Module of the SO WHAT tool and made available for Community Module to create maps of H&C demand distribution.

##### Land cover

CLC2018 is one of the Corine Land Cover (CLC) datasets produced by European Environment Agency (EEA) the within the frame the Copernicus Land Monitoring Service referring to land cover / land use status of year 2018. It provides consistent and thematically detailed information on land cover and land cover changes across Europe (<https://land.copernicus.eu/pan-european/corine-land-cover/clc2018?tab=mapview>).

These geodata could be downloaded from the website of Copernicus Land Monitoring Service, linked to the Database Module of the SO WHAT tool and made available for Community Module calculations

#### 4.2.1.5 Heating and Cooling Degree Days Database

For estimating H&C demand both in top down and bottom up approach, information about Heating and Cooling Degree days of the area under analysis are required. Possible sources of information could be represented by:

- Degree Days database (<https://www.degreedays.net/>). Degree Days calculated heating and cooling degree days for locations worldwide. This database could be accessed automatically by SO WHAT tool via APIs.
- EUROSTAT database (<https://ec.europa.eu/eurostat/web/energy/data/database>) where dataset of HDD and CDD at country and NUTS 2 region level are available.

#### 4.2.2 Databases for mapping RES and WH potential at local level

The description of all the databases required by the Community Module of SO WHAT tool for mapping RES potential at local level is presented in the following sections.

##### 4.2.2.1 PVGIS database

The Community Module of the SO WHAT tool (Commercial Version) will be provided with algorithms for mapping local potential of solar thermal, PV and wind energy. In this framework, PVGIS database ([https://re.jrc.ec.europa.eu/pvg\\_tools/en/tools.html](https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html)) represents a relevant source of data.

#### Mapping Solar Thermal and PV potential

PVGIS provides solar energy related data at a high-quality, high-resolution, for the entire Europe on an hourly, monthly and yearly basis. PVGIS service is an ongoing project that has been developed for more than 10 years by JRC and updates are periodically released. The solar radiation data used in PVGIS have mostly been calculated from satellite data. In this way data for any location over large geographical areas with hourly time resolution are available (by accessing the hourly radiation tool <https://ec.europa.eu/jrc/en/PVGIS/tools/hourly-radiation> ).

#### Mapping wind energy potential

As for solar radiation, hourly profiles of wind speed for the entire Europe are available and downloadable from PVGIS database (by accessing the hourly radiation tool <https://ec.europa.eu/jrc/en/PVGIS/tools/hourly-radiation>, it's possible to download WS10m: 10-m total wind speed - m/s). Moreover, a correlation for the estimation of the wind speed at higher quotes has been included in the software.

All the PVGIS tools can be accessed non-interactively using PVGIS web APIs, thus the connection between SO WHAT Community Tool and PVGIS database will be implemented allowing the user to retrieve site-specific information about solar radiation and wind speed.

##### 4.2.2.2 Open Street Maps Database

The algorithms for mapping solar thermal and PV potential of Community Module of SO WHAT tool will assume as panels' installation surface buildings' rooftops surfaces properly scaled with corrective factors to take into account roofs technical suitability. In this framework, Open Street Maps database (<https://www.openstreetmap.org> ) could provide georeferenced information about footprints of European buildings stock. The possibility to retrieve geodata from Open Street Map within the Community Module will be given to the user.

##### 4.2.2.3 Corine Land Cover 2018 database

CORINE Land Cover (CLC) <https://land.copernicus.eu/news/corine-land-cover-now-updated-for-the-2018-reference-year> is one of the most well-known and used products from the Copernicus Land Monitoring Service. It has previously been produced in 1990, 2000, 2006 and 2012 and now the 2018 edition is available. It consists of an inventory of land cover in 44 classes. It is produced with assistance from the European Environment Agency's Eionet network who contribute their own data produced mainly by visual interpretation of high resolution satellite imagery.

These geodata could be downloaded from the website of Copernicus Land Monitoring Service, linked to the Database Module of the SO WHAT tool and made available for Community Module calculations for mapping:

- Solar thermal potential to identify suitable areas for solar collectors other than buildings roofs
- Biomass potential to identify forest cover and land use for agriculture split in different categories
- Shallow geothermal potential to identify potential spatial constraints

#### 4.2.2.4 Natura 2000 areas (2016) database

The data set provided by European Environment Agency - Natura2000 areas – 2016 is relevant for Community Module of SO WHAT tool in order to identify possible spatial constraints (i.e. protected areas or other spatial constraints to exclude from potential energy production) for better mapping RES potential at local level.

