Local aggregation services for providing flexibility to grid operation including congestion management

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Electricity market in Cyprus is still in its infancy but aggregation is coming …

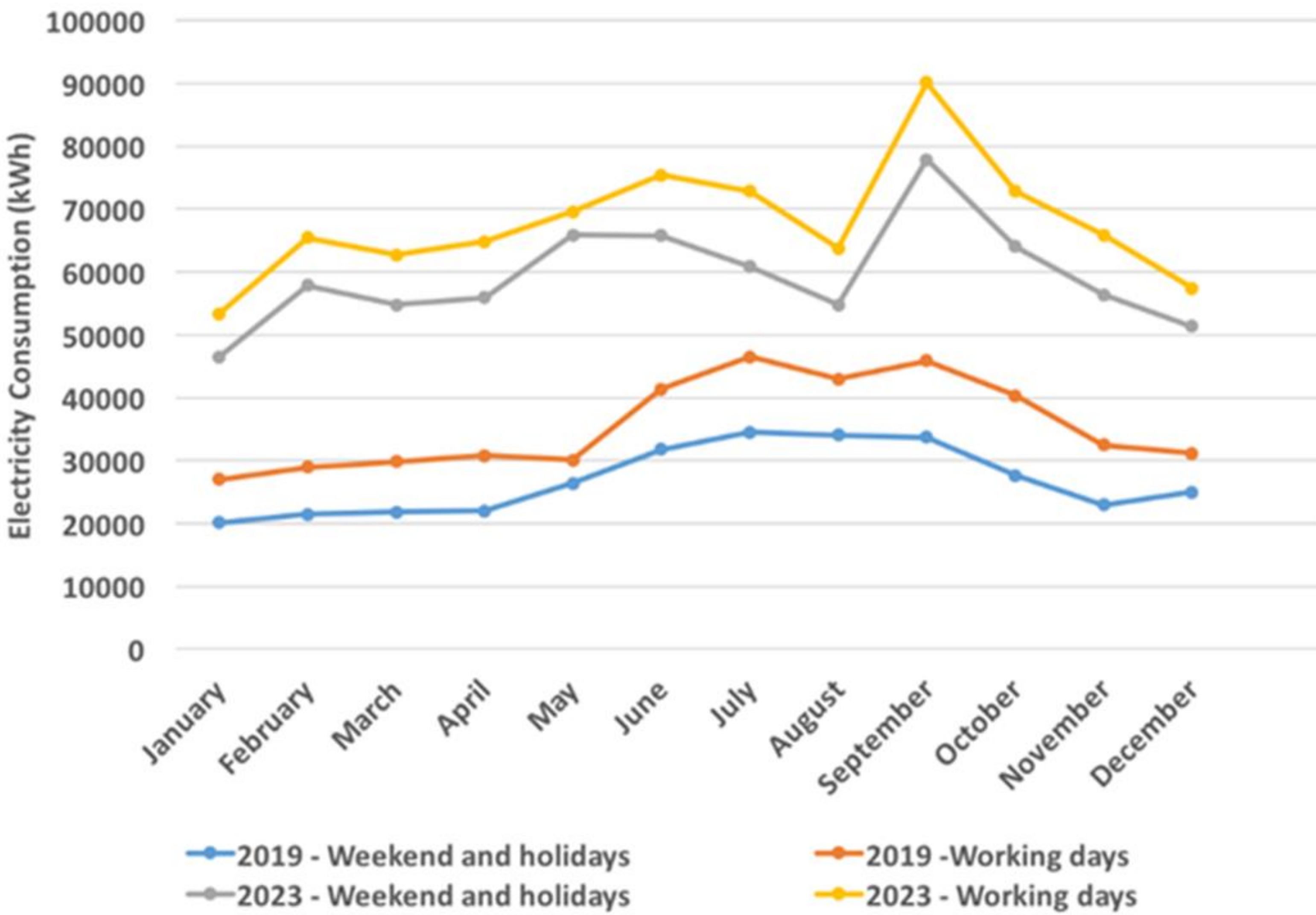
Definition of possible use cases

- Utilising net billing and net metering tariffs with time of use cost elements embedded in them offers options for minimizing energy cost through effective use of local RES generation and storage. This process will generate options for flexibility trading in support of the local grid as an added benefit. This case is being investigated in Cyprus with two distinct use cases:
  - Single mid-scale commercial or industrial consumers through the control of all assets from a single point of connection to the grid,
  - Spread small prosumers who are aggregated through the use of appropriate in-house energy management systems and smart connectivity with the local DSO.

