

# Memo

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Subject            CILOLAB sprint: Essent's energy solution proposal  
                         for customer X facilities

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## 1. Introduction

When developing new office building with warehouse or logistics facilities, it is essential to consider their future energy needs at an early stage. In the context of increasing grid congestion, it has become even more important to assess whether the required grid connection capacity is available and to pro-actively identify alternative solutions where necessary. In parallel, maximising the use of locally generated renewable energy can contribute to improved overall energy efficiency and reduced environmental impact of the building.

As an example, Essent conducted a short in-depth study and developed a proposed energy connection and charging concept for a new office building and warehouse. The proposed connection is designed not only to support the building and its operational energy demand, but additionally also to provide charging facilities for employees' vehicles and delivery vans.

In this memo, the following research question is answered: 'What are possible energy solutions for new facilities for customer X in times of grid congestion?'

## 2. Situation description

As an initial estimate, the expected total energy demand of the facility was determined based on the installed equipment and estimated work patterns. In a second step, benchmark data from similar facilities was used to refine this estimate.

In addition, requirements were defined to support charging infrastructure for employees' vehicles and the company's delivery vans.

From an operational perspective, it was assumed that the facility operates during normal office hours, from Monday to Friday, between 08:00 and 17:00. Under this assumption, employee vehicles would primarily charge during office hours, while delivery vans would mainly charge outside working hours.

If the available grid connection capacity during the day is insufficient, priority is given to supplying the facility's operational energy demand over employees' vehicle charging.

With regard to the proposed solutions, it is assumed that the grid connection capacity is limited. Therefore, the solution should combine multiple energy assets to optimise energy generation and usage. Different assets can be combined and optimised, as not all assets are utilised simultaneously. On-site energy generation is subject to constraints related to available space and the expected power demand.

The concept, connection and energy sources for the facilities are presented in Figure 1.

