Auto characterization of PEDs for digital references

towards iterative process optimisation

Project Nº: 43927229

Deliverable D4.1

State of the art for PED databases

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Lead beneficiary	DEM		
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1. Introduction

1.1. What is a Database?

A database is a logically organized collection of information, designed in such a way that the information within can be accessed for later use by a computer program. Databases are useful in many different scenarios for storing data. It is typical to use a database when different sets of data need to be linked together.

By definition, the data within a database needs to be arranged according to a consistent, logical set of underlying principles. The term data model describes the logical structure of a database, which determines the rules for how the information within can be organized and manipulated. When data is structured, that means it's formatted and searchable. Unstructured data lacks both formatting and accessibility, and is therefore much harder to analyse. The database needs to be organized according to a database schema. The schema of a database is what distinguishes it from a list or a spreadsheet: The schema organizes the data inside the database.

Once organized, still some ways are needed to interact with the database in order to perform the desired actions. A database management system (commonly abbreviated to DBMS) is the software that makes it possible for end users to create, modify, and manage databases, as well as define, store, manipulate, and retrieve the data inside those databases. Some examples of database management systems include MySQL, MongoDB, Oracle, FileMaker, Microsoft's Azure, and Airtable.

The three main advantages that databases have over other, simpler data storage systems (such as text files and spreadsheets) are access, integrity, and security. Access is about making data available to users. Databases support good data access because:

- Large volumes of data can be stored in one place,
- Multiple users can read and modify the data at the same time,
- Databases are searchable and sortable, so the data you need can be found quick and easily,
- The data structure is extendable and can be modified as requirements change,
- Databases can ensure that the data contained within them is correct, or has integrity.
- To ensure the integrity of a database, each change or transaction must conform to a set of rules:

Atomicity: when changing data within a database, if any part of the change fails, the whole change will fail and the data will remain as it was before the change was made; this prevents partial records being created,

- Consistency: before data can be changed in a database, it must be validated against a set of rules,
- Isolation: databases allow multiple changes at the same time, but each change is isolated from others,
- Durability: once a change has been made, the data is safe, even in the event of system failure,

- In addition, databases will have mechanisms for backup, distribution, and redundancy, to ensure data is not lost.

While access to text files or spreadsheets can be secured, once someone has access to a file, they have access to all data within that file. Databases can be made very secure, and that includes the ability to have access rights to specific parts of the database and not others. Databases allow access to be con-trolled, allowing users to have different privileges: for example, some users may be able to read data, but not to write it. Data can also be segmented so that users can access only certain parts.

1.2. What is it needed?

The PED-ACT project aims to innovate the early-stage design of a PED by improving the process for stakeholder cooperation and reinforced decision-making. Replication of PED is not simple, so it is im-portant to plan and model the replication possibility of PED at early design stage, by learning characteristics from existing PEDs for tailor-made solutions to local contexts. However, a common database of existing PEDs is not available yet, although several initiatives are developing PED database simultaneously with different highlights and semantic models. Semantic heterogeneity between vocabularies and data repre-sentations is a common issue in existing models that potentially hinders the design and planning of PEDs without common information representation and exchange among different databases. In this regard, the project extracts the main characterization of PEDs automatically by machine learning approaches through database development of an extensive set of existing PEDs in three countries, to develop a digitalized-and-standardized PED database for exchange of information.

A database of existing PEDs is a multidisciplinary and open tool, that starts from the aggregation and systematization of the gathered information, then returns a set of multiple features related to the PED design and realization. It is considered to be an online disruptive platform tool that allows the end-user to map, visualize, search, filter and compare results.

The database developed in PED-ACT project will collect information from PED experiences, foster the sharing of competences, investigate barriers and challenges, and recommend concepts, solutions, strat-egies and best practices for PED implementations in different contexts and geographical areas. The se-lection of the main parameters of the database will be based on a holistic and exhaustive methodology which highlights the multiple dimensions related to PEDs, for which definitions and characterization are quite broad in the context of the on-going international debate. This will be managed by identifying the main categories that address its multidimensionality nature and the specific insights from each project and ini-tiative according to an inclusive adherence to the PED approach definition in the EU countries. Therefore, PED developers can adopt this targeted information to drive the design according to the roughness of boundary conditions, needs and criticalities that characterize their own process. Moving from the district needs, they can find the best solutions and practices both to be adapted and improved in their projects and that can help overcome challenges.

To design a common database of existing PEDs which will best serve the objectives of the project, in light of the general definitions and criteria above, a survey has been conducted with the stakeholders, to understand the needs and priorities, and to create a common understanding with regards to the general structure and the components of the final product, through the following questions:

1. How do you prioritise the basic functions of a digital tool/PED database? (Please, check/mark all that apply and specify your recommendation(s), if any)

a. Access to thoroughly collected & well-organized quantitative and qualitative data sets

b. Data exchange opportunity

c. Knowledge/experience sharing component/platform

d. Access to EU-wide standards and legislative conditions

e. Access to EU-wide social models (e.g., energy communities, reducing energy poverty)

f. Access to EU-wide designers/experts and solution providers

g. Access to EU-wide funding opportunities & finance sources

h. Help desk (an interactive tool)

2. How do you prioritise the basic properties/features of a digital tool/PED database? (Please, check/mark all that apply and specify your recommendation(s), if any)

a. User-friendly interface

b. Facilitated storage, representation, retrieval, modification, and deletion of data

c. Data glossary

d. Data integrity management

e. Multi-user access control

f. Security management/GDPR

g. Back-up and recovery management

3. Please, choose the components/dimensions that need to be included in a PED database:

a. General:

- Geographical boundaries and map of the PED
- Physical and social structure
- Local legislation and regulatory framework for PEDs
- Identification and map of stakeholders

- Baseline/State of Play analysis
- Identified measures/opportunities, targets and timeframes, including energy flexibility
- Techniques and technologies (applied/to be applied)

b. **Quantitative – Energy & Emissions:**

- Positive annual energy balance
- Energy savings (targeted/realized)
- Renewable energy production (targeted/realized)
- Surplus energy stored for district use
- Surplus energy sold to neighbouring districts
- Emissions reductions (targeted/realized)
- Quantitative - Economic & Social:
- Cost components of ownership
- Cost-benefit analysis
- Funding sources & financial structure
- Number of jobs created

c. **Human/Social:**

- Awareness raising and knowledge sharing activities
- Behavioural changes
- Improvement of skills needed to plan, realize, monitor, and replicate the PED
- Establishment of climate-neutrality labs
- Innovation ecosystems
- Exploitation opportunities
- Improvements in quality of life

