D4.6.1. Report on the Middelkerke Groenhagemolen System

This document has been elaborated by KU Leuven for Middelkerke

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Executive summary

This report describes the performance of the PV-battery system at the SOLARISE Middelkerke Pilot Groenhagemolen, based on one year of data, from April 2021 to March 2022. The 9.1 kWp, 6 kVA PV system is combined with 14 kWh of Lithium-ion battery storage, which is installed at the historical site of the Groenhage mill.

The system is capable of meeting 83.5% of the site's annual energy needs: it reduces the need to purchase electricity from 3900 kWh/year to 640 kWh/year. Over the lifetime of the system, it is expected to save approximately 20.9 tonnes of CO_2 emissions. Possible means of further increasing the self-consumption (or reducing PV export to grid) could be to host public e-bike or electric vehicle charging points at the site, as well as increasing the number of events or gatherings at the Groenhagemolen site.

Contents

1. Context and historical development

Installing PV on or near to historically significant buildings in the Interreg 2Seas Region is a challenge, for which the Middelkerke Groenhagemolen Pilot demonstrates possible solutions. Figure 1 shows the roof intended for PV installation at the start of the project, with Figure 2 the solution found to host the PV modules: a renovation of the roof structure, with the removal of asbestos. As such, the project is future-proof, even in case of asbestos rules and regulations becoming more stringent over time.

