Cost-effective rehabilitation of public buildings into smart and resilient nano-grids using storage

Thematic Objectives: B.4 - Environmental protection, climate change adaptation and mitigation (Address common challenges in environment)
Priority: B.4.3 - Support cost-effective and innovative energy rehabilitations relevant to building types and climatic zones, with a focus on public buildings
Countries: Cyprus, Greece, Israel, Italy

Output n°: 4.1
Output Title: Tools Development for renovating public buildings with PV+ESS+DSM hybrid
Activity n°: 4.1.2
Activity title: Development of a policy makers' tool for policy recommendations

July 2023

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1 Document Info

Project Name	Cost-effective rehabilitation of public buildings into smart and resilient nano-grids using storage (BERLIN)
Funding Scheme	ENI CBC MED PROGRAMME 2014-2020
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Name of Work Package	Implementation of tools, cost-benefit analysis and training
Output Number	4.1
Date	31/07/2023
Authors	Angelos Nousdilis, UoWM
Contributors/ Reviewers	All BERLIN partners
Status	Final

2 Document History

Date	Author	Action	Status
05/05/2023	Angelos Nousdilis, UoWM	First Draft	Draft
31/07/2023	Angelos Nousdilis, UoWM	Finalization	Final

3 Copyright

Consisting of

Coordinator:	FOSS Research Centre for Sustainable Energy, University of Cyprus (UCY)	Cyprus
Partners:	University of Western Macedonia	Greece
	The municipality of Eilat	Israel
	University of Cagliari	Italy
	Ben Gurion University	Israel
	Deloitte Limited	Cyprus
	Hevel Eilot Regional Council	Israel

4 Contents

1 Project summary

In an effort to address high energy consumption in the building sector that is mainly fossil – fuelled, support rural areas and areas powered by weak grids, which are common in the MENA region, and achieve higher grid penetration of renewable energy sources (RES) while maintaining grid stability and power quality, this project aims at the implementation of cross border pilots that will support innovative and cost – effective energy rehabilitation in public buildings based on the nanogrid concept. Thus, BERLIN project focuses on the increase of photovoltaics (PV) penetration, which coupled with energy storage and demand – side management (DSM) will increase the energy efficiency (EE) of the buildings. The implementation of these technologies in a cost – effective way will result in high level of self – resilient public buildings that are green, smart, innovative, and sustainable. A total of 6 pilot buildings will be implemented by the end of the project, namely 1 in Cyprus, 2 in Greece, 2 in Israel and 1 in Italy.

The project started in September 2019 and will be completed in September 2023.

2 Introduction

The policy makers tool provides recommendations for policies and regulations that promote the adoption of the photovoltaics (PV) and energy storage systems (ESS) in public buildings with the potential for demand side management (DSM), referred here as PV+ESS+DSM scheme. Except from recommendations, it offers numerical results about (i) the profitability of PV+ESS+DSM systems in certain building types and (ii) the energy self-sufficiency of the building.

It consists of 7 tabs. The first three tabs, “Technical input”, “Financial input”, “Incentives/regulations for PV+ESS+DSM”, are used to collect all the required input data from the user. The next tab. i.e., “Run”, is used to load the inputs and execute the simulation. The last three tabs are used to display the numerical results (“NPV Results” and “SSR results”), as well as the recommendations for policies and regulations (“Recommendations”). Further information is provided within the next sections.

The policy makers tool was developed with the financial assistance of European Union under the ENI CBC Mediterranean Sea Basin Programme, under the project “BERLIN – Cost-effective rehabilitation of public buildings into smart and resilient nano-grids using storage”. Feel free to use the tool for your analyses.