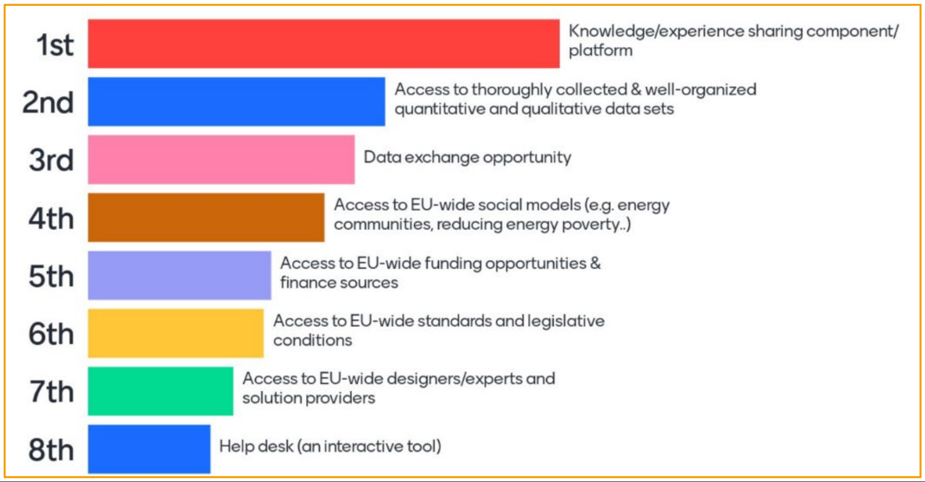
d. **Lessons-Learned and Recommendations:**

- Lessons-learned and recommendations for PED designers and implementers

The results of the survey are presented below:

1. How do you prioritise the basic functions of a digital tool/PED database? (Please, check/mark all that apply and specify your recommendation(s), if any)

Umeå



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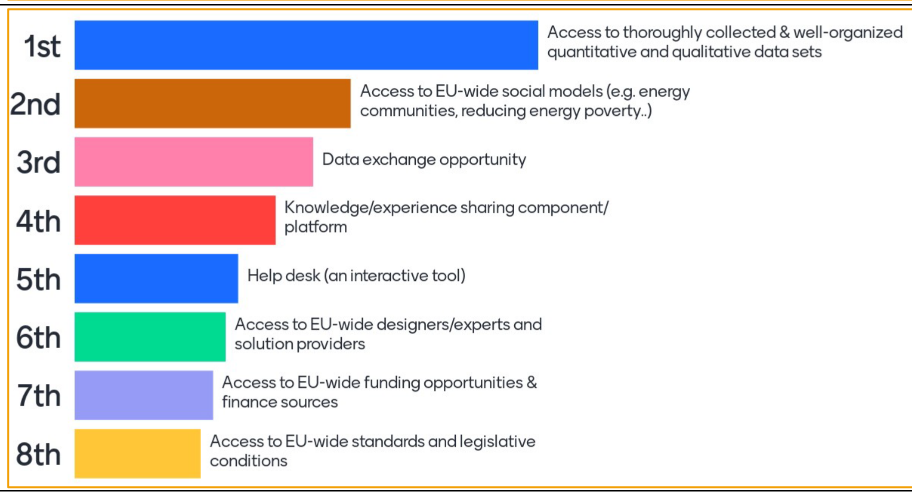

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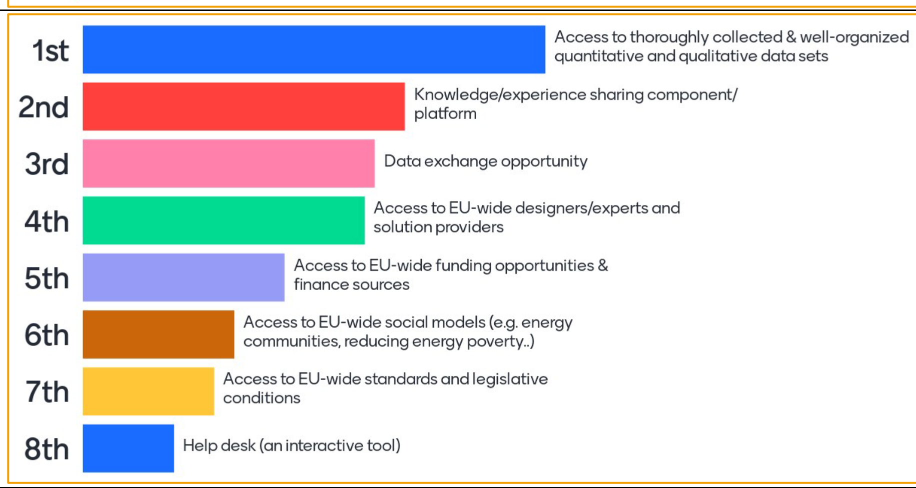
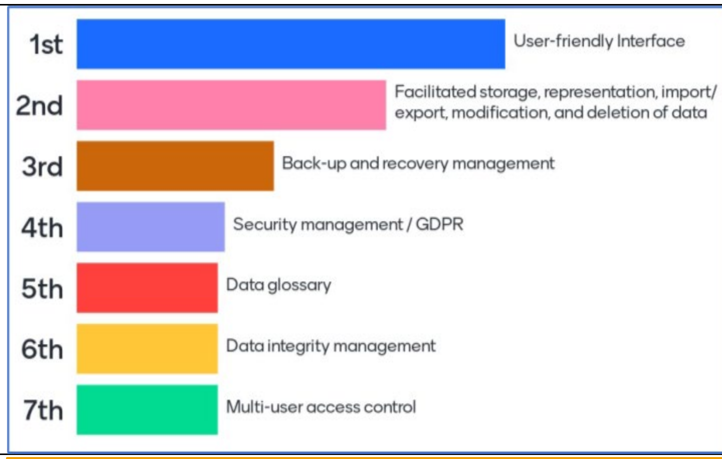


2. How do you prioritise the basic properties/features of a digital tool/PED database? (Please, check/mark all that apply and specify your recommendation(s), if any)

Umeå



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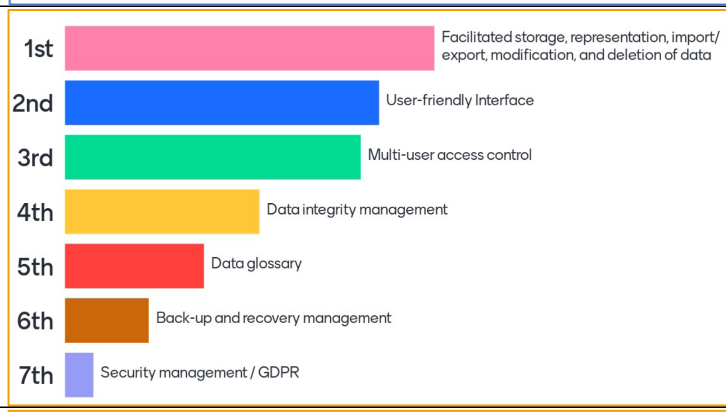

