StoRES

Promotion of higher penetration of Distributed PV through storage for all

Priority Axis 2: Fostering low-carbon strategies and energy efficiency in specific MED territories: cities, islands and remote areas

2.2: To increase the share of renewable local energy sources in energy mix strategies and plans in specific MED territories

Deliverable n°: **3.8.1**

Deliverable Name: **Online Storage Optimization Tool**

Project co-financed by the European Regional Development Fund

1. Document info

Project Name	Promotion of higher penetration of Distributed PV through storage for all (StoRES)
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Contributors / Reviewers	Georgios C. Christoforidis, Grigoris Papagiannis
Status	Final

2. Document History

Date	Author	Action	Status
28.02.2019	Angelos Nousdilis	1st draft report	Draft
29.03.2019	Georgios C. Christoforidis	Final version	Final

3. Contents

4. Executive Summary

The project addresses the development of an optimal policy for the effective integration of Renewable Energy Sources (RES) and Energy Storage Systems (ESS). The primary challenge is to achieve increased penetration of RES and predominantly photovoltaics (PV), in the energy mix of islands and rural areas in the Mediterranean (MED) region without compromising grid stability. The main objective of StoRES is to boost self-consumption in the MED region with the integration of optimal storage solutions. Testing coupled PV-ESS solutions in different pilot sites and taking into account local particularities for optimization, current barriers concerning grid reliability with higher RES deployment will be eliminated. In addition to this, the development and integration of the proposed solution at both residential and community levels and applying different policy scenarios will lift the barriers related to the gird integration of ESS and extend the practical knowledge about this technology. It is expected that all the shortcomings regarding the intermittent nature of PV energy for increased penetration into the energy mix will be addressed whilst maintaining smooth operation of the grid.

The project started on 1st of November 2016 and is expected to be completed within 30 months.

5. Introduction to Deliverable 3.8.1

This report deals with the development of an online optimization tool related to PV systems with storage. The goal of the tool is to provide relevant information to interested stakeholders, investors and researchers about the optimal sizing of both PV and storage systems based on several parameters. The developed tool has been constructed based on specifications commonly agreed by all partners of the StoRES project and ensuring that it is as user-friendly as possible.

Although the current version of the tool focuses on the countries of the StoRES consortium (i.e. Cyprus, France, Greece, Italy, Portugal, Slovenia, Spain) by having in-built average consumption profiles, it can be easily used for any other country/region as well. The only requirement is to upload sample average consumption profiles to be used in the calculations. In terms of the measurements of PV output power, these can either be provided by the user using a specific template, or the user can select an arbitrary location on the map and the tool will communicate with the PVGIS database to obtain the necessary climatic data for the estimation of the PV output power.

The tool can be assessed at the following address:

http://storestool.eu/

The rest of the document contains a detailed description of the online optimization tool with relevant pictures.

6. Description of the Tool

PV and Storage Optimization Tool has been built in the framework of *"Promotion of higher penetration of Distributed PV through storage for all - StoRES"* project. The objective of StoRES is to boost PV self-consumption in the MED region through an optimal residential storage solution. The approach is to test coupled solutions for the consumer in different pilot sites taking into account local parameters for optimization and using efficiency measures. StoRES is expected to change the current situation concerning grid reliability with higher Renewable Energy Sources deployment in islands/rural areas, giving a cost-effective option to the public on more affordable and sustainable energy supply.

The tool aims at calculating the optimal size of a hybrid PV+storage system in terms of net present value of the investment. The tool requires as inputs: electrical consumption, solar irradiation, PV and battery size,

and electricity costs. A financial analysis is undertaken for a period of 20 years, taking into consideration technical and financial parameters and various options of energy policies. The tool can be used by both professionals and non-professionals users.

This document is a short manual, providing the user with simple instructions. The procedure that should be followed to get the desired results is divided into 8 separate steps:

- Step 1: PV System Data
- Step 2: Consumption Data
- Step 3: Electricity Costs
- Step 4: Storage System
- Step 5: Policy
- Step 6: Financial
- Step 7: Validate Inputs
- Step 8: Getting the results

These steps are further analyzed in the remaining document.

6.1 PV System Data

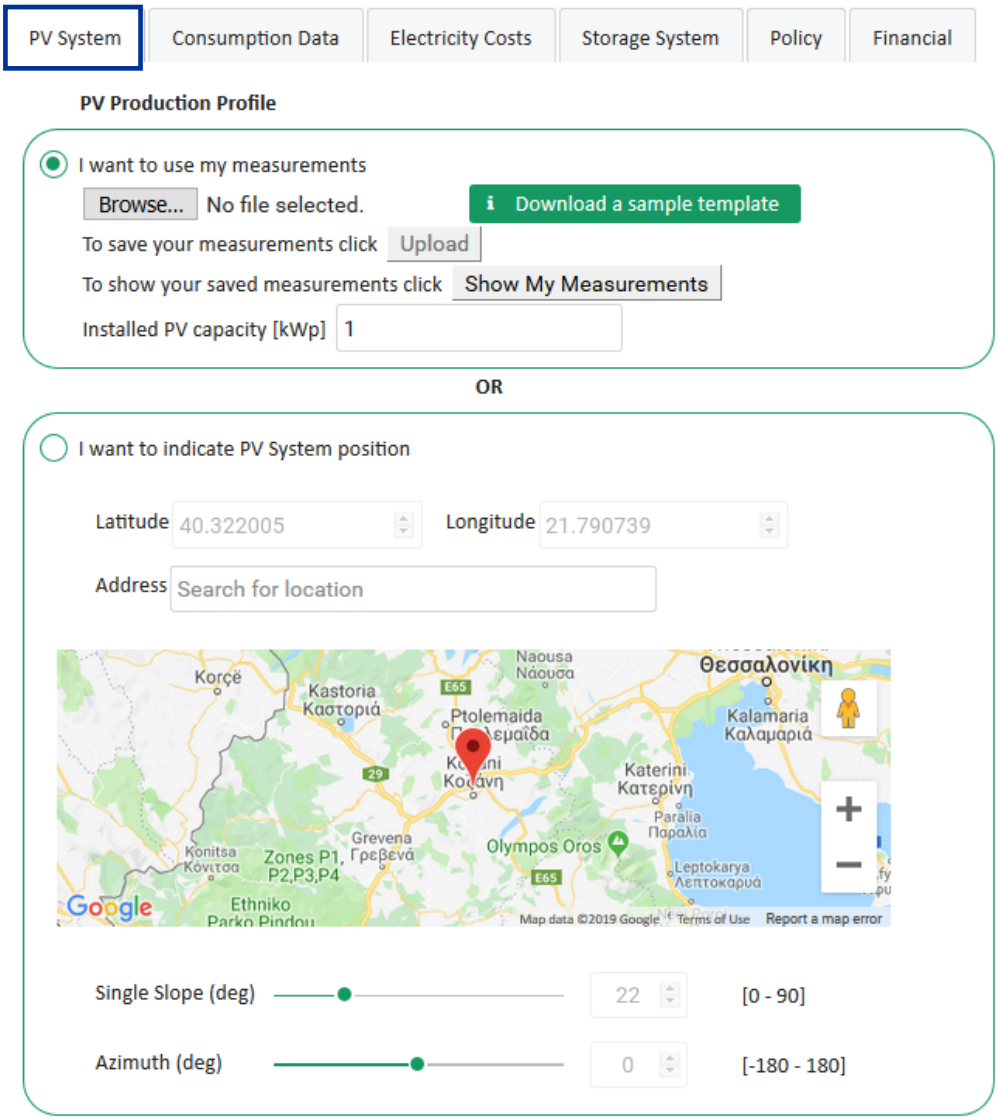
i. The "*PV production profile"* is essential for the tool calculations. The user should select one of the following two options:

a) If PV power measurements of a specific installation are available, the user can import these data in a *.csv* file and upload it by clicking *"Upload"*. The data should be entered using the sample template that can be downloaded from the corresponding button. Next, user should enter the PV capacity (in kWp) of the measured PV installation.

b) If no PV power measurements are available, the user can indicate the coordinates of the installation position and the orientation of the panels (slope and azimuth). The tool then communicates with the PVGIS platform[1] of the JRC and obtains the necessary climatic data for the specific location in order to estimate the PV power output. The calculation procedure is described in detail in a relevant publication[2].