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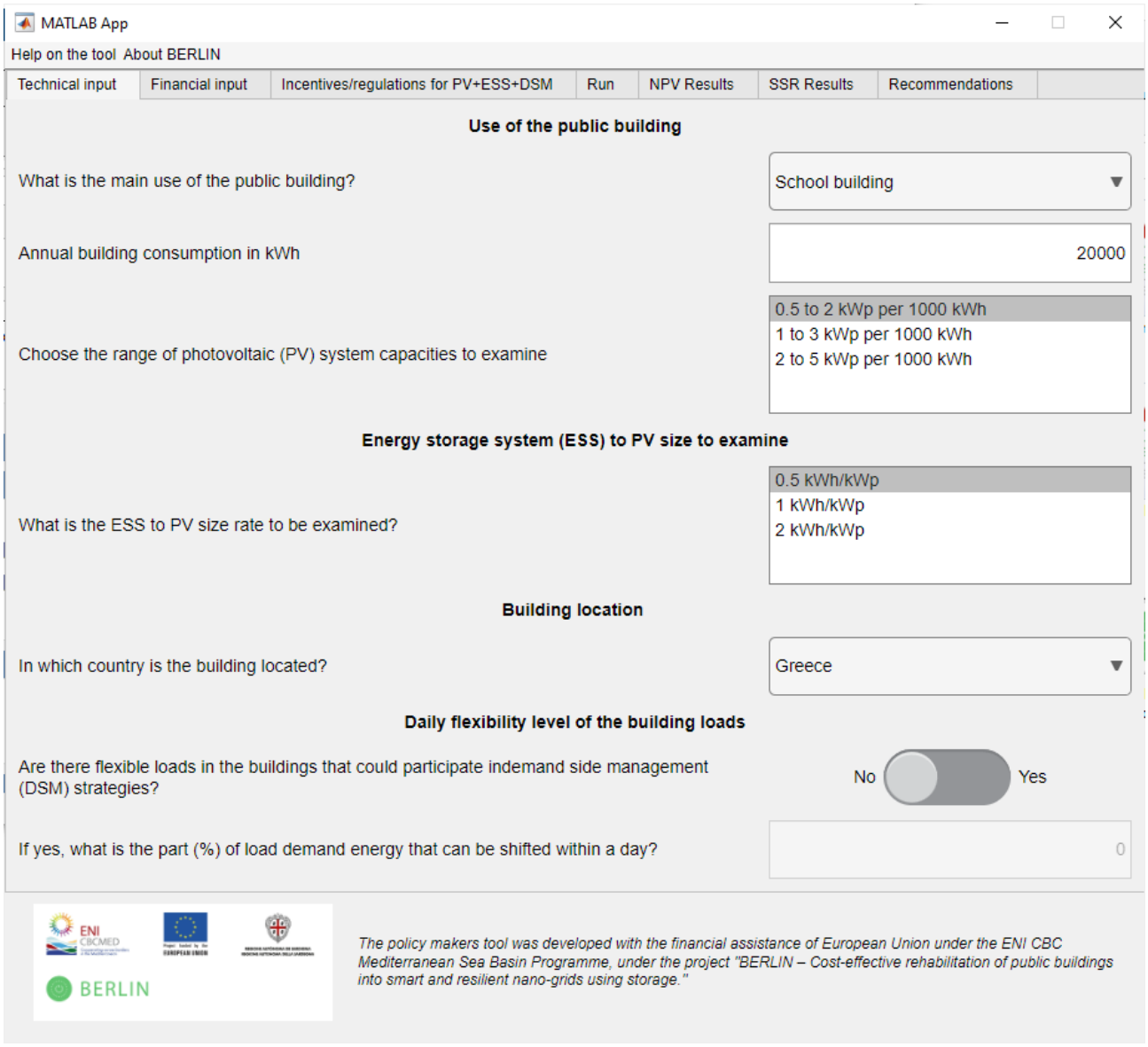
3 Technical input tab

Here please select all the information regarding the building you want to examine. Further help on the available options will be presented by leaving your mouse on the corresponding field.

