RENEWPORT RES toolkit for Med ports online

Deliverable D.1.2.1

Document control sheet

Programme	Interreg Euro-MED
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Project acronym	RENEWPORT
Project Title	Harnessing RENEWable energy potential for clean energy transition of MED PORTs
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Programme priority	Greener MED
Specific objective	RSO2.4: Promoting climate change adaptation and disaster risk prevention, resilience, taking into account eco-system-based approaches
Project mission	Promoting green living areas
Lead Partner	Port Network Authority of the Eastern Adriatic Sea

Work package	WP1 Developing a toolkit for renewable energy uptake in MED ports
Activity	Activity 1.2 Co-developing the RENEWPORT RES toolkit for MED ports
Deliverable name	D.1.2.1 RENEWPORT RES toolkit for Med ports online
Type of deliverable	Tool
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Work Package Leader	Valenciaport Foundation for research, promotion and commercial studies of the Valencian Region
Project partners involved	Port Network Authority of the Eastern Adriatic Sea (LP); Port Network Authority of the Northern Tyrrhenian Sea; Var Chamber of commerce and industry; Valenciaport Foundation for research, promotion and commercial studies of the Valencian Region; Valencia Port Authority; Luka Koper, port and logistic system, public limited company; Port of Rijeka Authority; Port of Bar JSC; Durres Port Authority; Piraeus Port Authority SA.
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Content

1. Introduction

1.1. Presentation of the project

The project "Harnessing RENEWable energy potential for clean energy transition of MED PORTs – RENEWPORT" is a Test project approved under the second call of the Interreg Euro-Med programme. The main objective is to tackle the negative contribution to climate change of ports by supporting the clean energy transition of MED ports, turning them from emitters of pollutants and greenhouse gases to clean energy hubs by exploiting the untapped potential of renewable energy sources (RES). Through RENEWPORT, policy makers will be endowed with new solutions supporting them to fight climate change reaching energy goals and carbon neutrality and citizens will benefit from cleaner air, MED territories becoming greener living areas.

The project is divided in three main activities:

- The first one is the development of a toolkit that will guide MED ports in the adoption of the most suitable renewable energy source in each location, based on their own current and future energy needs. The toolkit will be freely available on the project's website and will be replicable in other geographical contexts, even beyond the MED Area.
- The second one will consist of the testing of renewable energy options in MED ports. Each port participating in the project will implement concrete pilot activities and investments testing the use of RES in different scenarios and contexts. For the evaluation of these pilot actions, the partners jointly elaborate a set of processes, techniques models, tools, methods and services, deriving a solution answering the need of transforming ports in renewable energy hubs to be replicated in the MED area and beyond.
- At the end, the partners will upscale and transfer the project's solutions. By one side, an e-learning platform will be created containing the technical knowledge gathered in the development of the RENEWPORT RES toolkit and pilot activities and investments. By other hand, some networking activities will be organised with target groups at local, transnational and macro-regional level to inform them about the overall project's results.

The project is led by the Port Network Authority of the Eastern Adriatic Sea (Italy) and the partnership is composed of:

- Port Network Authority of the Northern Tyrrhenian Sea (Italy)
- Var Chamber of commerce and industry (France)
- Valenciaport Foundation (Spain)
- Valencia Port Authority (Spain)
- Luka Koper, port and logistic system, public limited company (Slovenia)
- Port of Rijeka Authority (Croatia)
- Port of Bar (Montenegro)
- Durres Port Authority (Albania)
- Piraeus Port Authority (Greece)

1.2. Presentation of the WP1

The first Work Package of the project is divided into 4 activities:

- Activity 1.1: Preparing the RENEWPORT RES toolkit for MED ports
- Activity 1.2: Co-developing the RENEWPORT RES toolkit for MED ports
- Activity 1.3: Evaluating the RENEWPORT RES toolkit for MED ports
- Activity 1.4: Delivering information on the RENEWPORT RES toolkit for MED ports

This deliverable is included in the Activity 1.2 of the Work Package 1. The aim of this activity is to develop a toolkit, i.e. a curated resource taking the form of a web tool to be uploaded on the project's website, that provides practical advice, guidance, information and calculation of the potential of RES use for MED ports, based on their energy needs and the geographical location. This will provide MED ports with a powerful solution for planning their clean energy transition.

The third activity will consist of a jointly peer review of the results achieved during the test, comparing data and results, learning from each other's experiences and leading the adjustments of the toolkit. The partners will assess the replicability potential of the toolkit in the MED area and beyond.

The last activity of this Work Package refers to the transfer of the know how developed to other ports that are not participating in the project. Some communication materials will be edited such as a dedicated infographic, a digital brochure and a short video. The partners will participate in some workshops and conferences to disseminate the work done among some target groups.

This document gives an overview of the toolkit that has been developed in the project.

2. The toolkit requirements

2.1. Toolkit's stakeholders

The potential stakeholders of the toolkit will be ports and all entities involved in their logistical activities. Therefore, both shipping companies and logistics centres, port authorities, mooring operators, terminals, tugboat operators, as well as all other companies operating within ports, will be likely to use the application.

The scope of this toolkit is focused on European ports, specifically those in the Mediterranean region initially, with the intention to expand access to ports across Europe in the future.

2.2. Data collection from port stakeholders and communication with APIs

The toolkit will require a series of input data specific to each port to calculate the output power derived from photovoltaic or wind systems.