[1] http://re.jrc.ec.europa.eu/PVGIS5-release.html (Assessed March 2019)

[2] . G. C. Christoforidis, I. P. Panapakidis, T. A. Papadopoulos, G. K. Papagiannis, I. Koumparou, M. Hadjipanayi and G. E. Georghiou, "A Model for the Assessment of Different Net-Metering Policies", Energies, 2016, 9(4), 262; doi:10.3390/en9040262.


PV System
Consumption Data
Electricity Costs
Storage System
Policy
Financial
PV Production Profile
I want to use my measurements
Browse...
No file selected.
Download a sample template
To save your measurements click
Upload
To show your saved measurements click
Show My Measurements
Installed PV capacity [kWp]
1
OR
I want to indicate PV System position
Latitude
40.322005
Longitude
21.790739
Address
Search for location
Korçë
Kastoria
Καστοριά
Naousa
Νάουσα
Ptolemaida
Κατερίνη
Katerini
Paralia
Παραλία
Olympos Oros
Grevena
Γρεβενά
Zones P1, P2,P3,P4
Konitsa
Κόνιτσα
Ethniko
Θεσσαλονίκη
Kalamaria
Καλαμαριά
Leptokarya
Λεπτοκαρυά
Google
Map data ©2019 Google
Terms of Use
Report a map error
Single Slope (deg)
22
[0 - 90]
Azimuth (deg)
0
[-180 - 180]

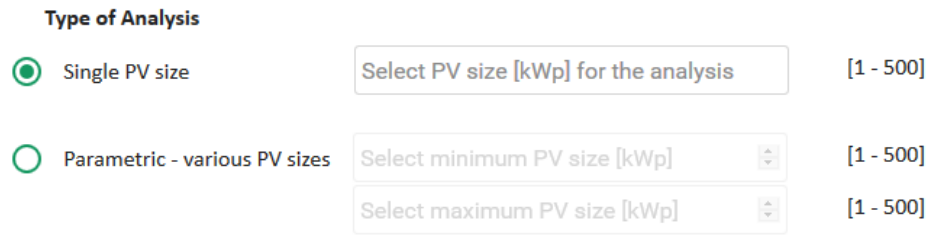
The next image is an overview of the *.csv* template file. Power should be imported in *kW*, considering a 15-min time interval.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Time Inste	Time	January	February	March	April	May	June	July	August	Septembe	October	Novembe	December
2	1	0:00	0	0	0	0	0	0	0	0	0	0	0	0
3	2	0:15	0	0	0	0	0	0	0	0	0	0	0	0
4	3	0:30	0	0	0	0	0	0	0	0	0	0	0	0
5	4	0:45	0	0	0	0	0	0	0	0	0	0	0	0
6	5	1:00	0	0	0	0	0	0	0	0	0	0	0	0
7	6	1:15	0	0	0	0	0	0	0	0	0	0	0	0
8	7	1:30	0	0	0	0	0	0	0	0	0	0	0	0
9	8	1:45	0	0	0	0	0	0	0	0	0	0	0	0
10	9	2:00	0	0	0	0	0	0	0	0	0	0	0	0
11	10	2:15	0	0	0	0	0	0	0	0	0	0	0	0
12	11	2:30	0	0	0	0	0	0	0	0	0	0	0	0
13	12	2:45	0	0	0	0	0	0	0	0	0	0	0	0
14	13	3:00	0	0	0	0	0	0	0	0	0	0	0	0
15	14	3:15	0	0	0	0	0	0	0	0	0	0	0	0
16	15	3:30	0	0	0	0	0	0	0	0	0	0	0	0
17	16	3:45	0	0	0	0	0	0	0	0	0	0	0	0
18	17	4:00	0	0	0	0	0	0	0	0	0	0	0	0
19	18	4:15	0	0	0	0	0	0	0	0	0	0	0	0
20	19	4:30	0	0	0	0	0	0	0	0	0	0	0	0
21	20	4:45	0	0	0	0	0	0.009749	0	0	0	0	0	0
22	21	5:00	0	0	0	0	0.018789	0.022621	0.010327	0	0	0	0	0
23	22	5:15	0	0	0	0	0.032497	0.034546	0.022116	0	0	0	0	0
24	23	5:30	0	0	0	0	0.045242	0.045536	0.032984	0.015007	0	0	0	0
25	24	5:45	0	0	0	0.019205	0.066868	0.060371	0.045288	0.02599	0	0	0	0
26	25	6:00	0	0	0	0.033309	0.09239	0.086093	0.068514	0.043193	0.009695	0	0	0
27	26	6:15	0	0	0.011089	0.057302	0.121039	0.113873	0.095486	0.068911	0.024975	0	0	0
28	27	6:30	0	0	0.029777	0.084524	0.151786	0.144452	0.125323	0.099887	0.048924	0	0	0
29	28	6:45	0	0	0.056851	0.114044	0.184018	0.176631	0.158803	0.13368	0.076692	0	0	0
30	29	7:00	0	0.01716	0.086273	0.145874	0.21686	0.210134	0.193582	0.170291	0.107482	0.016384	0	0
31	30	7:15	0	0.047947	0.118098	0.179172	0.250162	0.244314	0.229642	0.20814	0.141155	0.043273	0.012531	0
32	31	7:30	0.018846	0.080313	0.151434	0.212286	0.283393	0.278291	0.266968	0.247355	0.176236	0.074012	0.042515	0
33	32	7:45	0.054739	0.112541	0.185428	0.246031	0.316611	0.311114	0.304204	0.286287	0.211074	0.105438	0.069835	0.042426
34	33	8:00	0.087102	0.144632	0.220075	0.278772	0.348688	0.344667	0.340253	0.323984	0.246453	0.13742	0.103696	0.069505
35	34	8:15	0.115099	0.177435	0.252862	0.311327	0.379009	0.376711	0.377017	0.361788	0.2808	0.169991	0.133269	0.103244
36	35	8:30	0.143082	0.20925	0.28547	0.342267	0.408605	0.406835	0.412049	0.398366	0.314125	0.202454	0.163539	0.131876
37	36	8:45	0.169215	0.239237	0.316408	0.372257	0.43728	0.436014	0.445362	0.433165	0.346635	0.23393	0.192027	0.159603
38	37	9:00	0.194415	0.268394	0.346192	0.400271	0.463486	0.464532	0.478006	0.466479	0.376627	0.264427	0.218743	0.185483
39	38	9:15	0.218686	0.295613	0.373535	0.426752	0.488013	0.489886	0.507939	0.498085	0.405665	0.293155	0.244655	0.210551

example-file-template

ii. In the same Tab, the *"PV System characteristics"* – degradation and inverter efficiency have to be introduced.