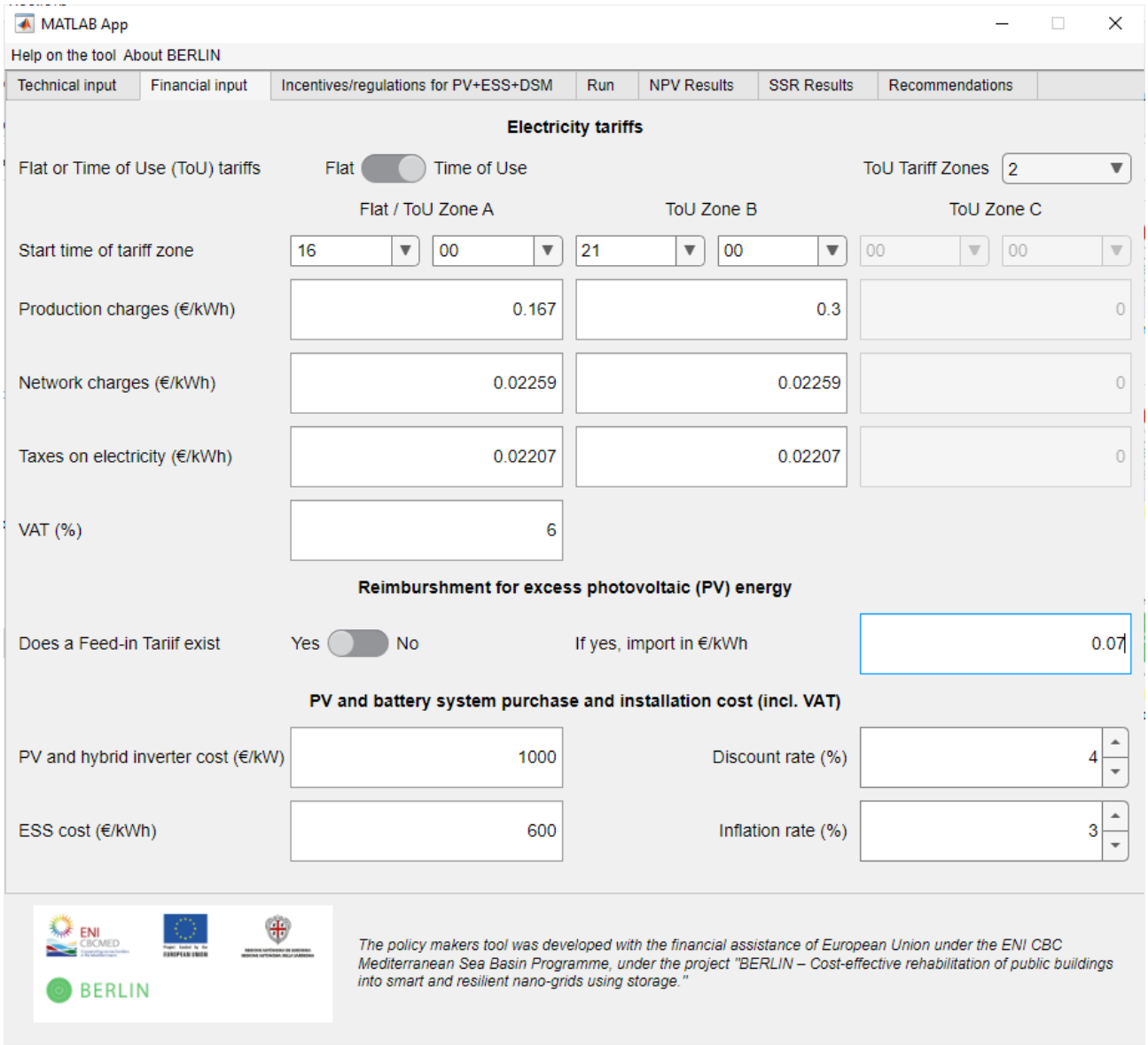


4 Financial input

Here please select all the information regarding:

- The electricity tariffs. In case of a Time of Use (ToU) pricing scheme, please pay attention to insert the information of the different time zones correctly:
    - Please select the starting time of the different tariff zones, in ascending order, beginning from Zone A.
    - Example 1: pricing scheme with 2 zones: 16:00-20:00 and 20:00-16:00 of the next day, two starting hours are considered in ascending order: 16:00 for Zone A and 20:00 for Zone B.
    - Example 2: pricing scheme with 3 zones: 10:00-16:00, 16:00-20:00 and 20:00-10:00 of the next day, three starting hours are considered in ascending order: 10:00 for Zone A, 16:00 for Zone B, and 20:00 for Zone C.
- The Feed-in Tariff provided to the prosumer as a reimbursement for any excess photovoltaic (PV) produced energy that is injected into the utility grid.
- The systems purchase and installation cost, including VAT.
- The discount and the inflation rate.

Further help on the available options will be presented by leaving your mouse on the corresponding field.