2.2.1. Photovoltaic generation

In the case of estimation of PV potential, the online PVGIS tool, developed by the EC Joint Research Centre (https://re.jrc.ec.europa.eu/pvg_tools/en/) and, more specifically, its API, will be used.

The description of the API and the input and output data can be found in the following link: https://joint-research-centre.ec.europa.eu/photovoltaic-geographical-information-system-pvgis/getting-started-pvgis/api-non-interactive-service_en#ref-1-basics

As an example, some of the variables needed as an input are the following (for a complete list, the two previous links should be reviewed):

Location:

- Latitude: The angular distance of a location north or south of the equator, measured in degrees.
- Longitude: The angular distance of a location east or west of the Prime Meridian, measured in degrees.
- Elevation: The height above sea level of a particular location, measured in meters.
- Mounting system: The anchoring system of photovoltaic panels can be fixed or tracking.

Photovoltaic module technology:

- There are different types of photovoltaic module technologies such as Crystalline Silicon, CIS, or CdTe.
- Peak power installed (this value depends on the installation surface and the number of photovoltaic panels).
- System loss: a default value is used unless a different value is indicated.

The RENEWPORT toolkit will allow the possibility to estimate the potential PV peak power that can be installed as a function of the surface selected on a map of the port. To do so, the toolkit must allow the selection of this surface by drawing subsequent points on the GIS interface. Once the area has been selected, the estimated peak power will be calculated applying the formula that relates the peak power with the area of modules, i.e.:

$$Ppeak = Area * panel\_efficiency$$

To do so, some parameters will be needed, such as the solar panels' efficiency and the relation between the total area available and the effective area of panels that fit into that area. More information can be found, for instance, in the following link: Using PVGIS - Frequently Asked Questions - European Commission (europa.eu).

2.2.2. Wind energy generation

To calculate the estimated wind energy production at a given site, the API of the Global Wind Atlas will be used (http://windatlas.xyz/docs/api/). This API needs specific input data such as the following:

- lat: Latitude
- lon: Longitude
- date_from Inclusive start date of requested data in YYYY-MM-DD format.
- date_to: Inclusive end date of requested data in YYYY-MM-DD format.
- height: Hub height in meters.

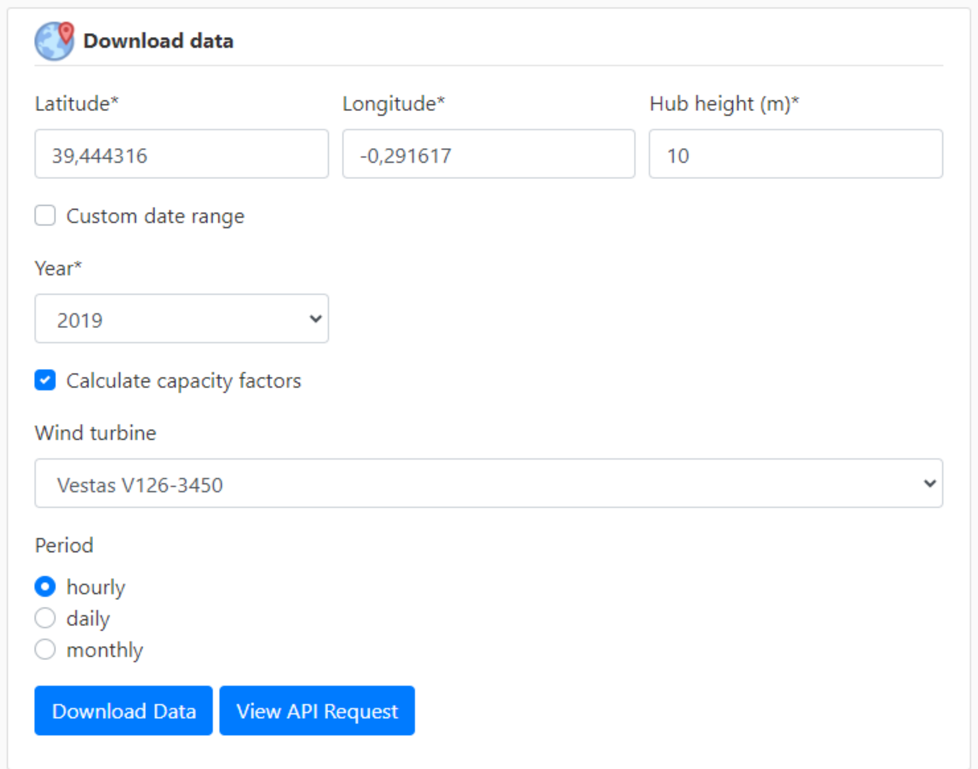

Image 1: Example of input data to the API.

In this case, the model of the turbine must also be chosen as an input. Therefore, the RENEWPORT toolkit will have to allow the user a selection of the model from a list, using the same models of turbines and their characteristics provided by the Global Wind Atlas tool, that can be found here: Windatlas - Wind Turbines.

The output of the API is a list of variables by each hour, for a complete year (2019, the last year with records available). The energy in KWh must be calculated as the product of the maximum nominal power of the turbine by the capacity factor (%) for each hour. Then, the energy obtained will be aggregated by month and displayed.

2.3. Toolkit functionality

The functionality of the tool is based on obtaining the necessary data to perform the photovoltaic and wind energy calculations, the calls to the corresponding APIs in order to obtain the installed power measurements, and the representation of this data independently or aggregated, with the idea of being able to have a general idea of the benefits of installing photovoltaic panels and/or wind turbines.