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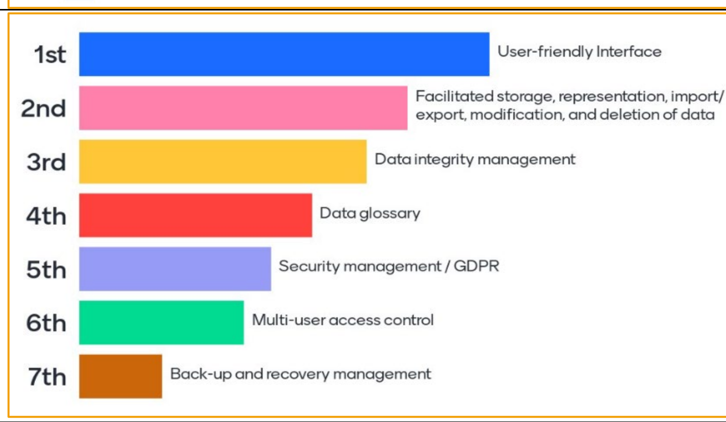
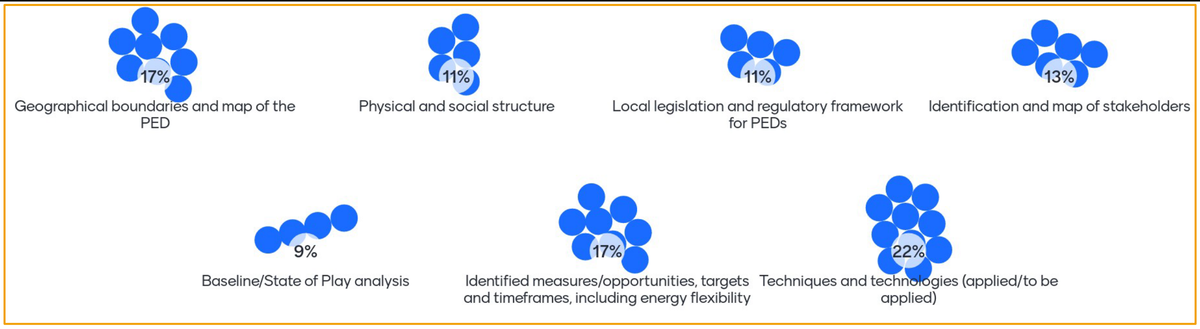


3. Please, choose the components/dimensions that need to be included in a PED database:

General:



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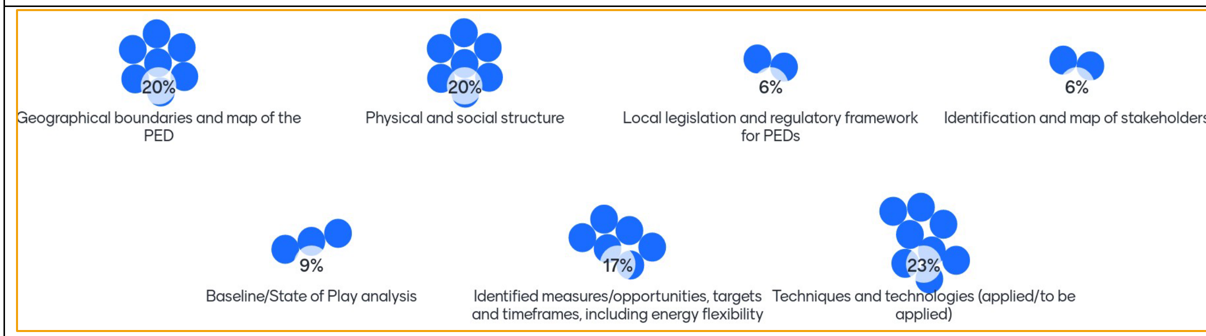

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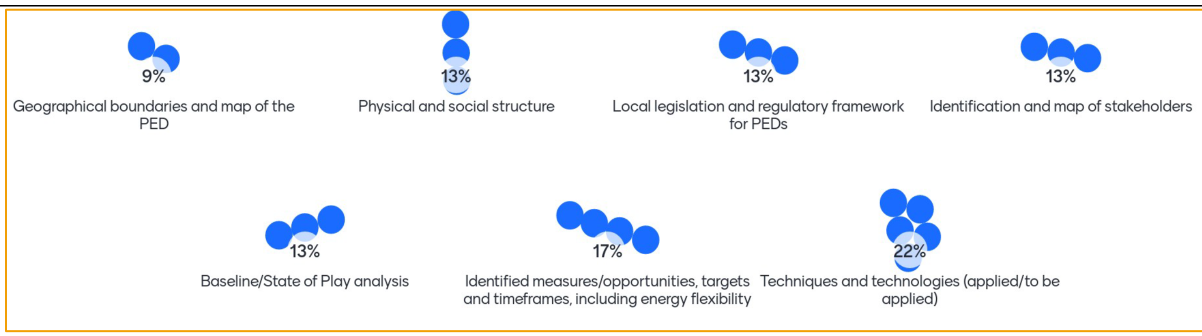

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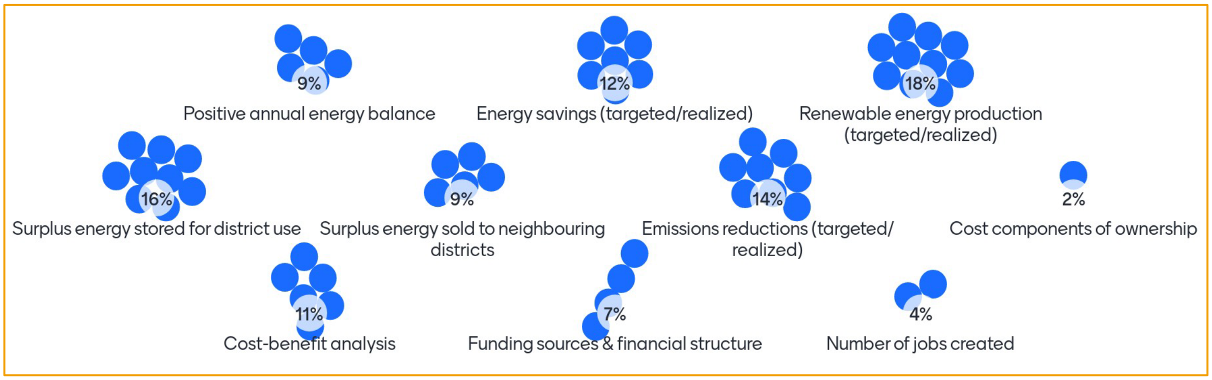
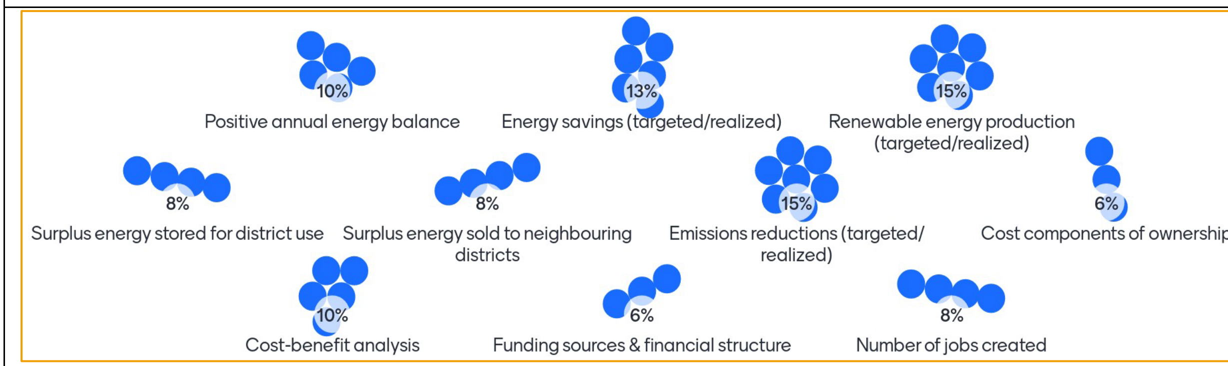
Quantitative:



Umeå



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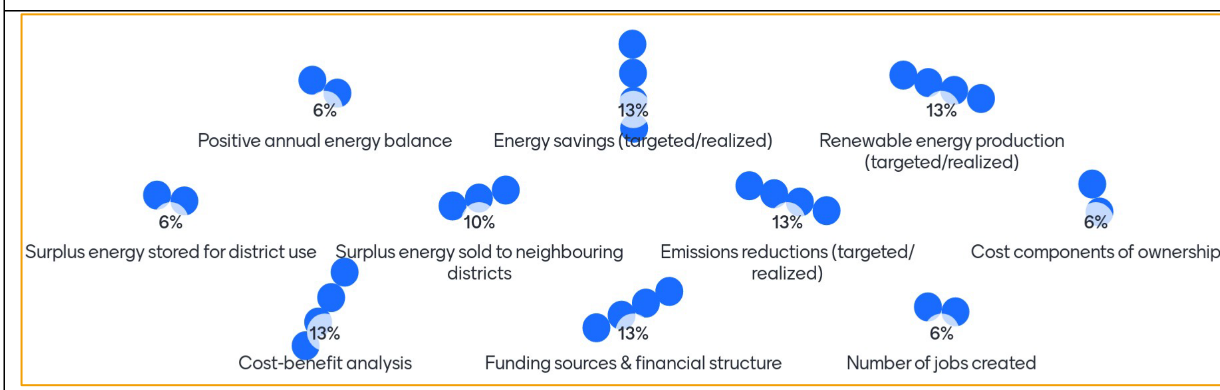

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Human / Social:

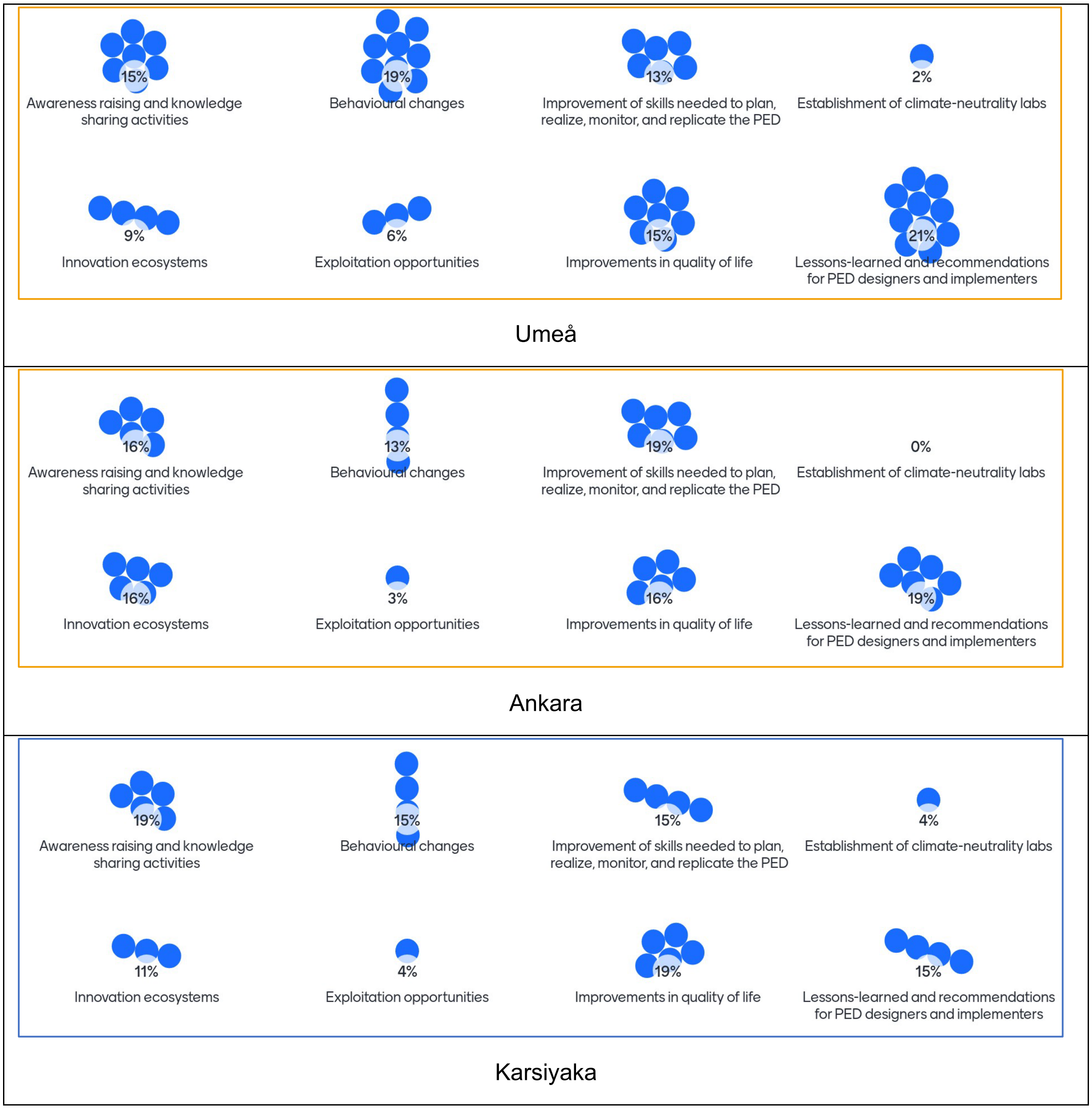


Figure 1 Digital tool PED database survey results

With regards to the basic functions of a digital tool/PED database, “Access to thoroughly collected & well-organized quantitative and qualitative data sets”, “Knowledge/experience sharing component/platform”, and “Data exchange opportunity” are respectively the most preferred dimensions of a digital tool/PED database, while “User-friendly interface”, “Facilitated storage, representation, import/export, modification, and deletion of data”, and “Data integrity management” respectively reflect the top-level features that the digital tool/PED database needs to have in terms of its basic features/properties.

According to the results of the survey, the top-priority general components/dimensions that need to be included in a PED database are “Techniques and technologies (applied/to be applied)”, “Identified measures/opportunities, targets and timeframes, including energy flexibility”, and “Geographical boundaries and map of the PED”, respectively. The most required quantitative components/dimensions appear as “Renewable energy production (targeted/realized”, “Emission reductions (targeted/realized”, and “Energy savings (targeted/realized). In social/human aspects, “Lessons-learned and recommendations for PED designers and implementers” is the leading component, while “Awareness raising and knowledge sharing activities” and “Improvements in quality of life” share the second rank, and “Behavioural changes” and “Im-provement of skills needed to plan, realized, monitor, and replicated the PED” are at the third level.

1.3. What Kind of Databases (Energy & Environment-related) are Existing?

The databases in this deliverable have been selected by related with PED and energy projects within the EU. Existing databases will be models to increase capacity building of PED design through PED-ACT project. In this regard finding databases are related with energy, energy community, and environment. Some databases are based on numeric parameters, while others include the list of research data and projects outputs.