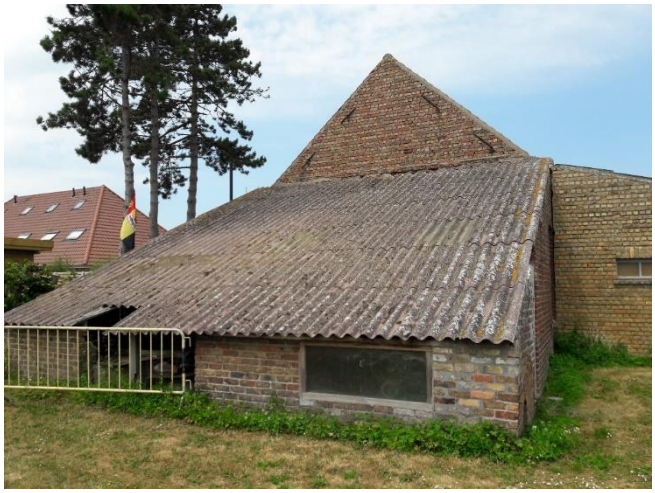

Figure 1: Roof with asbestos next to Groenhagemolen, before renovation

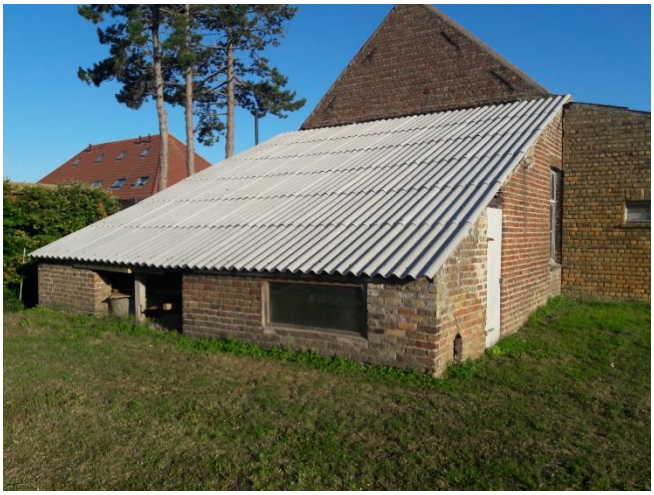

Figure 2: Renovated roof for PV installation

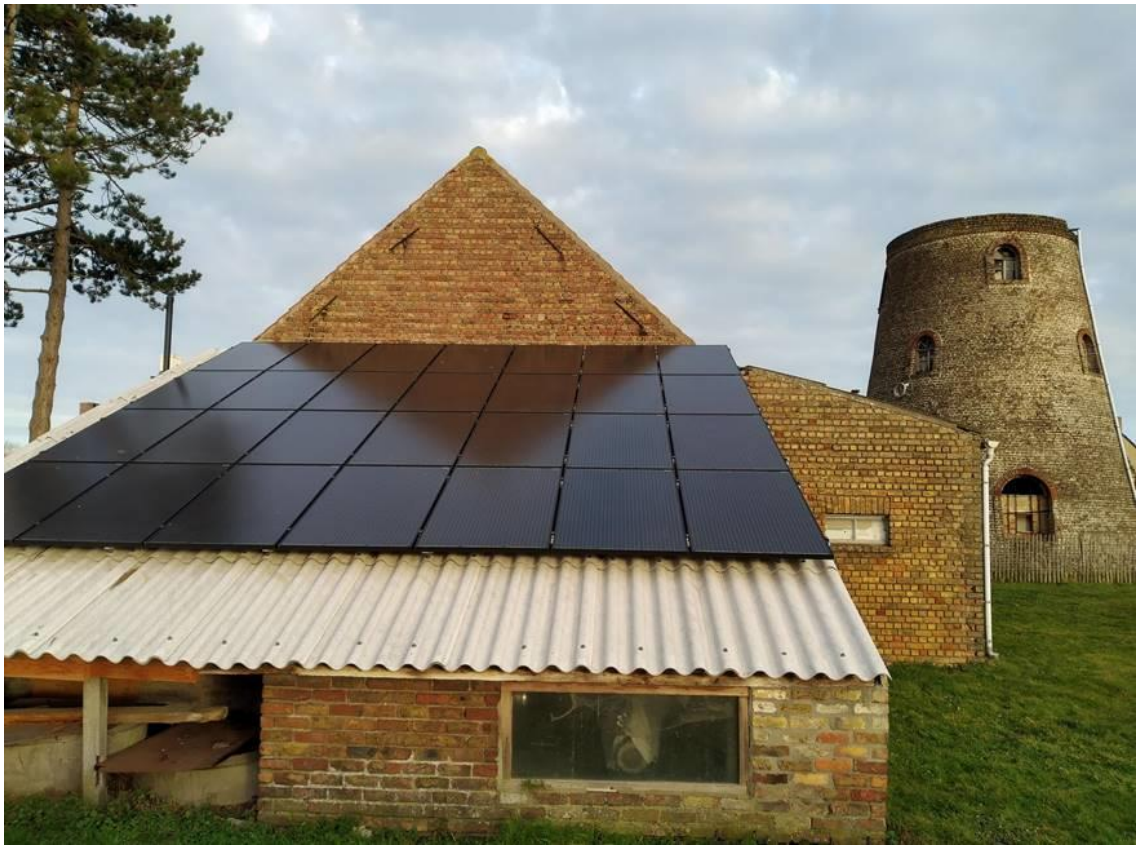

Figure 3: Installed PV system on the renovated roof. The Groenhage Mill tower (Groenhagemolen) can be seen in the background.

Table 1: System overview of Groenhagemolen PV-battery system

PV Modules	PV system DC power	PV system AC power	PV system tilt	PV system orientation	Battery system	Battery interface
325 Wp	**9.1 kWp**	**6 kVA** (2x 3 kVA SolarEdge inverters)	23.5°	148° (SE)	2x LG Resu 7 kWh = **14 kWh**	2x SolarEdge Storedge SESTI DC-DC converter

The Groenhagemolen site hosts a small event space and provides space for residents to meet. As such, its consumption is relatively constant over the year, with a few outliers when larger events occur.

2. Middelkerke Groenhagemolen Monitoring

While the data from the Groenhagemolen is not yet available for a full year, it does suggest that the CO_2 savings from the PV-battery system will amount to approximately 20.9 tonnes of CO_2, assuming a lifetime grid CO_2 emission profile average of 130 gCO_2/kWh for Belgium.

Table 2: Middelkerke Groenhagemolen energy yield, CO_2 savings and self-sufficiency metrics

PV production (1 Apr 2021 - 31 Mar 2022)	PV lifetime estimated electrical yield over 25 years	Full year PV export	Full year PV Self-consumption	Net annual energy demand	CO_2 savings over 25 years	Full year self-sufficiency	Full year self-consumption
6986 kWh	161 029 kWh	3790 kWh	3196 kWh	641 kWh	20.9 tCO_2	83.5%	46.5%

Figure 4 shows that the monthly energy consumption at the Groenhagemolen site varies throughout the year with activities on-site. Despite the available battery storage (14 kWh) and installed PV capacity, there are several days in summer and autumn where energy must be purchased from the grid (e.g. in August). As is typical for the 2Seas regions, the winter PV production is quite low, which results in nearly 100% daily self-consumption for these months.

This system has a high percentage of self-sufficiency at 83.5% (i.e. that the PV + battery is able to meet 83.5% of the site's energy needs, and only needs to purchase 16.5% of the site's energy demand), yet exported 3.79 MWh PV energy, approximately 53% of the total PV generation.

