Deliverable 3.2: Set of tools for energy planning

Supporting South Europe municipalities in the definition of Sustainable Local Heating and Cooling Plans

Date: 9/11/2025

Grant agreement No: 101167534 — LIFE23-CET-Plan4Cold

Project start date: 1st October 2024

Duration: 36 months

Deliverable Factsheet

Project name	Plan4Cold
Project website	https://www.climatealliance.org/activities/plan4cold.html
Coordinator	ADENE
Document title	**Set of tools for energy planning**
Deliverable nº	D3.2
Responsible Partner	R2M Solution
Work Package	WP3
Task	Customise tools and resources for Southern European cities
Submission date	Month Number 15
Deliverable nature	OTHER

Dissemination level	
x	PU – Public
	SEN - Sensitive

Document history			
Version	Date	Description	Author(s)
1.0	6.11.2025	First version	R2M Solution (Davide Quaggiotto, Yannick Bang, Bishnu Babu)

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2.0	17.12.2025	Second version	R2M Solution (Davide Quaggiotto, Marco Calderoni, Juan Penaranda)
2.1	29.12.2025	Review	Ambiente Italia (Chiara Lazzari, Riccardo Battisiti), ADENE (Joana Fernandes, Tiago Marques)
3.0	8.01.2026	Final version	R2M Solution (Davide Quaggiotto, Marco Calderoni, Juan Penaranda)

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PROJECT PARTNERS

ADENE: Agência para a Energia

Ambiente Italia

FEDARENE: Federation Europeenne des Agences et des Regions pour l'energie et l'environnement

R2M Solution

Inova+

APE FVG: Agenzia per l'energia del Friuli Venezia-Giulia

AREAM: Agência Regional Da Energia e Ambiente Da Região Autónoma Da Madeira

RDFCM: Regional Development Fund of Central Macedonia

CRES: Centre for Renewable Energy Sources and Saving Foundation

Svi.Med: Centro Euromediterraneo per lo sviluppo sostenibile

FAEN: Fundacion Asturiana de la Energia

Climate Alliance

Rea Kvarner: Regionalna Energetska Agencija Kvarner

ENA: Agência de Energia e Ambiente da Arrábida

TUC: Technical University of Crete

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ABREVIATION AND ACRONYMS

CINEA: the European Climate, Infrastructure and Environment Executive Agency

COP: Community of Practice

DHCN: District Heating and Cooling Network

DHW: Domestic Hot Water

EAB: European Advisory Board

EE: Energy Efficiency

EED: Energy Efficiency Directive

EU: European Union

GHG: Greenhouse Gases

H&C: Heating and Cooling

KPI: Key Performance Indicator

MS: Member State

NGO: Non-Governmental Organizations

Plan4COLD - Supporting South Europe municipalities in the definition of Sustainable Local Heating and Cooling Plans

RED: Renewable Energy Directive

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RES: Renewable Energy Sources

RESHC: Renewable Energy Sources for Heating and Cooling

RH&C: Renewable Heating and Cooling

SE&R: Sustainability, Exploitation and Replication

SLHCP: Sustainable Local Heating and Cooling Plan

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ABSTRACT

This report of the Plan4Cold project presents a comprehensive set of tools designed to support South European municipalities in developing Sustainable Local Heating and Cooling Plans (SLHCPs) in compliance with Article 25 of the Energy Efficiency Directive. Building on a review of 51 resources, the project employed 12 assessment criteria — including applicability, robustness, and user-friendliness — to select 16 specific tools capable of covering all phases of the planning process. To address the diverse technical and financial capabilities of municipalities, these selected resources were organised into three distinct packages:

• Package 1 offers user-friendly, free tools suitable for municipalities with limited resources.
• Package 2 supplements the free tools with "Thermos" to enable the initial design of district heating and cooling networks.
• Package 3 includes commercial or expert-level tools for detailed Digital Twin analysis and simulation.

The document details the methodology for tool selection, describes the main features of the selected tools, maps the input-output connections between resources to ensure a coherent workflow, and identifies specific gaps in existing free solutions regarding baseline assessments and retrofit scenarios. Consequently, it outlines the roadmap for developing a new, customised data-driven tool within the Plan4Cold Project to address these deficiencies, ensuring robust support for decarbonisation strategies in Southern Europe.

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1. Introduction

The Energy Efficiency Directive (EED) is a crucial component of the European Union's strategy to improve energy efficiency and reduce overall energy consumption. It establishes 'energy efficiency first' as a fundamental principle of EU energy policy. In practical terms, this means that EU countries must consider energy efficiency in all relevant policy and major investment decisions across the energy and non-energy sectors [1]. Article 25 of the recast Energy Efficiency Directive (EED) establishes several key obligations for Member States regarding the application of the "energy efficiency first" principle in energy infrastructure and network planning [2]. Member States should ensure that regional and local authorities prepare local heating and cooling plans at least in municipalities with a total population of more than 45,000 inhabitants. These plans should provide an estimate and a mapping of the potential for increased energy efficiency, including preparation for low-temperature district heating, high-efficiency cogeneration, waste heat recovery, and renewable energy for heat and cooling in the area in question [3].

The main objective of Plan4COLD is to support South European municipalities with more than 45,000 inhabitants in complying with Article 25 of the Energy Efficiency Directive (EED) and in preparing Sustainable Local Heating and Cooling Plans (SLHCPs).

Heating and cooling account for 50% of total energy consumption in Europe, 75% of which comes from fossil fuels [4]. The demand for cooling is expected to increase significantly due to climate change and rising temperatures, with projections indicating a 750% increase in residential cooling demand and a 275% increase in commercial cooling demand by 2050 [5].

European cities and municipalities face significant challenges in developing and implementing local heating and cooling plans due to a lack of essential resources. Many municipalities lack the technical capacity, dedicated funding, data, and tools required to effectively plan and execute decarbonisation efforts [6]. To bridge this gap and support the South European municipalities, the Plan4cold Project will develop customised resources, tools and materials, will actively support the capacity-building of its local and regional authorities, and will also collaborate directly with municipalities to define SLHCPs in leading cities in Italy, Greece and Portugal. Furthermore, these municipalities will serve as test cases to validate Plan4cold's selected resources, which can then be used by other municipalities with similar (or even different) geographical contexts to develop their own Local Heating and Cooling Plans.

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1.1 Work Package 3 Objectives

The main goal of WP3 is to select resources to support municipalities in developing their Sustainable Local Heating and Cooling Plans by identifying, evaluating, and, where necessary, improving or developing the tools required for this purpose. Therefore, the activity focused on:

- Conducting a comprehensive review of existing tools and resources available at the European (and, where relevant, international) level.
- Assessing their suitability for direct use in SLHCPs or determining what adaptations are needed to make them effective in the specific geographical and climatic contexts of southern European municipalities.
- Identifying gaps that cannot be addressed with current tools and defining a roadmap for new developments; where essential, the project will directly develop these missing tools and resources.
- Selecting the most suitable resources to support municipalities in developing SLHCPs.
- Create a complete set of capacity-building materials covering all aspects of SLHCP development. These will include written guides, tutorial videos, factsheets, best-practice examples, and economic assessment spreadsheets. All materials will be translated into local languages to maximise accessibility and engagement among stakeholders.

Relation to other WPs

WP2: It is based on the analysis of current heating and cooling trends in southern European municipalities, identifies specific needs, and establishes a reference methodology for SLHCP development. WP3 builds directly on these outcomes by selecting, adapting, or creating the tools and resources needed to implement the methodology and meet the identified needs.

WP4: It focuses on organising capacity-building activities (webinars and workshops at national, regional, and local levels) and on supporting beneficiary municipalities in applying the acquired knowledge to their own SLHCPs. WP3 will supply the full range of capacity-building materials (guides, videos, factsheets, best practices, spreadsheets, etc.), translated into local languages, for use in these activities. The materials will target policy makers, public officers, and heating & cooling market professionals in both directly involved and interested external regions/municipalities. Feedback collected during WP4 events will be used to iteratively improve the materials.

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WP7: It is responsible for replication and exploitation of project results. The tools, resources, and capacity-building materials developed in WP3 will serve as key assets for replication activities, particularly in follower municipalities wishing to adopt the project's approach and outputs.

Figure 1: Plan4Cold Overview of Work Packages

1.2 The role of Deliverable 3.2

Deliverable 3.2 constitutes the primary output of Task 3.2, which builds directly on the results of Task 3.1 (assessing existing resources for Sustainable Heating and Cooling Planning in southern European municipalities). The core objective of T3.2 (as documented in D3.2) is to provide a comprehensive, practical toolkit covering all SLHCP phases. In addition, Deliverable 3.2 proposes three tool packages specifically selected to fully address all planning phases while respecting the boundary conditions and specific requirements defined by the participating municipalities. Finally, where critical gaps are identified, the task will lead to the development of new open-source tools that will be made freely available to overcome current barriers and limitations faced by southern European municipalities in SLHCPs.

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2. Methodology for the selection of the Plan4Cold Tools

In a first step, a total of 29 tools were identified to support the development of Sustainable Local Heating and Cooling Plans. These tools were collected through a survey circulated within the consortium, allowing partners to report relevant resources already in use or known from previous projects. Deliverable 3.1 provided a detailed description of the investigated resources, evaluating their main features as well as their strengths and weaknesses.

In a second round of tool collection, the analysis was broadened by R2M: a total of 51 resources were examined, including 23 additional tools compared to the initial assessment. In ANNEX 1, a table listing the tools and their main features is available.

All these resources were subsequently tested, evaluating their applicability to cover all the different phases of the SLHCPs. Based on this testing phase, the most suitable tools were selected and grouped into three coherent packages, each corresponding to different municipal needs in local heating and cooling planning. All this process will be described in detail in the following paragraphs.

2.1 SLHCP phases and types of tools analysed

To understand Plan4Cold's tool selection methodology, it is first necessary to understand the main phases involved in developing an SLHCP and the types of tools needed to cover them.

As regards the first aspect, SLHCPs can be divided into three main phases:

Phase 1 - Baseline Assessment. In this first step, information is needed on buildings, facilities, generation sources, energy availability (gas, electricity, renewable sources, etc.), and data on local vulnerabilities and energy poverty. Phase 1 also typically involves baseline modelling (either using appropriate simulation tools or simple spreadsheet calculations). This phase is divided into two steps: **assessment of heating and cooling demand and consumption**, and **assessment of local vulnerabilities**.

Phase 2 - Intervention and decarbonisation scenarios. Development of several possible intervention scenarios. A time frame must be set. To model the scenarios, it is necessary to start from the baseline

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model and modify the parameters. This phase is divided into three steps: **assessment of building retrofit**, **assessment of renewable energy sources**, and **enhancement of distribution grids**.

Phase 3 - Evaluation and comparison of different scenarios (roadmap). Selection of specific scenarios among those identified in phase 2, based on the measures that the administration can implement and on the contributions of stakeholders. Macro sectors include public buildings (the administration intervenes directly), updating land-use planning tools (e.g. PGT), identifying entities that can deploy technical resources (e.g. installers or industrial associations to apply discounts; utilities) and financial resources (e.g. banks) and promoting the plan (awareness-raising and information). At a technical level, this usually leads to the development of a roadmap. There may be some specific actions that are examined in more detail (e.g. TLR, public buildings). This phase is divided into three steps: **energy, emissions, and economic comparison; impact of Energy Communities;** and **roadmap developmen**t.

On the other hand, to cover the different phases of SLHCPs, specific tools have been considered, which can be grouped into three main types: planning software, energy simulation tools (focused on buildings or renewable energy sources), and databases.

Planning tools: consist of digital platforms designed to support decision-making throughout local energy planning processes, enabling stakeholders to explore alternative scenarios, assess their impacts, and prioritise interventions.

Energy simulation tools: encompass methods and applications used to model the energy performance of buildings, estimate potential energy savings, and evaluate the feasibility and integration of renewable energy technologies within specific contexts.

Databases: offer essential datasets, such as energy consumption profiles, climate and environmental conditions, and vulnerability indicators, that serve as foundational input for comprehensive and evidence-based planning activities. Together, these three categories provide a structured overview of the diverse resources needed to develop robust, informed local Heating and Cooling Plans.

2.2 Tool assessment criteria

To assess the 51 identified resources to support the local energy planning process, a survey was distributed among the Plan4COLD project partners to jointly select and validate the evaluation criteria. Based on the feedback received, a set of 12 criteria was defined to ensure a comprehensive and consistent

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assessment of all identified tools. These criteria cover a wide range of functional, technical, and practical aspects, and include the following:

- Applicability – the extent to which the tool can be effectively used in different local contexts and planning scenarios.
- Robustness – the reliability and stability of the tool in handling data, running analyses, and producing consistent outputs.
- Suitability for Heating & Cooling (H&C) planning – the degree to which the tool specifically supports the development of local H&C strategies.
- User-friendliness – how intuitive and accessible the tool's interface and functionalities are to non-expert users.
- GIS-based resources – software applications and digital platforms that use geographic information to collect, manage, analyse, and visualise data. They allow the visualisation of outputs in a clear and straightforward way. Priority must be given to this type of resource.
- Technical know-how required from users – the level of expertise or specialised knowledge needed to operate the tool effectively.
- Compatibility and interoperability – the ability of the tool to integrate with other software, datasets, or digital planning environments.
- Costs – the financial implications associated with using the tool, including licenses, subscriptions, or required add-ons.
- Language – the availability of the tool in different languages and its accessibility to a broader audience.
- Flexibility and customisation – the extent to which the tool allows users to adapt settings, parameters, or models to local specificities.
- Technical support – the availability and quality of user support, documentation, training materials, or helpdesk services.
- Environmental and climate impact assessment – the tool's capability to evaluate environmental implications, climate-related impacts, or mitigation potential.