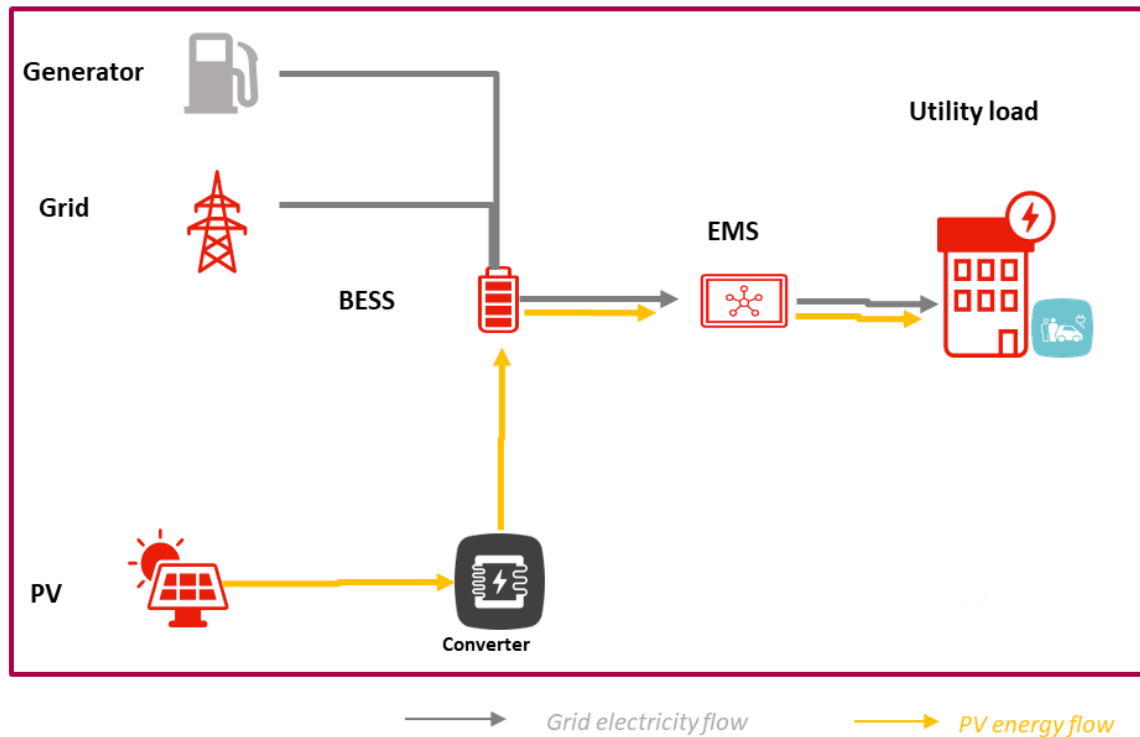


Figure 1: Schematic of expected energy sources for customer X.

The methodology employed consisted of an initial feasibility study followed by a more in-depth design phase. The feasibility study was conducted to provide the customer with an overview of what would be possible and to give a preliminary indication of costs and benefits. As such, it included multiple assumptions and estimates.

After the customer approved further development, Essent proceeded with a detailed design. This design was based on customer-provided data that had also been used in the building design phase. However, it was later observed that this data assumed a significantly higher energy demand than was realistic.

As a result, the initial design was over-dimensioned, leading to higher investment costs than necessary. To address this, a revised design was developed, aligning the energy system with more realistic demand levels while reducing overall investment costs.

### 3. Proposed energy solutions

#### 3.1. Initial proposition: No operation flexibility, high peak demand

Characteristics: The system is designed with operations as usual, meaning that all devices can operate at any time without restrictions, resulting in a high peak power demand. To support this, the solution provides high flexibility on the energy supply side through a combination of generation, storage, and grid usage. The objective is to allow the customer to operate without compromising energy use, while minimising reliance on the generator and maximising the use of renewable and grid energy. The generator is therefore intended only for peak demand and backup purposes.

The initial proposal is based on a system design that allows for maximum operational margins and operation under peak performance conditions. The energy system is designed to enable all components to be started up at any time.

The expected grid connection capacity available to the facility is 55 kW, while the estimated peak power demand is approximately 210 kW. Based on the expected operational profile, annual energy consumption is estimated at 818 MWh.

To meet this demand, a photovoltaic (PV) system with an installed capacity of 430 kWp has been proposed. To cover periods of low solar generation and provide a continuous power supply, the proposal included a biogas generator with a rated power of 240 kW. Although the selection of a biogas generator aims to reduce the facility's CO<sub>2</sub>-impact, biogas generators are significantly more expensive than biodiesel generators.

To further reduce generator usage, a battery energy storage system (BESS) with a storage capacity of 500 kWh has been proposed. This system can store surplus energy generated by the PV system and release it during periods of low solar generation.

### **3.2. Revised proposition: more realistic energy demand**

Characteristics: The main objectives remain unchanged; however, the system is scaled down to reflect more realistic energy consumption levels. This leads to a further reduction in expected generator usage, in line with the goal of limiting its use to peak and backup situations. In addition, demand optimisation measures are proposed, although on a voluntary basis. Operational recommendations are provided to guide user behaviour towards more efficient energy use, but the system is designed to ensure that sufficient energy is available even if these recommendations are not fully followed.

A more sophisticated solution was proposed based on insights from similar facilities. This revised approach takes into account the lower-than-expected energy demand and includes additional measures to reduce peak power demand, such as demand optimisation and improved management of load availability during the start-up phase of the working day.

For instance, the climate control system could be activated later in the morning, once PV generation becomes available. In addition, a larger energy reserve could be maintained in the BESS to supply predictable loads. This operational strategy can be further optimised based on actual PV energy generation and observed vehicle charging behaviour.

By combining adjustments to the charging strategy with increased flexibility in the sequencing of electrical loads, the expected peak power demand can be reduced to 115 kW. Consequently, the estimated annual energy consumption is reduced to 256 MWh/year.

