INTERREG SOLAR EMR : BUSINESS CASES

In this document, we describe and present the two PV business cases, namely the PV & battery simulation and a PV installation in the context of energy sharing. The SolarEMR deliverable 1 computational instrument (cfr. Interreg - Deliverable 3.1 – Computational instrument_v1.0) developed by Haulogy was employed to quantify and evaluate both business cases.

CONTENT

The SolarEMR project, is being carried out within the context of Interreg V-A Euregio MeuseRhine, with funding from the European Regional Development Fund.

INTRODUCTION

In the rapidly changing renewable energy landscape there is a growing need to accurately and rapidly assess and compare business cases for different assets (e.g. PV installation) in several contexts. For the purpose of the SolarEMR project we've chosen to address two use cases integrating PV installations. Specifically, a PV installation in combination with a battery and a PV installation in the framework of energy sharing.

Additionally, taking into account the content of WP1 and WP2 of the Interreg SolarEMR project, the tool also allows to promote different forms of PV (IPV, IIPV, DC vs AC, …) and to assess their profitability against others.

Both business cases were evaluated for a high-way tunnel in Belgium, with an existing noise-barrier adjacent and characterized by a specific consumption profile. In the context of WP1 and WP2 of the SolarEMR project, we've chosen to integrate the following two elements:

- We will simulate a noise-barrier IPV installation integrated in the existing noise-barrier.
- The target location is a tunnel, which is characterized by several DC-connected consumers (e.g. traffic lights, tunnel lighting, …).

The assessment and development of DC (components) connected PV installation forms part of the work done in WP2. The latter allows for additional efficiency gains through the avoidance of DC/AC conversion losses, as the noise-barrier IPV installation, battery and consumer (i.e. the tunnel) can be assumed to be DC connected.

Moreover, in line with Haulogy's other developments[1] we've chosen to only integrate "smart" batteries. The term "smart" refers to the intelligent steering of the battery based upon forecasts of solar production, consumption and electricity price, taking into account the pricing formula (night/day price, dynamic pricing, …). This allows the battery to make optimal use of "free" (e.g. solar production) or "cheap" (e.g. night price) electricity to charge.

Finally, in the energy sharing business case, we've opted for the optimal repartition key, namely the pro rata division. In this case, the excess PV production is divided proportionately according to the consumption at each 15 min interval. This allows to maximize auto consumption and minimize grid injection.

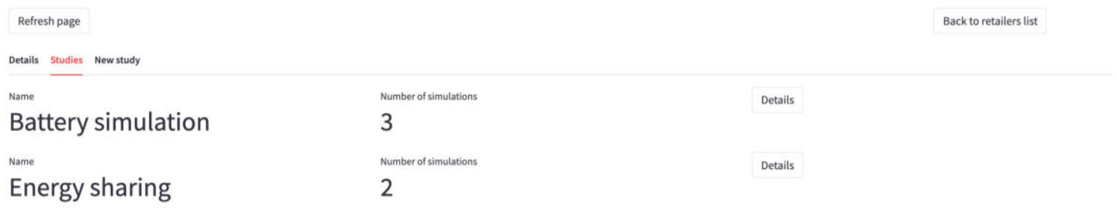

Figure 1: Summary of the two business cases

We evaluate the business cases of each simulation of each use case using the following parameters:

- Annual energy costs in €, representing the overall energy invoice, taking into account offtake, injection, energy shared and grid fees
- Self-consumption rate, defined as the ratio of the total energy consumption and the total energy production, in %

[1] Haulogy's Optiflex software

- Self-coverage rate, defined as the ratio of the total energy production and the total energy consumption, in %
- Investment costs in €
- Payback time in years

BUSINESS CASE 1: PV AND BATTERY SIMULATION

USE CASE

The use case computed in business case 1 consists of the following assets:

- A consumption site, i.e. the tunnel, characterized by a consumption profile for 2022.
- A 600 kWp noise-barrier IPV installation adjacent to the consumption site (i.e. the tunnel), characterized by the specific production profile obtained as a deliverable from WP2 in the SolarEMR project. The PV installation cost was estimated at 1500 €/kWp for a total investment of 900.000 €.
- A 300 kWh battery with an inverter power of 150 kW, which is smart controlled based upon the electricity price (dynamic spot market contract). The battery cost was set at 220.000 € following the current battery market prices.