Together, these criteria form a structured framework for systematically evaluating tools and selecting the most suitable ones to cover the different phases of the SLHCPs. In the end, 16 tools were selected from the 51 identified thanks to these criteria.

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2.3 Three different packages for municipalities

The selected 16 tools were considered to cover the different steps of the three phases of the H&C Plans in three different packages. The latter seeks to meet the diverse needs and opportunities of the supported municipalities.

Package 1 offers very user-friendly, free tools for municipalities that lack specialised technicians and financial resources to develop Heating and Cooling Plans.

Package 2 offers free tools and a tool for expert users. The latter is **Thermos** (shown in red in the image below, to indicate that it is the only tool that differs from package 1). This tool enables more detailed development of an SLHCP, supporting the initial design of a district heating or cooling network.

Table 1: Tools selected to cover the different phases and steps in Packages 1 - 2

1. Baseline assessment

H&C demand and consumption	Assessment of local vulnerabilities
Citiwatts	Energy poverty indicator dashboard
CoolLIFE	Risk Data Hub - ATLAS
EUCityCalculator	Vulnerability dashboard - DRMKC

2. Intervention and decarbonisation scenarios

Buildings retrofit	Renewable energy sources	Enhancement of distribution grids
CoolLIFE	Citiwatts (solar thermal, geothermal)	Citiwatts
EUCityCalculator	PVGIS (PV)	Thermos (Package 2)
	Global Solar Atlas (PV)	

3. Evaluation and comparison of different scenarios - Roadmap

Energy, emission and economic comparison	Roadmap development
EUCityCalculator	EUCityCalculator

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Package 3 offers free or commercial tools, which can also require expert users to develop SLHCP. This package enables detailed analysis of the consumption and efficiency of individual buildings, which can be modelled using tools for developing Digital Twins.

Table 2: Tools selected to cover the different phases and steps in Package 3

1. Baseline assessment

H&C demand and consumption	Assessment of local vulnerabilities
Citiwatts	Energy poverty indicator dashboard
Copernicus Land Monitoring Service	Vulnerability dashboard - DRMKC
QGIS	GreenPass
IES iCD	IES iCD

2. Intervention and decarbonisation scenarios

Buildings retrofit	Renewable energy sources	Enhancement of distribution grids
IES iCD	IES iCD (PV)	nPro
	PVGIS (PV)	
	nPro (Solar thermal, Geothermal)	

3. Evaluation and comparison of different scenarios - Roadmap

Energy, emission and economic comparison	Impact of Energy Communities	Roadmap development
IES iCD	IES iVN	IES PowerBI
nPro		

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3. Set of tools for Heating & Cooling Plan

3.1 Description of the selected resources

In this paragraph, the 16 tools selected to cover the different phases of SLHCPs are described, highlighting their main characteristics: developer, resource type, H&C Plan phase and step, availability (free/license), required input, output, main advantages, and disadvantages.

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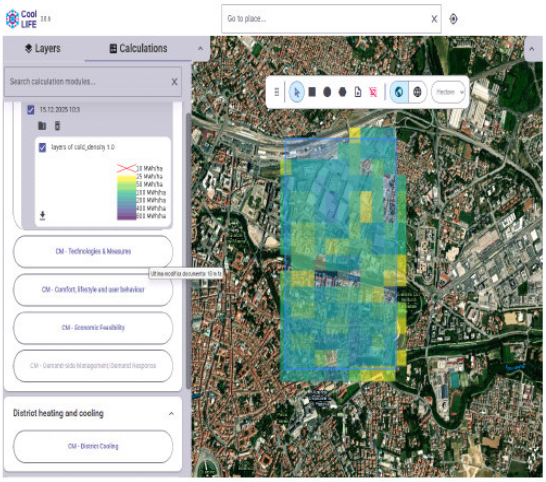
CoolLIFE



SOURCE
https://tool.coollifeproject.eu/map

DEVELOPER
CoolLife project EU funded

TYPE OF RESOURCES
Planning tool

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

TUTORIALS AVAILABLE
https://www.youtube.com/watch?v=BNxwndkm3zI

SHORT DESCRIPTION

It is a planning and analysis tool designed to support public authorities, engineers and other stakeholders in making better low-carbon cooling decisions for buildings and cities by mapping space cooling demand from the local (hectare) scale up to the EU-wide (continental) level, analysing current and future cooling needs including behavioural and comfort factors, offering recommendations on efficient and sustainable cooling options such as the integration of renewable energy sources, and presenting the economic, legal, policy and regulatory considerations that influence cooling-related decisions.

PHASE OF THE H&C PLAN

- **Baseline assessment:** H&C demand and consumption
- **Intervention and decarbonisation scenarios:** Simulating building retrofits.

OUTPUT OF THE TOOL

- Space cooling demand of buildings with efficiency measures (fans and shading) [MWh/yr]
- Cooling power capacity with efficiency measures (fans and shading) [MW]

REQUIRED INPUT

Selected area

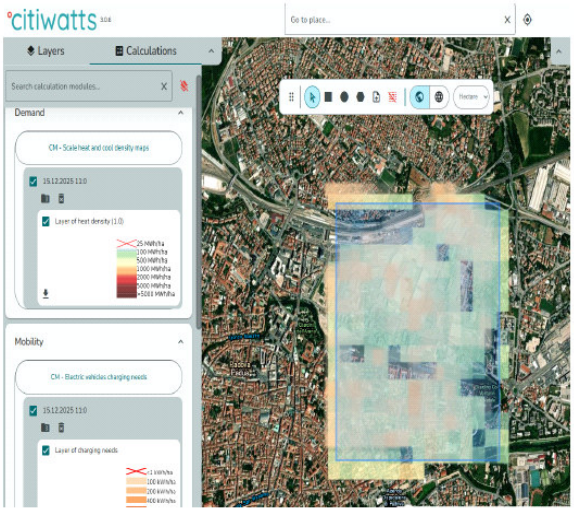
MAIN ADVANTAGES

- Very userfriendly and free.
- Addresses legal, policy and regulatory considerations.
- Timely and Relevant: as the project ended in August 2025 its findings and materials are up-to-date and relevant to the current challenges.

MAIN DISADVANTAGES

- Only for cooling (no heating)
- No info about CO2 emissions

Citiwatts



SOURCE
https://citiwatts.cloud/map

DEVELOPER
Hotmaps project EU funded

TYPE OF RESOURCES
Planning tool

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

TUTORIALS AVAILABLE
https://wiki.hotmaps.eu/en/Training-Material

SHORT DESCRIPTION

It is an open-source heating/cooling mapping and planning toolbox that intends to allow public authorities to identify, analyses, model and map resources and solutions to supply energy needs within their territory of responsibility in a resource and cost efficient way. Those results will help authorities to develop heating and cooling strategies on local, regional and national scale which are in line with RES and CO2-Emission targets on national and EU level.

PHASE OF THE H&C PLAN

- **Baseline assessment:** H&C demand and consumption.
- **Intervention and decarbonisation scenarios:** renewable energy sources, enhancement of distribution grids.

OUTPUT OF THE TOOL

- Space heating and cooling density needs of buildings [MWh/ha]
- Heating and cooling demand of buildings (total, residential, non-residential) [MWh]
- Industrial Sites Excess Heat (localisation, temperature range) [GWh/yr]
  Excess heat from wastewater treatment plants (localisation) [kW]
- Potential solar thermal collectors (rooftop or open-field) [MWh/yr]
- Potential PV panels [MWh/yr]
- Shallow geothermal energy potential [W/mk]

REQUIRED INPUT

Selected area

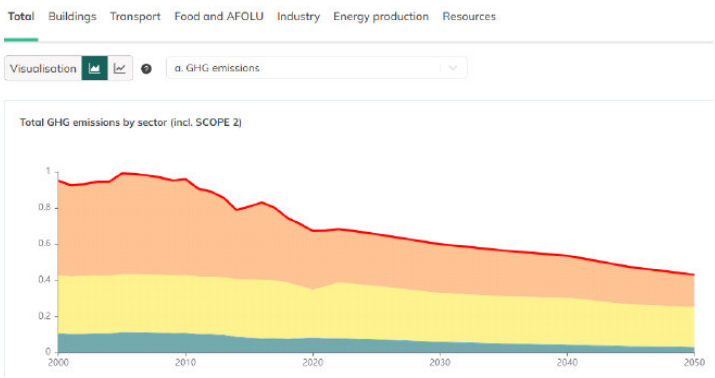
MAIN ADVANTAGES

Open-source and free to use

MAIN DISADVANTAGES

No real-time data

EUCityCalculator



SOURCE
https://eucitycalc.climact.com

DEVELOPER
EU Project

TYPE OF RESOURCES
Planning tool

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

TUTORIALS AVAILABLE
https://www.youtube.com/watch?v=qtnfTPsX_-E

SHORT DESCRIPTION

The EU City Calculator aims to deliver an energy modelling tool adapted to the city needs and representative of the major material, energy and emission-related processes happening within the city's administrative areas and beyond. The tool plans to integrate specific mitigation actions formulated at the city level into its modelling framework and provide cities with an easy-to-use web-interface for model exploration. Possibility for the users to manually import all relevant data. While the interface is intuitive once data is uploaded, there is no step-by-step import -wizard, and support materials may be needed.

PHASE OF THE H&C PLAN

- **Baseline assessment:** H&C demand and consumption.
- **Intervention and decarbonisation scenarios:** simulating building retrofits.
- **Evaluation and comparison of different scenarios – Roadmap:** energy comparison, emission comparison, economic comparison, roadmap development.

OUTPUT OF THE TOOL

- GHG emissions at munincipal level (baseline and intervention scenarios) [tCO_2]
- Final energy demand at munincipal level (baseline and intervention scenarios) [GWh]
- Primary energy demand and production at munincipal level (baseline and intervention scenarios) [GWh]
- Primary energy demand and GHG emissions per scenario comparison
- Costs per scenario comparison (capex, opex, fuel) [€]
- Visualisation of different roadmaps (Current local policy, Moderate and Ambitious) related to GHG emissions and to primary energy demand

REQUIRED INPUT

SECAP

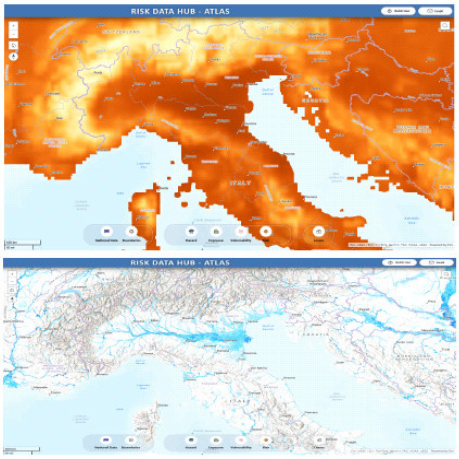
MAIN ADVANTAGES

The webtool is designed to facilitate the transfer of data from the SECAP template provided by the Covenant of Mayors to the EU City Calculator, and the transfer of outputs from the webtool (measures and their implications) back to the SECAP template.

MAIN DISADVANTAGES

It is a linear model and does not provide optimised scenarios or forecasts. The tool is more difficult to use when the city is not included in the existing database (and even more difficult without a covenant of mayors account), as it requires significant manual data preparation and input before accessing its full functionality.

Risk Data Hub - ATLAS



SOURCE
https://drmkc.jrc.ec.europa.eu/risk-data-hub#/atlas

DEVELOPER
European Commission Disaster Risk Management Knowledge Centre

TYPE OF RESOURCES
Database

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

TUTORIALS AVAILABLE
https://www.youtube.com/watch?v=IJ821FSOJII

SHORT DESCRIPTION
The Risk Data Hub (RDH) is a geospatial web platform that collects and standardises hazard, exposure, vulnerability and risk at the european level. Developed with the goal of supporting risk assessment and risk analysis processes, the RDH facilitates the collection, sharing, and analysis of data that is crucial for understanding and mitigating risks. This repository offers a variety of datasets, tools, and resources that can be utilized by policy-makers, researchers in the field of disaster risk reduction.