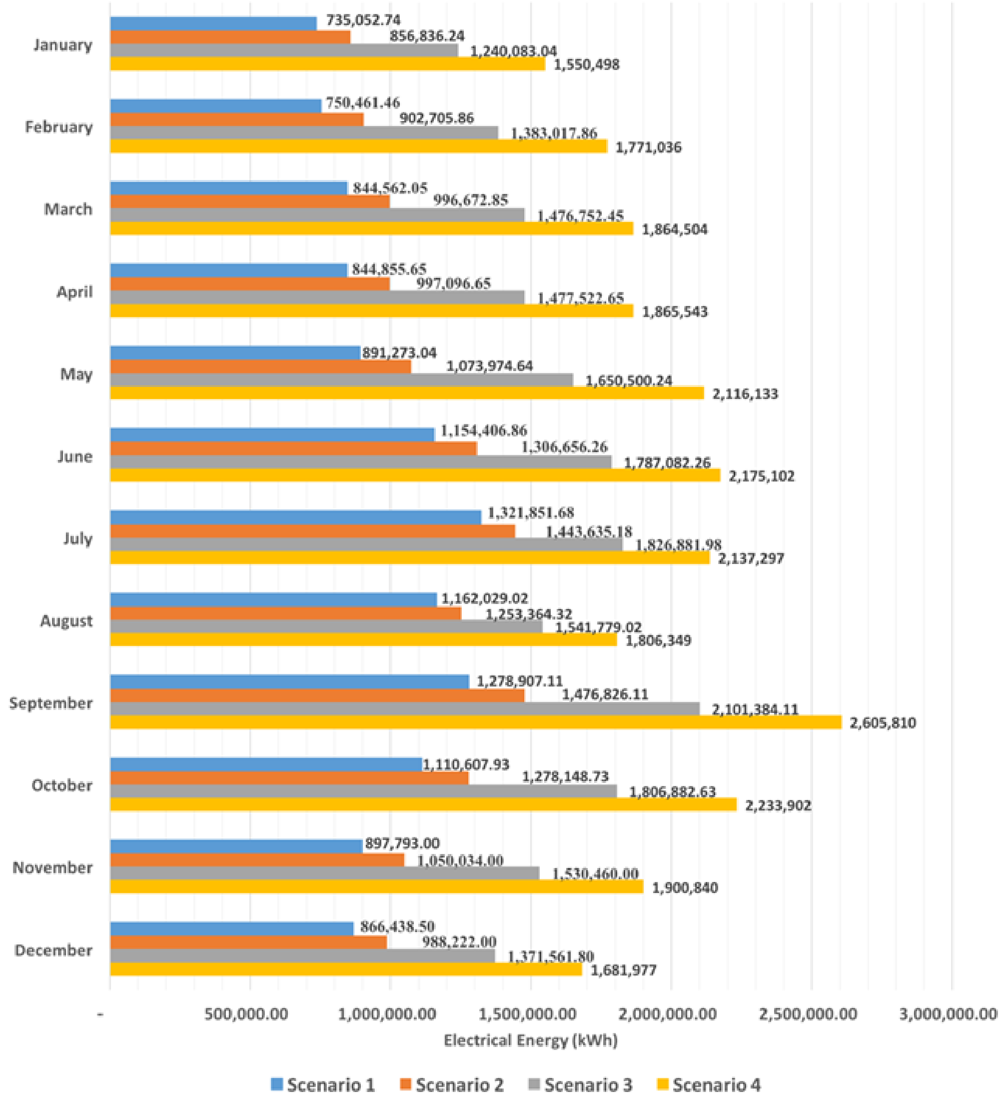
The Cyprus University campus: Pilot

A use case for BestRES but also for many other projects:
DELTA, GOFLEX, InteGRIDy and PEGASUS