MATLAB App
Help on the tool About BERLIN
Technical input
Financial input
Incentives/regulations for PV+ESS+DSM
Run
NPV Results
SSR Results
Recommendations
Electricity tariffs
Flat or Time of Use (ToU) tariffs
Flat
Time of Use
ToU Tariff Zones
2
Flat / ToU Zone A
ToU Zone B
ToU Zone C
Start time of tariff zone
16
00
21
00
00
00
Production charges (€/kWh)
0.167
0.3
0
Network charges (€/kWh)
0.02259
0.02259
0
Taxes on electricity (€/kWh)
0.02207
0.02207
0
VAT (%)
6
Reimbursment for excess photovoltaic (PV) energy
Does a Feed-in Tariif exist
Yes
No
If yes, import in €/kWh
0.07
PV and battery system purchase and installation cost (incl. VAT)
PV and hybrid inverter cost (€/kW)
1000
Discount rate (%)
4
ESS cost (€/kWh)
600
Inflation rate (%)
3
BERLIN
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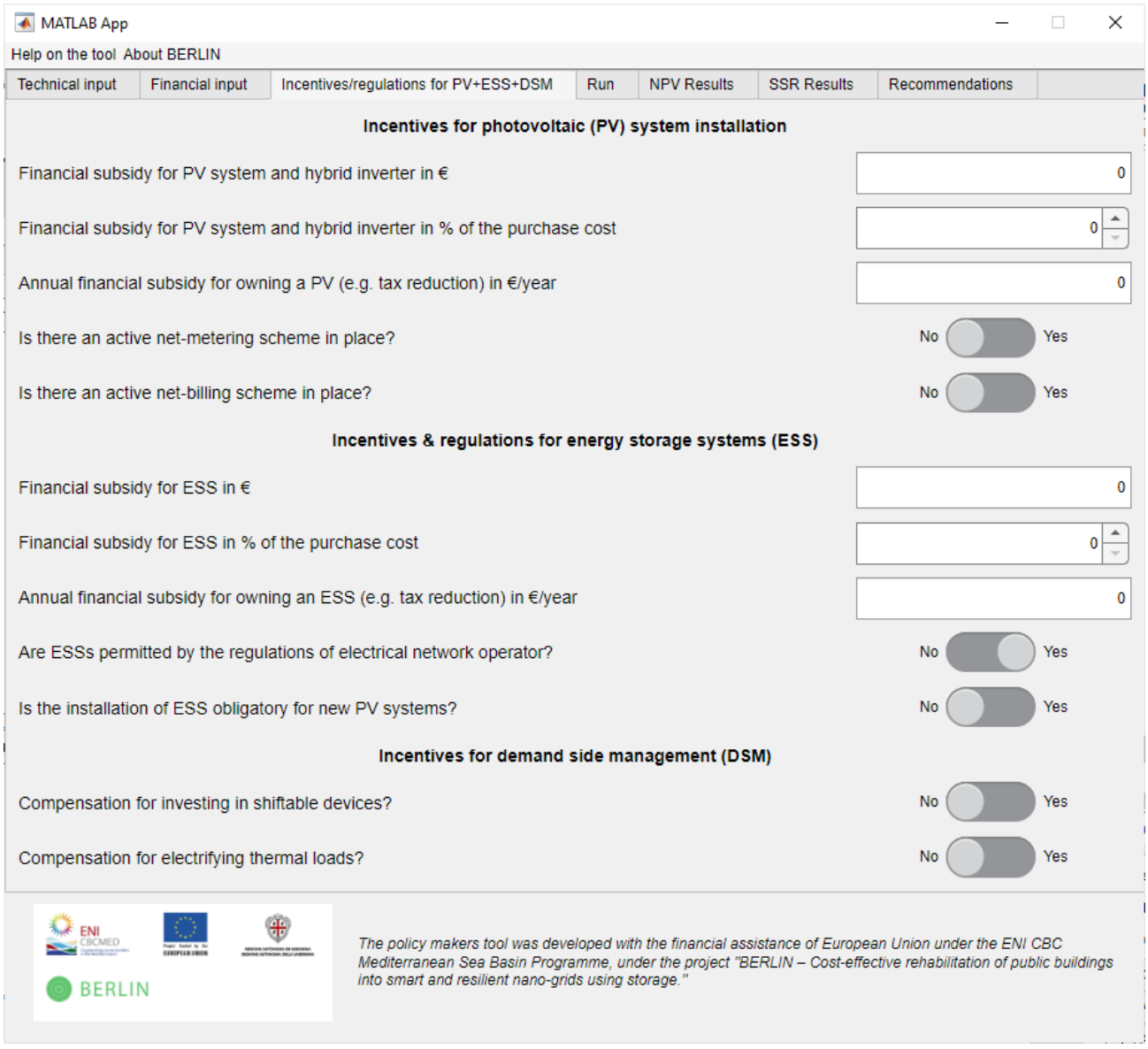
5 Incentives/regulations for PV+ESS+DSM tab