PHASE OF THE H&C PLAN
- Baseline assessment: assesment of local vulnerabilities

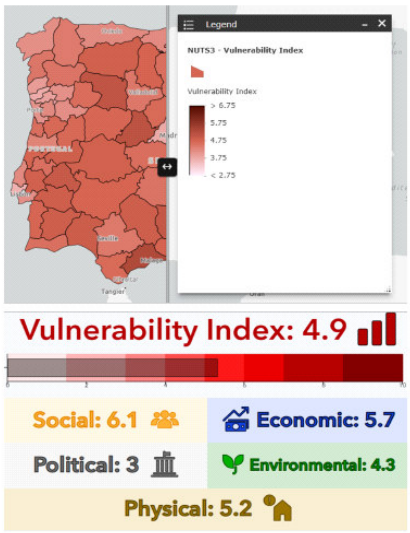
OUTPUT OF THE TOOL
Extreme Heat Hazard (Wet Bulb Globe Temperature indicator) [°C]
River Flood [100-year return period]

REQUIRED INPUT
Location

MAIN ADVANTAGES
- Centralized, curated EU-wide data
- Support for decision-making
- Geospatial visualization and analysis
- Policy and framework Alignment

MAIN DISADVANTAGES
- Data analysis requests
- Focus on post-event data challenges
- Limited attention to uncertainty

Vulnerability dashboard DRMKC



SOURCE
https://drmkc.jrc.ec.europa.eu/risk-data-hub#/ vulnerability/dashboard

DEVELOPER
European Commission Disaster Risk Management Knowledge Centre

TYPE OF RESOURCES
Database

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

TUTORIALS AVAILABLE
https://www.youtube.com/watch?v=KFczUZfGTUY

SHORT DESCRIPTION
It assesses vulnerability at the European level, considering five dimensions: social, economic, political, environmental and physical, without relating to any specific hazard. The index is scored on a scale of 0 to 10. There are time series for the indicators inside each of the five dimensions (EU, country and NUT2 and NUT3 levels).

PHASE OF THE H&C PLAN
Baseline assessment: Assessment of local vulnerabilities

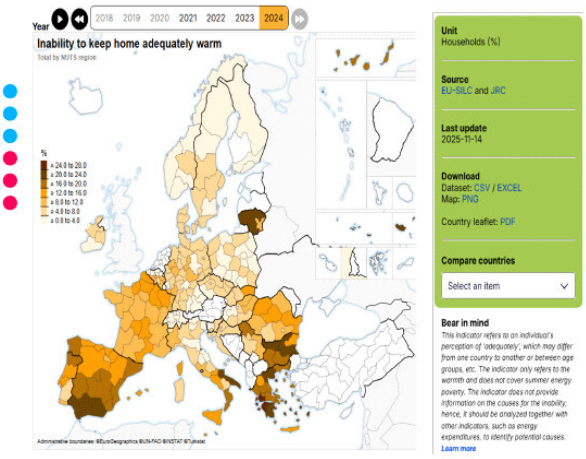
OUTPUT OF THE TOOL
Vulnerability index considering five dimensions: social, economic, political,environmental and physical

REQUIRED INPUT
Location

MAIN ADVANTAGES
- Harmonised and comparable overview of vulnerability indicators across European countries and region
- Multiple datasets into a single, easy-to-use visual platform

MAIN DISADVANTAGES
- Strong dependence on the availability, quality and update frequency of datasets, which can lead to gaps or uncertainties in some regions or indicators

Energy poverty indicators dashboard



SOURCE
https://energy-poverty.ec.europa.eu/epah-indicators

DEVELOPER
The European Comission

TYPE OF RESOURCES
Database

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

SHORT DESCRIPTION
In this database, you can find energy poverty indicators organised by topics for each European country. In this indicators collection, publicly available EU-wide datasets are considered.

PHASE OF THE H&C PLAN
- Baseline assessment: assesment of local vulnerabilities

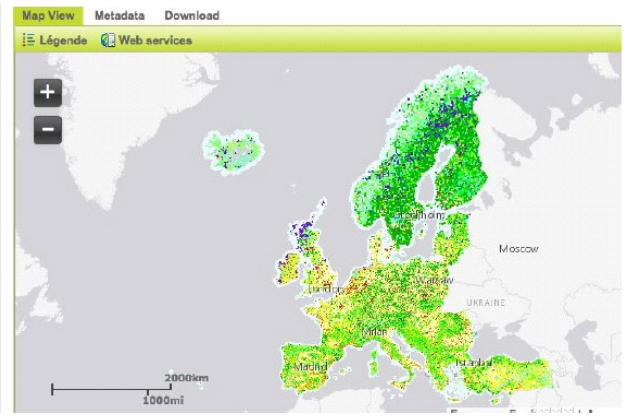
OUTPUT OF THE TOOL
- Inability to keep home adequately warm [%]
- Population living in dwellings comfortably cool in summer time [%]
- Population living in a dwelling equipped with heating facilities [%]
- Population living in a dwelling equipped with air conditioning [%]

REQUIRED INPUT
Location

MAIN ADVANTAGES
Possible to find energy poverty indicators organised by topics for each European country.

MAIN DISADVANTAGES
- In this tool, available EU datasets are used, so some data is unavailable for specific years or countries.
- Most of the data is available at the national level (not local).

Copernicus Land Monitoring Service



SOURCE
https://land.copernicus.eu/en/dataset-catalog

DEVELOPER
Copernicus Programme of the EU, implemented by the European Space Agency (ESA) and the European Environment Agency (EEA)

TYPE OF RESOURCES
Database

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

SHORT DESCRIPTION
The Copernicus Land Monitoring Service provides geospatial information on land cover and land use across Europe. It offers harmonized land cover and land use datasets to support spatial and environmental planning, aiding in the selection of optimal sites for cold storage facilities.

PHASE OF THE H&C PLAN
Baseline assessment: The Building Height Raster and the Destination use of buildings Vector can used in energy simulation tools to evaluate H&C demand and consumption

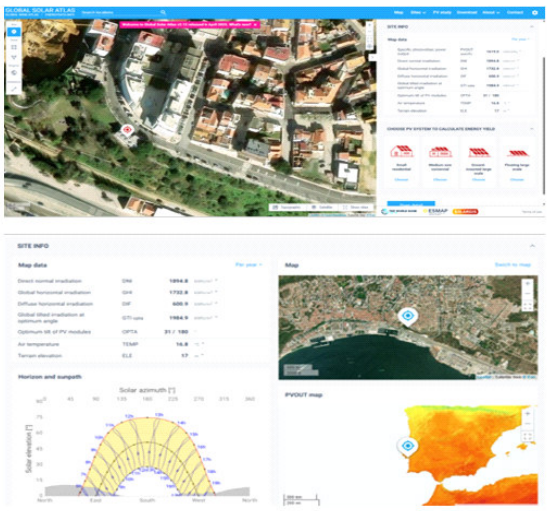
OUTPUT OF THE TOOL
- Building Height Raster [m]
- Destination use of buildings Vector

REQUIRED INPUT
Selected area

MAIN ADVANTAGES
- Geospatial coverage of Europe: detailed land use and land cover data for cities and peri-urban zones
- Free and official EU dataset: ensures harmonization and relevant data
- Essential for urban energy planning: inputs for zoning, demand estimation, green space assessment

MAIN DISADVANTAGES
- The datasets are periodically updated but not real-time or dynamic.
- Outputs must be used in other platforms to simulate energy systems or cooling strategies.

Global Solar Atlas



SOURCE
https://globalsolaratlas.info/map

DEVELOPER
Solargis

TYPE OF RESOURCES
Energy simulation tool

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

SHORT DESCRIPTION
Developed by the World Bank Group with the International Solar Alliance (ISA) and Solargis, it provides calculations and global geospatial data on solar energy potential.

PHASE OF THE H&C PLAN
Intervention and decarbonisation scenarios: renewable energy sources

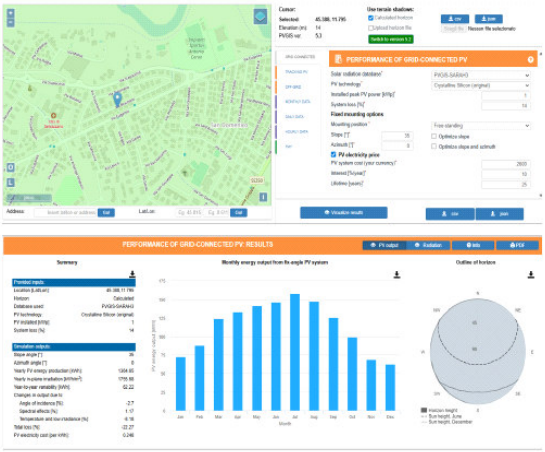
OUTPUT OF THE TOOL
Irradiation (direct normal, global horizontal, diffuse horizontal) [kWh/m^2]

REQUIRED INPUT
Location

MAIN ADVANTAGES
Very user-friendly tool

MAIN DISADVANTAGES
- The calculation of the output of the photovoltaic system is very approximate.
- Photovoltaic electricity prices are not provided.

PVGIS



SOURCE
https://re.jrc.ec.europa.eu/pvg_tools/en/

DEVELOPER
European Commission's Joint Research Centre

TYPE OF RESOURCES
Energy simulation tool (RES)

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
User-friendly

TUTORIALS AVAILABLE
https://www.youtube.com/watch?v=Zm4NLbvOwjw

SHORT DESCRIPTION
Web application that allows the user to obtain data on solar radiation and photovoltaic (PV) system energy production, including cost of PV electricity anywhere in most parts of the world. It provides estimates on monthly and yearly electricity production of a PV (fixed PV connected to the electricity grid, free-standing or on a building, tracking PV, or Off-grid), by selecting the location and some parameters.

PHASE OF THE H&C PLAN
Intervention and decarbonisation scenarios: Renewable energy sources

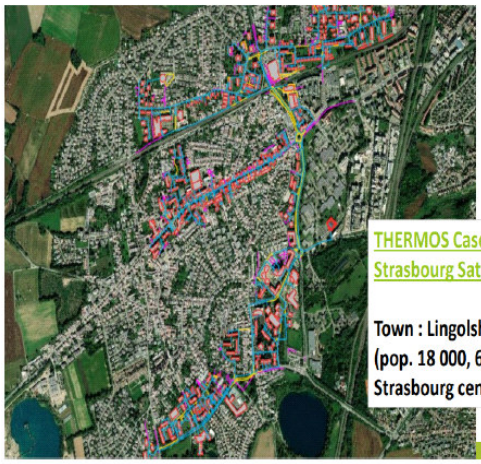
OUTPUT OF THE TOOL
- Monthly and yearly electricity production [kWh]
- Monthly and yearly in-plane irradiation for fixed angle [kWh/m2]
- PV electricity cost [€/kWh]

REQUIRED INPUT
- Location PV technology Installed capacity System Loss Mounting options
- Location Slope and Azimuth angle
- PV system cost Interest Lifetime

MAIN ADVANTAGES
Allow to download hourly values

MAIN DISADVANTAGES
Limited choice among PV technologies (Crystalline silicon, CIS, CdTe).

THERMOS



SOURCE
https://www.thermos-project.eu/thermos-tool/tool-access/

DEVELOPER
THERMOS EU-funded project

TYPE OF RESOURCES
Energy simulation tool (DHCN)

AVAILABLE FOR FREE/LICENSE
Entirely free

USER FRIENDLINESS
Need for practice

TUTORIALS AVAILABLE
https://www.thermos-project.eu/tool-support/training-materials/

SHORT DESCRIPTION
THERMOS is web-based energy planning software that provides accurate heat and cold network options analysis instantly within one web-based. The software is designed to optimise local district energy network planning processes and sustainable energy master planning to facilitate the deployment of new low-carbon heating and cooling systems and a fast upgrade, refurbishment, and expansion of existing systems.

PHASE OF THE H&C PLAN
Intervention and decarbonisation scenarios: Enhancement of distribution grids

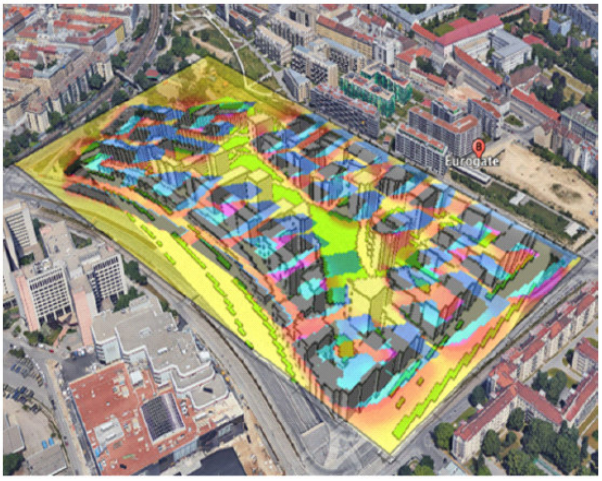
OUTPUT OF THE TOOL
- Space heating and cooling demand of buildings [MWh/yr]
- Optimised DHCN design (including supply model) Network heat losses [kWh]
- GHG emissions [t/yr]
- DHCN costs (total and specific) and revenues [€]

REQUIRED INPUT
- Selected area
- Excess heat from industrial sites wastewater treatment plants

MAIN ADVANTAGES
Free and open Source

MAIN DISADVANTAGES
It cannot consider buildings connected to the network as prosumers.

GREENPASS®



SOURCE
https://www.greenpass.io/

DEVELOPER
GreenPass

TYPE OF RESOURCES
Energy simulation tool (buildings)

AVAILABLE FOR FREE/LICENSE
Licence needed

USER FRIENDLINESS
Need for practice

TUTORIALS AVAILABLE
https://support.greenpass.io/portal/en/home

SHORT DESCRIPTION
GREENPASS offers a solution to quantify and measure the effects of green infrastructures on urban areas, enabling the efficient planning of climate resilient livable cities. It is an artificial intelligence-based platform for analyzing climate-resilient properties in compliance with the EU taxonomy.