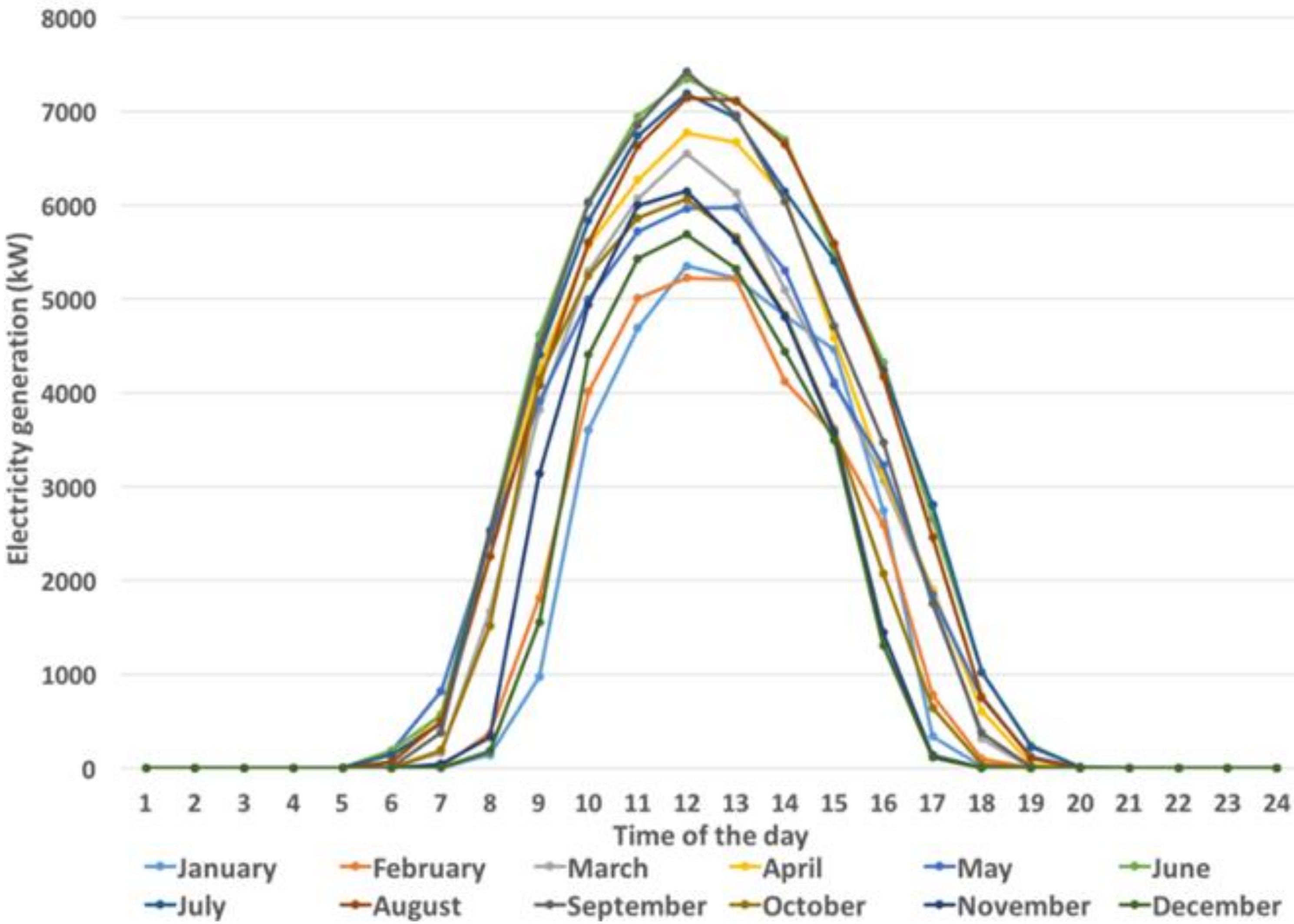
Current and estimated future average daily electricity consumption of UCY campus



Current and future load profile of UCY campus



Hourly generation curve from the projected 10MWp PV installation



Current optimization strategy

- An optimization function is used to decide the optimum BESS size that will minimize the costs of the electricity bill for the UCY campus microgrid in combination with the PV production on site and the net billing tariff that prevails.
- The BESS is generally charged during periods that PV generation exceeds the campus loads, in order to optimize the energy cost of the university by minimizing grid purchases during peak hours.
- In order to find the most feasible investment option, different BESS / PV sizes are considered. The generation and consumption profiles are evaluated using recorded data over a complete year.