2. State of the Art

Table 1 Description of platforms

Platform name	Platform detail	Platform content	Type of data	Related projects
PEDEU-NET DB: Positive Energy Districts European Network	It is an interactive database that is constantly updated and has a filter feature for PED projects.	Map and table view	Community, energy,	POCITYF, MAKING CITY, SPARCS, Synk.ikia, SmartEnCity, GRETA
EISMEA datahubs	It is a database for EU projects which are related with Energy efficiency	Map view	Hub location	EU funding programme
sEEnergies Open Data	It is an open platform including related projects data which based on GIS and downloadable	GIS database	GIS data: Industrial excess heat potentials, urban areas, buildings, transport and mobility, industry, project index, gas and thermal grids	sEEnergies EU projects

Enermaps DATA tool	It is designed for making decisions, developing policies and informing about the energy sector for users. It is providing accessibility of energy researches for the renewable energy industry.	Research database	Publications, research data and software	EnerMaps project
TRANS PED C0-PRODUCTION TOOLBOX	It is designed for knowledge transfer and co-producing to help PED stakeholders.	Output database	Projects outputs, researches, publications, impacts, principles, references	Trans-Ped

- **PEDEU-NET DB: https://pedeu.net/**

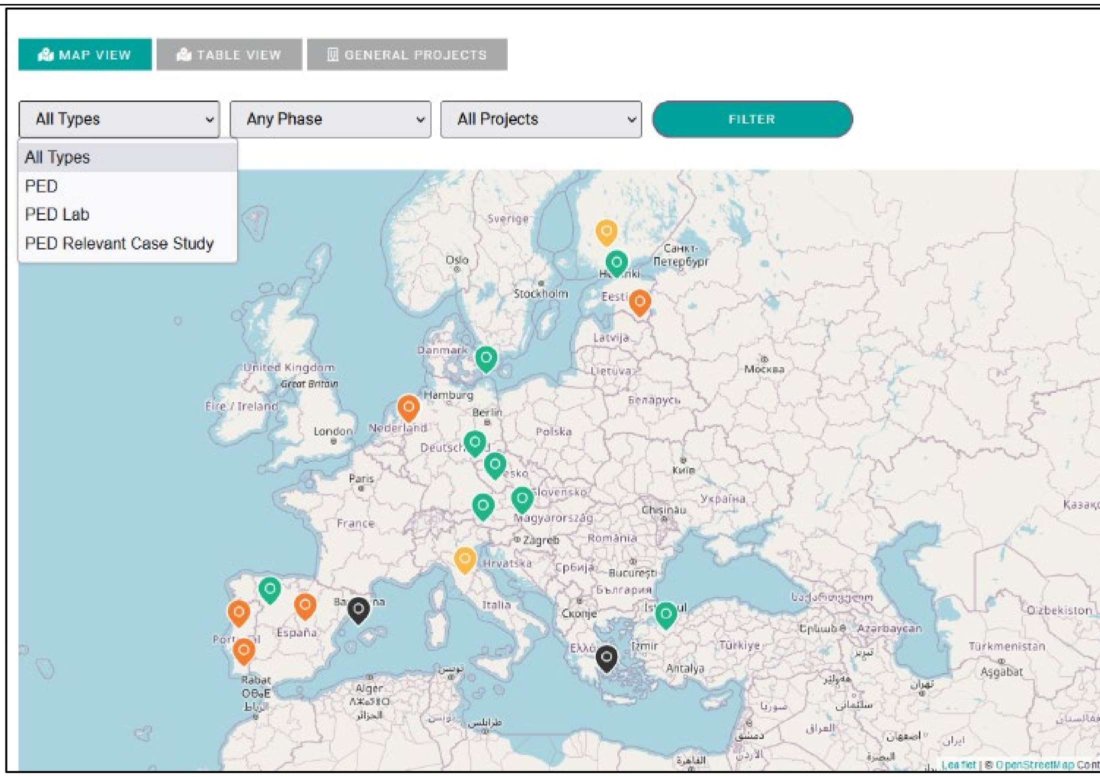
The COST Action Positive Energy Districts European Network (PED-EU-NET) aims to mobilise re-searchers and other relevant stakeholders across different domains and sectors to drive the deployment of Positive Energy Districts (PEDs) in Europe through open sharing of knowledge, exchange of ideas, pooling of resources, experimentation of new methods and co-creation of novel solutions.

Europe is set to be a global role model in energy transition. It has made significant progress in building level innovations and is now stepping up efforts towards city-wide transformation with the pi-oneering concept of Positive Energy Districts (PEDs). The EU's Strategic Energy Technology Plan (SET-Plan) has set out a vision to create 100 PEDs in Europe by 2025. The concept of PEDs is emerging and the knowledge and skills needed for the planning and designing, implementation and monitoring, as well as replication and mainstreaming of PEDs are yet to be advanced. The challenge is cross sectors and domains; thus, the solutions can only be found through collective innovation.

This COST Action will drive the deployment of PEDs by harmonising, sharing and disseminating knowledge and breakthroughs on PEDs across different stakeholders, domains and sectors at the na-tional and European level. It will establish a PED innovation eco-system to facilitate open sharing of knowledge, exchange of ideas, pooling of resources, experimentation of new methods and co-creation of novel solutions across Europe. Additionally, this COST Action will support the capacity building of new generation PED professionals, Early Career Investigators as well as experienced practitioners. It will mobilise the relevant actors from and across Europe to collectively contribute to the long-term climate neutral goal.

https://pedeu.net/ [1]

[1] Date of access: April, 2023



MAP VIEW | TABLE VIEW | GENERAL PROJECTS

All Types | Any Phase | All Projects | FILTER

Clear Filters
Show 10 entries

Search:

Name	Project	Type
Lund/Brunnshög	Cast Studies – Table View	Ped Case Study
Am Kempelenpark	Cast Studies – Table View	Ped Case Study
Évora, Portugal	Cast Studies – Table View	PED/PED relevant case study. / Ped Lab
Kladno, Sletiště (Sport Area), PED Winter Stadium	Cast Studies – Table View	PED/PED relevant case study.
Groningen, the Netherlands – PED South	Cast Studies – Table View	Ped Lab
Groningen, the Netherlands – PED North	Cast Studies – Table View	Ped Lab
Maia, Sobreiro Social Housing	Cast Studies – Table View	Ped Lab
Lubia (Soria), CEDER-CIEMAT	Cast Studies – Table View	Ped Lab
Tampere, Ilokkaanpuisto district	Cast Studies – Table View	PED/PED relevant case study.
Leon, Former Sugar Factory district	Cast Studies – Table View	Ped Case Study

Showing 1 to 10 of 20 entries — Previous 1 2 Next

Figure 2 pedeu.net PED database interface

- **Horizon 2020 Energy Efficiency Data Hub: https://energy.easme-web.eu/**

This interactive datahubs have been developed by The European Innovation Council and Small and Medium-sized Enterprises Executive Agency (EISMEA) involving projects related with energy efficiency on EU funding programme. In the first, the datahubs aim is to show all beneficiaries of the programme and projects on the map view. There are 3 different modules: map, list & statistics and different filters option which consists the number of beneficiaries or allocated money, the list of beneficiaries or list of projects, a module (map, list, statistics), filters, free text search box, embed a datahub.