In this tab, information about the existing framework of incentive policies is collected.

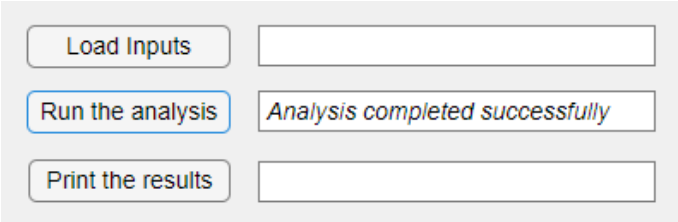


6 Run tab

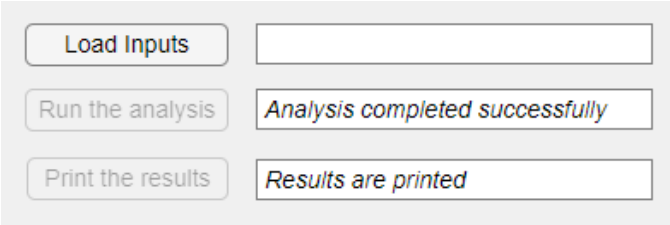
As described on the tab, the outputs of the tool are presented following three sequential steps:

1) **Load the inputs**. Once the inputs are loaded, they are validated and if all values are correctly entered, a message of successful loading will appear and the button "Run the analysis" will be enabled. If an error exists, a related warning will appear. The user has to correct the invalid hours and press again the "Load inputs" button.

2) **Run the analysis**. As soon as the inputs are successfully loaded the user has the option to run the analysis. A message of successful analysis will appear as soon as the analysis calculations are complete.