To perform these calculations, it is necessary to integrate a map so that the user can select the location of the port to be studied and extract the latitude, longitude, and elevation data. An example could be Google Maps API, Leaflet, Mapbox OpenLayers or Openstreetmap. This will be useful for both photovoltaic and wind energy cases.

Once the point where the installation would be made is selected, it should be possible to choose whether the calculation will be for photovoltaic or wind energy. Once the type of calculation is selected, the other necessary variables must be entered to perform the calculation. After all the data is entered, the user should press a "Calculate" button to have the application send the request to the corresponding API and obtain the calculated data.

Once the data is obtained, it should be graphically represented, showing a monthly estimate of the energy production for one year, by each installation and also aggregated. Each query, whether for wind or photovoltaic energy, should be saved in the user's session. Additionally, it should be possible to select these queries in the results panel to study how the installed power varies when installing turbines or photovoltaic panels in different locations within the port. Each turbine has a nominal power and the API gives the capacity factor in the desired installation area therefore the toolkit has to calculate energy produced by hour and aggregate it by month.

Datetime	Wind_speed	Capacity_factor
2019-01-31	9.07	0.54
2019-02-28	8.87	0.47
2019-03-31	10.91	0.57
2019-04-30	8.41	0.53
2019-05-31	7.24	0.4
2019-06-30	7.74	0.42
2019-07-31	7.04	0.37
2019-08-31	7.34	0.4
2019-09-30	9.56	0.6
2019-10-31	10.26	0.68
2019-11-30	9.73	0.61
2019-12-31	11.34	0.65

Vestas V110-2000 thewindpower

Power: 2000.0 kW

Diameter: 110.0 m

Power per swept area: 210.5 W/m^2

Image 2: Vestas V110-2000 in north area of the port of Valencia

2.4. Information shared by the toolkit

The information that will be shared by the tool will be that related to each case study that the user wishes to enter. Therefore, for both the photovoltaic and the wind part, the results obtained by the user can be displayed or downloaded in CSV or JSON format, or PDF documents with graphics and statistics.

2.5. System Architecture

2.5.1. Architecture overview

The architecture proposed for the tool will be composed of a database which will contain all the information necessary for queries to the APIs of external tools, a backend responsible for performing the necessary functions to obtain, calculate and manage the application's data, and finally a frontend responsible for visualising the data obtained and the different web visualisation modules.

2.5.2. Front-end

The frontend will be in charge of generating the GUI of the tool. The GUI is intended to be friendly and simple, with tips and basic information that can facilitate its use to the end user.

The desired framework must be Angular, using NodeJS as runtime environment.

Results will be displayed in the frontend, and also available for download in csv and json formats, and also as pdf reports, very similar to the results obtained when using the PVGIS tool (see an example in the next Figure). The graphs produced should be also available for download in PNG format, similar to the PVGIS tool results' interface.

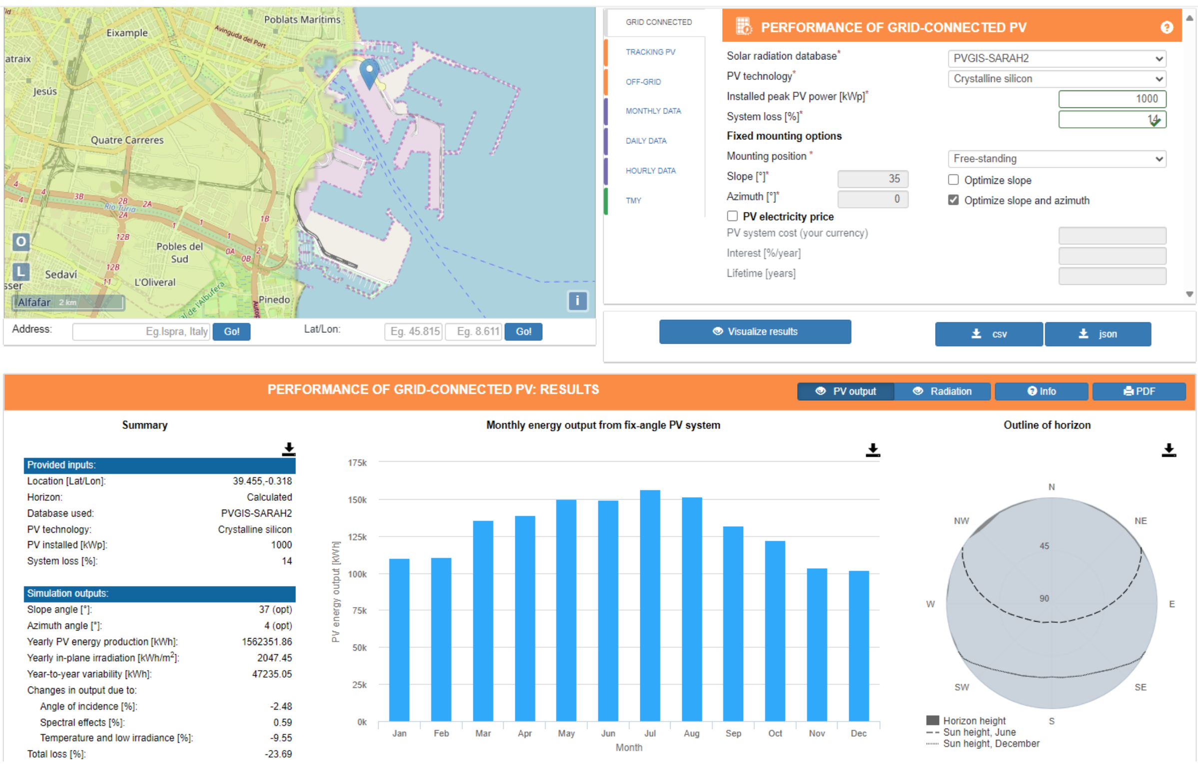

Image 3: Example of results' interface in PVGIS

The frontend must include mention to all the APIs used in its development, and specifically references to Global Wind Atlas and PVGIS, as indicated in their respective sites, https://globalwindatlas.info/es/about/TermsOfUse and Photovoltaic Geographical Information System (PVGIS) - European Commission (europa.eu).