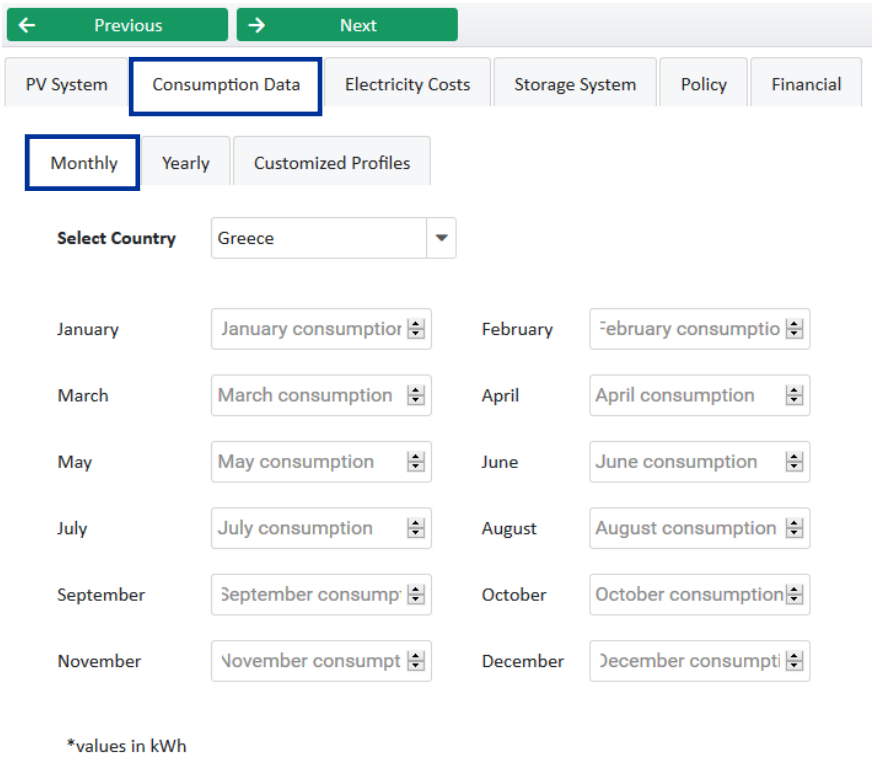
iii. The last option of this step refers to the *"Type of Analysis"*. The option to choose between a single PV size and various PV sizes is given and the user is able to switch accordingly to his proper installation.



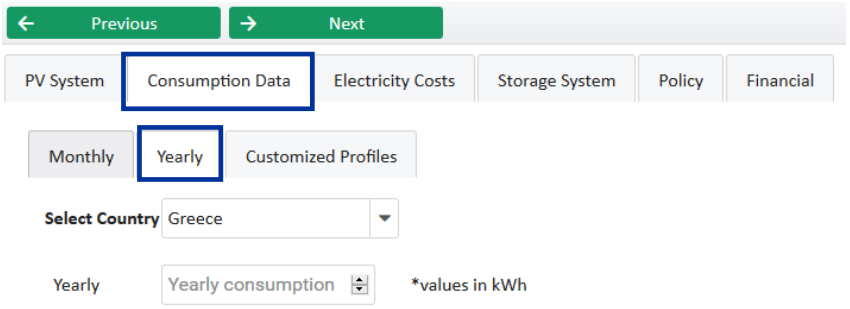
6.2 Consumption Data

The consumption of the installation should be inserted here. In this case, the user can either use a predefined country-specific consumption profile by introducing his monthly or yearly consumption, or upload a customized profile of the installation.

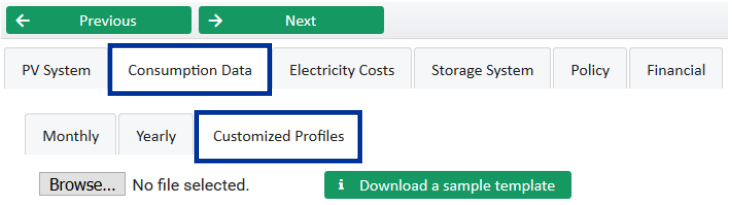
i. Monthly Consumption Data: Select the country of the installation under study and insert the energy consumption of each month over a year, in *kWh*.



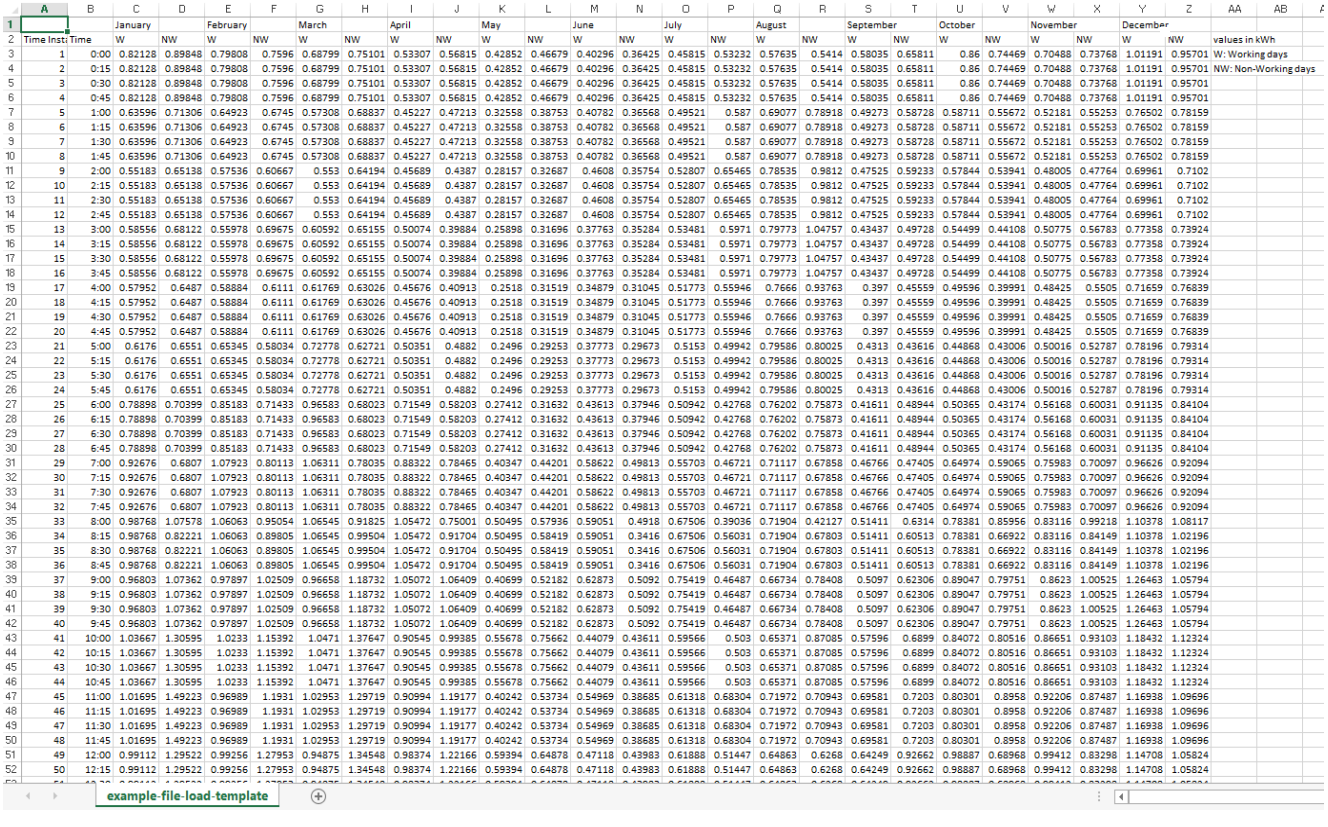
ii. Yearly Consumption Data: Select the country of the installation under study and insert the total energy consumption over a year, in *kWh*.



iii. Customized Profiles: The user has the option to upload own consumption by means of a *.csv* file using the provided template. The template can be downloaded by clicking the corresponding button.