Monetary saving of assessed microgrid configurations

Description	Annual energy cost in €	PV in kWp	Storage in kWh	Savings in mil €	capital cost in mil €	Generation in kWh
Without PV and S	2,413,969	0	0	0.000	0.000	0
With PV and without S	1,213,483	5,000	0	1.200	5.000	8,100,000
With PV and without S	1,008,058	6,000	0	1.406	6.000	9,720,000
With PV and without S	807,759	7,000	0	1.606	7.000	11,340,000
With PV and without S	609,486	8,000	0	1.804	8.000	12,960,000
With PV and S	1,398,670	4,000	2,350	1.015	5.410	6,480,000
With PV and S	1,286,764	4,500	2,350	1.127	5.910	7,290,000
With PV and S	1,179,485	5,000	2,350	1.234	6.410	8,100,000
With PV and S (licensed sizes)	1,075,717	5,500	2,350	1.338	6.910	8,910,000
With PV and S	974,060	6,000	2,350	1.440	7.410	9,720,000
With PV and S	773,761	7,000	2,350	1.640	8.410	11,340,000
With PV and S	674,425	7,500	2,350	1.740	8.910	12,150,000
With PV and S (Generated energy equivalent to load)	575,488	8,000	2,350	1.838	9.410	12,960,000

A good business perspective

- By taking into consideration the IRR and NPV of the investment, the obtained results point to the direction of the installation of **a PV installation of 8 MWp and a battery capacity of 2.35 MWh**.
- A payback period of less than 7 years is evaluated with the current electricity prices giving a strong positive message for the opted solution and the adapted microgrid architecture.
- In this analysis, the BESS has only been considered for supplying PV generated energy to the university microgrid. Other uses of battery, such as tariff arbitraging, ancillary and flexibility services that would increase the BESS's cost-effectiveness are not considered.
- These ancillary and flexibility services will be profitable for the UCY campus microgrid, when the electricity market will move into a liberalized form.

Support to the DSO grid with the generated flexibility & congestion management

- Since maximum demand occurs only a few hours per year, the microgrid operation can provide a reliable way to avoid Transmission and Distribution grid reinforcements by relieving peaks in demand, compensating for large feed-in from renewables and generally helping to balance the system and stabilize the grid.
- An estimation of the financial gains can be made, based on the assumption that the estimated grid investments of the DSO are avoided.

Managing the peak of the grid

- A first estimation of the financial gains is modelled by the difference in maximum peak demand between the Basic Load Curve, and the Resulting Load Curve after the operation of the microgrid.
- The equation used to estimate the ratio of investment savings is the following:

$$PD_{ratio} = \frac{PD_{RLC}}{PD_{BLC}}$$

where PD_{BLC} is the peak demand of the base scenario curve, PD_{RLC} is the peak demand of the load curve after the microgrid operation and PD_{ratio} is the ratio between the maximum values of the two load curves.

Reduced grid losses for the benefit of the system

- Reduced grid losses, which can be represented by the difference between the grid losses before and after the microgrid operation, have a potential to represent savings in monetary terms for the DSO.
- Total savings from avoided PV generation grid losses take into account the system availability and grid connection power losses (ηPPC) that are saved due to increased self-consumption of the PV generated energy. These losses, based on grid data of the past 5 years, range on average at 4.42% in the island of Cyprus. The annual financial benefit of the avoided distribution losses is calculated as follows:

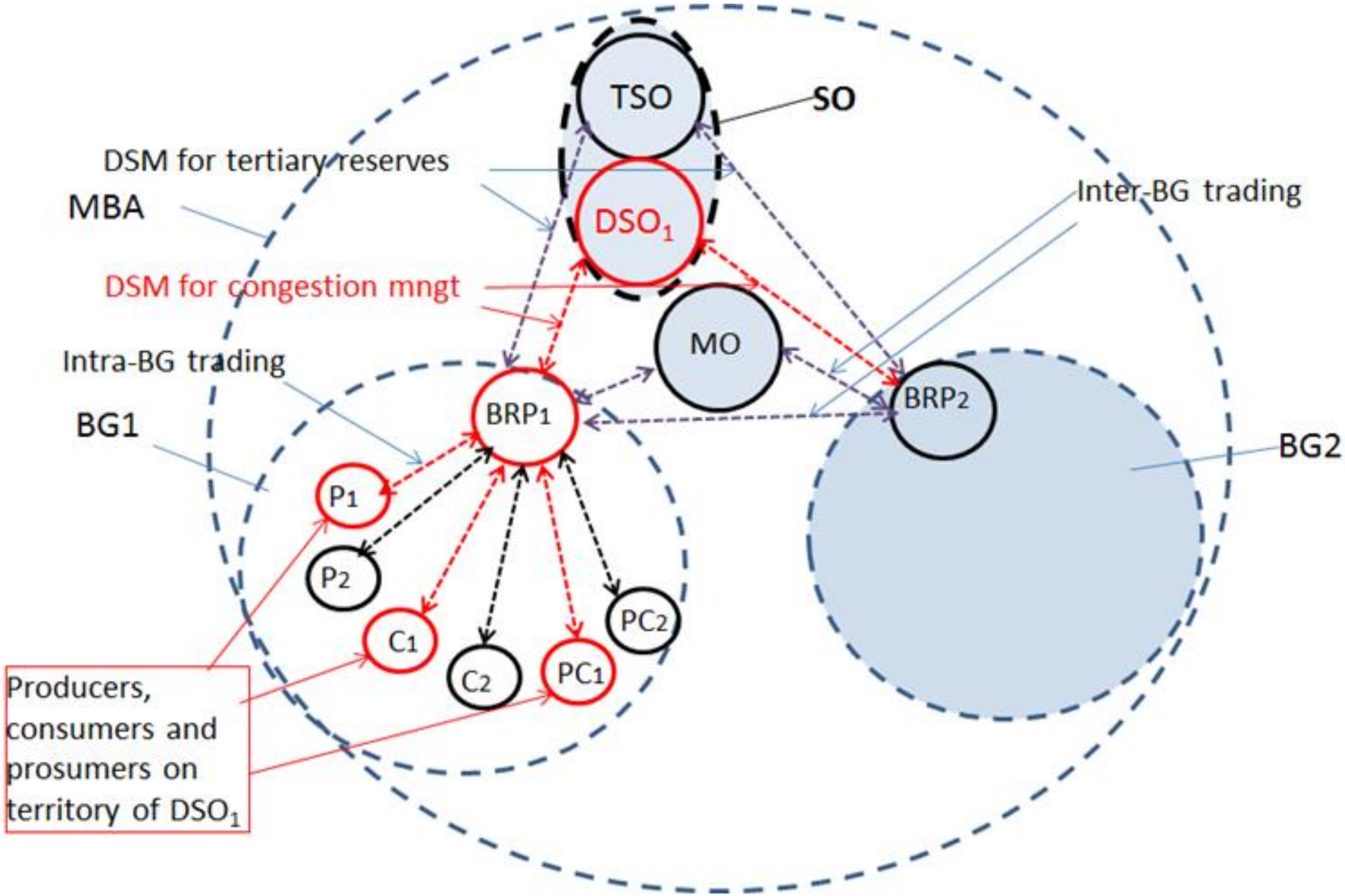
$$\pi_{losses} = \sum_{d=1}^{365} [\eta_{PPC} * PV'_{cons_i} * P_{PV}]$$

where P_{PV} is the wholesale electricity price that is offered by the utility for the energy that is sold to the grid and PV'_{cons_i} is the amount of PV generation that is directly consumed or stored by the microgrid in a single day.

Benefits that can be capitalised

- The operation of the microgrid results in monetary benefits of €1,002,282 for the DSO during the 4 years of development.
- The gains obtained under this scenario are derived from the reduction of distribution grid losses and the deferral of grid investments.
- It is apparent from the obtained results that the microgrid operation would be both beneficial and profitable for all parties involved.
- A theoretical *Optimal* scenario can be useful if conducted for this case as well, by analysing knowledge of imbalance prices and the best option between *optimal energy balance* and *Imbalance that can be extended to peak shifting and congestion*.

DR using generated flexibilities for congestion management at DSO level



Lessons learned and next steps

- The optimal sizing of the PV - battery storage combination is pivotal in creating business options medium to large commercial and industrial users.
- Moreover, the potential for the microgrid / self control to act as an alternative DSO option to grid investment but also managing operational congestion with the identified possible benefits through the generated flexibilities can form the business opportunity for aggregators in Cyprus.
- Obtained results show that the microgrid operation / self control can defer the upgrade of transmission and distribution grids and is able to lower their capacity demand and the electricity benefit brought by the reduction of grid losses provides another indirect benefit for the environment and the DSO and the system.
- This analysis has revealed that the opted business enhancement for aggregators in Cyprus can be in the first phase the following: Local aggregation services for providing flexibility to grid operation including congestion management

Thank you !

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