PHASE OF THE H&C PLAN
Baseline assessment: Assessment of local vulnerabilities

OUTPUT OF THE TOOL
- Outdoor Thermal Comfort (climate heat islands) [%]
- Mitigation and adaptation recommended measures
- Implemtation costs mitigation and adaptation measures [€]

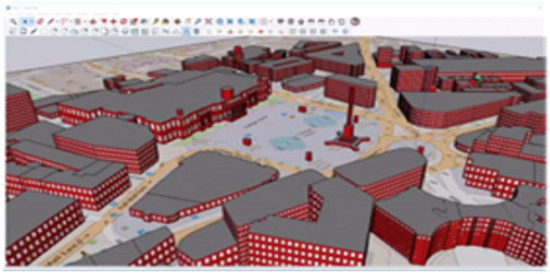
REQUIRED INPUT
- Selected area
- GIS file of buildings height
- Presence and type of nature-based solutions

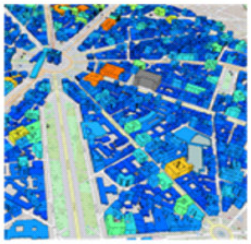
MAIN ADVANTAGES
Use of nature based solutions

MAIN DISADVANTAGES
Not free

IES iCD

(Intelligent Community Design)





iCD
Intelligent Community Design (iCD)

SOURCE
https://www.iesve.com/products/icd

DEVELOPER
IES

TYPE OF RESOURCES
Energy simulation tool (buildings)

AVAILABLE FOR FREE/LICENSE
Not free

USER FRIENDLINESS
Need for practice

TUTORIALS AVAILABLE
https://www.iesve.com/support/icd

SHORT DESCRIPTION
It is a 3D urban planning tool that allows for the development of the baseline scenario and the application of requalification scenarios at the urban level through dynamic energy simulation.

PHASE OF THE H&C PLAN
- **Baseline assessment:** H&C demand and consumption
- **Intervention and decarbonisation scenarios:** simulating building retrofits, renewable energy sources.
- **Evaluation and comparison of different scenarios–roadmap:** energy, emissions and economic comparison.

REQUIRED INPUT
- Outdoor Thermal Comfort (climate heat islands) [°C]
- Buildings energy consumptions (heating, cooling, DHW, electricity, lighting) [MWh/yr]
- Annual and monthly site energy consumption (heating, cooling, DHW, electricity, lighting) [MWh]
- Primary energy demand per scenario comparison [GWh]
- CO_2 emissions per scenario comparison [kgCO_2]

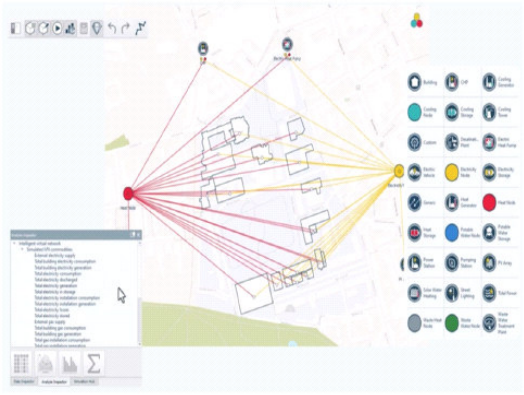
REQUIRED INPUT
- Selected area
- GIS file of buildings height
- GIS file of destination use of building

MAIN ADVANTAGES
- Ready-made report available
- Possible to import data (building geometry, use) from OpenStreetMap
- Possible to use the internal database based on ASHRAE 90.1-2016 Standard

MAIN DISADVANTAGES
Like all Urban Building Energy Models (UBEMs), accuracy can be affected by simplifications necessary for large-scale analysis

iVN

(Intelligent Virtual Network)



SOURCE
https://www.iesve.com/products/ivn

DEVELOPER
IES

TYPE OF RESOURCES
Energy simulation tool (buildings)

AVAILABLE FOR FREE/LICENSE
Not free

USER FRIENDLINESS
Need for practice

TUTORIALS AVAILABLE
https://www.iesve.com/support/ivn

SHORT DESCRIPTION
IES iVN is a software solution used for local energy decarbonisation and feasibility studies for new or existing communities, campuses. It allows engineers and planners to design, model, and optimize integrated energy networks—including electricity, heating, cooling, and water—by simulating how they interact with each other and with the energy demands of the connected buildings.

PHASE OF THE H&C PLAN
Evaluation and comparison of different scenarios – Roadmap: Impact of energy communities

OUTPUT OF THE TOOL
Self-consumption of electricity produced by PV for the HP installed in the considered buildings

REQUIRED INPUT
Energy simulation performed with iCD

MAIN ADVANTAGES
- Holistic and integrated network modeling for the different energy vectors
- Comprehensive analysis and reporting

MAIN DISADVANTAGES
- Complexity and learning curve
- Data dependency
- Cost and access

Power BI

SOURCE
https://www.microsoft.com/it-it/power-platform/products/power-bi?market=it

DEVELOPER
Microsoft

TYPE OF RESOURCES
Planning tool

AVAILABLE FOR FREE/LICENSE
License needed

USER FRIENDLINESS
User-friendly

TUTORIALS AVAILABLE
https://learn.microsoft.com/en-us/training/modules/get-started-with-power-bi/

SHORT DESCRIPTION
It is an interactive data-visualisation and analytics solution based on Microsoft Power BI, designed to support energy system analysis and decision-making. It integrates and processes large energy-related datasets to present key indicators, trends and scenarios through intuitive dashboards and reports. The tool enables users to monitor performance, compare scenarios, and support strategic planning by translating complex technical and economic data into clear, accessible insights for policymakers, planners, engineers and other energy stakeholders.

PHASE OF THE H&C PLAN
Evaluation and comparison of different scenarios – Roadmap: Roadmap development

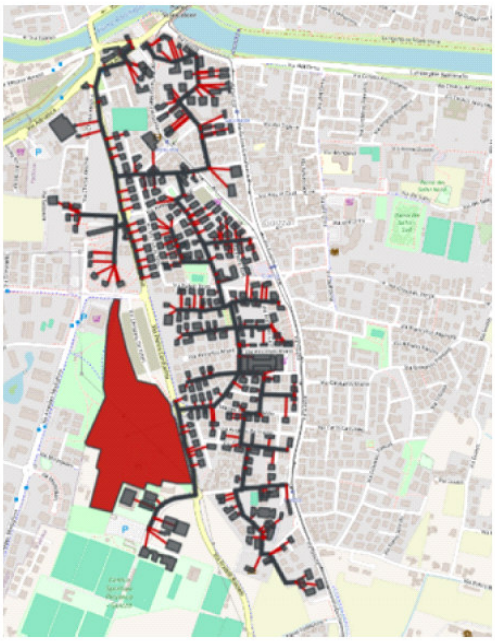
OUTPUT OF THE TOOL
- Visualisation of different roadmaps related to primary energy demand [MWh/yr]
- Visualisation of different roadmaps related to CO2 emissions [kgCO2/yr]

REQUIRED INPUT
- Primary energy demand results from iCD
- CO_2 emissions results from iCD

MAIN ADVANTAGES
- Intuitive and interactive dashboard
- Graphical outputs for stakeholders: useful for municipal reporting and decision-making
- Supports scenario comparison

MAIN DISADVANTAGES
- Commercial software: requires licensing.
- It is primarily a decision-support and visualisation tool rather than a standalone simulation or optimisation engine.

nPro



SOURCE
https://app.npro.energy/

DEVELOPER
nPro Energy

TYPE OF RESOURCES
Energy simulation tool (DHCN)

AVAILABLE FOR FREE/LICENSE
License needed

USER FRIENDLINESS
Need for practice

TUTORIALS AVAILABLE
https://www.youtube.com/@npro_energy%20/videos

SHORT DESCRIPTION
nPro is a modular, flexible software tool that simplifies and accelerates the traditional, manual planning of districts. It was specifically developed for the early planning phase, where only limited information about a district and energy system is available.

PHASE OF THE H&C PLAN
Intervention and decarbonisation scenarios: renewable energy sources, enhancement of distribution grids
Evaluation and comparison of different scenarios – Roadmap: energy, emission and economic comparison

OUTPUT OF THE TOOL
- Space heating and cooling demand of buildings [MWh/yr]
- Optimised DHCN design (including supply model)
- Network heat losses [kWh]
- CO2 emissions [tCO2/yr]
- DHCN costs (total and specific) and revenues [€]
- Heat extraction/(injection) from borehole field (hourly profile) [MWh]
- Solar thermal plant heat production (hourly profile) [MWh]

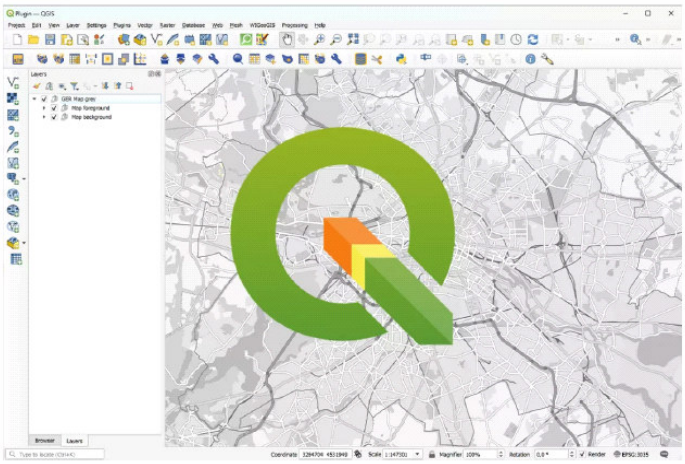
REQUIRED INPUT
- Selected area
- GIS file buildings geometry and consumptions
- Excess heat from industrial sites, wastewater treatment plants
- Geothermal borehole field specifications (for geothermal HP)
- Slope and Azimuth angle (for solar thermal plant)

MAIN ADVANTAGES
- Scenario-based planning: models different energy futures including district cooling and RES integration
- Graphical outputs for stakeholders: useful for municipal reporting and decision-making
- Ready-made report available
- It can consider buildings connected to the network as prosumers.

MAIN DISADVANTAGES
- Commercial software: requires licensing, which may be a barrier for smaller municipalities
- Users must understand energy system modeling principles to fully utilize it

QGIS

(Quantum Geographic Information System)



SOURCE
https://qgis.org/

DEVELOPER
QGIS Development Team

TYPE OF RESOURCES
Planning tool

AVAILABLE FOR FREE/LICENSE
Free

USER FRIENDLINESS
Need for practice

TUTORIALS AVAILABLE
https://docs.qgis.org/3.40/en/docs/training_manual/index.html

SHORT DESCRIPTION
It is a free, open-source geographic information system that allows users to create, edit, analyse and visualise spatial and geospatial data through an intuitive interface, supporting a wide range of data formats and tools for mapping, spatial analysis and decision support.

PHASE OF THE H&C PLAN
Baseline assessment: H&C demand and consumption

OUTPUT OF THE TOOL
- GIS file of buildings height
- GIS file of destination use of buildings

REQUIRED INPUT
- Building height Raster
- Destination use of buildings Vector

MAIN ADVANTAGES
- It is free and open-source
- It supports a large variety of spatial data formats and standards, ensuring strong interoperability
- It has a large and active user and developer community that continuously improves the software and provides extensive documentation

MAIN DISADVANTAGES
- The learning curve can be steep for new users due to the wide range of tools and options

3.2 Connections between the different tools (input - output)

The link between the different selected tools and the results they produce is crucial, particularly in clearly defining how inputs and outputs relate across successive steps of the methodology in the different packages. So, in this paragraph, we will deal with which inputs are necessary and how outputs from one tool can feed into the next step, especially for tools applied at multiple stages. This will support a coherent workflow and ensure that the methodology remains adaptable to varying levels of data availability across the different cities involved as use cases in the project.

The tables below show the inputs and outputs and their units of measurement for each tool, for each phase of the H&C plans (Baseline Assessment, Intervention and Decarbonisation Scenarios, Evaluation and Comparison of Different Scenarios - Roadmap) and for each package. It is important to note that Packages 1 and 2 differ only for the Thermos tool, which is part of Package 2 and characterises the "Enhancement of distribution grids" step of the "Intervention and decarbonisation scenarios" phase. For this reason, Packages 1 and 2 are shown together below, and the Thermos table (with inputs and outputs) is shown in red.