The next image is an overview of the *.csv* template file. Power should be imported in *kW*, considering a 15-min time interval. Consumption should be inserted in the specified columns per month, taking into consideration a classification between working and non-working days.



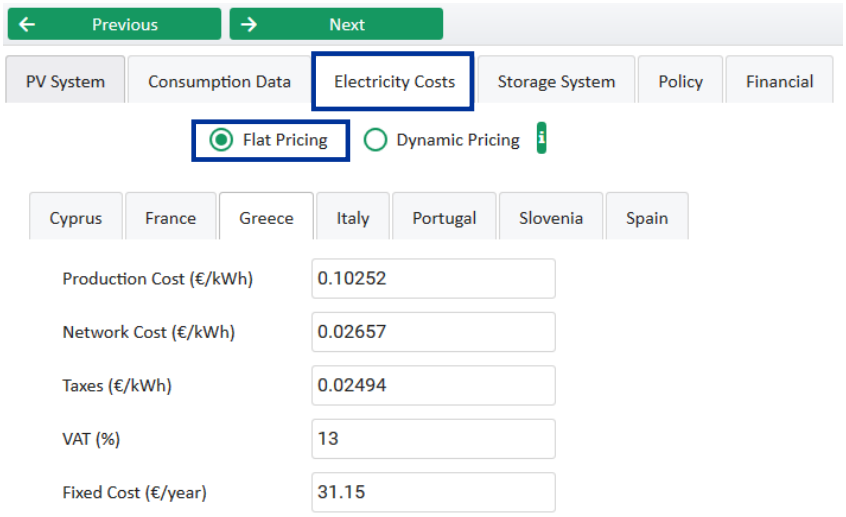
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1			January		February		March		April		May		June		July		August		September		October		November		December			
2	Time Inst	Time	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	values in kWh	
3	1	0:00	0.82128	0.89848	0.79808	0.7596	0.68799	0.75101	0.53307	0.56815	0.42852	0.46679	0.40296	0.36425	0.45815	0.53232	0.57635	0.5414	0.58035	0.65811	0.86	0.74469	0.70488	0.73768	1.01191	0.95701	W: Working days	
4	2	0:15	0.82128	0.89848	0.79808	0.7596	0.68799	0.75101	0.53307	0.56815	0.42852	0.46679	0.40296	0.36425	0.45815	0.53232	0.57635	0.5414	0.58035	0.65811	0.86	0.74469	0.70488	0.73768	1.01191	0.95701	NW: Non-Working days	
5	3	0:30	0.82128	0.89848	0.79808	0.7596	0.68799	0.75101	0.53307	0.56815	0.42852	0.46679	0.40296	0.36425	0.45815	0.53232	0.57635	0.5414	0.58035	0.65811	0.86	0.74469	0.70488	0.73768	1.01191	0.95701		
6	4	0:45	0.82128	0.89848	0.79808	0.7596	0.68799	0.75101	0.53307	0.56815	0.42852	0.46679	0.40296	0.36425	0.45815	0.53232	0.57635	0.5414	0.58035	0.65811	0.86	0.74469	0.70488	0.73768	1.01191	0.95701		
7	5	1:00	0.63596	0.71306	0.64923	0.6745	0.57308	0.68837	0.45227	0.47213	0.32558	0.38753	0.40782	0.36568	0.49521	0.587	0.69077	0.78918	0.49273	0.58728	0.58711	0.55672	0.52181	0.55253	0.76502	0.78159		
8	6	1:15	0.63596	0.71306	0.64923	0.6745	0.57308	0.68837	0.45227	0.47213	0.32558	0.38753	0.40782	0.36568	0.49521	0.587	0.69077	0.78918	0.49273	0.58728	0.58711	0.55672	0.52181	0.55253	0.76502	0.78159		
9	7	1:30	0.63596	0.71306	0.64923	0.6745	0.57308	0.68837	0.45227	0.47213	0.32558	0.38753	0.40782	0.36568	0.49521	0.587	0.69077	0.78918	0.49273	0.58728	0.58711	0.55672	0.52181	0.55253	0.76502	0.78159		
10	8	1:45	0.63596	0.71306	0.64923	0.6745	0.57308	0.68837	0.45227	0.47213	0.32558	0.38753	0.40782	0.36568	0.49521	0.587	0.69077	0.78918	0.49273	0.58728	0.58711	0.55672	0.52181	0.55253	0.76502	0.78159		
11	9	2:00	0.55183	0.65138	0.57536	0.60667	0.553	0.64194	0.45689	0.4387	0.28157	0.32687	0.4608	0.35754	0.52807	0.65465	0.78535	0.9812	0.47525	0.59233	0.57844	0.53941	0.48005	0.47764	0.69961	0.7102		
12	10	2:15	0.55183	0.65138	0.57536	0.60667	0.553	0.64194	0.45689	0.4387	0.28157	0.32687	0.4608	0.35754	0.52807	0.65465	0.78535	0.9812	0.47525	0.59233	0.57844	0.53941	0.48005	0.47764	0.69961	0.7102		
13	11	2:30	0.55183	0.65138	0.57536	0.60667	0.553	0.64194	0.45689	0.4387	0.28157	0.32687	0.4608	0.35754	0.52807	0.65465	0.78535	0.9812	0.47525	0.59233	0.57844	0.53941	0.48005	0.47764	0.69961	0.7102		
14	12	2:45	0.55183	0.65138	0.57536	0.60667	0.553	0.64194	0.45689	0.4387	0.28157	0.32687	0.4608	0.35754	0.52807	0.65465	0.78535	0.9812	0.47525	0.59233	0.57844	0.53941	0.48005	0.47764	0.69961	0.7102		
15	13	3:00	0.58556	0.68122	0.55978	0.69675	0.60592	0.65155	0.50074	0.39884	0.25898	0.31696	0.37763	0.35284	0.53481	0.5971	0.79773	1.04757	0.43437	0.49728	0.54499	0.44108	0.50775	0.56783	0.77358	0.73924		
16	14	3:15	0.58556	0.68122	0.55978	0.69675	0.60592	0.65155	0.50074	0.39884	0.25898	0.31696	0.37763	0.35284	0.53481	0.5971	0.79773	1.04757	0.43437	0.49728	0.54499	0.44108	0.50775	0.56783	0.77358	0.73924		
17	15	3:30	0.58556	0.68122	0.55978	0.69675	0.60592	0.65155	0.50074	0.39884	0.25898	0.31696	0.37763	0.35284	0.53481	0.5971	0.79773	1.04757	0.43437	0.49728	0.54499	0.44108	0.50775	0.56783	0.77358	0.73924		
18	16	3:45	0.58556	0.68122	0.55978	0.69675	0.60592	0.65155	0.50074	0.39884	0.25898	0.31696	0.37763	0.35284	0.53481	0.5971	0.79773	1.04757	0.43437	0.49728	0.54499	0.44108	0.50775	0.56783	0.77358	0.73924		
19	17	4:00	0.57952	0.6487	0.58884	0.6111	0.61769	0.63026	0.45676	0.40913	0.2518	0.31519	0.34879	0.31045	0.51773	0.55946	0.7666	0.93763	0.397	0.45559	0.49596	0.39991	0.48425	0.5505	0.71659	0.76839		
20	18	4:15	0.57952	0.6487	0.58884	0.6111	0.61769	0.63026	0.45676	0.40913	0.2518	0.31519	0.34879	0.31045	0.51773	0.55946	0.7666	0.93763	0.397	0.45559	0.49596	0.39991	0.48425	0.5505	0.71659	0.76839		
21	19	4:30	0.57952	0.6487	0.58884	0.6111	0.61769	0.63026	0.45676	0.40913	0.2518	0.31519	0.34879	0.31045	0.51773	0.55946	0.7666	0.93763	0.397	0.45559	0.49596	0.39991	0.48425	0.5505	0.71659	0.76839		
22	20	4:45	0.57952	0.6487	0.58884	0.6111	0.61769	0.63026	0.45676	0.40913	0.2518	0.31519	0.34879	0.31045	0.51773	0.55946	0.7666	0.93763	0.397	0.45559	0.49596	0.39991	0.48425	0.5505	0.71659	0.76839		
23	21	5:00	0.6176	0.6551	0.65345	0.58034	0.72778	0.62721	0.50351	0.4882	0.2496	0.29253	0.37773	0.29673	0.5153	0.49942	0.79586	0.80025	0.4313	0.43616	0.44868	0.43006	0.50016	0.52787	0.78196	0.79314		
24	22	5:15	0.6176	0.6551	0.65345	0.58034	0.72778	0.62721	0.50351	0.4882	0.2496	0.29253	0.37773	0.29673	0.5153	0.49942	0.79586	0.80025	0.4313	0.43616	0.44868	0.43006	0.50016	0.52787	0.78196	0.79314		
25	23	5:30	0.6176	0.6551	0.65345	0.58034	0.72778	0.62721	0.50351	0.4882	0.2496	0.29253	0.37773	0.29673	0.5153	0.49942	0.79586	0.80025	0.4313	0.43616	0.44868	0.43006	0.50016	0.52787	0.78196	0.79314		
26	24	5:45	0.6176	0.6551	0.65345	0.58034	0.72778	0.62721	0.50351	0.4882	0.2496	0.29253	0.37773	0.29673	0.5153	0.49942	0.79586	0.80025	0.4313	0.43616	0.44868	0.43006	0.50016	0.52787	0.78196	0.79314		