The grid connection capacity remains unchanged at 55 kW. However, the PV system capacity is increased to 500 kWp, while the generator capacity is reduced to 50 kW. The required BESS capacity is also reduced to 230 kWh as shown in Figure 2.

Under this revised load scenario, the generator's operating hours are reduced. This reduction allows a shift from biogas to biodiesel while still achieving lower expected CO<sub>2</sub>-emissions compared to Scenario 1. Lower CO<sub>2</sub>-emissions are important for reporting requirements and for demonstrating compliance with sustainability objectives for the facility.

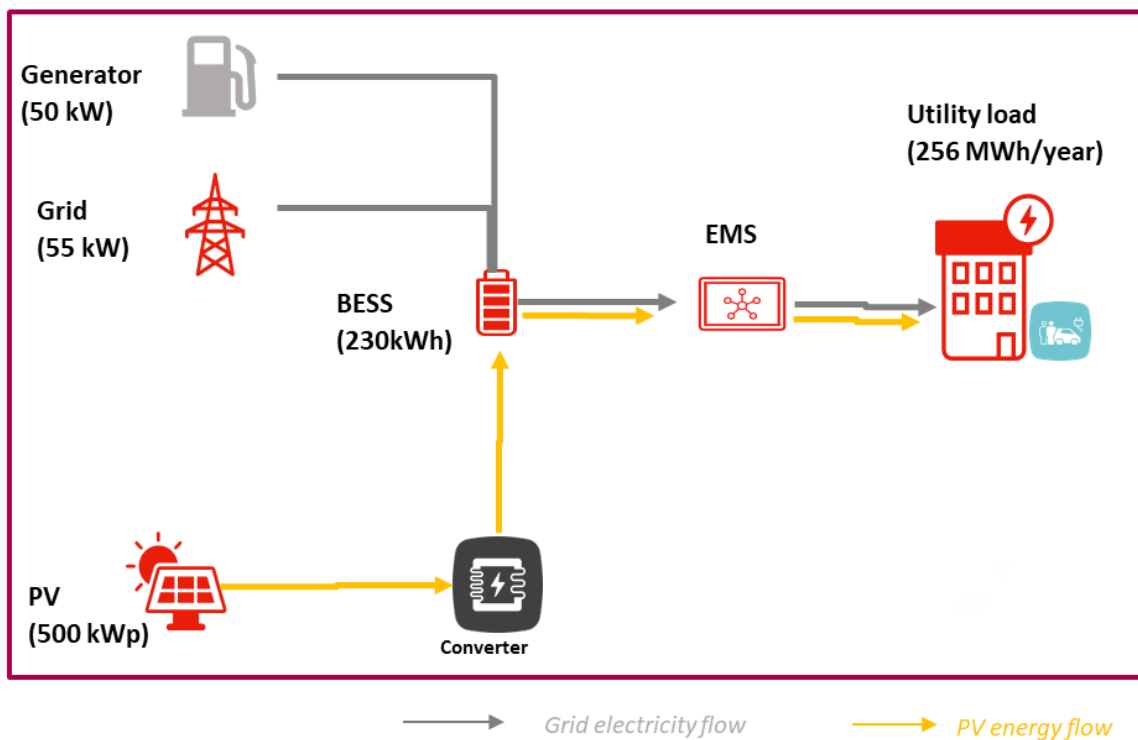


Figure 2: Scenario 2 energy connection schematics.

## 4. Outcomes

Considering the estimated annual energy demand of 256 MWh, it is expected that around 105 MWh of energy will need to be purchased from the grid. This relates to the coverage of energy needs in winter and when PV production is insufficient. Based on data from the [Global Solar Atlas](#), the PV production is estimated at around 446 MWh.

