Flexibility for Markets and Grids: Economic and Technical Evaluation of the hybrid-VPP Concept

HYBRID VPP4DSO powered by klima+ energie fonds

hybrid-VPP Concept

The project **hybrid-VPP4DSO** investigates the concept of a hybrid virtual power plant to provide services for distribution **grid operators, grid customers** and **balancing markets** in parallel. For this, a coordination scheme between the DSO and the hybrid-VPP operator was developed, using a traffic light concept: In grid sections, which are in the **green** state, market participation is possible without restrictions. In the **yellow** state, a grid section is close to its limits (voltage or current) and market participation for the hybrid-VPP is restricted. Finally, if a grid section is in the **red** state and thus faces some potential voltage or overloading problems, the grid demands active support from the hybrid-VPP.

To realize this traffic light system an **enhanced interaction** between the different stakeholders would be required. Figure 1 shows the required interactions for one of the investigated use cases.

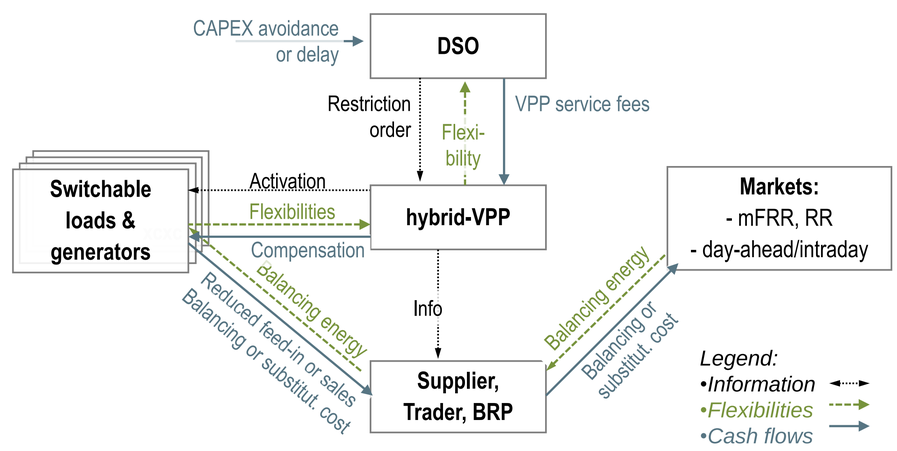


Figure 1: Main interactions between the stakeholders in the grid driven hybrid use case.

Economic and Technical Results

Customer driven use case

New grid customers or existing customers who want to increase their connection capacity can decrease their grid connection costs when participating in a hybrid-VPP. They thereby agree to **curtail their feed-in or consumption** on demand of the DSO during critical times, which should not count for more than 300 h/a. This use case was analysed in several case studies using grid simulations as well as economic calculations. Figure 2 shows the results of a scenario where three wind parks were connected in different grid sections. The economic assessment showed that **substantial savings** are possible for those new generators. However, this use case is strongly dependent on the grid topology and the value of the curtailed feed-in (or consumption).

Market driven use case

In critical grid sections, market operations of VPPs could cause voltage or overloading issues (Figure 3). In that case, the DSO would limit or exclude flexibilities in critical sections from the participation on the balancing market. If the current grid status is taken into account by the VPP operator (via a traffic light system), potential grid problems can be prevented. Therefore, introducing the hybrid-VPP concept **enables (more) flexibilities to participate in the market** in critical grid areas.

Figure 4 shows the results of a break-even analysis for this use case: The critical mass of a hybrid-VPP to participate is ca. 12 MW, assuming a payback-time of one year and 50% revenue sharing with the customer and an average of 1 MW of flexibility per customer.

Grid driven use cases

The hybrid-VPP can support DSOs with its flexibility in critical grid sections, thus **preventing or delaying** otherwise required **grid enhancements**. This use case was analysed for a grid area in Slovenia over one year, as shown in Figure 5. Under-voltage problems caused by a large amount of new customers would require reinforcements of the grid. As an alternative, using the the flexibility provided by the hybrid-VPP, those grid problems could be solved without reinforcements. Another use case for the DSO is to get **support during maintenance or special switching states**. In those situations the hybrid-VPP can support the grid operation and prevent possible disconnection of customers. The economic feasibility of this use case is heavily dependent on the (future) regulatory framework.