2.5.3. Backend

The backend will be in charge of receiving the requests and managing them, the programming modules must be able to manage queries for both photovoltaic and wind calculations. Once the input information has been collected, the call to the corresponding API must be made, which will calculate and return the calculated data. Once the data has been obtained, the information must be prepared so that the frontend can retrieve it and carry out the visualisation tasks.

The desired framework must be Django/Flask if Python is preferred or NodeDJ with typescript.

Additional programming will be needed for the special case when the GPS coordinates entered by the user are not recognized by the PVGIS or Global Wind Atlas APIs. This can happen because the selected area might be assigned to a sea, offshore region. In this case, a search algorithm should reallocate the coordinates to the nearest GPS coordinates that can be identified by the API. This can be done by implementing an iterative k-Nearest Neighbor algorithm, such as the one that can be found in the following link: https://kandi.openweaver.com/codesnippet/Find-Distance-to-Nearest-GPS-Coordinates-Nearest-Neighbors-Search--4592868945950067.

2.5.4. Database

Ideally, MongoDB will be used (other NoSQL platforms could be discussed). The models have to ensure the correct data management and authentication.

2.6. Security

At the security level, a certificate policy must be established for the interconnection of the different hosts or services, since the tool will be public, all the necessary security measures must be guaranteed in order to face possible cyberattacks.

2.6.1. Roles and Permissions

The toolkit will allow access to all internet users so that they can make use of it, lower level records will not be persisted in memory. On the other hand, the toolkit will allow the creation of identified users, for these users it will be necessary to manage the history of queries and approaches made. In this way, it will be possible to retrieve information over time and also to modify the data of a specific query. In addition to these two levels, an administrator level will be created, which will have access to all the searches and proposals that have been made by each of the users, and will also have access to the elimination, creation and modification of level 2 users.

2.6.2. Infrastructure

The infrastructure of the toolkit will be built following a containerization model, allowing the use of Kubernetes clusters, Docker Swarm, Ranger, etc. Additionally, the source code of the different components must be provided for future expansions and improvements. The intellectual property of the code will be shared.

3. The toolkit result

The toolkit is available at the link Renewable Energy Toolkit. In the following pages, some screenshots of the different functionalities are showed.