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Package 1-2 - Baseline Assesment

H&C demand and consumption

Citiwatts		
Input	**Output**	**Unit**
Selected area	Space heating and cooling density needs of buildings	MWh/ha
	Heating and cooling demand of buildings (total, residential, non-residential)	MWh
	Industrial Sites Excess Heat (localisation, temperature range)	GWh/yr
	Excess heat from wastewater treatment plants (localisation)	kW

CoolLIFE		
Input	**Output**	**Unit**
Selected area	Space cooling demand of buildings with efficiency measures (fans and shading)	MWh/yr
	Cooling power capacity with efficiency measures (fans and shading)	MW

EUCityCalc		
Input	**Output**	**Unit**
SECAP	GHG emissions (munincipality)	tCO2
	Energy demand final (munincipality)	GWh
	Primary energy demand and production (munincipality)	GWh

Assessment of local vulnerabilities

Energy poverty indicators dashboard		
Input	**Output**	**Unit**
Location	Inability to keep home adequately warm	%
	Population living in dwellings comfortably cool in summer time	%
	Population living in a dwelling equipped with heating facilities	%
	Population living in a dwelling equipped with air conditioning	%

Risk Data Hub – ATLAS		
Input	**Output**	**Unit**
Location	Extreme Heat Hazard (Wet Bulb Globe Temperature indicator)	°C
	River Flood	100-year return period

Vulnerability dashboard – DRMKC		
Input	**Output**	**Unit**
Location	Vulnerability index (social, economic, political,environmental and physical)	Score in tenths

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Package 1-2 - Intervention and decarbonisation scenarios

Buildings retrofit

CoolLIFE		
Input	**Output**	**Unit**
Selected area	Space cooling demand of buildings with efficiency measures (fans and shading)	MWh/yr
	Cooling power capacity with efficiency measures (fans and shading)	MW

EUCityCalc		
Input	**Output**	**Unit**
SECAP	GHG emissions with efficiency measures (munincipality)	tCO2
	Energy demand final with efficiency measures (munincipality)	GWh
	Primary energy demand and production with efficiency measures (munincipality)	GWh

Renewable energy sources

Citiwatts		
Input	**Output**	**Unit**
Selected area	Potential solar thermal collectors (rooftop or open-field)	MWh/yr
	Potential PV panels	MWh/yr
	Shallow geothermal energy potential	W/mk

PVGIS		
Input	**Output**	**Unit**
Location PV technology Installed capacity System Loss	Monthly and yearly electricity production	kWh
Location Slope and Azimuth angle	Monthly and yearly in-plane irradiation for fixed angle	kWh/m2
PV system cost Interest Lifetime	PV electricity cost	€/kWh

Global Solar Atlas		
Input	**Output**	**Unit**
Location	Irradiation (direct normal, global horizontal, diffuse horizontal)	kWh/m2

Enhancement of distribution grids

Citiwatts		
Input	**Output**	**Unit**
Selected area	District Heating Potential Areas (location)	/

Thermos		
Input	**Output**	**Unit**
Selected area, Excess heat from industrial sites, wastewater treatment plants	Space heating and cooling demand of buildings	MWh/yr
	Optimised DHCN design (including supply model)	/
	Network heat losses	kWh
	GHG emissions	t/yr
	DHCN costs (total and specific) and revenues	€

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Package 1-2 - Evaluation and comparison of different scenarios (Roadmap)

Energy, emission and economic comparison

EUCityCalc		
Input	**Output**	**Unit**
SECAP	Primary energy demand per scenario comparison	GWh
	GHG emissions per scenario comparison	tCO2
	Costs per scenario comparison (capex, opex, fuel)	€

Roadmap development

EUCityCalc		
Input	**Output**	**Unit**
SECAP	Visualisation of different roadmaps (Current local policy, Moderate and Ambitious) related to GHG emissions	tCO2

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Package 3 - Baseline Assesment

H&C demand and consumption

Citiwatts		
Input	**Output**	**Unit**
Selected area	Space heating and cooling density needs of buildings	MWh/ha
	Industrial Sites Excess Heat (localisation, temperature range)	GWh/yr
	Excess heat from wastewater treatment plants (localisation)	kW

Copernicus Land Monitoring Service		
Input	**Output**	**Unit**
Selected area	Building Height Raster	m
	Destination use of buildings Vector	/

QGIS		
Input	**Output**	**Unit**
Building Height Raster	GIS file of buildings height	/
Destination use of buildings Vector	GIS file of destination use of buildings	/

IES iCD		
Input	**Output**	**Unit**
Selected area GIS file of buildings height GIS file of destination use of buildings	Buildings energy consumptions (heating, cooling, DHW, electricity, lighting)	MWh/yr
	Annual and monthly site energy consumption (heating, cooling, DHW, electricity, lighting)	MWh

Assessment of local vulnerabilities

Energy poverty indicators dashboard		
Input	**Output**	**Unit**
Location	Inability to keep home adequately warm	%
	Population living in dwellings comfortably cool in summer time	%
	Population living in a dwelling equipped with heating facilities	%
	Population living in a dwelling equipped with air conditioning	%

Vulnerability dashboard – DRMKC		
Input	**Output**	**Unit**
Location	Vulnerability index (social, economic, political,environmental and physical)	Score in tenths

GreenPass		
Input	**Output**	**Unit**
Selected area GIS file of buildings height Presence and type of nature-based solutions	Outdoor Thermal Comfort (climate heat islands)	%
	Mitigation and adaptation recommended measures	/
	Implemtation costs mitigation and adaptation measures	€

IES iCD		
Input	**Output**	**Unit**
Selected area GIS file of buildings height GIS file of destination use of buildings	Outdoor Thermal Comfort (climate heat islands)	°C

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Package 3 - Intervention and decarbonisation scenarios

Buildings retrofit

IES iCD		
Input	**Output**	**Unit**
Selected area GIS file of buildings height GIS file of destination use of buildings	Buildings' energy consumptions with efficiency measures (heating, cooling, DHW, electricity, lighting)	MWh/yr
	Annual and monthly site energy consumptions (heating, cooling, DHW, electricity, lighting)	MWh
	GIS file of buildings geometry and consumptions	/

Renewable energy sources

IES iCD		
Input	**Output**	**Unit**
Selected area GIS file of buildings height	Sizing of the PV system, optimising the position of PV panels on building roofs	MWh/yr
	PV electricity production	MWh

PVGIS		
Input	**Output**	**Unit**
Location PV technology Installed capacity	Monthly and yearly electricity production	kWh
Location Slope and Azimuth angle	Monthly and yearly in-plane irradiation for fixed angle	kWh/m2
PV system cost Interest Lifetime	PV electricity cost	€/kWh

nPro		
Input	**Output**	**Unit**
Location Geothermal borehole field specifications	Optimised sizing of geothermal borehole field	/
	Heat extraction/(injection) from borehole field (hourly profile)	MWh
Location Slope and Azimuth angle	Optimised sizing of solar thermal systems	/
	Solar thermal plant heat production (hourly profile)	MWh

Enhancement of distribution grids

nPro		
Input	**Output**	**Unit**
Selected area GIS file buildings geometry and consumptions Excess heat from industrial sites, wastewater treatment plants	Space heating and cooling demand of buildings	MWh/yr
	Optimised DHCN design (including supply model)	/
	Network heat losses	kWh
	CO2 emissions	tCO2/yr
	DHCN costs (total and specific) and revenues	€

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Package 3 - Evaluation and comparison of different scenarios - Roadmap

Energy, emission and economic comparison

IES iCD		
Input	**Output**	**Unit**
Selected area GIS file of buildings height GIS file of destination use of buildings	Primary energy demand per scenario comparison	GWh
	CO2 emissions per scenario comparison	kgCO2

nPro		
Input	**Output**	**Unit**
Selected area GIS file buildings geometry and consumptions Excess heat from industrial sites, wastewater treatment plants	Primary energy demand per DHCN scenario comparison	GWh
	CO2 emissions per DHCN scenario comparison	tCO2
	Costs per DHCN scenario comparison (capex, opex, revenues)	€

Imapct of Energy Communities

IES iVN		
Input	**Output**	**Unit**
Energy simulation performed with iCD	Self-consumption of electricity produced by PV for the HP installed in the considered buildings	kWh/yr

Roadmap development

IES PowerBI		
Input	**Output**	**Unit**
Primary energy demand results from iCD	Visualisation of different roadmaps related to primary energy demand	MWh/yr
CO2 emissions results from iCD	Visualisation of different roadmaps related to CO2 emissions	kgCO2/yr

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4. Development of a customised tool

4.1 Gaps in the tools currently available for Heating and Cooling Plans

The selected tools can already be used in sequence without generating significant interoperability issues. However, the free solutions currently available cannot provide good results when datasets related to the base line are not complete, which is often the case in local energy planning projects. The only exception is when datasets are available from previously elaborated SECAPs. The development of a new tool would allow for more robust, replicable, and consistent assessments at the local scale.

4.2 Development of a data-driven tool for baseline assessment and evaluation of decarbonization scenarios

The proposed activity focuses on the development of a data-driven analytical tool designed to support the large-scale assessment of building energy performance and the strategic planning of energy retrofit interventions. The tool is intended to operate at different spatial scales, including city-wide, neighbourhood-level, or specific urban areas, enabling a comprehensive evaluation of energy consumption patterns and greenhouse gas emission profiles across many buildings. The first objective of the tool is to systematically analyse energy consumption and associated emissions for aggregated groups of buildings. By integrating heterogeneous data sources, such as building characteristics, energy usage data, and climatic conditions, the tool will quantify the overall energy demand and emissions produced by the selected building stock. This analysis will enable the definition of a baseline energy scenario that represents the current state of energy performance against which future improvements and policy targets can be evaluated. Building upon the baseline assessment, the tool will identify and prioritise energy retrofit measures required to align the analysed building stock with the requirements of the revised Energy Performance of Buildings Directive (EPBD). Through advanced data analytics and scenario modelling, the tool will enable evaluation of a wide range of retrofit options, including envelope improvements, heating and cooling system upgrades, renewable energy source integration, and energy efficiency technologies. Emphasis will be placed on identifying cost-effective intervention strategies, allowing to determine where investments can achieve the highest energy savings and emission reductions

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with the lowest financial effort. This prioritisation process will support evidence-based decision-making by highlighting optimal investment pathways under technical, economic, and regulatory constraints.

The tool is designed to address the lack of granular data from municipalities during the Baseline Assessment and Intervention Scenarios by leveraging a pre-calculated internal database. During the development phase, the tool will be populated with extensive building datasets, primarily sourced from Energy Performance Certificates (EPCs) collected across various European regions.

Using machine learning algorithms, the tool will classify these buildings into specific clusters and identify a representative reference building (archetype) for each category. A wide range of dynamic energy simulations will then be performed on these archetypes beforehand to evaluate various energy-efficiency measures.

Consequently, the tool will not perform live simulations during end-user operation. When a user inputs a new building, the system will assign it to a predefined cluster. Through data extrapolation from the representative archetype's results, the tool will estimate energy savings and the impact of interventions for the specific building, ensuring robust outputs even when municipal input data is limited.

The Data-driven tool will be developed in 3 phases:

- Phase 1: Data Acquisition, Extraction, and Harmonisation. The initial phase will focus on the collection and systematic organisation of a comprehensive dataset comprising a large number of buildings. The primary data sources will be Energy Performance Certificates (EPCs), from which key energy-related variables are extracted. To ensure efficiency, an automated data extraction process should be developed and implemented to parse information from these certificates and organise it into a structured database (spreadsheet format). This phase will ensure that all qualitative and quantitative building features are harmonised for subsequent analysis.

- Phase 2: Machine Learning Clustering and Archetype Definition. In this stage, a Machine Learning (ML) algorithm will be deployed to identify complex correlations between building variables - such as thermal envelope properties, HVAC systems, geometry, and building use - and their respective energy consumption patterns, specifically focusing on heating and cooling demands. Based on these correlations, the algorithm will categorise the building stock into distinct clusters. For each cluster, a representative building (archetype) will be defined, embodying the statistical average characteristics of that specific group.

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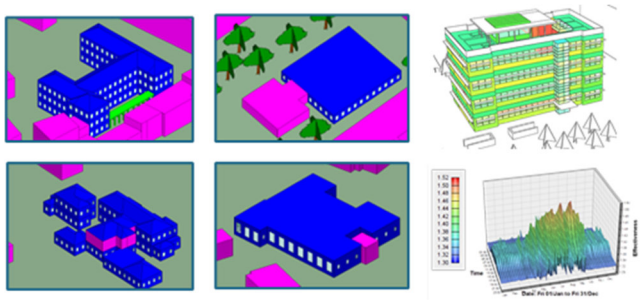

Figure 2: Development of a data-driven tool - grouping buildings in different clusters and dynamic energy modelling of each cluster's representative building

- Phase 3: Pre-calculated Simulation and Extrapolation Framework. The final development phase will involve conducting extensive dynamic energy simulations on the identified archetypes using external specialised energy simulation software. Various energy-efficiency scenarios will be simulated for each representative building to establish a robust library of pre-calculated energy-savings percentages. By completing these simulations during the development stage, the tool will eliminate the need for real-time computation. Consequently, when a user inputs a new building, the tool simply assigns it to the corresponding cluster and extrapolates the results, providing immediate estimates of energy savings and efficiency impacts.

The data-driven tool will provide a comprehensive set of outputs for each analysed building, quantifying potential energy savings across different intervention scenarios. These outputs will be tailored to reflect the specific energy carriers and systems involved:

- Heating Energy Savings by carrier: The tool will calculate reductions in natural gas consumption (for thermal demand) and changes in electricity demand. Depending on the baseline, it will identify savings from existing electrical heating systems or the additional electricity requirements/offsets resulting from system upgrades.

- Cooling Demand Reduction: In addition to heating, the tool will quantify the energy savings related to space cooling, accounting for envelope improvements and system efficiencies.

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- Renewable Energy Integration: For scenarios involving Photovoltaic (PV) installations, the tool will estimate the potential energy generated and will determine the specific percentage of heating and cooling demand covered by self-produced renewable energy.

- Baseline Estimation (Hypothetical Consumption): In cases where initial consumption data is unavailable (data gaps), the tool will generate synthetic baselines. It will approximate hypothetical heating and cooling demands based on the assigned cluster's characteristics, ensuring that savings can still be calculated.

Leveraging the underlying dynamic energy simulations performed on the archetypes, the tool will not be limited to annual aggregates. It will provide results at a monthly or hourly resolution, enabling more sophisticated analyses of peak loads and seasonal performance variations.