27	25	6:00	0.78898	0.70399	0.85183	0.71433	0.96583	0.68023	0.71549	0.58203	0.27412	0.31632	0.43613	0.37946	0.50942	0.42768	0.76202	0.75873	0.41611	0.48944	0.50365	0.43174	0.56168	0.60031	0.91135	0.84104		
28	26	6:15	0.78898	0.70399	0.85183	0.71433	0.96583	0.68023	0.71549	0.58203	0.27412	0.31632	0.43613	0.37946	0.50942	0.42768	0.76202	0.75873	0.41611	0.48944	0.50365	0.43174	0.56168	0.60031	0.91135	0.84104		
29	27	6:30	0.78898	0.70399	0.85183	0.71433	0.96583	0.68023	0.71549	0.58203	0.27412	0.31632	0.43613	0.37946	0.50942	0.42768	0.76202	0.75873	0.41611	0.48944	0.50365	0.43174	0.56168	0.60031	0.91135	0.84104		
30	28	6:45	0.78898	0.70399	0.85183	0.71433	0.96583	0.68023	0.71549	0.58203	0.27412	0.31632	0.43613	0.37946	0.50942	0.42768	0.76202	0.75873	0.41611	0.48944	0.50365	0.43174	0.56168	0.60031	0.91135	0.84104		
31	29	7:00	0.92676	0.6807	1.07923	0.80113	1.06311	0.78035	0.88322	0.78465	0.40347	0.44201	0.58622	0.49813	0.55703	0.46721	0.71117	0.67858	0.46766	0.47405	0.64974	0.59065	0.75983	0.70097	0.96626	0.92094		
32	30	7:15	0.92676	0.6807	1.07923	0.80113	1.06311	0.78035	0.88322	0.78465	0.40347	0.44201	0.58622	0.49813	0.55703	0.46721	0.71117	0.67858	0.46766	0.47405	0.64974	0.59065	0.75983	0.70097	0.96626	0.92094		
33	31	7:30	0.92676	0.6807	1.07923	0.80113	1.06311	0.78035	0.88322	0.78465	0.40347	0.44201	0.58622	0.49813	0.55703	0.46721	0.71117	0.67858	0.46766	0.47405	0.64974	0.59065	0.75983	0.70097	0.96626	0.92094		
34	32	7:45	0.92676	0.6807	1.07923	0.80113	1.06311	0.78035	0.88322	0.78465	0.40347	0.44201	0.58622	0.49813	0.55703	0.46721	0.71117	0.67858	0.46766	0.47405	0.64974	0.59065	0.75983	0.70097	0.96626	0.92094		
35	33	8:00	0.98768	1.07578	1.06063	0.95054	1.06545	0.91825	1.05472	0.75001	0.50495	0.57936	0.59051	0.4918	0.67506	0.39036	0.71904	0.42127	0.51411	0.6314	0.78381	0.85956	0.83116	0.99218	1.10378	1.08117		
36	34	8:15	0.98768	0.82221	1.06063	0.89805	1.06545	0.99504	1.05472	0.91704	0.50495	0.58419	0.59051	0.3416	0.67506	0.56031	0.71904	0.67803	0.51411	0.60513	0.78381	0.66922	0.83116	0.84149	1.10378	1.02196		
37	35	8:30	0.98768	0.82221	1.06063	0.89805	1.06545	0.99504	1.05472	0.91704	0.50495	0.58419	0.59051	0.3416	0.67506	0.56031	0.71904	0.67803	0.51411	0.60513	0.78381	0.66922	0.83116	0.84149	1.10378	1.02196		
38	36	8:45	0.98768	0.82221	1.06063	0.89805	1.06545	0.99504	1.05472	0.91704	0.50495	0.58419	0.59051	0.3416	0.67506	0.56031	0.71904	0.67803	0.51411	0.60513	0.78381	0.66922	0.83116	0.84149	1.10378	1.02196		
39	37	9:00	0.96803	1.07362	0.97897	1.02509	0.96658	1.18732	1.05072	1.06409	0.40699	0.52182	0.62873	0.5092	0.75419	0.46487	0.66734	0.78408	0.5097	0.62306	0.89047	0.79751	0.8623	1.00525	1.26463	1.05794		
40	38	9:15	0.96803	1.07362	0.97897	1.02509	0.96658	1.18732	1.05072	1.06409	0.40699	0.52182	0.62873	0.5092	0.75419	0.46487	0.66734	0.78408	0.5097	0.62306	0.89047	0.79751	0.8623	1.00525	1.26463	1.05794		
41	39	9:30	0.96803	1.07362	0.97897	1.02509	0.96658	1.18732	1.05072	1.06409	0.40699	0.52182	0.62873	0.5092	0.75419	0.46487	0.66734	0.78408	0.5097	0.62306	0.89047	0.79751	0.8623	1.00525	1.26463	1.05794		
42	40	9:45	0.96803	1.07362	0.97897	1.02509	0.96658	1.18732	1.05072	1.06409	0.40699	0.52182	0.62873	0.5092	0.75419	0.46487	0.66734	0.78408	0.5097	0.62306	0.89047	0.79751	0.8623	1.00525	1.26463	1.05794		
43	41	10:00	1.03667	1.30595	1.0233	1.15392	1.0471	1.37647	0.90545	0.99385	0.55678	0.75662	0.44079	0.43611	0.59566	0.503	0.65371	0.87085	0.57596	0.6899	0.84072	0.80516	0.86651	0.93103	1.18432	1.12324		
44	42	10:15	1.03667	1.30595	1.0233	1.15392	1.0471	1.37647	0.90545	0.99385	0.55678	0.75662	0.44079	0.43611	0.59566	0.503	0.65371	0.87085	0.57596	0.6899	0.84072	0.80516	0.86651	0.93103	1.18432	1.12324		
45	43	10:30	1.03667	1.30595	1.0233	1.15392	1.0471	1.37647	0.90545	0.99385	0.55678	0.75662	0.44079	0.43611	0.59566	0.503	0.65371	0.87085	0.57596	0.6899	0.84072	0.80516	0.86651	0.93103	1.18432	1.12324		
46	44	10:45	1.03667	1.30595	1.0233	1.15392	1.0471	1.37647	0.90545	0.99385	0.55678	0.75662	0.44079	0.43611	0.59566	0.503	0.65371	0.87085	0.57596	0.6899	0.84072	0.80516	0.86651	0.93103	1.18432	1.12324		
47	45	11:00	1.01695	1.49223	0.96989	1.1931	1.02953	1.29719	0.90994	1.19177	0.40242	0.53734	0.54969	0.38685	0.61318	0.68304	0.71972	0.70943	0.69581	0.7203	0.80301	0.8958	0.92206	0.87487	1.16938	1.09696		
48	46	11:15	1.01695	1.49223	0.96989	1.1931	1.02953	1.29719	0.90994	1.19177	0.40242	0.53734	0.54969	0.38685	0.61318	0.68304	0.71972	0.70943	0.69581	0.7203	0.80301	0.8958	0.92206	0.87487	1.16938	1.09696		
49	47	11:30	1.01695	1.49223	0.96989	1.1931	1.02953	1.29719	0.90994	1.19177	0.40242	0.53734	0.54969	0.38685	0.61318	0.68304	0.71972	0.70943	0.69581	0.7203	0.80301	0.8958	0.92206	0.87487	1.16938	1.09696		
50	48	11:45	1.01695	1.49223	0.96989	1.1931	1.02953	1.29719	0.90994	1.19177	0.40242	0.53734	0.54969	0.38685	0.61318	0.68304	0.71972	0.70943	0.69581	0.7203	0.80301	0.8958	0.92206	0.87487	1.16938	1.09696		
51	49	12:00	0.99112	1.29522	0.99256	1.27953	0.94875	1.34548	0.98374	1.22166	0.59394	0.64878	0.47118	0.43983	0.61888	0.51447	0.64863	0.6268	0.64249	0.92662	0.98887	0.68968	0.99412	0.83298	1.14708	1.05824		
52	50	12:15	0.99112	1.29522	0.99256	1.27953	0.94875	1.34548	0.98374	1.22166	0.59394	0.64878	0.47118	0.43983	0.61888	0.51447	0.64863	0.6268	0.64249	0.92662	0.98887	0.68968	0.99412	0.83298	1.14708	1.05824		