In light of the invasion of Ukraine by Russia from 24 February 2022 and the impacts this has had on energy markets in Europe, the high self-sufficiency of the Groenhagemolen stands out as a positive note, as the site must only purchase 16.5% (641 kWh) from the grid, instead of the baseline 3900 kWh.

Possible means of further increasing the self-consumption (or reducing PV export to grid) could be to host public e-bike or electric vehicle charging points at the site, as well as increasing the number of events or gatherings at the Groenhagemolen site.

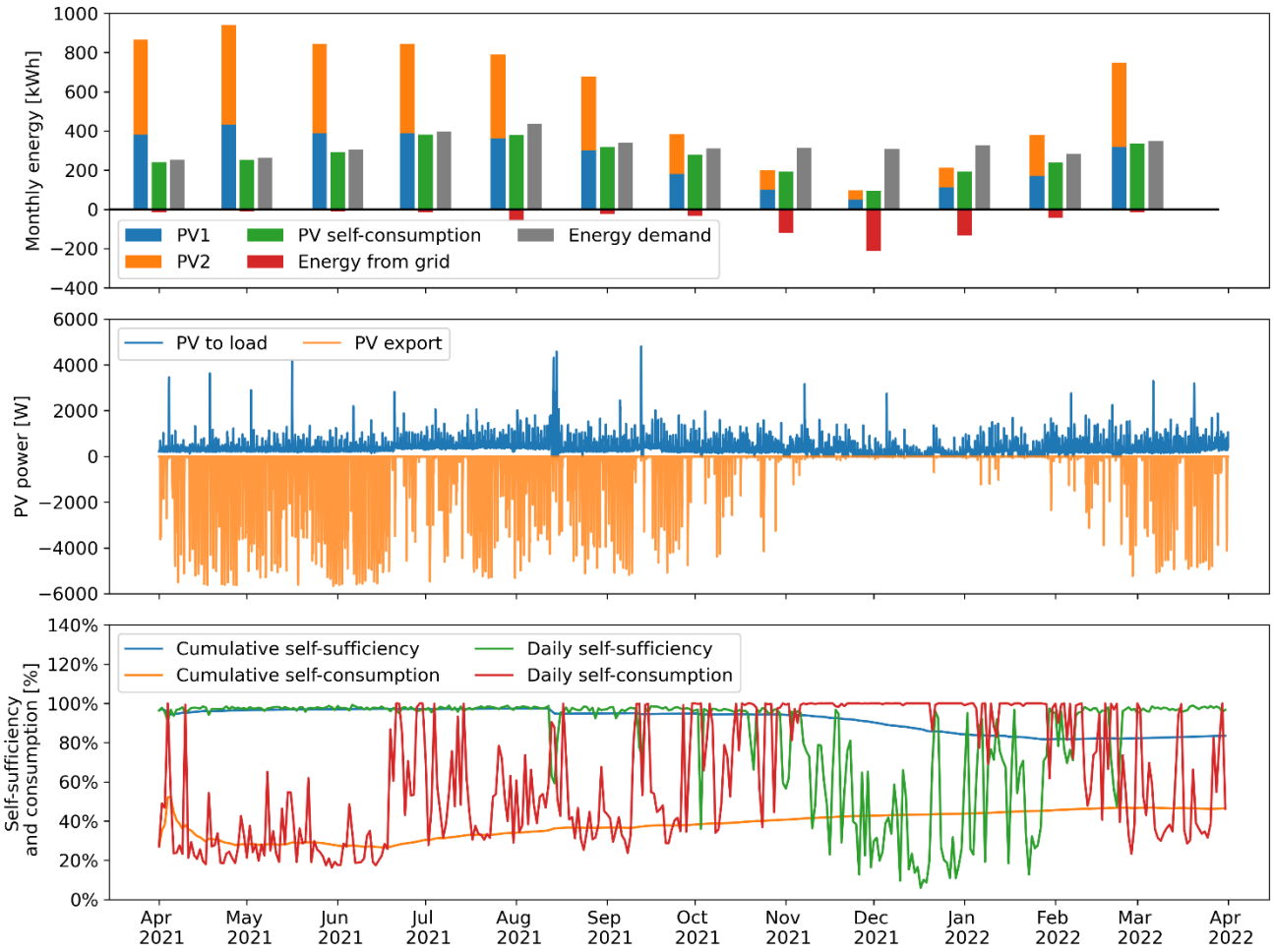

Figure 4: Total monthly energy generation and consumption (top pane), hourly PV power to load and export (middle) and daily self-sufficiency and self-consumption values for Groenhagemolen