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5. Conclusions and future steps

The project identified 51 resources and selected 16 specific tools suitable for developing Sustainable Local Heating and Cooling Plans (SLHCPs). To address the varying technical and financial capabilities of municipalities, these tools were organized into three distinct packages. Package 1 (basic) is characterised by user-friendly, free tools (e.g., Citiwatts, CoolLIFE, EUCityCalculator) for municipalities with limited technical and economic resources. Package 2 (intermediate), which adds the Thermos tool to the free package to allow for the initial design of district heating/cooling networks. Package 3 (advanced), which includes commercial or expert-level tools (e.g., IES suite, nPro) for detailed analysis and Digital Twin development. An important part of the description of the selected 16 tools was defining the connections between them in terms of input-output. To ensure the selected resources can be used in a coherent sequence, the study established a structured workflow in which specific inputs (e.g., building density, solar radiation) and outputs (e.g., energy demand, PV potential) were mapped for every phase of the Heating and Cooling plans: Baseline Assessment, Intervention Scenarios, and Roadmap creation. However, a significant gap was identified within the current landscape of free resources. The analysis revealed that existing free tools often lack the reliability required for detailed baseline assessments and the specific evaluation of building retrofit scenarios, particularly when high-quality pre-existing SECAP data is unavailable. To bridge this gap, in the Plan4Cold Project, a data-driven tool will be developed to perform the baseline assessment, building retrofit scenario evaluation and the comparison of scenarios. Meanwhile, moving to Work Package 4, the tools included in the various packages will be used to support the different cities involved as use cases in the project. This includes training policy makers and technical experts through webinars and workshops, and direct support for the development of Sustainable Heating and Cooling Plans.

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6. References

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[4] https://redi4heat.ehpa.org/project-materials/map-of-heating-and-cooling-measures/

[5] https://www.wri.org/insights/europes-heat-and-air-conditioning-dilemma

[6] https://eurocities.eu/resources/cities-central-role-in-decarbonising-eu-heating-and-cooling-sector

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ANNEX 1 - Resources analysed

	Tool	Type of tool/resource	Tool provider	Description	Tool/Resource link	Available for free / payment (license)	Open source	Geographical area covered	Applicability	User friendliness	Interoperability	Language	Tutorials available (link)	Technical support available	Advantages	Disadvantages
1	Global Solar Atlas	Data Basis	Solargis	Developed by the World Bank Group with the International Solar Alliance (ISA) and Solargis, it provides global geospatial data on solar energy potential.	https://globalsolaratlas.info	Entirely free	Yes	Almost the entire world	Useful for some planning tasks	User-friendly	-	English	https://globalsolaratlas.info/support/user-guide	https://globalsolaratlas.info/pages/contact	Very user-friendly tool	The calculation of the output of the photovoltaic system is very approximate. Photovoltaic electricity prices are not provided
2	Kassandra	Other	Kassandra Project	It is a service which creates a digital twin for urban planning and resource management, enhancing the natural and built environment	https://www.kassandraproject.org/	Not free	No	It seems worldwide but as far it seems it doesnt provide the data	The tool is not avaiable. It can be requested as a service	Need for practice	-	English	There is no many information online about this tool nor a way to download it	No	/	It is a service, not a tool
3	PVGIS	Energy simulation (RES)	Joint Research Institute	Web application that allows the user to obtain data on solar radiation and photovoltaic (PV) system energy production, including cost of PV electricity anywhere in most parts of the world	https://re.jrc.ec.europa.eu/pvg_tools/en/	Entirely free	No	Worldwide	Useful for some planning tasks	User-friendly	The tool has limited integration capabilities	English Italian German French	Yes	https://joint-research-centre.ec.europa.eu/photovoltaic-geographical-information-system-pvgis/getting-started-pvgis/pvgis-user-manual_en	Planning renewable energy potential, Easy-to-use Quick-to-use Provides also PV electricity prices Multilanguage Complete geographical coverage	Limited choice among PV technologies (Crystalline silicon, CIS, CdTe)
4	EU Tracker - Local heating and cooling plans	Other	Energy Cities	How well EU Member States support their local governments in preparing decarbonisation plans for heating and cooling. We can take as example the countries which are currently better on creating and implementing these plans as Netherlands and Denmark so we can see if their methologies work for all european union states or they were created for their specific country. But in any case there is a good source of information. To see how things are getting done already, even before the regulations.	https://energy-cities.eu/local-heating-and-cooling-plan/	Entirely free	-	European Union countries	Low applicability	User-friendly	The tool has limited integration capabilities	English	There is no need for tutorials, its pretty intuitive and simple. Is not a software but a data base.	/	Examples of best practices	Not usefull as a tool to directly support munincipaliteis in LHCP
5	Municipal heat planning - guidelines for action (Germany)	Other	Climate Protection and Energy Agency Baden-Württemberg (KEA-BW)	Guide for municipal heat planning - https://api.kww-halle.de/fileadmin/PDFs/Leitfaden_W%C3%A4rmeplanung_final_17.9.2024_gesch%C3%BCtzt.pdf	https://www.bmwk-energiewende.de/EWD/Redaktion/EN/Newsletter/2024/07/Meldung/news2.html	Entirely free	-	Germany	Highly applicable	Need for practice	-	German	It's a document	/	Examples of best practices	Not usefull as a tool to directly support munincipaliteis in LHCP
6	ENERGYDATA.INFO	Data Basis	World Bank Group (WBG)	ENERGYDATA.INFO is an open data platform providing access to datasets and data analytics that are relevant to the energy sector	ENERGYDATA.INFO	Entirely free	-	It seems there is not a lot european data	Low applicability	Need for practice	-	English	https://energydata.info/dataset/	/	Database with large amounts of documents and data.	Not easy to find what you are looking for
7	Appropriate legal framework for local authorities to develop heating and cooling policy	Other	Denmark city council	In Denmark, city councils have the authority to regulate both district heating and natural gas networks, providing a strong legal mandate for municipalities.	https://energy-cities.eu/countries/denmark/	Entirely free	-	Denmark	Useful for some planning tasks	Hard to use	-	Danish	-	/	Example of legal mandate for Danish municipality	In Danish
8	REScoop – Support for European citizen energy cooperatives	Other	REScoop.eu was legally set up in 2013 as a Belgian not-for-profit association	It is designed to empower citizens to co-own and democratically control renewable energy projects, promoting energy democracy through local energy cooperatives. It supports the development and growth of citizen energy cooperatives across Europe by providing resources, guidance, and a platform for collaboration.	https://www.rescoop.eu/services	Entirely free	-	Europe	Useful for some planning tasks	Hard to use	-	Multiple languages	-	info@rescoop.eu	Examples of best practices	Not usefull as a tool to directly support munincipaliteis in LHCP
9	SHIFFT - Co-creation and stakeholder engagement for sustainable heating	Other	Developed as part of the EU Interreg 2 Seas funded project SHIFFT	Four detailed, comprehensive, and illustrative guides, which provides methodology, good practices and case studies, and facilitates collaboration and co-creation of solutions to decarbonize heat, ultimately driving the heating transition at city level.	https://shifftproject.eu/about/	Entirely free	-	European Union	Useful for some planning tasks	User-friendly	-	EnglishFrench	-	/	Examples of best practices	Not usefull as a tool to directly support munincipaliteis in LHCP
10	mPower - peer to peer learning programme	Other		mPOWER will enable an in-depth, wide-scale and systematic peer-to-peer learning programme among at least 100 local public authorities, in order to replicate innovative best practices in municipal energy, and developing ambitious energy transition plans.	https://municipalpower.org/	Entirely free	-	Urban local authorities from EU-28 countries	-	User-friendly	-	English	https://shifftproject.eu/publications/shifft-guidance-en-how-to-accelerate-the-heat-transition-a-guide-for-local-government-and-actors/	/	Best practice guides	Not usefull as a tool to directly support munincipaliteis in LHCP
11	Womble Bond Dickinson: Heat Networks Procuring Finance	Other		WBD provides heat networks guidance for the Department for Business, Energy and Industrial Strategy	https://www.womblebonddickinson.com/uk/insights/news/wbd-provides-heat-networks-guidance-department-business-energy-and-industrial	Entirely free	-	United stated and United Kingdom	Low applicability	User-friendly	-	English	rowan@platformlondon.org	/	Heat Networks Guidance	Not usefull as a tool to directly support munincipaliteis in LHCP
12	Manual for the Estimation of Regional Waste Heat Potential	Other	Interreg Central Europe	It is a key result of the European project CE-HEAT. You will learn more about typical waste heat sources and how the waste heat can be recovered or transformed into other energy uses. The Toolbox is aimed at supporting entrepreneurs and investors who would like to discover untapped potential of waste heat, understand technological aspects of its recovery into usable energy and get familiar with formal, administrative and financial issues of starting a new business based on waste heat.	https://www.waste-heat.eu/waste-heat-toolbox	Entirely free	-	Europe	-	Need for practice	-	English	https://assets.publishing.service.gov.uk/media/5b6acd8440f0b62ec1fa6110/heat-networks-procuring-finance.pdf	/	Guide to get familiar with formal, administrative and financial issues of waste heat	Not usefull as a tool to directly support munincipaliteis in LHCP
13	Planheat: Mapping Tool	Planning software	The tool is on Github. It was developed within the Planheat project. The owner seems RINA Consulting.	PLANHEAT is a QGIS plug-in based on open source code that can analyze, plan and simulate low-carbon heating and cooling scenarios. It includes three open-source modules, the mapping, planning and simulation module, which can be used via the integrated tool or individually.	https://github.com/Planheat/Planheat-Tool/tree/master/PlanheatMappingModule	Entirely free	Yes	Apprently whole EU	Useful for some planning tasks	Hard to use	The tool has limited integration capabilities	English	In princple here: https://planheat.geonardo.com/ But registration is not possible.	No	Map locally available energy sources; Forecast demand for heating and cooling; Simulates alternative scenarios; Identify potential for fdistrict heating and cooling; Evaluate energetic, economic and	Not working so far (still under development)
14	Energyplus	Energy simulation (buildings)	U.S. Department of Energy's (DOE) Building Technologies Office (BTO)	EnergyPlus is an energy simulation program for buildings used to model both energy consumption (for heating, cooling, ventilation, lighting, and process and plug loads) and water use in buildings	https://energyplus.net/	Entirely free	Yes	Worldwide	Useful for some planning tasks	Hard to use	The tool has limited integration capabilities	English Some third party interfaces are available in other languages	https://energyplus.net/documentation	https://energyplus.net/support-training	Very detailed buildings simulations, energy demand quantification	Not relevant for energy planning at municipal level, since each building requires significant effort to be modelled.
15	European Heat Pump Association (Tool Heat Pump)	Energy simulation (RES)	EHPA (European Heat Pump Association)	To select an optimal heat pump, you need to know the cost of operating a heat pump per year. With the help of this tool you can determine the cost of electrical power consumed by the heat pump per year and compare it with other sources of heat, for example: gas boiler, electric boiler or solid fuel boiler.	https://myheatpump.ehpa.org/en/heat-pump-cal	Entirely free	No	Europe	Useful for some planning tasks	User-friendly	The tool has limited integration capabilities	English	https://www.youtube.com/watch?v=zsNRV0dqA5o	Yes (but the tool is veery simple)	Quick estimation of energy consumption (and cost) of operating a HP. Rough sizing of the HP.	Each calculation is performed for a specific end-user, the tool is not meant for calculations of a series of buldings. Nevertheless, up-scaling the results may be an option.