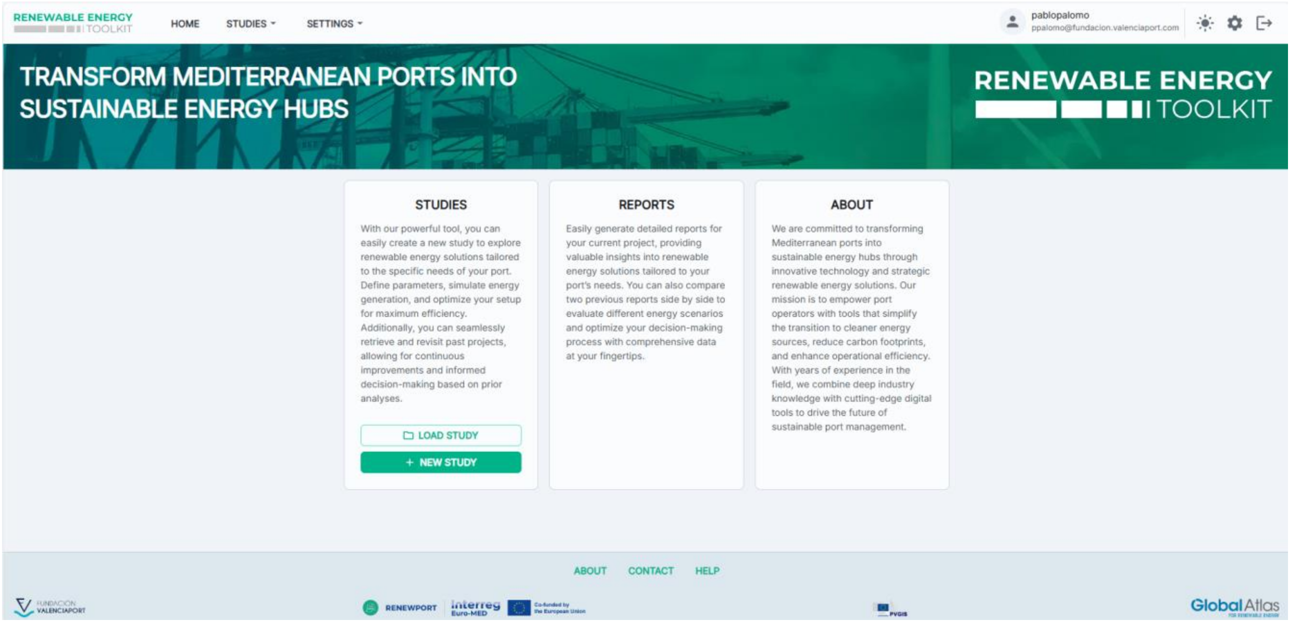

Image 4: Main screen

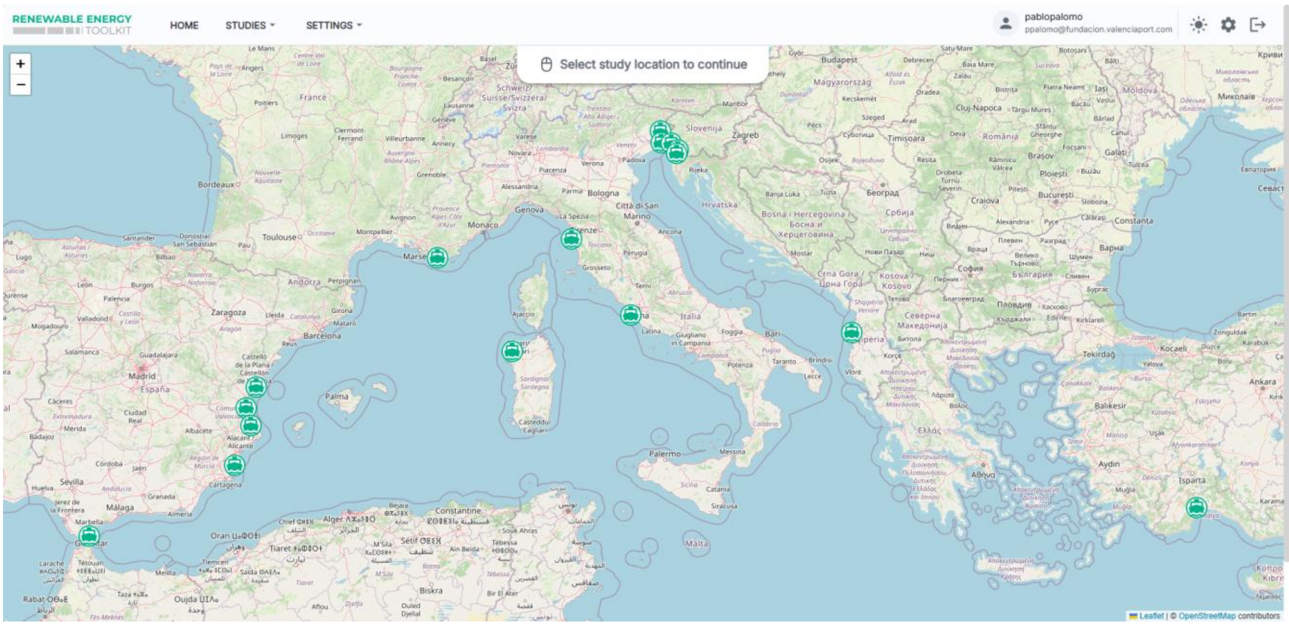

Image 5: Map with ports represented

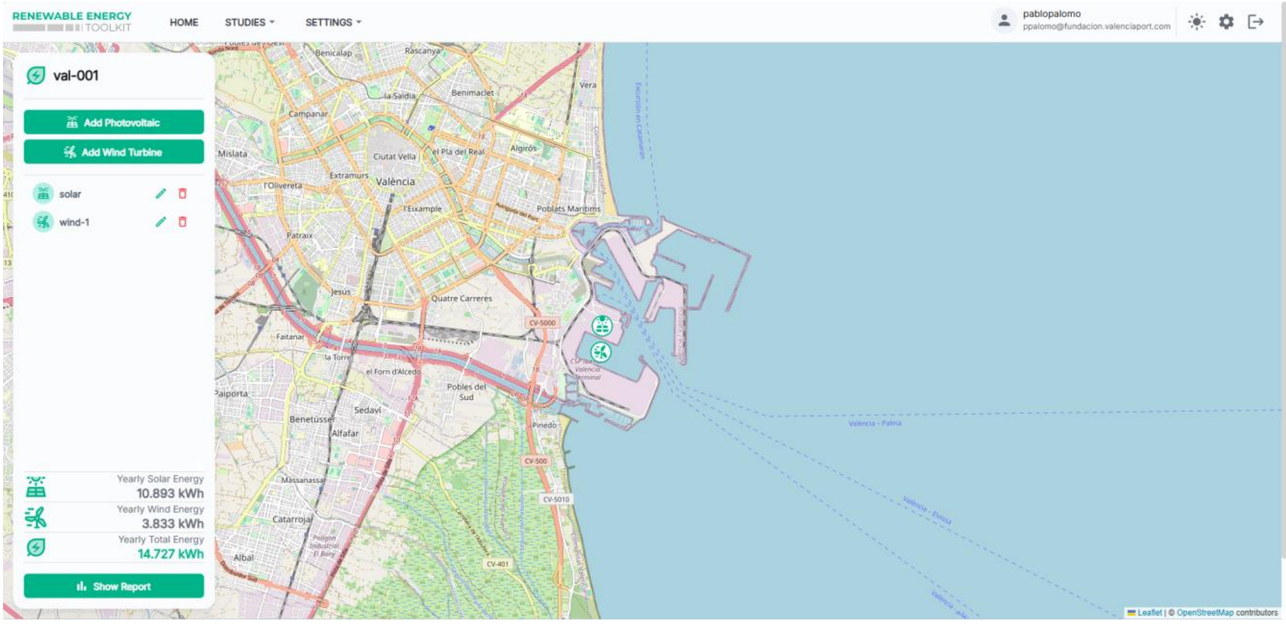

Image 6: Example of study in the Port of Valencia