example-file-load-template

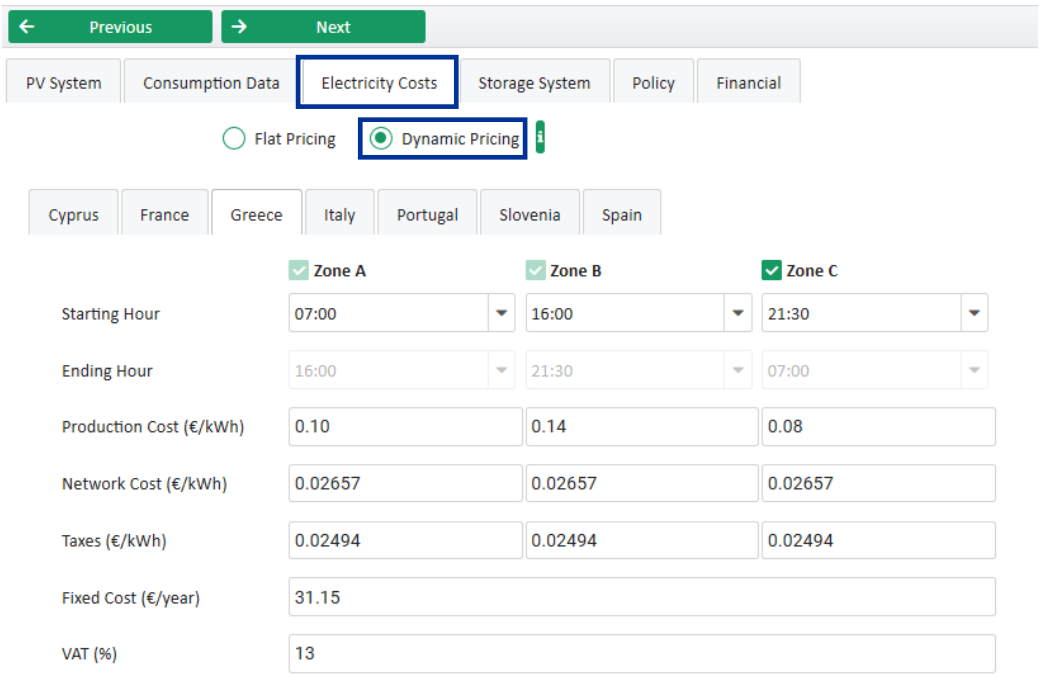
6.3 Electricity Costs

This tab consists of two options describing the electricity costs of the installation under study.

User can choose between either a *"flat pricing"* scheme, i.e. constant electricity charges throughout the period of a day, or a *"dynamic pricing"* scheme, where more than one time zones are valid.



In the dynamic pricing scheme, user should specify if two or three charge zones exist, by checking accordingly the *"Zone C"* option. The starting hour of each zone should be declared in an ascending order, beginning from Zone A. The ending hour is automatically filled in. Electricity costs should be inserted accordingly. It should be noticed that a dynamic pricing scheme cannot be selected when a *"Partial net-metering"* policy is selected in the *"Policy"* tab.



All values should be entered before VAT. Specifically,

- *"Production cost"* corresponds to the charges per kWh for the generation of electrical energy. It includes supply costs as well.
- *"Network cost"* corresponds to the costs per kWh that are charged to the prosumer for the use of distribution network and transmission system.
- *"Taxes"* include all other charges that may be applicable.
- *"Fixed cost"* refers to the fixed annual charges.
- *"VAT"* is the VAT that applies to the total electricity cost (sum of the above).