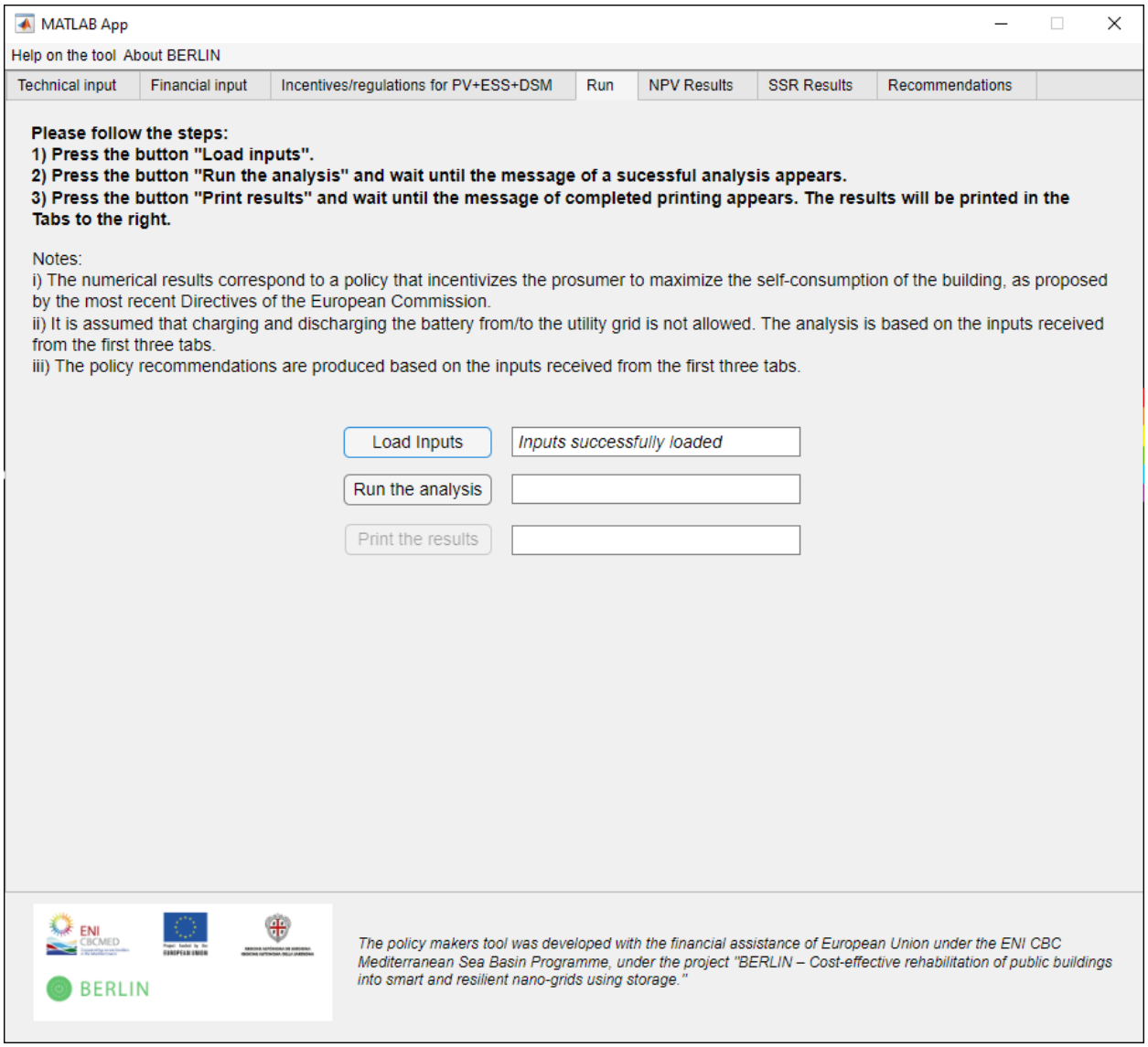


3) **Print the results**. Since the analysis is successfully completed, the user can press the third button to print the results in the following three tabs.



All imported values are maintained until the tool is closed. In case the user changes some of the values in the first three tabs, the three steps have to be repeated to receive the new results.

Further help on the available options will be presented by leaving your mouse on the corresponding field.


MATLAB App
Help on the tool About BERLIN
Technical input
Financial input
Incentives/regulations for PV+ESS+DSM
Run
NPV Results
SSR Results
Recommendations
Please follow the steps:
1) Press the button "Load inputs".
2) Press the button "Run the analysis" and wait until the message of a sucessful analysis appears.
3) Press the button "Print results" and wait until the message of completed printing appears. The results will be printed in the Tabs to the right.
Notes:
i) The numerical results correspond to a policy that incentivizes the prosumer to maximize the self-consumption of the building, as proposed by the most recent Directives of the European Commission.
ii) It is assumed that charging and discharging the battery from/to the utility grid is not allowed. The analysis is based on the inputs received from the first three tabs.
iii) The policy recommendations are produced based on the inputs received from the first three tabs.
Load Inputs
Inputs successfully loaded
Run the analysis
Print the results
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7 Net present value (NPV) results tab

In the first figure, the NPV based on the imported data by the user is demonstrated for the different combinations of PV and battery capacity.