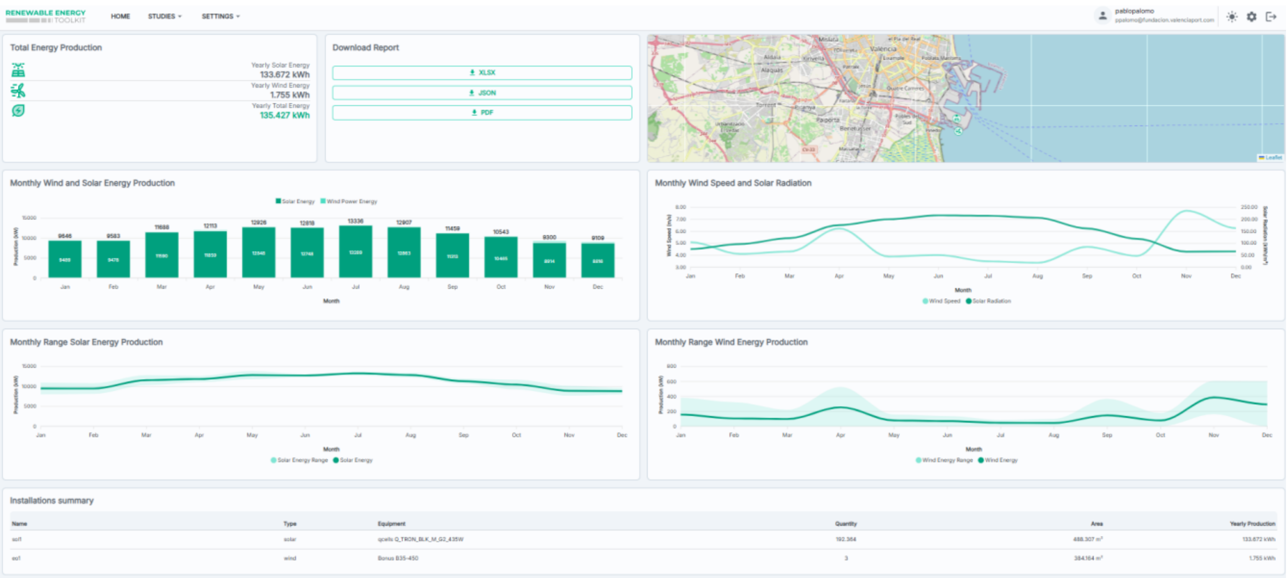

Image 7: Example of report in the Port of Valencia

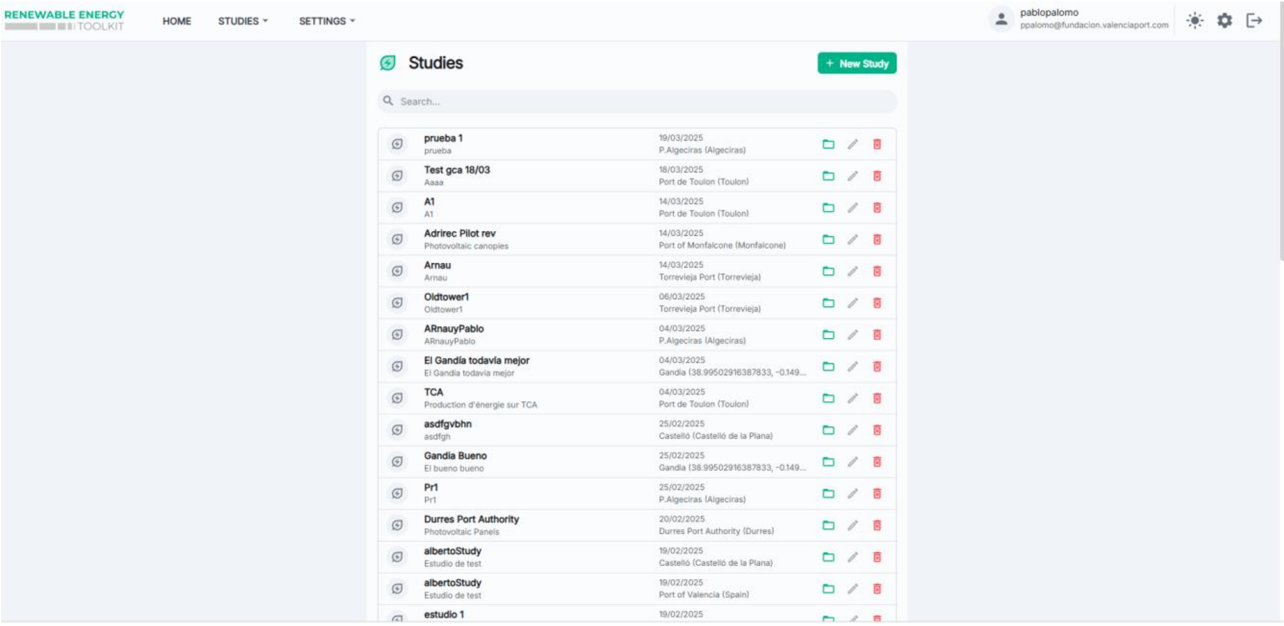

Image 8: List of studies already implemented