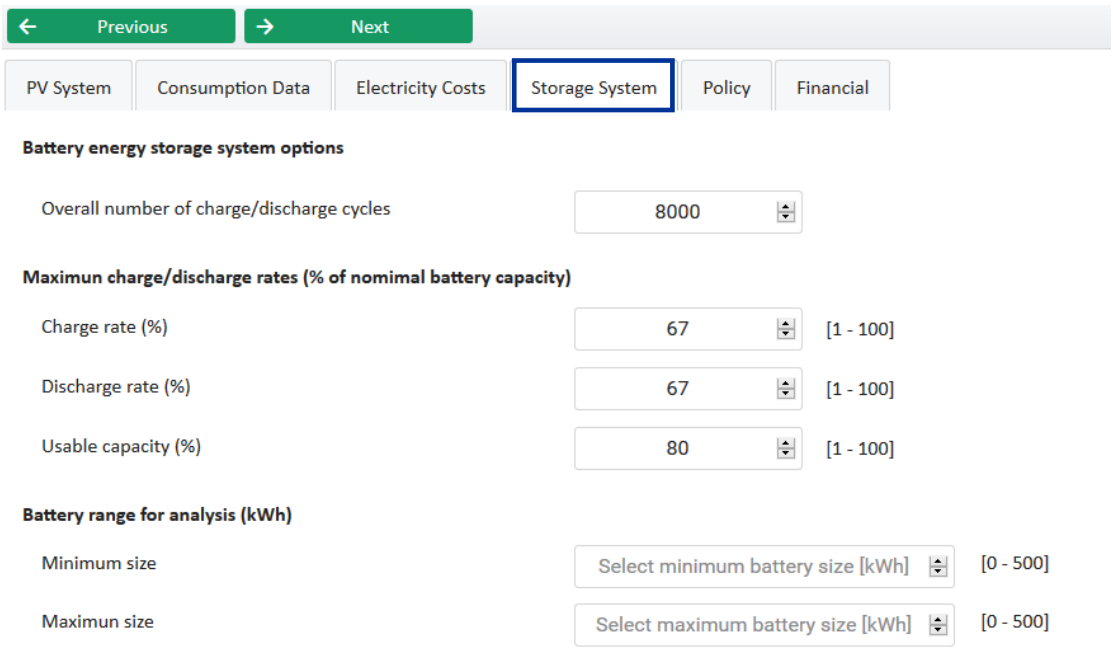
6.4 Storage System

The characteristics of the Battery Energy Storage System (BESS) are defined in this tab. The user is able to perform an analysis for different BESS sizes.

The expected *"overall number of charge/discharge cycles"* should be inserted, as declared by the manufacturer of the BESS. A number of 8000 cycles could be used as a typical value for Li-Ion batteries.

User should also define *"maximum charge/discharge rate"* of the BESS, as a percentage (%) of the nominal battery capacity. For example, if 50% is selected here, a 10 kWh BESS will have a maximum rate of 5 kW.

Finally, user should define the BESS size range to be analyzed by the tool.

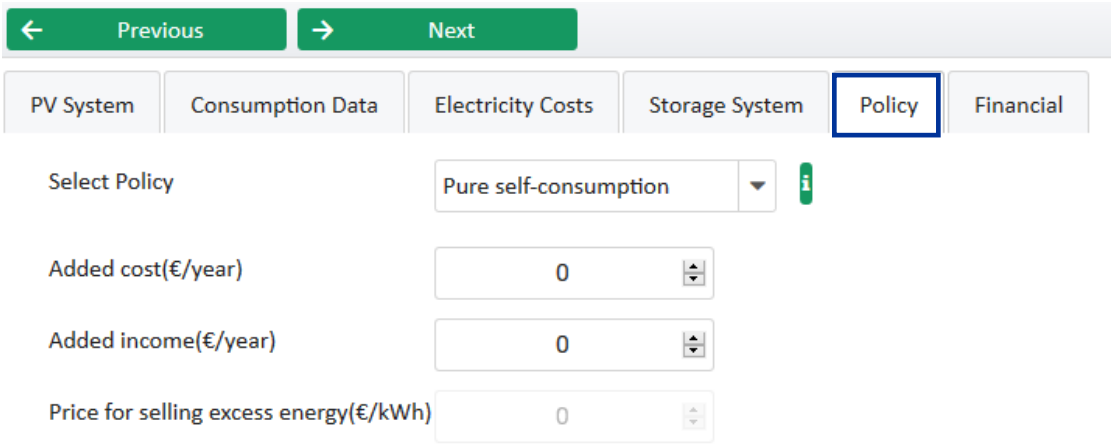


6.5 Policy

The user is able to choose between 3 policies from the drop-down menu *"Select Policy"*:

i. The first option refers to the *"Pure self-consumption"* policy, where PV excess energy exported to the grid is not compensated at all.
ii. The second option refers to the "*Self-consumption*" policy, where PV excess energy exported to the grid is compensated at the price specified in the corresponding box further down.
iii. The third option is available only under a *"Flat Pricing"* scheme (this can be chosen in the *"Electricity Costs"* tab). Specifically, it refers to a "*partial net-metering*" policy, where prosumer is charged on the net consumed energy by the production cost price, at the end of each billing period. If there is a surplus of produced energy (net consumed energy is zero in this case) over a billing period, this amount of energy is transferred - in the form of renewable energy credits - to the next billing period. At the end of each year, any renewable energy credits are erased. Prosumer is charged on the imported energy by the network costs and taxes declared in the *"Electricity costs"* tab.

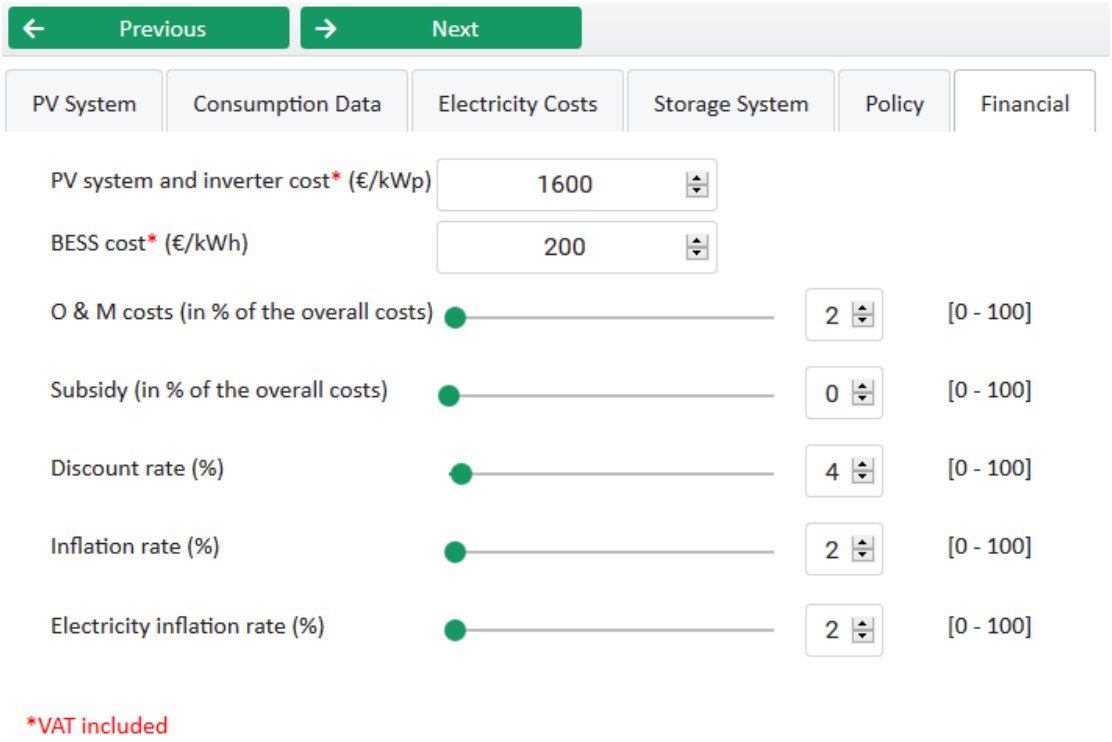
Furthermore, the user can define any added cost or added income that may apply to the prosumers for operating a PV or/and storage system.