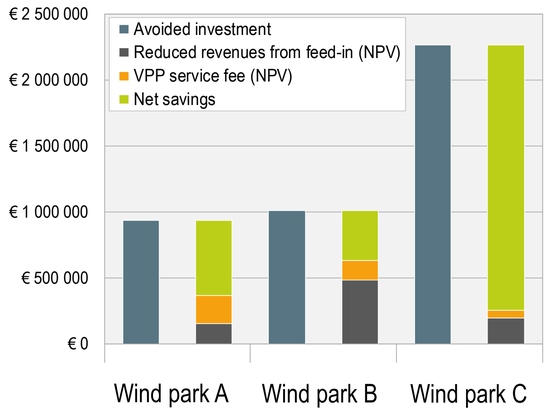


Figure 2: Customer driven use case – Economic assessment shows a profitability increase for 3 new wind power plants in different grid sections.

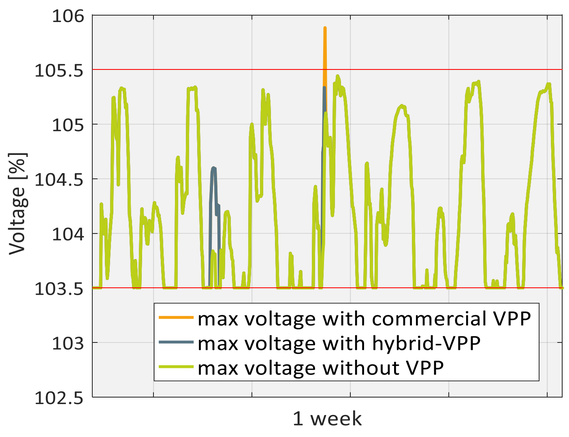


Figure 3: Market driven use case – Grid simulations show the possible benefits (from grid perspective) of a hybrid-VPP compared to a pure commercial VPP.

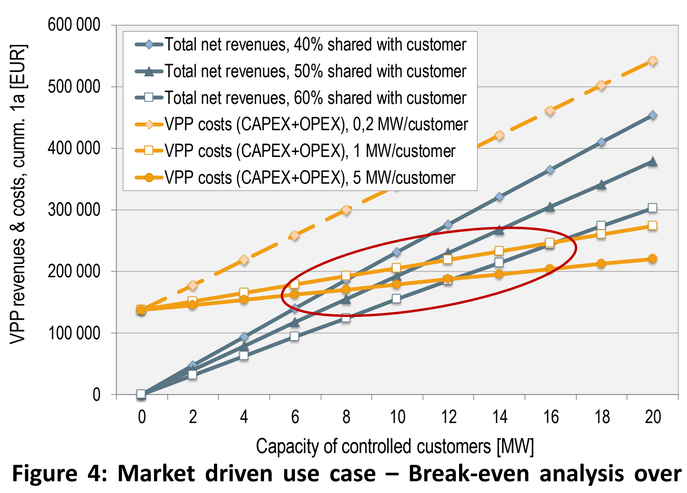


Figure 4: Market driven use case – Break-even analysis over one year operation time for different sizes of customers and service fees.