The application consists of 3 different modules: map, list and statistics and different filters option. The desired view can be chosen via following icons, including the number of beneficiaries or allocated money, the list of beneficiaries or list of projects, modules (map, list, statistics), filters, free text search box, and embedding datahubs.

A dynamic map shows all the beneficiaries of the programme. The red pins indicate project coordinators, the green ones, project partners. Clicking on a pin generates information on the beneficiary and the project, which is displayed in a pane on the right side of the screen.

https://energy.easme-web.eu/ [2]

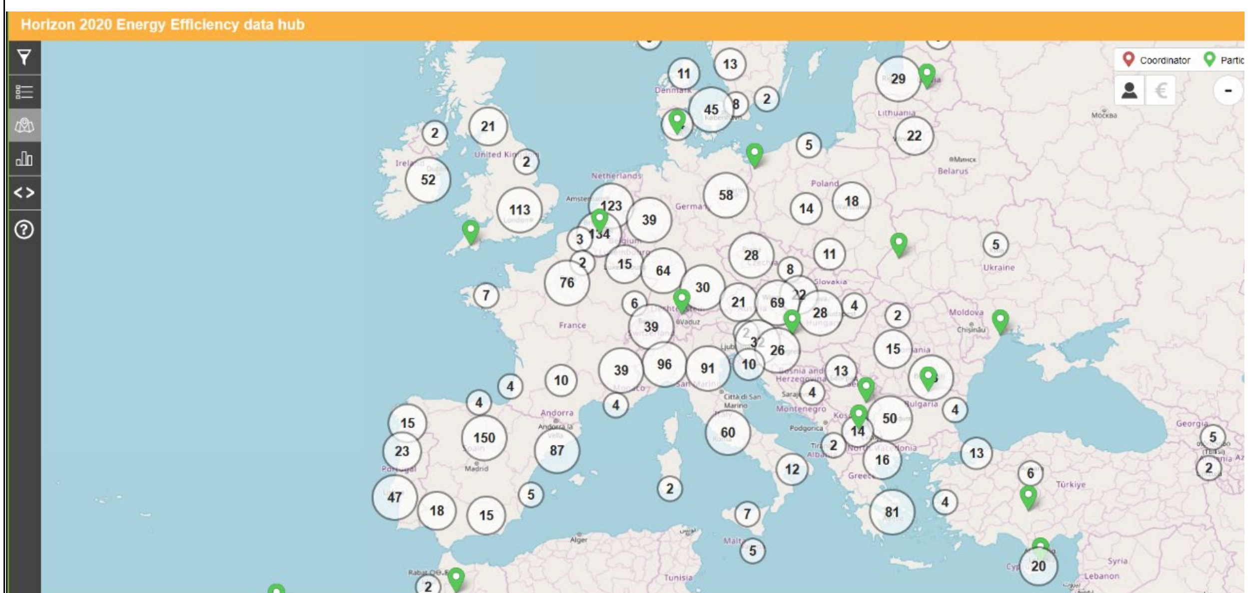


Figure 3 Horizon 2020 Energy Efficiency Data Hub interface

- **sEEnergies Open Data**: https://s-eenergies-open-data-euf.hub.arcgis.com/

This is a platform for exploring and downloading GIS data produced in the sEEnergies-Project which is a European Horizon2020 project that quantifies and operationalizes the potential for energy efficiency in buildings, transport, and industry, considering all aspects of the Energy Efficiency First Principle. Data can be accessed via APIs and downloaded to GIS formats. The

[2] Date of access: April, 2023

components of the database are industrial excess heat potentials, urban areas, buildings, transport and mobility, industry, gas grids, and thermal grids.

https://s-eenergies-open-data-euf.hub.arcgis.com/[3]

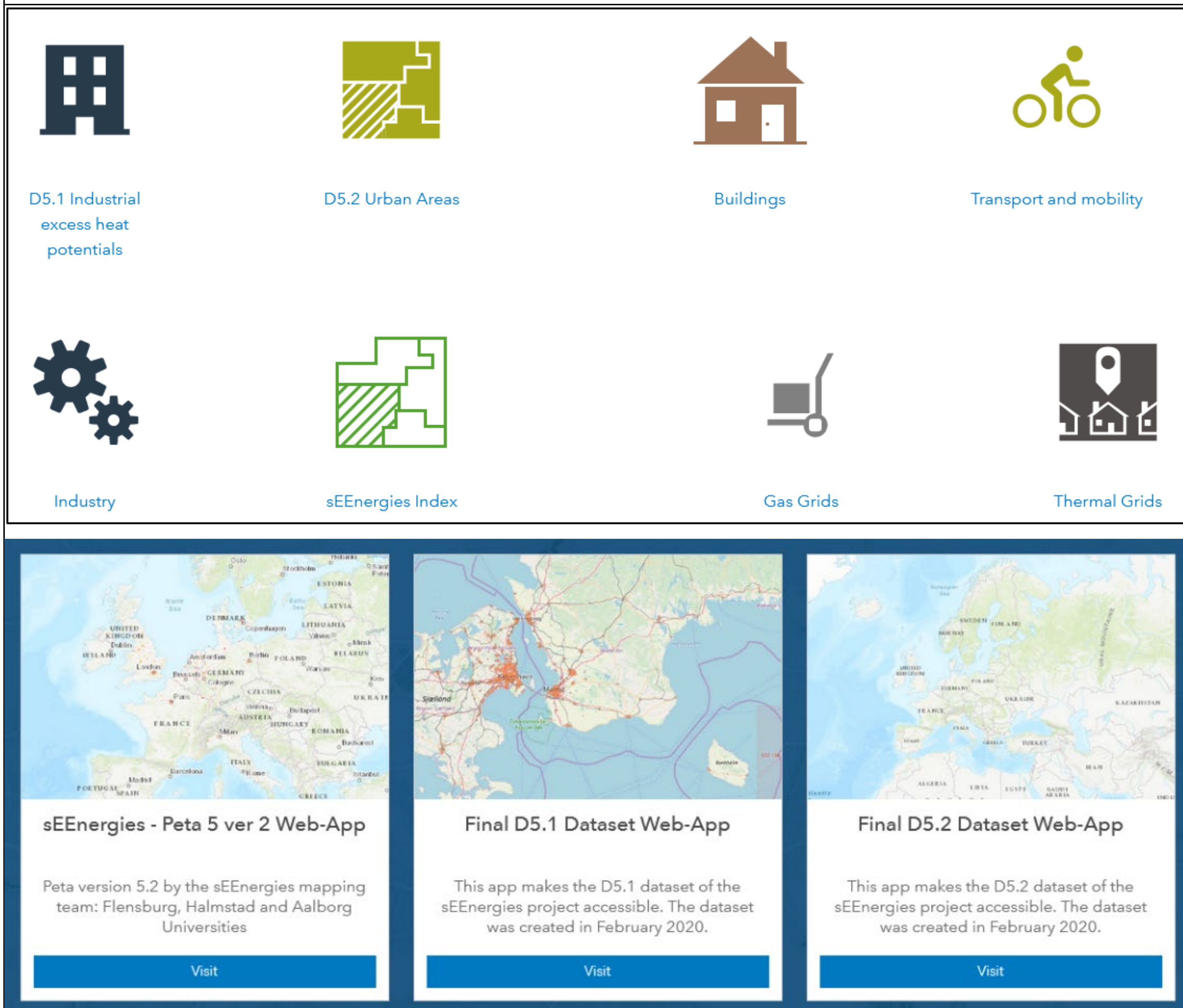


Figure 4 sEEnergies Open Data interface

- **EnerMaps**: https://enermaps.eu/news/enermaps-project-a-new-open-energy-data-tool-to-accelerate-the-energy-transition/

