D5.2 & D5.3. – VPP system architecture and implementation of regional & interregional services

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Executive summary

The research project REgions investigates the provision of regional services in the electricity sector using renewable energies. For this purpose, use cases (UC) were defined to demonstrate grid congestion management, reactive power provision and interregional collateralization of balancing reserve during grid congestion. The renewable energy plants are integrated into Fraunhofer IEE's virtual power plant (VPP) enabling central control of the plants. For the demonstration of the defined use cases, the IEE.vpp has to be upgraded in various respects. This includes creating the system architecture of the VPP for the different demontration regions in France and Germany, integrating the plants and other components (such as power forecasts) into the VPP, and adding new functionalities to the VPP. Among the new functionalities is "Smart Dispatch", which not only allows the task of a plant to be distributed to other plants in the event of its failure or the failure of the communication channel, but also makes it possible to specify a ramping mode. Moreover, the web interface of the IEE.vpps has been extended as a new functionality to allow the user to monitor the plant behavior, to test the plant control and to perform the Smart Dispatch (including ramp control).

New functionalities were also developed on the plant side. The PV plants used were upgraded to determine the available active power (AAP) using SCADA, the controller and weather measurement data. The PV plants were also adapted to the requirements of the project in terms of the command chain and the security standards for plant control.

Résumé exécutif

Le projet REgions examine la fourniture de services régionaux dans le secteur de l'électricité en utilisant des énergies renouvelables. À cette fin, des cas d'usage (UC) ont été définis pour tester la gestion de la congestion du réseau, la fourniture de puissance réactive et la résolution de conflits interrégionaux entre réserve d'équilibrage et congestion du réseau. À cette fin, les installations d'énergie renouvelable sont intégrées dans la centrale électrique virtuelle (VPP) de Fraunhofer IEE, qui permet un contrôle central des installations. Pour la démonstration des cas d'usage définis, la centrale virtuelle IEE.vpp doit être mise à niveau à divers égards. Cela comprend la création de l'architecture du système de la VPP pour les différentes régions de démonstration en France et en Allemagne, l'intégration des centrales et d'autres modules (tels que les prévisions de production) dans la VPP, et l'ajout de nouvelles fonctionnalités à la VPP. Parmi ces nouvelles fonctionnalités figure le "Smart Dispatch", qui permet non seulement de distribuer la consigne d'une centrale à d'autres centrales en cas de défaillance de celle-ci ou du canal de communication, mais aussi de spécifier un mode de rampe. L'interface web de IEE.vpps a également été étendue à une nouvelle fonctionnalité permettant à l'utilisateur de surveiller le comportement de la centrale, de tester le contrôle de la centrale et d'effectuer le Smart Dispatch (y compris le contrôle de la rampe).

De nouvelles fonctionnalités ont également été développées du côté des centrales de production. Les centrales PV utilisées ont été mises à niveau pour déterminer la puissance active disponible (AAP) à l'aide du SCADA, du contrôleur et des données de mesure météorologiques. Les chaines de communications ont également été adaptées aux exigences du projet en termes de chaîne de commande et de normes de sécurité pour le contrôle de la centrale.

Zusammenfassung

Im Forschungsprojekt REgions wird die Bereitstellung von regionalen Dienstleistungen im Strombereich mittels erneuerbaren Energien untersucht. Hierfür wurden Use Cases (UC) zur Demonstration von Netzengpassmanagement, Blindleistungsbereitstellung und interregionaler Besicherung von Regelleistung während Netzengpässen definiert. Die erneuerbaren Energieanlagen werden hierfür in das virtuelle Kraftwerke (VPP) des Fraunhofer IEE integriert, wodurch die zentrale Steuerung der Anlagen ermöglicht wird. Für die Demonstration der definierten Use Cases muss das IEE.vpp in verschiedener Hinsicht ertüchtigt werden. Dazu zählt die Systemarchitektur des VPP für die unterschiedlichen Untersuchungsregionen in Frankreich und Deutschland zu erstellen, die Integration der Anlagen und weiterer Komponenten (wie Leistungsvorhehrsagen) in das VPP durchzuführen und das VPP mit neuen Funktionalitäten zu versehen. Zu den neuen Funktionalitäten zählt der "smart dispatch", der es nicht nur erlaubt, die Aufgabe einer Anlagen bei ihrem Ausfall oder dem Ausfall des Kommunikationskanals auf andere Anlagen zu verteilen, sondern der es auch ermöglicht, eine Rampenfahrweise vorzugeben. Auch das Web interface des IEE.vpps wurde als neue Funktionalität erweitert um den Nutzer die Möglichkeit zu eröffnen das Anlagenverhalten zu überwachen, die Anlagensteuerung zu testen und den Smart Dispatch (inkl. Rampensteuerung) durchzuführen.