The reference power market prices of the year 2021 were used in combination with the specifications of a dynamic supply contract. We chose 2021, because the electricity prices in 2022 were very extreme and not representative.

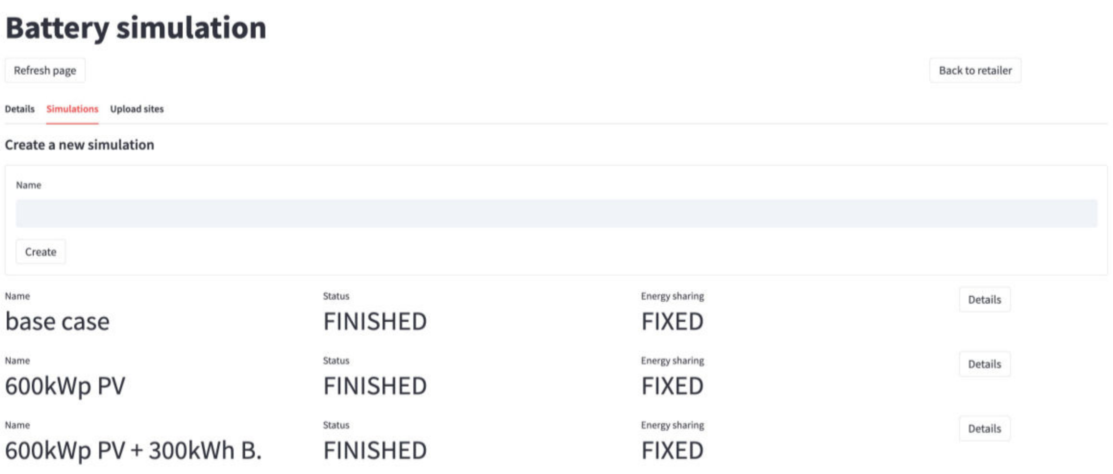

Figure 2: Summary of the simulations performed in business case 1, the battery simulation

BASE CASE

In the base case we simulate the “as-is situation”, a tunnel characterized by its 2022 consumption profile. The idea is to have a reference against which to compare the other simulations within the business case. The base case is also used as a reference to determine the payback time of the different simulations.

NOISE-BARRIER IPV INSTALLATION SIMULATION

In the second simulation we’ve added the 600 kWp noise-barrier IPV installation. In this way we can determine the value of the PV installation and battery independently from each other.

NOISE-BARRIER IPV INSTALLATION AND BATTERY SIMULATION

The third and final simulation consist of both the 600 kWp noise-barrier IPV installation and the 300 kWh battery.