The shape file is available and downloadable from the following link: <https://www.eea.europa.eu/data-and-maps/data/natura-11/natura-2000-spatial-data/natura-2000-shapefile-1>

These geodata could be downloaded, linked to the Database Module of the SO WHAT tool and made available for Community Module calculations for mapping:

- Biomass potential
- Deep geothermal potential

#### 4.2.2.5 Global ecological zones (2010) database

The data set made available by FAO - Classification of forests into Global ecological zones -2010 represents an input for mapping biomass potential.

These geodata could be downloaded (following this link: <http://www.fao.org/geonetwork/srv/en/main.home?uuid=2fb209do-fd34-4e5e-a3d8-a13c241eb61b>), linked to the Database Module of the SO WHAT tool and made available for Community Module calculations.

#### 4.2.2.6 Crop production and specific calorific value databases

Further input data to algorithms for mapping potential from biomass of Community Module are information about crop production, specific calorific value of the crop and net annual increment. This information could be retrieved respectively on:

- EUROSTAT database - Cultivated area per region and Yield in ton/ha for different types of crops ([http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=apro\\_cpnh1&lang=en%20\[\]](http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=apro_cpnh1&lang=en%20[]))
- Biomass Energy Europe - Harmonization of biomass resource assessments Volume I Best Practices and Methods Handbook ([http://www.eu-bee.eu/\\_ACC/\\_components/ATLANTIS-DigiStore/BEE%20Best%20Practices%20and%20methods%20handbook8d4c.pdf?item=digistorefile;249820;837&params=open;gallery](http://www.eu-bee.eu/_ACC/_components/ATLANTIS-DigiStore/BEE%20Best%20Practices%20and%20methods%20handbook8d4c.pdf?item=digistorefile;249820;837&params=open;gallery))

- *Net Annual Increment*  $_{reg}$  [tonnesDM/(ha yr)] - the primary energy production differs from one tree type to another one and the value of this parameter is acquired from IPCC database

These data could be linked to the Database Module of the SO WHAT tool and made available for Community Module calculations.

#### 4.2.2.7 European Soil density database

Density of rocks is a key information for mapping shallow geothermal potential. Information at EU level are available on a dedicated database developed by JRC <https://esdac.jrc.ec.europa.eu/resource-type/european-soil-database-soil-properties>.

Raster files with different spatial resolution are downloadable. "European Soil Database v2 Raster Library" contains raster (grid) data files with cell sizes of both 1km x 1km and 10km x 10km for a large number of soil related parameters.

The raster file could be downloaded and linked to the Database Module of SO WHAT tool.

#### 4.2.2.8 Soil temperature at generic depth database

Community Module will be provided with algorithms for mapping locally geothermal potential (shallow geothermal up to 150 m; deep geothermal from 1 km to 7 km). The key information for these algorithms is the temperature of the soil at the generic depth.

GeoDH information system could represent a source of information to be downloaded and linked to the database module (<http://geodh.eu/geodh-map/>)

#### 4.2.2.9 Technology database for mapping RES technical potential

The Community Module will allow mapping RES physical potential (i.e. local solar radiation), geographical potential (available surface/space for installations) and technical potential (conversion efficiency). A link to Planheat tool will be provided in order to give the possibilities to map the aforementioned potentials.

In order to move from geographical to technical potential, a value for the conversion efficiency of the considered technology is used. For the technologies listed below a typical conversion efficiency will be provided. It is important here to highlight the fact that this represents an estimation for mapping purposes and a more accurate value for the efficiency will be included in the modules for energy calculations.

- Solar thermal collectors: flat plate collectors, evacuated tube collectors and concentrating solar collectors
- Biomass technologies: traditional hot water boilers, condensing hot water boilers, steam boilers, gasifiers, ORCs.
- Deep geothermal energy technologies: heat exchangers and heat to power technologies
- Shallow geothermal energy technologies: water source heat pumps
- PV panels (mono-crystalline panels, poli-crystalline panels, amorphous silicon panels, thin film panels)
- Wind turbines (vertical axis, horizontal axis)

#### 4.2.2.10 E-PRTR (European Pollutant Release and Transfer Register) database

The Community tool is provided with a method for assessing, for large industries, the available waste heat. The method is based on CO<sub>2</sub> emissions that are correlated to the energy consumption of the plant in line with the STRATEGO project<sup>2</sup>; for smaller industrial facilities, a correlation has been retrieved between available excess heat and the footprint area of buildings based on the experience of RINA-C in carrying out energy audits at smaller industrial facilities.