The EnerMaps project (Horizon 2020 project) acts as a quality-checked database of crucial energy data that will communicate and disseminate data effectively and efficiently using practices to make the data findable, accessible, interoperable, and re-usable, also called the FAIR principle. The project follows the recommendations made for the European Open Science Cloud (EOSC)1.

[3] Date of access: April, 2023

To improve the current situation, a central aim of EnerMaps is to obtain a coherent data management while adapting to the different user needs. We know that the type and the precision of energy data available has strongly increased this last decade and, as a result, different projects which aimed at centralising data in a common platform have been started. However, many projects aiming solely at centralising environmental data have failed or have not managed to interest users sufficiently.

Common problems are: that the interface was not sufficiently flexible to adapt to the different user needs; that long-term support was not available; and that the quality of the metadata and data was not checked with enough detail for the users, who need to know exactly how the data was produced to be able to reuse it. Hence, EnerMaps needs to adapt its interface for different users while keeping a coherent unique data management, while also developing an efficient quality-check process to be able to centralise energy data in a common platform with a long-term support.

To this end, EnerMaps tool is formed of two connected platforms which adapt to user's needs. In a first layer, it will use the power of OpenAIRE algorithms to find nearly all energy data with their related publications though a research gateway which has a long-term support. In a second layer, critical energy datasets are selected and visualised after a quality-check process. In this way, we obtain a tool which responds to different data needs, accessing a large number of datasets without drowning the user with too much information. The second layer is based on the tools and software developed during another H20202 project called HotMaps.

- **Trans-Ped**: https://trans-ped.eu/toolbox/

Trans-Ped is a 2-year pilot project to develop a governance approach for positive energy district stakeholders to better realise deep changes to their cities. trans-ped is an international project involving 11 partners from Austria, Belgium and Sweden, led by kth royal institute of technology and co-funded by JPI Urban Europe. the team will develop the governance approach through collaboration with five established and aspirational peds.

This toolbox has been designed for knowledge transfer to help PED stakeholders by increasing their building capacity of participatory action research through their PED projects. In this circumstance the toolbox has 5 tools: TRANS-PED research infrastructure, introduction to participatory action research, co-production, TRANS-PED workshop outlines and toolbox references.

https://trans-ped.eu/toolbox/:

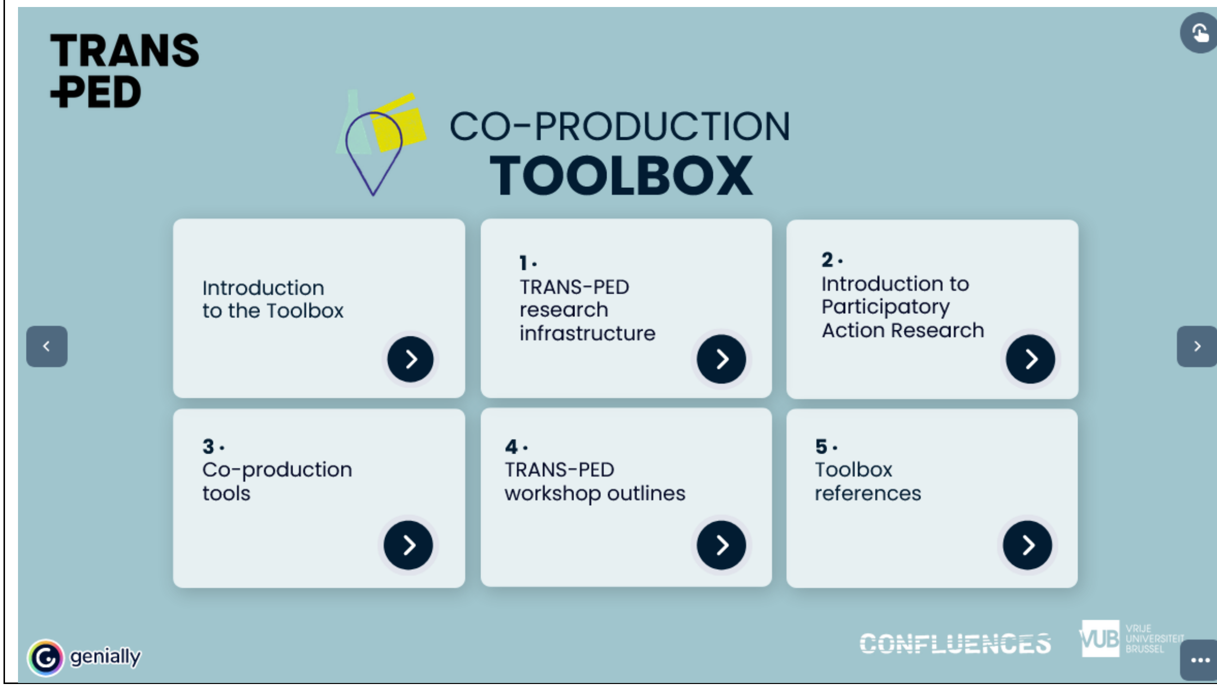


Figure 5 Trans-Ped interface

- **InterACT**: https://www.ped-interact.eu/

Integration of Innovative Technologies of Positive Energy Districts into a Holistic Architecture (INTERACT) is an international research and innovation project with a cross-sectional collaboration between academia, municipalities, and businesses with participants from Austria, the Czech Republic, and Sweden. INTERACT boosts the emergence of Energy Communities as one crucial building block to achieve Positive Energy Districts. The project will design an optimal organization and structure for Energy Communities based on success-factors from a competence-network of existing PED/PEN approaches, stakeholder needs and motivation, the available technologies, and holistic architecture. The project will develop a roadmap for the Energy Community's secure and reliable embedding into the power system structure, focusing on two pilot regions in Sweden and Austria.

The overall project goal is to develop a roadmap for the implementation of Energy Communities that operate in harmony with the grid and integrate the cross-vector and end-user sector coupling. NTERACT is an applied research project that focuses on establishing a roadmap for the design and implementation of Energy Communities as a major building block of Positive Energy Districts. Best practices from existing PED/PEN projects are incorporated to ensure the satisfaction of all stakeholder needs. The investigation of two specific regions, i.e., Großschönau in Austria and Fyllinge in Sweden, serves to derive the generic roadmap applicable also to other regions.