RESULTS

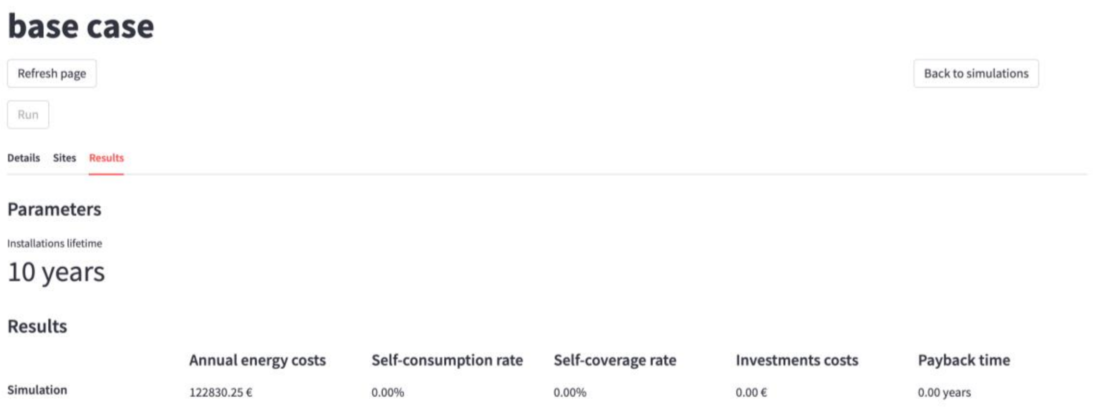

Figure 3: Results of the base case simulation

The above Figure 3Figure 9 shows the results of the base case or “as-is situation” for the battery simulation business case. Given that this is the “as-is situation”, no assets (PV or battery) nor investments costs were defined and the resulting payback time is 0 years. The resulting self-consumption and self-coverage rate are both 0%. The annual energy costs represent the current yearly electricity invoices.

The Figure 4 below represents the “to-be situation”, for which we wish to know the business case. In this case, a 600 kWp noise-barrier IPV installation was defined with an investment cost of 900k€. This allowed the site to reduce its energy bill by almost 130k€, resulting in a payback time of 7.06 years.

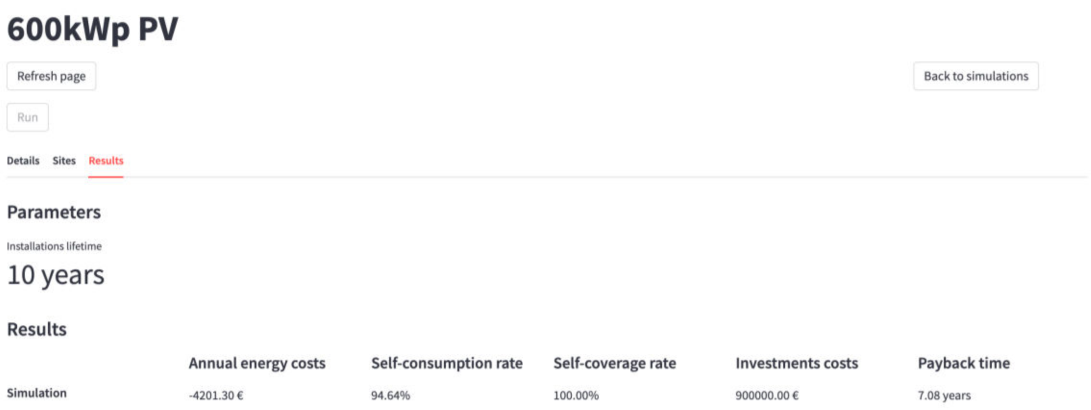

Figure 4: Results of the 600 kWp noise-barrier IPV installation simulation

Figure 5: Visual representation of the energy flows and prices for the 600 kWp noise-barrier IPV installation simulation for a given week

The Figure 6Figure 4 below represents the second "to-be situation", for which we wish to know the business case. In this case, a 600 kWp noise-barrier IPV installation was defined with an investment cost of 900k€, as well as a 300 kWh battery with an investment cost of 220.000€. This allowed the site to reduce its energy bill by over 150k€, resulting in a payback time of 7.32 years.

600kWp PV + 300kWh B.

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Parameters

Installations lifetime

10 years

Results

	Annual energy costs	Self-consumption rate	Self-coverage rate	Investments costs	Payback time
Simulation	-30139.36 €	94.64%	100.00%	1120000.00 €	7.32 years

Figure 6: Results of the 600 kWp noise-barrier IPV installation + 300 kWh battery simulation

Figure 7: Visual representation of the energy flows and prices for the 600 kWp noise-barrier IPV installation + 300 kWh battery simulation for a given week

BUSINESS CASE 2: ENERGY SHARING

THE USE CASE

The use case computed in business case 2 consist of the following assets:

- A consumption site, i.e. the tunnel, characterized by a consumption profile for 2022.
- A secondary consumption site, i.e. an educational institute, characterized by a reference consumption profile for 2022.
- A 600 kWp noise-barrier IPV installation adjacent to the consumption site (tunnel), characterized by the specific production profile obtained as a deliverable from WP3 in the SolarEMR project. The PV installation cost was estimated at 1500 €/kWp for a total investment of 900.000 €.