This database includes data on pollutant releases from industries belonging to nine industrial macro-sectors (energy, production and processing of metals, mineral industry, chemical industry, waste and waste water management, paper and wood production and processing, intensive livestock production and aquaculture, animal and vegetable products from the food and beverage sector, and other activities).

The E-PRTR Dataset could be downloaded and linked to the Database module of the SO WHAT tool.

### 4.2.3 Technologies and Infrastructure for Utilising Waste Heat/Cooling in the Community

If the user is interested in understanding how waste heat/ cooling from industry can be used in the community, then a database that enables the user to simulate these technologies and required infrastructure will be available. The technologies will be contained in the same database as for the Manufacturing Module (see Section 4.1.5), and the options the user sees will only include those technologies relevant to the community. As well as this, the tool will also need to show the infrastructure (e.g. District Heat network) existing or required to move waste heat/cooling to the desired end users.

## 4.3 Databases related to Decision Support Module

The objective of the Decision Support Module of SO WHAT tool is to bring together all of the results relating the different ways that an industry or community could utilise waste heat/cooling from industry and summarise these into Key performance Indicators (KPIs) that can be visualised and understood by expert and non-expert users. Strategic information for KPIs calculations is:

- Primary Energy Factors and Emission Factors linked to the different energy sources
- Performance parameters and costs related to WH/C technologies
- Energy prices

### 4.3.1 Primary Energy Factors and Emission Factors Database

Primary energy and emission factors are needed for the calculations of primary energy and pollutant emission once final energies are calculated by the tool. To do so, available dataset has been identified in order to provide those values for all the EU-28 countries.

#### 4.3.1.1 IPCC Emissions Factors Database (EFDB)

EFDB is a database on various parameters to be used to support calculation of anthropogenic emissions by sources and removals by sinks of greenhouse gases. It covers not only the so-called "emission factors" but also the other relevant parameters: <https://www.ipcc->

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<sup>2</sup> <http://stratego-project.eu/>

[nggip.iges.or.jp/EFDB/main.php#:~:text=Terminology%3A%20EFDB%20is%20a%20database,also%20the%20other%20relevant%20parameters.](http://nggip.iges.or.jp/EFDB/main.php#:~:text=Terminology%3A%20EFDB%20is%20a%20database,also%20the%20other%20relevant%20parameters.)

EFDB is meant to be a recognised library, where users can find emission factors and other parameters with background documentation or technical references that can be used for estimating greenhouse gas emissions and removals.

#### 4.3.1.2 PLANHEAT database for primary energy and emissions factors

In the framework of the PLANHEAT project a dataset of primary energy factors and greenhouse gas emission factors have been developed. The objective of this dataset is to analyse and synthesize the impact of heating and cooling in the different EU countries in terms of primary energy consumption and emissions. To this purpose the energy consumption related to H&C demand and the energy mix of the different countries is taken into account in order to assess the footprint of these activities.

This dataset could be relevant for KPI calculation in the Decision Support Module.

#### 4.3.2 Energy tariffs/fuels costs database

Different datasets and publications are related to energy tariffs and fuel costs in all European countries are available to be downloaded. In order to calculate the cost related to the use of different fuels and energy carriers in the Decision Support Module, an appropriate database will be created collecting all the information available.

In particular, natural gas and electricity prices for household and non-household consumers within the European Union are downloadable from EUROSTAT database (<https://ec.europa.eu/eurostat/web/energy/data/database>). For heating oil prices, Statista web database can be taken as reference <https://www.statista.com/statistics/288712/change-of-domestic-heating-oil-price-in-selected-countries/>, while for biomass sources and district heating facilities the EC report on Mapping and analyses of the current and future (2020-2030) heating/cooling fuel deployment (fossil/renewables) could be taken as reference ([https://ec.europa.eu/energy/studies/mapping-and-analyses-current-and-future-2020-2030-heatingcooling-fuel-deployment\\_en?redir=1](https://ec.europa.eu/energy/studies/mapping-and-analyses-current-and-future-2020-2030-heatingcooling-fuel-deployment_en?redir=1)).

## 5 Summary of relevant databases for SO WHAT tool

This chapter provides an overview of all the databases that will be managed by the SO WHAT tool.