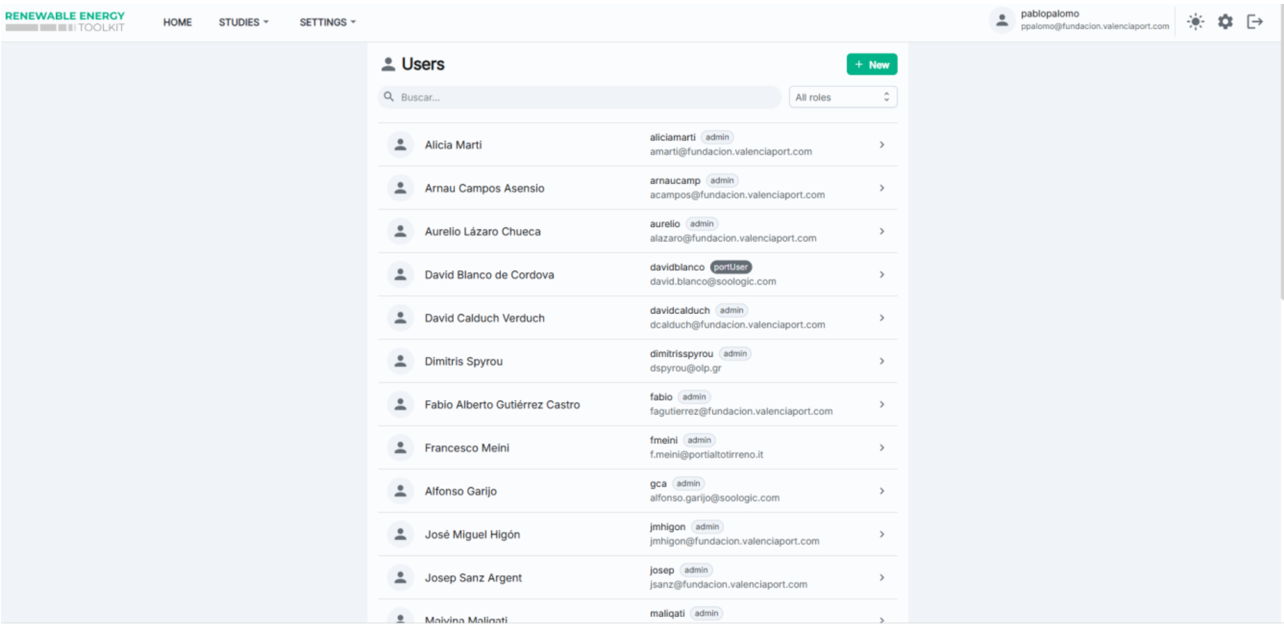

Image 9: List of users

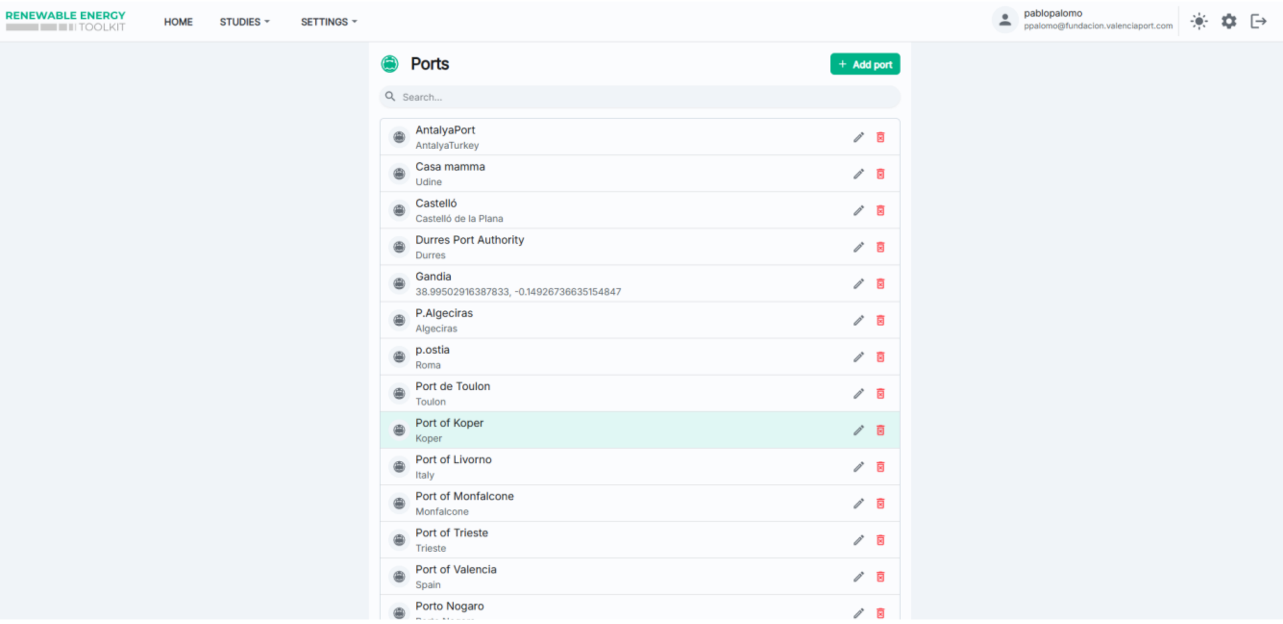

Image 10: List of ports

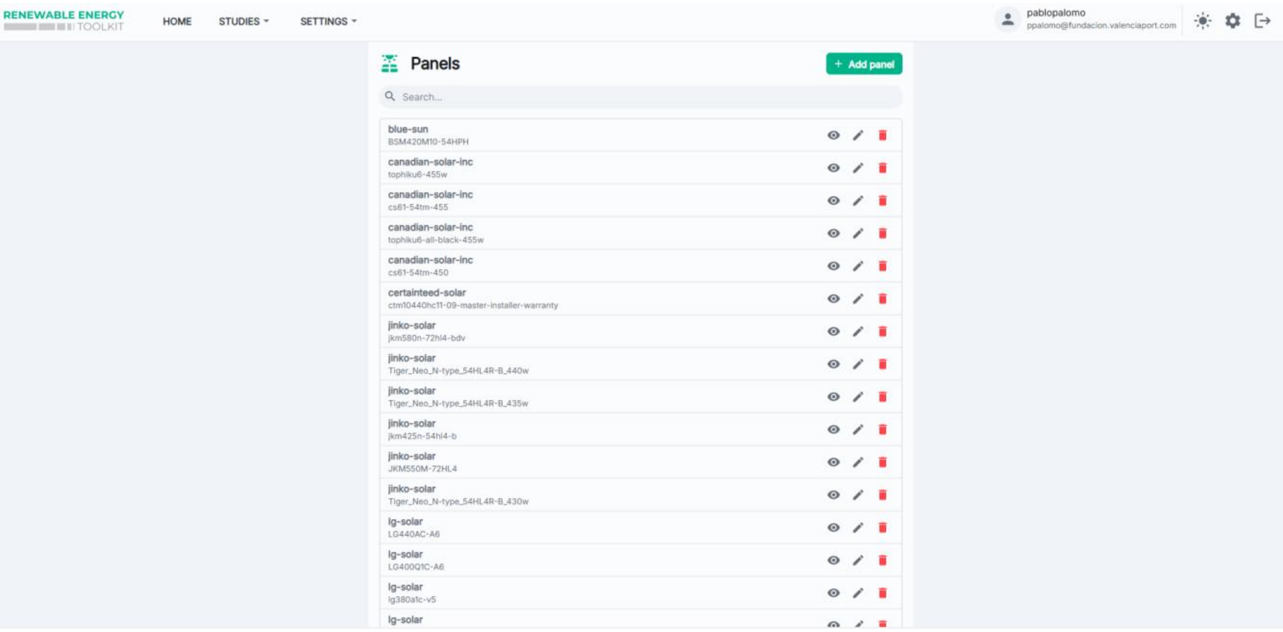

Image 11: List of solar panels