A battery was omitted from this business case as the idea is to share the excess energy with the secondary consumption site.

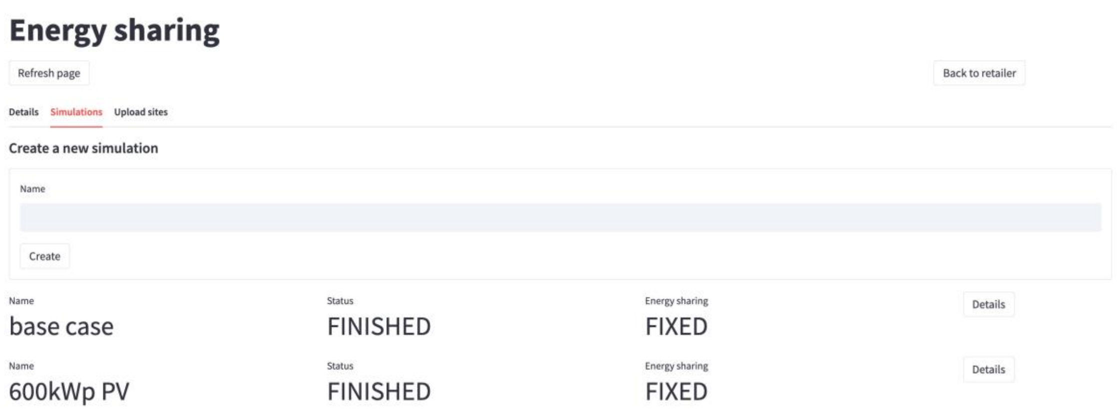

Figure 8: Summary of business case 2, the energy sharing

BASE CASE

In the base case we simulate the "as-is situation", a tunnel characterized by its 2022 consumption profile. The idea is to have a reference against which to compare the other simulations within the business case. The base case is also used as a reference to determine the payback time of the different simulations.

NOISE-BARRIER IPV INSTALLATION SIMULATION + ENERGY SHARING

In this simulation we've added a secondary site, i.e. the academic institute, and the 600 kWp noise-barrier IPV installation, in the framework of energy sharing.

RESULTS

base case

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Parameters

Installations lifetime

10 years

Results

	Annual energy costs	Self-consumption rate	Self-coverage rate	Investments costs	Payback time
Simulation	169816.52 €	0.00%	0.00%	0.00 €	0.00 years
Site 5	122830.25 €	0.00%	0.00%	0.00 €	0.00 years
Site 6	46986.27 €	0.00%	0.00%	0.00 €	0.00 years

Figure 9: Results of the base case energy sharing simulation

The above Figure 9 shows the results of the base case or "as-is situation" for a certain energy sharing simulation. Given that this is the "as-is situation", no assets (PV or battery) nor investments costs were defined and the resulting payback time is 0 years. The resulting self-consumption and self-coverage rates are both 0%. The annual energy costs represent the current yearly electricity invoices.

The Figure 10 below represents the "to-be situation", for which we wish to know the business case. In this case, a 600 kWp PV installation was defined on site 10 with an investment cost of 900k€. This allowed the site to reduce its energy bill by almost 135k€, resulting in a payback time of 6.68 years. The overall business case of the integration of the PV installation and the energy sharing has a payback time of 6 years.

600kWp PV

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Parameters

Installations lifetime

10 years

Results

	Annual energy costs	Self-consumption rate	Self-coverage rate	Investments costs	Payback time
Simulation	41895.70 €	100.00%	74.47%	900000.00 €	7.04 years
Site 9	7589.76 €	94.64%	100.00%	900000.00 €	7.81 years
Site 10	34305.94 €	0.00%	0.00%	0.00 €	0.00 years

Figure 10: Results of the 600 kWP noise-barrier IPV installation + energy sharing simulation

Figure 11: Visual representation of the 600 kWP noise-barrier IPV installation + energy sharing simulation of the tunnel for a given week