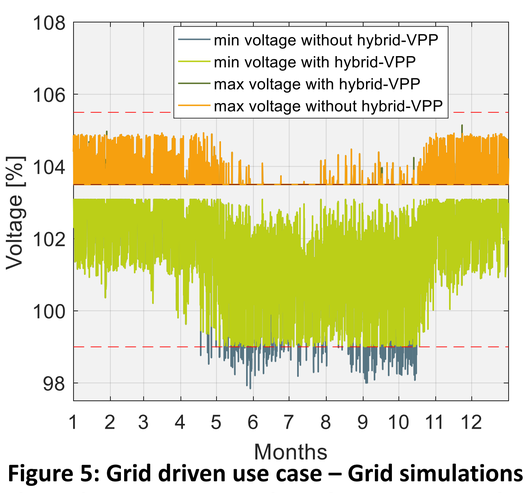


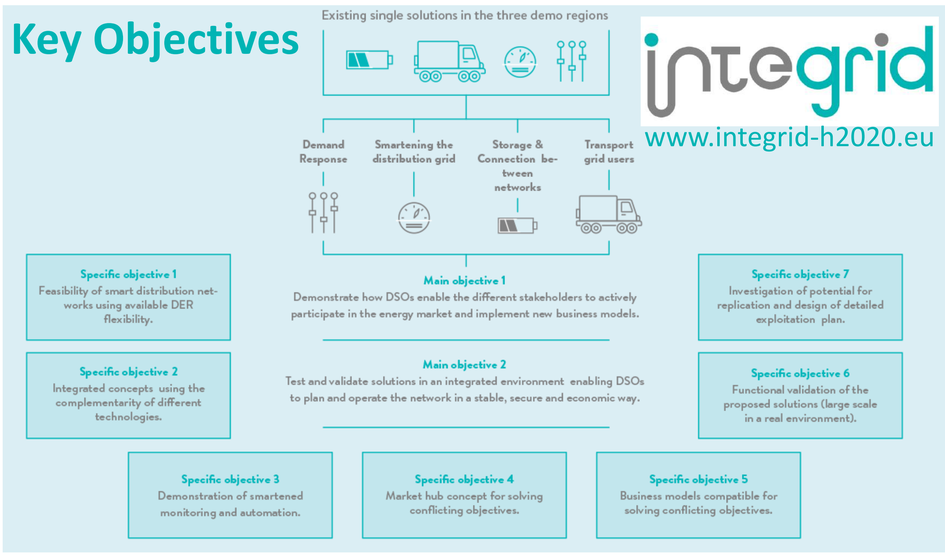
Figure 5: Grid driven use case – Grid simulations show that necessary grid reinforcements can be postponed by using a hybrid-VPP.

Conclusions

- The project successfully demonstrated the potential of a hybrid-VPP to **support DSOs in parallel to the active participation on a national market** for tertiary control.
- The applicability of the hybrid-VPP depends on the grid topology and the connection points, capacity and type of available flexibilities. The simulations showed that a **pool with units that are diverse in location and include demand side management as well as different types of (renewable) generators** is recommended in order to be able to successfully support the distribution grid operation throughout a whole year.
- The added value of a hybrid-VPP is mainly related to the **multitude of different use cases** (e.g. the reduction of investment costs for new users who connect to the grid and the prevention/deferral of grid investments of DSOs), which can be realized using the **same hybrid-VPP platform**.
- **Regulatory barriers for the integration of the hybrid-VPP** were identified especially for the remuneration of grid-friendly flexibility operation.
- Two promising solutions for the configuration of the **hybrid-VPP operator** were identified: i) the aggregator as hybrid-VPP-operator and ii) the DSO as market facilitator.

Outlook

The **Traffic Light System** as investigated in the hybrid-VPP4DSO project **will be further developed in the Integrid project**, funded by the EU's **H2020 program. InteGrid** aims at demonstrating how DSOs can enable different stakeholders to actively participate in the energy market, by testing and validating solutions in an integrated environment. Among these tools, the Traffic Light System will be refined in order to comply with multiple markets designs and regulations and to reach a higher Technological Readiness Level. State of the art **forecasting and optimisation algorithms** (like multi-period Optimal Power Flow) will be integrated to realize the Traffic Light System as a tool for DSOs. In addition, the concept will be implemented in **a Market Hub platform** and tested by the DSO Elektro Ljubljana in the scope of the Slovenian pilot of a technical VPP. In the project two proof-of-concepts of the Traffic Light System in **two demonstration sites in Slovenia and Portugal** will be performed. Based on these results a **Scalability and Replicability Analysis** will be conducted to evaluate the potential of this concept under different scenarios and framework conditions.



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