	Tool	Type of tool/resource	Tool provider	Description	Tool/Resource link	Available for free / payment (license)	Open source	Geographical area covered	Applicability	User friendliness	Interoperability	Language	Tutorials available (link)	Technical support available	Advantages	Disadvantages
16	COOLING DOWN	Still in development	EU Funded project (LIFE) coordinated by EUROPEAN GEOTHERMAL ENERGY COUNCIL	Online tool. Where the installed heating system is located. Enter some details about the characteristics of your home and get an overview of the different suitable alternatives	https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE21-CET-COOLING-COOLING-DOWN-101077140/unlocking-	Entirely free	No	-	Highly applicable			English	-	-	-	Still in development
17	HARP (Marco)	Other	ADENE	Calculation of energy label of a heating appliance	https://aquecimentoeficiente.adene.pt/aplicacao-harp/	Entirely free	No	Portugal, Italy, Spain, France, Germany	Low applicability	User-friendly	The tool has limited integration capabilities	Portuguese	https://aquecimentoeficiente.adene.pt/aplicacao-harp/	No	-	Not useful for energy planning
18	INERGY	Service	EU Funded project (LIFE) coordinated by EREVNITIKO PANEPISTIMIAKO INSTITOUTO SYSTIMATON	For planning grid-connected PV systems with or without battery storage, intelligent energy management or e-mobility, off-grid or hybrid off-grid systems	https://aiod.eu/ https://cordis.europa.eu/project/id/101016508/results	Entirely free	No	Europe	Low applicability	User-friendly	The tool has limited integration capabilities	English	-	https://i-nergy.eu/contact	-	Not usefull as a tool to directly support municipalitels in LHCP
19	SunnyDesign	PV panel web based energy simulator	SMA Solar Technology AG	Design and simulation web based software for photovoltaic systems	https://www.sunnydesignweb.com/sdweb/#/	Free tier with limited features	No	Europe	Useful for some planning tasks	User-friendly	The tool has limited integration capabilities	English/Italian	https://www.sunnydesignweb.com/sdweb#/Home	https://my.sma-service.com/s/?language=en_US	Free version with a lot of features	For battery and inverter, only the SUNNY products are considered
20	PVSyst	Energy simulation sofware for PV systems	PVsyst SA	Design and simulation software for photovoltaic systems	https://www.pvsyst.com/	Not free	No	World	Low applicability	Need for practice	The tool has limited integration capabilities	English	https://www.pvsyst.com/video-tutorials/	https://www.pvsyst.com/consulting/	Detailed tool for design and simulation of photovoltaic systems	Not free The trial version can simulate PV in very strict geographical areas
21	SCE.CLima	Excel tool	Directorate-General for Energy and Geology of Portugal	SCE.CLIMA is software that helps prepare reference climate files. This software is used in conjunction with "SCE.ER," which is for data and calculations related to the use of renewable energy in buildings.	https://www.dgeg.gov.pt/media/mstjdqrw/0016522.xlsm	Entirely free	No	Portugal	Low applicability	User-friendly	The tool has limited integration capabilities	English Portuguese	-	Yes	It produces climate data in EPW format, making it compatible with various software applications.	The tool is specifically applicable only to Portugal.
22	EuCityCalculator	Webtool to simulate low-carbon scenarios	EU Project	It aims to deliver an energy modelling tool adapted to the city needs and representative of the major material, energy and emission-related processes happening within the city's administrative areas and beyond. The tool plans to integrate specific mitigation actions formulated at the city level into its modelling framework and provide cities with an easy-to-use web-interface for model exploration. If the city is not already in the EUCityCalculator database, users must manually import all relevant data using the	https://eucitycalc.climact.com/it	Entirely free	Yes	It has included data for 11 european cities, where the pilots were implemented, but has the possibility to	Useful for some planning tasks	User-friendly	The tool has limited integration capabilities	English	https://www.youtube.com/watch?v=jrsQPYaRsgU https://www.youtube.com/watch?v=qtnfTPsX_-E		The webtool is designed to facilitate the transfer of data from the SECAP template provided by the Covenant of Mayors to the EU City Calculator, and also the transfer of outputs from the webtool (measures and their implications) back to	The EU City Calculator is a linear model and does not provide optimised scenarios or forecasts. The tool is more difficult to use when the city is not included in the existing database (and even more difficult without a convenant
23	HAP	Energy simulation (buildings)	Carrier	HAP is a dual function program - full-featured load estimating and system sizing for commercial buildings plus versatile hour-by-hour energy and operating cost analysis	https://www.carrier.com/commercial/en/us/software/hvac-system-design/hourly-analysis-program/	Not free	No	World	Highly applicable	Hard to use	The tool has limited integration capabilities	English	https://www.carrier.com/commercial/en/us/software/hvac-system-design/software-training/	Yes	It enables the hourly simulation of energy consumption and system performance, providing detailed insights into the operational efficiency of heating, ventilation, and air conditioning systems.	Not free The trial version can simulate PV in very strict geographical areas
24	Hotmaps	GIS-based online mapping software		Open source heating / cooling mapping and planning toolbox that intends to allow public authorities to identify, analyse, model and map resources and solutions to supply energy needs within their territory of responsibility in a resource and cost efficient way. Those results will help authorities to develop heating and cooling strategies on local, regional and national scale which are in line with RES and CO2-Emission targets on national and EU level.	https://www.hotmaps.eu/map	Entirely free	Yes	Europe	Highly applicable	User-friendly		English	https://wiki.hotmaps.eu/en/Training-Material	https://www.hotmaps-project.eu/contact/ info@hotmaps-project.eu.	Open-source and Free to Use User-friendly Interface	Limited Real-time Data
25	LEAP-RE	Doesnt seem like a tool	Long-Term Joint European Union - African Union Research and Innovation Partnership on Renewable Energy	Enables the identification, assessment and optimisation of the technical and financial feasibility of potential renewable energy and energy efficiency projects	Doesnt seem like a tool				-							
26	RETScreen	Energy Management Software	Government of Canada	Energy modeling software to support building energy efficiency programs at district or city level. Enables low-cost energy planning, implementation, monitoring and reporting.	https://natural-resources.canada.ca/maps-tools-publications/tools-applications/retscreen	Free tier with limited features	No	Worldwide	Useful for some planning tasks	Need for practice	The tool has limited integration capabilities	English	youtube.com/@retscreenelearning4393	RETScreen@nrcan-rncan.gc.ca	- All-in-One Analysis: It's a comprehensive package that covers the entire project lifecycle, from initial benchmarking and feasibility studies (both technical and financial) to ongoing performance verification and portfolio management	- Pre-feasibility Focus: While excellent for feasibility analysis, it is not a detailed engineering design tool - Dated User Interface: - Can Be Overwhelming: The sheer amount of information and the number
27	CityBES	Open web-based data and computing platform	BayREN Integrated Commercial Retrofits (BRICR)	City Building Energy Saver (CityBES) is an open web-based data and computing platform, focusing on energy modeling and analysis of a city's building stock to support district or city-scale efficiency programs. CityBES uses an international open data standard, CityGML, to represent and exchange 3D city models. CityBES employs EnergyPlus to simulate building energy use and savings from energy efficient retrofits. CityBES provides a suite of features for urban planners, city energy managers, building	https://citybes.lbl.gov/projects/new?city_total_area=1824315&method=post	Entirely free	No	Its seems only for cities on US plus Shanghai	Low applicability			/	/	/	/	/
28	IES iCD	Energy simulation (buildings)	IES	Quick energy and carbon assessments for portfolios, campuses and cities. Map out routes to net-zero with iCD's high-level analysis capabilities. Identify high/low performers, explore potential retrofit options to investigate further, and use multi-year simulations to understand the energy and carbon impact of various interventions across both new and existing buildings.	https://www.iesve.com/products/icd	Not free	No	Worldwide	Highly applicable	Need for practice	The tool has limited integration capabilities	English	https://distance-learning.iesve.com/courses/category/scalable-energy-analysis-icd	https://www.iesve.com/support/contact/query	- Scalability for Urban Areas - Early-Stage Masterplanning and Scenario Analysis - iCD can work in conjunction with other IES tools like IESVE (for detailed individual building analysis), iVN, (for energy	- Like all Urban Building Energy Models (UBEMs), accuracy can be affected by simplifications necessary for large-scale analysis - The tool itself, being comprehensive, can have a steep learning curve and
29	GreenPass	Energy simulation (buildings)	GreenPass	GREENPASS® offers a solution to quantify and measure the effects of green infrastructures on urban areas, enabling the efficient planning of climate resilient livable cities.	https://www.greenpass.io/	Not free	No	Worldwide	Useful for some planning tasks	Need for practice	The tool has limited integration capabilities	English	https://support.greenpass.io/portal/en/home	https://support.greenpass.io/portal/en/kb/greenpass/support	- Use of nature based solutions - Passive cooling strategies without energy consumption - Applicability on hot weathers	- Not free - No interoperability - Very Specialized software
30	Thermos	Energy simulation (buildings)	THERMOS EU-funded project	THERMOS is a free, web-based energy planning software that provides accurate heat and cold network options analysis instantly within one web-based, user-friendly tool. Developed by the THERMOS EU-funded project, the software is designed to optimise local district energy network planning processes and sustainable energy master planning to facilitate the deployment of new low-carbon heating and cooling systems and a fast upgrade, refurbishment, and expansion of existing systems	https://tool.thermos-project.eu/login?redirect_to=/	Entirely free	Yes	Worldwide	Useful for some planning tasks	Need for practice	The tool has limited integration capabilities	English	https://www.thermos-project.eu/tool-support/training-materials/	Not sure, info@thermos-project.eu	- Free and Open Source - Accelerates Early-Stage Planning - Considers also economic feasibility	It does not help with analyzing or selecting the energy source - It is intended for strategic planning and pre-feasibility studies, not for the detailed engineering and hydraulic calculations required for the final design