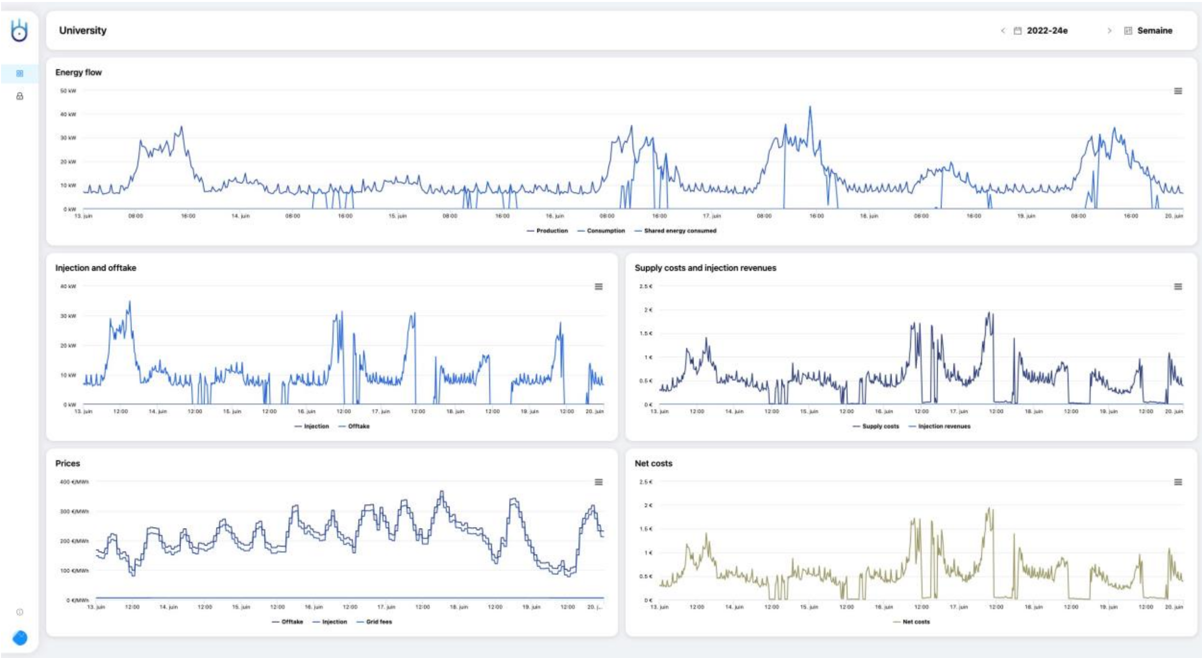

Figure 12: Visual representation of the 600 kWP noise-barrier IPV installation + energy sharing simulation of the university for a given week

CONCLUSION

Table 1 below shows a summary of the results of both scenarios with each of the defined simulations. The first 3 lines represent the scenario in which we simulated the PV installation and optionally the battery, while the last 2 lines represent the energy sharing scenario in combination with the PV installation. The latter shows the overall results for the combined sites.

We can clearly conclude that the integration of the PV installation has the biggest impact on all indicators in both scenarios. A decrease of the annual energy costs of over 120k€ can be concluded in both cases. The addition of a battery decreases the annual energy costs further with over 25k€, but also represents a significant investment cost of 220k€, which leads to an increased payback time.

	Annual energy costs (€)	Self-consumption rate (%)	Self-coverage rate (%)	Investment cost (€)	Payback time (years)
base case PV + battery	122830	0	0	0	0
600 kWp PV	-4201	96.64	100	900000	7.06
600 kWp PV + 300 kWh battery	-30139	96.64	100	1120000	7.32
base case PV + energy sharing	169816	0	0	0	0
600 kWp PV + energy sharing	41896	100	74.47	900000	7.04

Table 1: Concluding table summarizing the results of all simulations.

We can conclude that both business cases can be considered relevant and economically viable, whether in combination with a battery or not. Purely based on the payback time, the preferred scenario is the integration of the PV installation in the context of energy sharing.

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