As mentioned, based on the data from the Global Solar Atlas, it can be observed that, for most months, the majority of solar generation occurs during the facility's operational hours (Figure 3). During the winter, PV generation may not fully cover the total energy demand if the energy demand is distributed equally throughout the year (see Fig. 4). It is expected that 49% of the generated PV energy will be consumed by the facility. This can be achieved thanks to the BESS. The BESS throughput energy is estimated at around 60 MWh. To cover peak demand when insufficient PV generation occurs, it is expected that the generator will need to deliver around 1.7 MWh of energy, which translates to around 473 litres of bio-diesel.

**Average hourly profiles**

Total photovoltaic power output [kWh]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0 - 1												
1 - 2												
2 - 3												
3 - 4												
4 - 5												
5 - 6					5.029	10.024	5.013					
6 - 7				8.754	26.256	29.067	24.017	14.104	0.916			
7 - 8			13.198	54.713	75.606	75.362	65.553	54.698	37.895	4.533		
8 - 9		11.784	70.885	118.559	136.905	133.181	122.470	113.418	99.195	61.670	6.314	
9 - 10	17.542	71.850	124.170	175.599	189.490	183.616	171.641	167.298	154.555	114.989	47.627	11.784
10 - 11	54.857	115.828	160.511	213.704	221.008	218.225	206.635	203.277	185.812	146.200	80.116	45.742
11 - 12	74.263	142.587	191.018	235.476	234.177	229.207	222.335	220.425	207.576	168.012	120.483	64.920
12 - 13	87.338	156.989	209.042	244.336	240.941	239.018	233.134	231.518	218.448	181.088	127.369	71.803
13 - 14	83.318	158.165	208.078	235.132	230.318	234.605	223.757	225.172	206.174	164.657	112.480	66.060
14 - 15	65.272	130.280	171.661	206.345	200.921	207.993	202.835	200.086	177.232	131.255	66.429	49.323
15 - 16	39.750	97.455	137.291	165.233	171.324	177.468	173.631	164.636	137.869	94.110	35.270	16.050
16 - 17	5.102	50.393	96.470	120.739	130.205	137.844	137.255	125.172	95.570	46.628	3.283	0.277
17 - 18		5.825	44.778	67.517	77.942	87.388	87.385	75.218	42.998	2.994		
18 - 19			2.433	19.158	30.849	39.596	39.758	27.485	3.242			
19 - 20				0.500	8.708	15.222	13.756	4.037				
20 - 21						1.942	1.354					
21 - 22												
22 - 23												
23 - 24												
Sum	427	941	1,430	1,866	1,980	2,020	1,931	1,827	1,567	1,116	599	326

Figure 3: Expected PV energy production based on Global Solar Atlas.