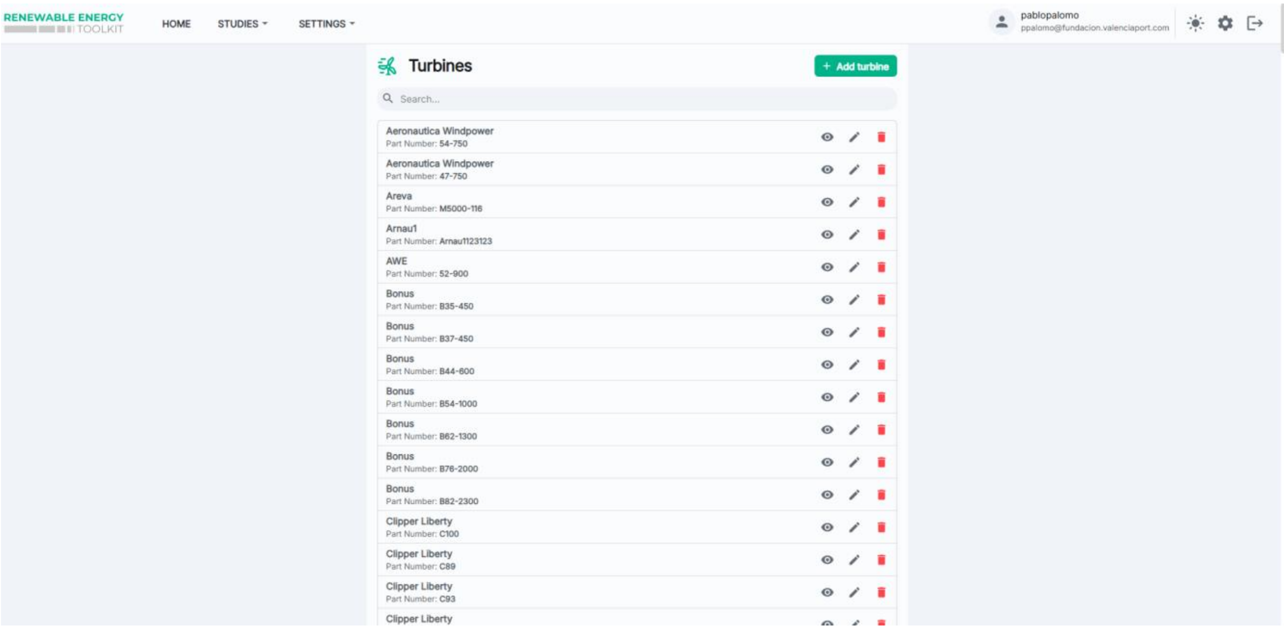

Image 12: List of turbines

The toolkit is not yet finished. It will be improved following the communication rules of the Interreg Euro-Med Programme and the tests managed by the partners.