The LINK-based holistic architecture is used to ensure the integrity of the solution by harmonizing all interactions within the Energy Community itself and between it and the market and the European power system. Its standardized and flexible structure allows the straightforward application of the roadmap to perfectly meet the diverse necessities. INTERACT explores how energy communities can act coordinated and in harmony with the power grid, providing flexibility by integrating innovative technologies and solutions, such as e-mobility.

https://www.ped-interact.eu/about/#details

Figure 6 InterACT interface

2.1. Summary of the state of art

Please summarize the state of the art in PED concept definition, boundaries, KPIs, technologies, strategies for target groups, interoperability level that are defined in existing databases. (The types of data have been already listed in table 1). These can also be integrated in table 1.

Existing databases have provided useful information for stakeholders to design, implement and evaluate PED from different aspects. All the state-of-the-art datasets were created based on research projects and systematic management ensures the quality of the data. They can be classified into categories: district-based (PEDEU-NET), project-based (EISMEA), measurement-based (sEEnergies), and tool-based (Enermaps and TRANS PED). District-based data focuses on a wider range of parameters that can be collect from various PEDs. It is easy compare a specific dimension depending on user’s need. Pro-ject-based data presents an overview of different projects, where the data is more unstructured and mi-cro-level information may not be available. Measurement-based data is collected for pre-defined variables. They can present time dependence, spatial correlation, or both of them. This type of data is structured and easy to be integrated into another dataset. Tool-based data helps users select methods, make calculations, share knowledge, and provide action plans. It generates quick answers to the implementation of a project. These categories of dataset may be expanded or merged to a new category, which is still a significant research gap. A question is: what functions, features and components/dimensions need to be included in a PED database. In addition to the survey made in this report. There are two principles that need to be con-sidered:

1) It is necessary to automate the data collection process. When a project end, continuing data col-lection without too much human effort will largely increase the data usability and

reliability. The process requires well-established information and communications technology (ICT) and suitable governance model to ensure the quality of data.

2) The collected data should be easily linked to analytical tools. Since most of the data are un-structured, such as text and video data, it is not straightforward to analyze such type of data. Analytical methods for handling the data also need to be available in the tools.

3. How PED-ACT Will Benefit from Existing DBs - Discussions and Results

A database setup can play a significant role in the development of PED-ACT by providing a centralized platform to store, manage and analyze data related to energy consumption, production, and distribution in the district. Here are some ways in which a database setup can be beneficial for the development of PED-ACT project:

- Energy monitoring: A database setup can be used to collect data from various sources such as smart meters, building automation systems, and weather sensors to monitor energy consumption and pro-duction in the district. This data can be used to identify areas where energy use is high and where improvements can be made to increase energy efficiency.
- Demand response: By analyzing the data collected in the database, it is possible to predict energy demand patterns and adjust the energy supply accordingly. This can help to reduce the need for peak energy production and distribution, which can be expensive and contribute to grid instability.
- Optimization of renewable energy production: PED aim to generate more renewable energy than they consume. A database setup can help to optimize renewable energy production by analyzing data from solar panels, wind turbines, and other renewable energy sources. This can help to identify the most efficient energy generation methods and improve energy production in the district.
- Energy storage: Energy storage is an important component of PED, as it allows excess energy to be stored and used when demand is high. A database setup can help to monitor and manage energy storage systems, ensuring that they are used efficiently and effectively.
- Reporting and decision-making: A database setup can provide valuable insights into energy use and production in the district, which can be used to inform decision-making and report on progress towards sustainability goals. This can help to increase transparency, accountability, and encourage collaboration between stakeholders in the district.

In addition to the energy-related benefits, a database setup can also help to address social factors such as:

- Community engagement: A database setup can be used to gather feedback and input from community members, such as through surveys or other forms of data collection. This can help to ensure that the development of the district is informed by the needs and preferences of the people who live and work there.

- Health and well-being: PEDs aim to create healthy and sustainable living environments. A database setup can help to track indicators of health and well-being, such as air quality, temperature, and noise levels. This information can be used to identify areas where improvements can be made to promote better health outcomes for residents.
- Equity and social justice: PEDs strive to be equitable and inclusive, and to address issues of social justice. A database setup can help to monitor and track indicators of equity, such as access to energy and transportation services, affordable housing, and job opportunities. This information can be used to identify areas where improvements are needed to ensure that everyone in the district has access to the resources and opportunities they need to thrive.
- Education and awareness: PEDs can also serve as educational tools, helping to raise awareness about sustainable living practices and energy conservation. A database setup can be used to track and an-alyze data related to education and awareness, such as participation in workshops or events, or changes in behavior related to energy use.

3.1. Synthesis of DBs and Interactions with PED-ACT

The databases discussed in section 2 can provide knowledge and breakthroughs on PED across different stakeholders, domains, and sectors at the national and European level.

The PED-EU-NET DB can help in planning and designing, implementation and monitoring, as well as replication and mainstreaming of PED-ACT. It can also support the capacity building of new generation PED professionals, early career investigators, as well as experienced practitioners.

The Horizon 2020 Energy Efficiency Data Hub can help in identifying and locating beneficiaries of the EU funding programme related to energy efficiency projects while offering dynamic maps that show all beneficiaries of the programme and provide information on the beneficiary and the project.

The sEEnergies Open Data database can provide GIS data on industrial excess heat potentials, urban areas, buildings, transport and mobility, industry, gas grids, and thermal grids. This data can be helpful in the PED-ACT project to identify potential energy efficiency measures and optimize energy use in buildings, transport, and industry.

The EnerMaps database can act as a quality-checked database of crucial energy data that will communicate and disseminate data effectively and efficiently using practices to make the data findable, accessible, interoperable, and re-usable. It can help PED-ACT project in obtaining a coherent data management while adapting to the different user needs.

4. Conclusion and Further Steps

This project supports cities in passing from an integrated energy planning stage to the implementation of strategies towards the climate neutrality target, by using an attractive, innovative and human-centered approach, through design and implementation of PED projects.

The PED-ACT project facilitates the de-cision-making process by providing information on the available district resources, the solutions and in-novations adopted, urban directives, implementation processes, expected and measured metrics, or as-sociated drivers and barriers. The transition process needs to consider contextual and regional factors in order to achieve favourable PED implementations with low resource investments and utilization of local resources.

The designed PED database introduces definitions and insights that will guide cities' stakeholders in the creation of capacity at different levels as well as by defining core capabilities. The developed framework provides an understanding of the state of play and PED concept directions, views, values and functionality to create a learning environment for capacity building and, at the same time, to establish a vision for to-morrow.

PED concepts must be highly structured, based on local resources, with the high involvement of urban stakeholders and should be strongly linked to global governance models for which no factor can be left out. Indeed, in a PED scenario, several stakeholders are required to cooperate in a strategical PED vision, where technological and non–technological solutions are tightly connected. It is necessary to consider citizens' needs and challenges, through the process of authorization and the realization of both public and private buildings intervention, with the involvement of the relative municipal officers. Local citizens' associations play a role in enhancing opportunities and synergies in the social field that can arise in a PED context.

The PED database provides a balanced overview of the technological and non–technological solutions that require the cooperative involvement of several stakeholders, and those that collect the key resources, making sure that such resources are effectively integrated.