No.	SO WHAT Module of relevance	Database name	Database description	Database provider	Possible integration with SO WHAT Tool
1	Manufacturing module	Data about energy audit at the industrial site	Aggregated Energy consumption of the specific industrial site	User or automatically retrieved by iScan Robot application	Dataset integrated within SO WHAT Database Module
2	Manufacturing module	Profiles for estimating industrial processes consumption	Pre-defined profiles for performing break down of aggregated energy consumption data related to the specific industrial site	Provided by SO WHAT tool	Dataset integrated within SO WHAT Database Module
3	Manufacturing module	Pre-defined and simulated industrial buildings and processes for simplified estimation of waste heat and cooling per industry and country	Pre-defined and simulated industrial buildings and processes for simplified estimation of waste heat and cooling per industry and country	Provided by SO WHAT tool	Dataset integrated within SO WHAT Database Module
4	Manufacturing module	Industrial processes and machineries database connected to data input about industrial site	"catalogue" of processes and machineries to characterize their energy consumption and accomplish the audit phase foreseen by the Manufacturing Module	Provided by SO WHAT tool	Dataset integrated within SO WHAT Database Module
5	Manufacturing module	Database of industrial WH/C recovery technologies	Performance parameters and costs related to WH/C technologies	Provided by SO WHAT tool	Dataset integrated within SO WHAT Database Module



6	Community Module	Heat RoadMap Europe – Data set for Heating and Cooling Demand	Heating and cooling demand profiles for all EU28 member states	External database <a href="https://heatroadmap.eu/wp-content/uploads/2018/09/HRE4-Exchange-Template-WP3_v22b_website.xlsx">https://heatroadmap.eu/wp-content/uploads/2018/09/HRE4-Exchange-Template-WP3_v22b_website.xlsx</a>	Dataset downloadable from external databases and linked to SO WHAT Database Module
7	Community Module	European Building Stock Database	Statistics about technical buildings systems for space heating, space cooling and water heating is available for European Countries and for different years.	External database <a href="https://ec.europa.eu/energy/en/eu-buildings-database">https://ec.europa.eu/energy/en/eu-buildings-database</a>	Dataset downloadable from external databases and linked to SO WHAT Database Module
8	Community Module	Odyssee database for energy consumption	Detailed energy consumption data by sector and end-use at EU level	External database <a href="http://www.indicators.odyssee-mure.eu/energy-efficiency-database.html">http://www.indicators.odyssee-mure.eu/energy-efficiency-database.html</a>	Dataset downloadable from external databases and linked to SO WHAT Database Module
9	Community Module	Spatial indicators for creating H&C maps	Population density Land cover	External databases Global Human Settlement (GHS) map restricted to Europe <a href="https://ghsl.jrc.ec.europa.eu/download.php?ds=pop">https://ghsl.jrc.ec.europa.eu/download.php?ds=pop</a> Inventory of land cover in 44 classes <a href="https://land.copernicus.eu/news/corine-land-cover-now-updated-for-the-2018-reference-year">https://land.copernicus.eu/news/corine-land-cover-now-updated-for-the-2018-reference-year</a>	Dataset downloadable from external databases and linked to SO WHAT Database Module
10	Community Module	Degree Days Database	Heating and Cooling Degree days for locations worldwide	External databases <a href="https://www.degreedays.net/">https://www.degreedays.net/</a>	Connection via API
11	Community Module	PVGIS database	It includes data about solar radiation and wind speed for the entire Europe on an hourly, monthly and yearly basis	External database <a href="https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html">https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html</a>	Connection via API



12	Community Module	Open Street Maps Database	Georeferenced information about footprints of European buildings stock	External database <a href="https://www.openstreetmap.org">https://www.openstreetmap.org</a>	Connection via API
13	Community Module	CLC2018	Inventory of land cover in 44 classes	External database <a href="https://land.copernicus.eu/news/corine-land-cover-now-updated-for-the-2018-reference-year">https://land.copernicus.eu/news/corine-land-cover-now-updated-for-the-2018-reference-year</a>	Dataset from Planheat database and linked to SO WHAT Database Module
14	Community Module	Natura 2000 areas (2016)	protected areas or other spatial constraints to exclude from potential energy production	External database <a href="https://www.eea.europa.eu/data-and-maps/data/natura-11/natura-2000-spatial-data/natura-2000-shapefile-1">https://www.eea.europa.eu/data-and-maps/data/natura-11/natura-2000-spatial-data/natura-2000-shapefile-1</a>	Dataset from Planheat database and linked to SO WHAT Database Module
15	Community Module	Global ecological zones (2010)	Protected areas or other spatial constraints to exclude from potential energy production	External database <a href="http://www.fao.org/geonetwork/srv/en/main.home?uuid=2fb209do-fd34-4e5e-a3d8-a13c241eb61b">http://www.fao.org/geonetwork/srv/en/main.home?uuid=2fb209do-fd34-4e5e-a3d8-a13c241eb61b</a>	Dataset from Planheat database and linked to SO WHAT Database Module
16	Community Module	Crop production, specific calorific value and biomass Net Annual Increment	Classification of forests into Global ecological zones	External database <a href="http://ref.data.fao.org/map?entryId=2fb209do-fd34-4e5e-a3d8-a13c241eb61b">http://ref.data.fao.org/map?entryId=2fb209do-fd34-4e5e-a3d8-a13c241eb61b</a>	Dataset from Planheat database and linked to SO WHAT Database Module
17	Community Module	European Soil density database	Information at EU about density of rocks	External database <a href="https://esdac.jrc.ec.europa.eu/resource-type/european-soil-database-soil-properties">https://esdac.jrc.ec.europa.eu/resource-type/european-soil-database-soil-properties</a>	Dataset from Planheat database and linked to SO WHAT Database Module