	Tool	Type of tool/resource	Tool provider	Description	Tool/Resource link	Available for free / payment (license)	Open source	Geographical area covered	Applicability	User friendliness	Interoperability	Language	Tutorials available (link)	Technical support available	Advantages	Disadvantages
31	Modelica	Data base	Modelica Association	Modelica is not a single tool, but rather a powerful, open-source modeling language. You use a separate software environment (like Dymola or the free OpenModelica) to build and simulate models written in the Modelica language. A free, open-source library for modeling of building energy and control systems using the equation-based, object-oriented Modelica language	https://modelica.org/libraries/	Entirely free	Yes	Worldwide	Low applicability	Hard to use	-, The tool integrates with a wide range of other systems	English	- modelica.org/documentation - openmodelica.org/doc/OpenModelicaUsersGuide/latest/	- stackoverflow.com/questions/tagged/modelica - openmodelica.org/forum	- High-Fidelity Simulation - Extensive Free Libraries - Open Source	- Engineering Tool, Not a Planning Tool: Modelica is for detailed engineering simulation, not high-level urban planning - Requires Deep Expertise - Computationally Intensive: Running detailed simulations is time-consuming, which makes it impractical for rapidly
32	In-plan	Guidelines, references	EU Funded project coordinated by North-West Croatia Regional Energy Agency (REGEA)	IN-PLAN provides a structured methodology that enhances cross-sector and multi-level coordination, supporting the integration of energy, climate, and spatial planning. This approach enables more coherent and effective implementation of sustainable strategies. The methodology is particularly valuable for small municipalities, as it provides ready-to-use templates and a structured process, making it accessible even without a dedicated energy planning team. For medium to large municipalities, it facilitates cross-departmental collaboration (e.g., between urbanism, energy, and legal	https://fedarene.org/wp-content/uploads/2024/10/IN-PLAN-Practice.pdf	Entirely free	-	EU	Highly applicable			English	in-plan-project.eu/	No Active Support	- Focus on Integration: Its primary strength is providing a framework for breaking down silos between energy and spatial planning departments within a municipality. - Policy and Process-Oriented: It addresses the crucial, non-technical	- Not a software tool - Qualitative, Not Quantitative: The focus is on processes and qualitative guidance. It will not give you quantitative data on the best network route or the energy savings of a specific technology.
33	Open EI	USA Data base	Open Energy data initiative	The platform is a wiki, similar to Wikipedia in the energy data realm	https://openei.org/wiki/Main_Page https://openei.org/wiki/Gateway:Buildings	Entirely free	Yes	Mainly US Based	Low applicability	User-friendly	The tool integrates with some key systems	English	openei.org/wiki/Help:Contents	groups.google.com/group/openei	- Vast Data Resource: Its single greatest advantage is providing free access to thousands of datasets on renewable energy, energy efficiency, utility rates, and more. This data is essential for running any kind of energy model or analysis	It's a Data Source, Not a Tool: You must use the data from OpenEI as an input for other specialized tools - Data Quality Can Vary: While efforts are made to ensure quality, the platform relies on contributions from many different sources, which can lead to
34	Solargis	Solar and PV Panels analysis	Solargis	We provide solutions for all phases of solar energy projects, from initial planning and securing financing to daily operations, management, and maintenance.	https://solargis.com/	Not free	No	Worlwide	Low applicability	User-friendly	The tool integrates with a wide range of other systems	English	https://solargis.com/resources/webinars	support@solargis.com	- Bankable Accuracy: This is its core strength. Solargis data is independently verified to have very high accuracy and low uncertainty, making it a "bankable" standard trusted by banks and investors for energy yield assessments. - High-Resolution Data: It provides data	- Commercial Cost: As a premium service, it comes at a significant cost - Solar-Focused Only: The platform is exclusively designed for solar energy projects (PV and CSP). It has no native capabilities for analyzing heating or cooling
35	Global Wind Atlas	Information map	energydata.info	The Global Wind Atlas is a free, web-based application developed to help policymakers, planners, and investors identify high-wind areas for wind power generation virtually anywhere in the world, and then perform preliminary calculations.	https://globalwindatlas.info/en/	Entirely free	No	Worldwide	Low applicability	User-friendly	The tool integrates with some key systems	English	https://globalwindatlas.info/en/about/VideoTutorials	globalwindatlas.info/help-desk	- Completely Free: It provides open and free access to a global dataset of wind resources, making it an invaluable tool for public planners, researchers, and early stage project screening. - Standardized Methodology - Data Accessibility: The platform makes	- Pre-feasibility Data: The data is designed for preliminary screening and is not "bankable." It cannot replace the need for on-site wind measurements required for securing financing for a specific project. - Wind-Focused Only:
36	Pan-European Thermal Atlas	Heat demand map	sEEnergies, funding from EU Horizon 2020	Map layers showing the status-quo of the heat sector and energy efficiency potentials in the building, transport, and industry sectors	https://euf.maps.arcgis.com/apps/webappviewer/index.html?id=8d51f3708ea54fb9b732ba0c94409133	Entirely free	No	Europe	Useful for some planning tasks	User-friendly	The tool integrates with some key systems	English	https://zenodo.org/records/4785336 - heatroadmap.eu/videos/	/	- Comprehensive Thermal Data: It is the most comprehensive, harmonized source of data for the heating and cooling sector at a European level. It maps heat/cool demand, waste heat sources, renewable energy potential (geothermal, solar), and infrastructure	- Strategic Level Only: The data resolution (typically 100x100m at best) is suitable for national and regional analysis but is not detailed enough for local project planning or engineering design. The creators note that the confidence level is
37	Climate App	Not quite sure which tool we are referring to		The climate adaptation app gives urban designers, engineers or others insight in feasible measures for a project with a specific climate adaptation goal. The app will generate a selection of feasible climate adaptation measures in less than a minute. If for instance, an urban development in a flood plain is to be prepared for river flooding, the app will rank feasible measures based on the local conditions and the user's input.	https://www.climateapp.org/ ????			-		/	English	/	/	/	/
38	CoolLife	Energy simulation (buildings)	CoolLife project EU funded	The CoolLIFE project aims to address the need for sustainable solutions to the EU's rising demand for space cooling in buildings. The project developed open-source tools which encourage the consideration of green cooling solutions in public and private decision-making, planning, design, and implementation processes	https://tool.coollifeproject.eu/map	Entirely free	Yes	Europe, especially South, Central, and Northern European urban zones	Highly applicable	Need for practice	The tool integrates with some key systems	English	https://www.youtube.com/watch?v=BNxwndkm3zI	Yes	- Very userfriendly and free - Addresses Policy and Training: It directly targets the integration of these design principles into building regulations and provides training for professionals (architects, engineers), tackling key non-technical barriers.	- Only for cooling - No info about CO2 emissions
39	solarAPI	Solar and PV Panels analysis	Google	The Google Maps Platform Solar API generates detailed rooftop data based on Google's extensive geospatial data and computing resources to evaluate rooftop solar energy potential. It provides access to the solar potential of hundreds of millions of buildings, aiding in the acceleration of solar and energy system installations.	https://mapsplatform.google.com/maps-products/solar/	Free tier with limited features	No	USA, Europe, Australia, parts of Asia and parts of Africa	Useful for some planning tasks	Hard to use	The tool integrates with a wide range of other systems	English	https://www.youtube.com/watch?v=LotnMK6T2hQ - https://www.youtube.com/watch?v=GmDN6cQD0xU	https://developers.google.com/maps/support	- Rooftop-level PV Analysis: provides high-resolution solar potential estimates ideal for urban cooling planning via PV systems - Real-time API access: allows integration with dashboards and energy planning tools	- Solar-only focus: it does not support heating or broader energy planning—only PV systems - Requires programming integration: planners must code or build front-ends to extract value - No visualization: needs to be
40	nPRO	Energy simulation (buildings)	nPro Energy GmbH	nPro is a modular, flexible software tool that simplifies and accelerates the traditional, manual planning of districts. It was specifically developed for the early planning phase, where only limited information about a district and energy system is available.	https://app.npro.energy	Free tier with limited features	No	Over 40 countries (USA, Europe, Australia, China...)	Highly applicable	User-friendly	The tool integrates with some key systems	English, German	https://www.youtube.com/@npro_energy/videos	support@npro.energy	- Scenario-based planning: models different energy futures including district cooling and RES integration - Graphical outputs for stakeholders: useful for municipal reporting and decision-making - No programming required as it is	- Commercial software: requires licensing, which may be a barrier for smaller municipalities - Users must understand energy system modeling principles to fully utilize it - Electricity-centric: needs custom
41	EUReCA	Excel tool	BETALAB research group of the University of Padua, Italy	EUReCA is an open-source Urban Building Energy Modeling platform, entirely developed in Python, aiming at simulating and predicting cities and urban areas' energy consumption. The tool exploits a bottom-up modeling methodology, creating simple and useful dynamic building energy models.	https://github.com/BETALAB-team/EUReCA	Entirely free	Yes	Europe	Useful for some planning tasks	Hard to use	The tool integrates with some key systems	English	https://github.com/BETALAB-team/EUReCA?	https://github.com/BETALAB-team/EUReCA?	- Open-source flexibility: users can modify and adapt the tool to their needs - Modular energy planning: allows custom definition of energy systems and regional boundaries - Highly customizable for cooling	- Requires coding knowledge: not immediately usable for planners without Python experience - No graphical interface: command-line and script-driven, which limits its accessibility - Limited documentation: support may
42	USGS Landsat	USA Data base	U.S. Geological Survey (USGS) in partnership with the NASA	The Landsat Program is a series of Earth-observing satellite missions jointly managed by NASA and the U.S. Geological Survey. Since 1972, Landsat satellites have continuously acquired images of the Earth's land surface and provided an uninterrupted data archive to assist land managers, planners, and policymakers in making more informed decisions about natural resources and the environment.	https://earthexplorer.usgs.gov	Free tier with limited features	Data yes, Tool no	Worldwide	Useful for some planning tasks	Need for practice	-	English	https://www.usgs.gov/software/introduction-landsat-stac-tutorial? - https://www.usgs.gov/landsat-missions/news/new-tutorials-help-navigate-landsat-data-cloud?		- Long-term earth observation: to establish historical land use and urban heat trends - Freely accessible data to supports open planning processes - Compatible with GIS as it can be combined with spatial datasets for	- Data, not software: USGS Landsat provides raw satellite imagery, not a tool for simulation or scenario building - Requires post-processing: must process and interpret the data using GIS or remote sensing tools - Low temporal resolution: data every
43	CliamteEngine Landsat database	Open web-based data and computing platform	Desert Research Institute	ClimateEngine empowers users of all technical proficiencies to harness the power of cloud computing to analyze decades of Earth Observations data. Collectively, the app, API, and reports are a powerful set of tools that bring together climate and remote sensing data to allow users to explore various environmental questions.	https://www.climateengine.org	Entirely free	No	Worldwide	Useful for some planning tasks	User-friendly	The tool has limited integration capabilities	English	https://support.climateengine.org/article/24-tour-the-app? - https://support.climateengine.org/article/33-dive-in-make-a-graph?	https://support.climateengine.org/#contact	- User-friendly interface, designed for planners with minimal GIS or coding skills - Quick visualization of climate metrics: useful for assessing cooling trends (temperature, evapotranspiration)	- Basic functionality: designed for simple visualizations, not in-depth scenario analysis - No built-in modeling: outputs require interpretation and external analysis to support planning - Predefined indicators only: limited
44	ESA Urban TEP	GIS-based online mapping software	European Spatial Agency	The Urban Thematic Exploitation Platform (Urban TEP), funded by the European Space Agency (ESA), is developed to provide end-to-end and ready-to-use solutions for a broad spectrum of users (experts and non-experts) to extract unique information and indicators required for urban management and sustainability.	https://urban-tep.eu/geobrowser/?id=opendata#!&context=WSF%2FWSF2015	Entirely free	Data yes, Tool no	Europe	Useful for some planning tasks	Need for practice	-	English	https://urban-tep.github.io/documentation/overview/data-processing.html		- Urban morphology and density insights: Provides critical data for urban cooling design and land use zoning - EO-based datasets: Includes spatial indicators for impervious surfaces, green coverage, etc.	- Complex EO interface: not designed for non-experts in satellite imagery or urban geospatial analysis - Weak integration: limited API or export capabilities; data often has to be interpreted manually - High technical barrier: requires
45	Copernicus Atmosphere Monitoring Service (CAMS)	Information map	European Centre for Medium-Range Weather Forecasts (ECMWF), on behalf of the EU	The Copernicus Atmosphere Monitoring Service (CAMS) provides continuous data and information on atmospheric composition. The service describes the current situation, forecasts the situation a few days ahead, and analyses consistently retrospective data records for recent years.	https://ads.atmosphere.copernicus.eu/#!/home	Entirely free	Data yes, Tool -	Worldwide (with a focus on Europe)	Low applicability	Hard to use	The tool integrates with some key systems	English	https://ads.atmosphere.copernicus.eu/training	https://ads.atmosphere.copernicus.eu/help	- Key climate inputs for cooling demand: Provides temperature, radiation, and emissions data across Europe - Public and standardized: Ensures consistent input for multiple tools - Usable with GIS/Models: exports in	- Not Plug-and-Play: requires GIS or climate modeling experience to extract full value - No urban-specific scenarios: general climate data lacks direct application to specific planning zones - Availability of many datasets, units,

	Tool	Type of tool/resource	Tool provider	Description	Tool/Resource link	Available for free / payment (license)	Open source	Geographical area covered	Applicability	User friendliness	Interoperability	Language	Tutorials available (link)	Technical support available	Advantages	Disadvantages
46	OECD Atlas	Information map	Organisation for Economic Co-operation and Development (OECD)	The OECD Regions and Cities Atlas is a one-stop shop to access and visualise indicators for regions, cities, and functional urban areas. It allows users to explore a range of indicators, including demographic trends, economic performance, labor market dynamics, and environmental statistics.	https://www.oecd.org/en/data/tools/oecd-regions-and-cities-atlas.html // https://www.oecd.org/en/topics/environmental-statistics-accounts-and-	Entirely free	No	Europe, North America, parts of South America and parts of Asia	Useful for some planning tasks	Need for practice	-	English, French	https://www.youtube.com/watch?v=LUkdELW7mpQ		- Socio-economic contextualization: helps align cooling strategies with energy poverty and demographic data - User-friendly: easy to navigate - Covers entire OECD Region which allows cross-national comparisons in urban planning	- No technical modeling features: purely a visualization platform with no scenario or impact simulation capabilities - Data download options limited as it is designed more for communication than analysis
47	Copernicus Land Monitoring Service (CLMS)	Heat demand map	Copernicus Programme of the EU, implemented by the European Space Agency (ESA) and the European Environment Agency (EEA)	The Copernicus Land Monitoring Service provides geospatial information on land cover and land use across Europe. It offers harmonized land cover and land use datasets to support spatial and environmental planning, aiding in the selection of optimal sites for cold storage facilities.	https://land.copernicus.eu/en/map-viewer	Entirely free	Data and Global Land Service Tools yes	Europe	Highly applicable	Need for practice	The tool integrates with some key systems	English, multiple EU languages	https://ads.atmosphere.copernicus.eu/user-guide	https://land.copernicus.eu/en/contact-service-helpdesk	- Geospatial coverage of Europe: detailed land use and land cover data for cities and peri-urban zones - Free and official EU dataset: ensures harmonization and relevant data - Essential for urban energy planning;	- GIS-specific expertise needed: requires training or support to use effectively in planning - The datasets are periodically updated but not real-time or dynamic - Outputs must be used in other platforms to simulate energy systems
48	Excel Tools related to Energy Efficient Buildings	Energy analysis (buildings, HP, PV)	Umiversitat Innsbruck	Tool to calculate U value wall, tube, boiler consumption, and heat pump design	https://www.uibk.ac.at/en/energy-efficient-building/research/software-and-tools/excel-tools-related-to-energy-efficient-buildings/	Entirely free	No	World	Highly applicable	User-friendly	The tool integrates with some key systems	English, multiple EU languages	-	bauphysik@uibk.ac.at	User-friendly tool to calculate U value wall, tube, boiler consumption, and heat pump design	It doens't allow the analysis of the building energy consumption
49	Renewable Thermal Collaborative Tools	Energy analysis (HP)	The Renewable Thermal Collaborative (RTC) is the global coalition of companies, institutions, and governments committed to decarbonizing	Tool 1: Initial Screening helps companies understand where a heat pump might be useful, identify suitable technologies, and provide examples of similar installations using simple inputs. Tool 2: Feasibility Assessment enables users to assess the commercial viability of a heat pump project for a specific site or operation. This tool now includes a rapid assessment feature for quicker feedback as well as improved cost and performance estimations.	https://www.renewablethermal.org/heat-pump-decision-support-tools/	Entirely free	Yes	World	Highly applicable	Need for practice	The tool integrates with some key systems	English, multiple EU languages	https://www.renewablethermal.org/event/rtc-heat-pump-decision-support-tools-launching-version-2-0/	info@renewablethermal.org	With this tool, you can both perform initial screening to find applicable heat pump technologies or high level technical and commercial viability assessments	It's focused only on heat pump
50	Energy poverty indicators dashboard	Database	The European Comission	In this database, you can find EPAH indicators organised by topics for each European country. In this indicators collection, publicly available EU-wide datasets are considered	https://energy-poverty.ec.europa.eu/epah-indicators?indicator-heating+dgr+days-none-	Entirely free	Yes	Europe	Highly applicable	User-friendly	The tool integrates with some key systems, The tool has limited integration capabilities	English, multiple EU languages	-	overty.ec.europa.eu/our-work/tech	Possible to find Energy Poverty indicators organised by topics for each European country.	In this tool, available EU datasets are used, so some data is unavailable for specific years or countries. Most of the data is available at the national level (not local)
51	QGIS	Planning tool	QGIS Development Team	It is a free, open-source geographic information system that allows users to create, edit, analyse and visualise spatial and geospatial data through an intuitive interface, supporting a wide range of data formats and tools for mapping, spatial analysis and decision support.	https://qgis.org/	Entirely free	Yes	World	Highly applicable	Need for practice	The tool integrates with a wide range of other systems	English	https://docs.qgis.org/3.40/en/docs/training_manual/index.html	rg/resources/support/?utm_source=	It is free and open-source It supports a large variety of spatial data formats and standards, ensuring strong interoperability It has a large and active user and developer community that continuously improves the software	The learning curve can be steep for new users due to the wide range of tools and options