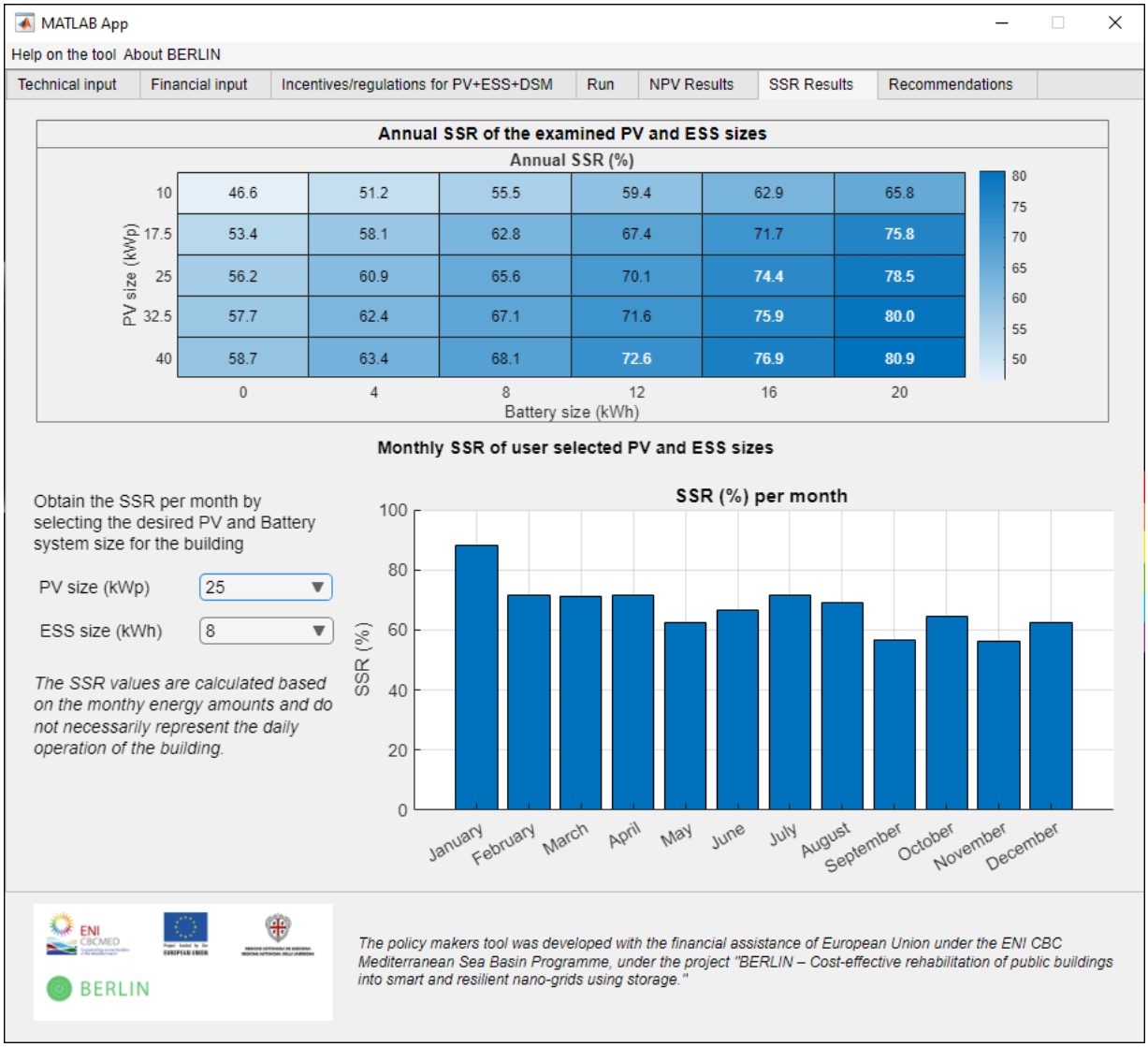
In the second figure, the NPV based on the imported data by the user and the modifications inserted by moving the two sliding bars is demonstrated. This figure shows the effect of the financial subsidies on the profitability of the investment on PV+ESS+DSM schemes.

8 Self-sufficiency rate (SSR) results tab

In the first figure of this tab, the annual SSR based on the imported data by the user is demonstrated for the different combinations of PV and battery capacity. SSR is defined as the portion of the load demand energy that is covered by own PV production either directly or at a later time exploiting the battery, and can be calculated as follows:

$$SSR = \frac{[Consumption\ energy] - [Energy\ imported\ from\ grid]}{[Consumption\ energy]}$$

The second figure illustrates the monthly SSR values for the PV-battery combination selected on the left-side of the figure.



9 Recommendations tab

The last tab provides the recommendations for policies and regulations that promote the PV+ESS+DSM system, aiming to enhance the self-sufficiency of buildings. By pressing the button "Export recommendations", the user can save all the presented recommendations in a Microsoft Excel file. The Excel file is separated into two sheets, one used for the policies and the other for the regulations.