18	Community Module	GeoDH information system	Soil temperature at generic depth database	External database <a href="http://geodh.eu/geodh-map/">http://geodh.eu/geodh-map/</a>	Dataset from Planheat database and linked to SO WHAT Database Module
19	Community Module	<i>Simplified Technology database for mapping RES technical potential</i>	List of technologies with related efficiencies	Provided by Planheat tool GUI	Dataset from Planheat database and linked to SO WHAT Database Module
20	Community Module	<i>E-PRTR (European Pollutant Release and Transfer Register) database</i>	Data on pollutant releases from industries belonging to nine industrial macro-sectors	<a href="https://prtr.eea.europa.eu/#/home">https://prtr.eea.europa.eu/#/home</a>	Dataset integrated within SO WHAT Database Module
21	Community Module	<i>IES database for individual and network Infrastructure database</i>	Performance parameters and costs related to individual and centralized energy systems and infrastructure	Provided by SO WHAT tool	Dataset integrated within SO WHAT Database Module
22	Decision Support Module	<i>IPCC Emissions Factors Database (EFDB)</i>	Primary energy and emissions factors for energy sources	<a href="https://www.ipcc-nggip.iges.or.jp/EFDB/main.php#:~:text=Terminology%3A%20EFDB%20is%20a%20database,also%20the%20other%20relevant%20parameters.">https://www.ipcc-nggip.iges.or.jp/EFDB/main.php#:~:text=Terminology%3A%20EFDB%20is%20a%20database,also%20the%20other%20relevant%20parameters.</a>	Dataset integrated within SO WHAT Database Module
23	Decision Support Module	<i>PLANHEAT database for primary energy and emissions factors</i>	Primary energy and emissions factors for energy sources	Provided by SO WHAT tool	Dataset integrated within SO WHAT Database Module
24	Decision Support Module	<i>EUROSTAT –</i>	<i>Natural gas and Electricity prices in Europe</i>	External database <a href="https://ec.europa.eu/eurostat/web/energy/data/database">https://ec.europa.eu/eurostat/web/energy/data/database</a>	Dataset downloadable from external databases and linked to SO WHAT

					Database Module
25	Decision Support Module	Statista database	Energy prices	External database <a href="https://www.statista.com/statistics/288712/change-of-domestic-heating-oil-price-in-selected-countries/">https://www.statista.com/statistics/288712/change-of-domestic-heating-oil-price-in-selected-countries/</a>	Dataset downloadable from external databases and linked to SO WHAT Database Module
26	Decision Support Module	EC publications	Energy prices - biomass	External database <a href="https://ec.europa.eu/energy/studies/mapping-and-analyses-current-and-future-2020-2030-heatingcooling-fuel-deployment_en?redir=1">https://ec.europa.eu/energy/studies/mapping-and-analyses-current-and-future-2020-2030-heatingcooling-fuel-deployment_en?redir=1</a>	Dataset downloadable from external databases and linked to SO WHAT Database Module

## 6 Conclusions

The purpose of this document has been to identify and analyse which database could be relevant for SO WHAT tool considering the defined conceptual software architecture. The goal has been also to identify whether data sources internal or external to the SO WHAT tool will be used to better understand how these data sources could be integrated during the software development phase.

This document will be used by Task 2.3 'Common IT framework and architecture' where the functionalities of SO WHAT Tool will be translated into the technical specification that will allow each piece of software and module to communicate and exchange data with each. All this information from WP2 will then allow the SO WHAT tool to be developed in WP4 and relevant connection and APIs to be established.