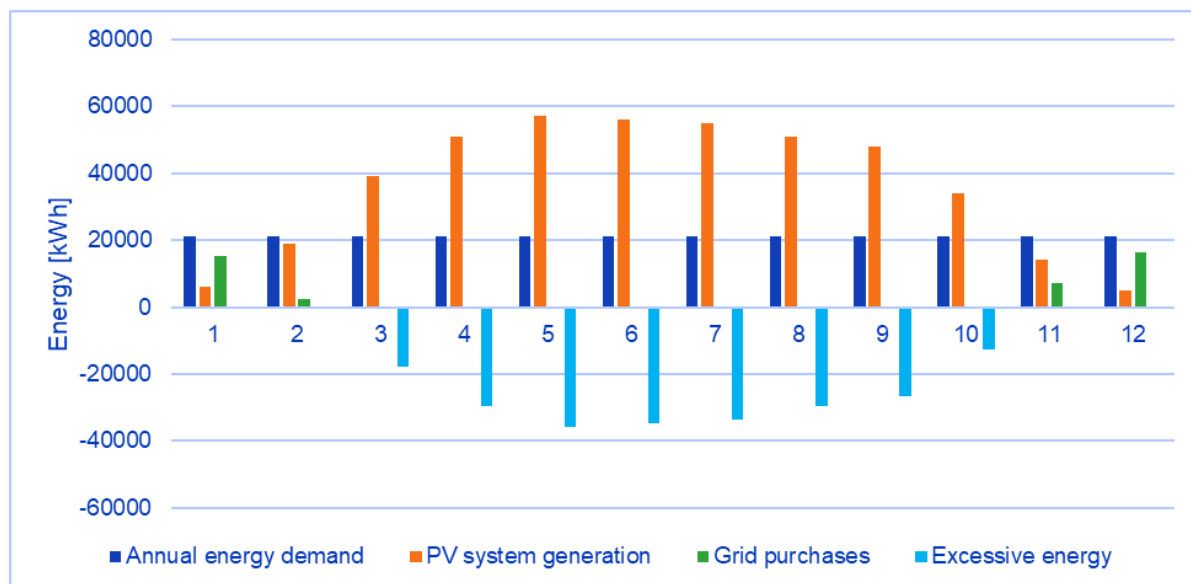


Figure 4: The facility's energy balance over the course of a year.

It is expected that approximately 226 MWh of excess energy will be generated by the PV system. This energy can be used for charging employee vehicles or, alternatively, exported to the grid. At present, however, exporting energy is not possible due to grid congestion. Although this may change in the future, the grid operator has not provided a timeline, and it is therefore likely that this limitation will remain for several years. As a result, the available surplus energy must either be used for vehicle charging or will be lost.

## 5. Conclusion

In summary, the solutions focus on supporting a limited grid connection with on-site PV generation, battery energy storage systems (BESS), demand-side optimisation, and supplementary generation (e.g. biofuel-based generators) to ensure reliable operation while minimising peak power demand.

Moreover, it is interesting to conclude that the Essent study results show that designs based solely on building plans and nominal equipment capacities can lead to oversizing of the solution. Incorporating realistic operational assumptions appears essential to avoid over-dimensioning.

Furthermore, some key take-a-ways emerged from the study:

Firstly, when there is no sufficient grid connection, it is important to consider and integrate different energy components, such as grid connection, PV, BESS and generators.

Secondly, system sizing and scoping should be combined with an understanding of energy consumption patterns. Aligning energy generation profiles with consumption patterns and shifting consumption away from peak times helps to reduce demand at these times and improves overall energy utilisation.

Thirdly, grid congestion affects not only the supply of energy from the grid but also the ability to export energy to the grid. Therefore, oversizing energy production can lead to wasted energy and unnecessary investment if alternative uses, such as charging employee vehicles, are not explored.

Fourthly, if conventional diesel fuel (EN 590) were used instead of biodiesel, the expected CO<sub>2</sub>-emissions from generator operation would be approximately 1,500 kg CO<sub>2</sub> per year, calculated on an operational (tank-to-wheel) basis.

Fifthly, for biodiesel, direct operational CO<sub>2</sub>-emissions are accounted for as zero, in line with standard reporting practices. However, when a life-cycle assessment (well-to-wheel) perspective is applied, biodiesel still results in emissions. Under the assumed operating conditions, these life-cycle emissions are estimated at approximately 23 kg CO<sub>2</sub> per year.

Finally, energy flexibility, enabled through BESS, demand-side management, and adaptable charging strategies, is a key enabler for operating facilities under constrained grid connections.

### 5.1. Limitations and open points

Due to non-disclosure agreements, sharing detailed data on Essent customer behaviour patterns is not feasible. As a result, in-depth analysis at a daily or monthly resolution could not be performed. Yet Essent validated the emerged findings of this study.

For the same reasons, expected charging behaviour and vehicle usage patterns could not be explicitly analysed or presented in this memo. It is recommended that Essent and its customer will execute a more detailed study further on in the development process, to better understand and create more insight into the electric charging limitations.

The memo is based on limited data from the company in question because of privacy issue, making it challenging to fully assess and validate the design choices proposed. Nevertheless, the results clearly indicate that improvements could be achieved by reducing reliance on the generator and by lowering peak power demand of the facility. This enabled more effective utilisation of the grid connection, battery energy storage system (BESS), and PV power generation.