6.6 Financial

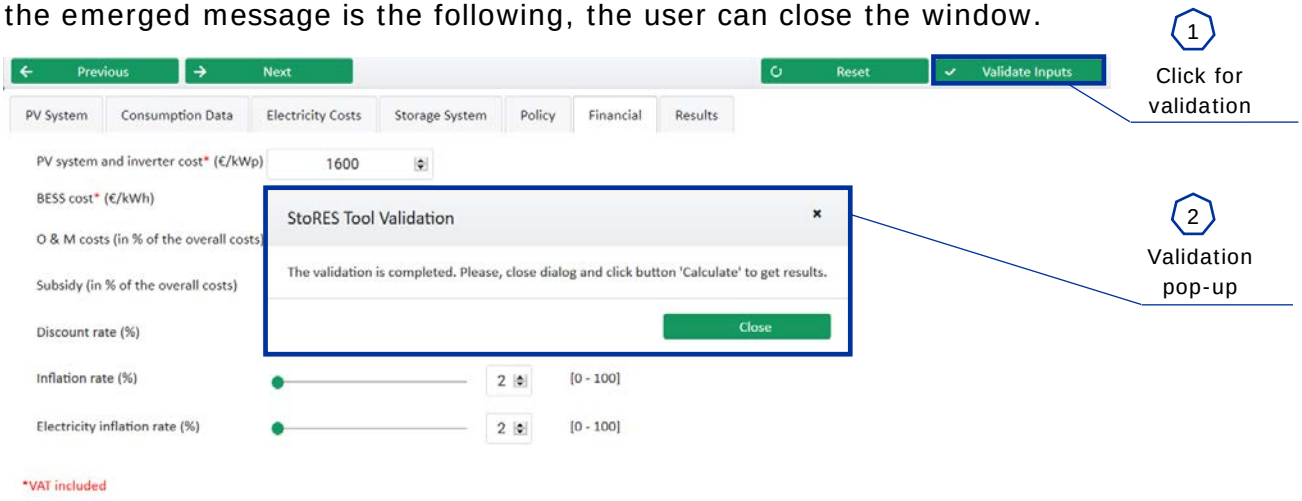
User should define the cost of purchasing the equipment, the Operation and Maintenance (O & M) costs of the hybrid PV and storage system, the subsidy as a percentage of the overall system cost, the discount rate, the inflation rate and the electricity inflation rate as shown below.

"PV and inverter cost" includes the cost of PV panels, the hybrid inverter, engineering, administrative and balance of systems costs (per kWp installed), whereas *"BESS cost"* refers to the battery energy storage system cost (per kWh), and includes only the cost of the battery module.



6.7 Validate Inputs

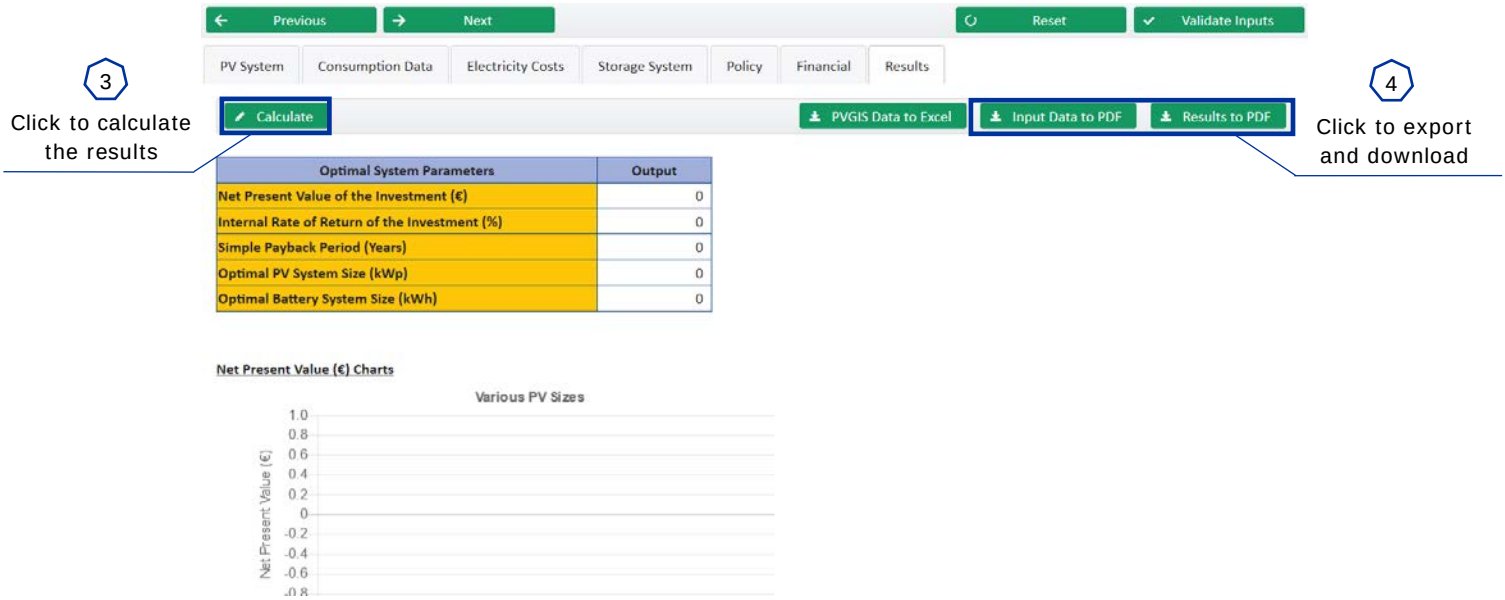
Once all the data have been inserted, user has to validate them by clicking on *"Validate Inputs"* button. A pop-up window confirms the validity of the inputs. The message indicates where the problem exists, if so, and after solving it, the user has to revalidate the inputs. A soon as the emerged message is the following, the user can close the window.



6.8 Getting the Results

Once the validation of the inputs is successful and the pop-up window is closed by the user, the tab *"Results"* is activated automatically. No results are depicted yet. The user has to click on "*Calculate*" button so that the tool starts the analysis.

When the analysis is finished, the results will be visualized on this screen. Analysis has a duration of several seconds to 2 minutes, respecting to the user specified options (PV and BESS size range for analysis).



To export the input data and the results in form of a *.pdf* file, user can click on the proper buttons that appear on the right-top of the page.