Auch auf Seiten der Anlagen wurden neue Funktionalitäten entwickelt. Die verwendeten PV-Anlagen wurden dahingehend ertüchtigt, unter Verwendung des SCADA, des Controllers und von Wettermessdaten die mögliche Einspeisung (available active power, AAP) zu bestimmen. Die PV-Anlagen wurden auch hinsichtlich der Befehlskette und der Sicherheitsstandards bei der Anlagensteuerung an die Anforderungen des Projektes angepasst.

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List of acronyms

AAP – available active power

FRR - Frequency Restoration Reserve

HV – High voltage

ICT - Information and communications technology

IEE.vpp – VPP of the Fraunhofer Institute for Energy Economics and Energy System Technology (IEE)

KPI – Key Performance Indicator

MV – Medium voltage

PV - Photovoltaics

RE - Renewable Energy

SCADA - Supervisory Control and Data Acquisition

UC – Use case

VPN - Virtual Private Network

VPP – Virtual power plant

WP –wind farm cluster

1 Introduction

This report describes the REgion project's system architecture of VPPs and the implementation of additional services and functionalities delivery by VPPs. Thus, this report represents an integration of the two initially intended deliverables D5.2 “System architecture for regional VPPs” and D5.3 “Regional VPPs and the interaction of VPPs to provide interregional services implemented”. The integration into a single report makes it possible to better contextualize these two related topics. The report is structured according to the different system architectures developed for the regional VPPs under consideration (French VPP in chapter 3, German VPP in chapter 4) and the interregional VPP (in chapter 5), which connects the French and German VPP via an interregional controller. The VPP systems have been expanded by implementations, that enable the VPPs to perform the project’s use cases (UC) and provide regional ancillary services. These implementations are explained in the subchapters of the respective VPP. However, there are two implementations that are used for more than one VPP, namely the "Smart Dispatch" (chapter 2.2) and the "Web interface" (chapter 2.4), whose descriptions are placed in chapter 2 “IEE.vpp implementations”. The same applies to the “Plant integration” process (chapter 3.1), which is described in the chapter on the French VPP, as the development of new interfaces and the integration of new assets was only here necessary. The "FRR Provision" implementation was already part of the predecessor project "REstable" and is therefore not described in detail in the present report. Both the system architectures and the implementations are developed to perform the demonstration of the use cases described in deliverable D3.1.1. Table 1 provides an overview of the developed system architectures and the related VPP implementations and use cases.

System architecture	VPP implementation	Use Case
French VPP	Smart dispatch Forecast integration Web interface	1 Congestion management / REdispatch in France
	REactive power delivery	2 Voltage support in France
German VPP	Smart dispatch Antimetric REdispatch REdispatch 2.0 participation Web interface	3 Participation in flexibility process in Northern Germany
Interregional VPP (French & German VPP)	Smart dispatch Web interface FRR provision Interregional connector	7 International collateralisation of balancing reserve during congestion

Table 1 : Assignment of VPP architectures, VPP services and use cases

The French and the German VPP, as well as the interregional VPP are integral parts of the IEE.vpp of the Fraunhofer IEE and developed explicitly for the REgions project. Figure 1 shows the macro architecture of the REgions IEE.vpp and indicates the newly developed implementations. It also becomes clear that the REgions IEE.vpp aggregates exclusively renewable energy (RE) assets, namely wind turbines and photovoltaic systems.

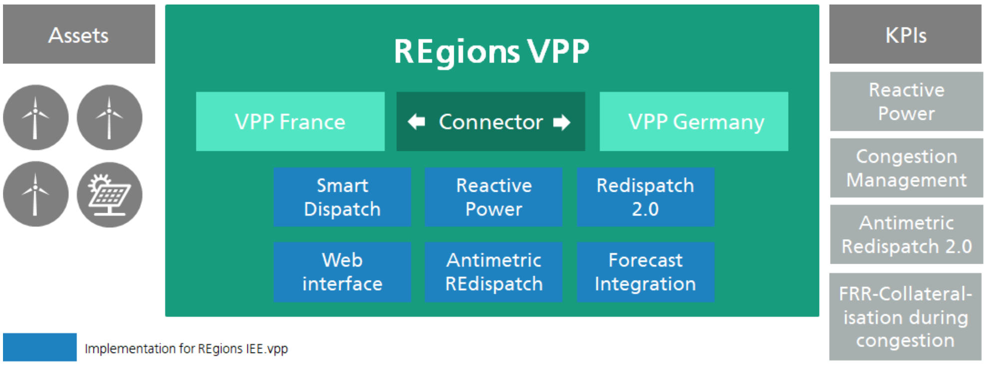


Figure 1 : Macro architecture of REgions IEE.vpp

Table 2 provides an overview of the wind energy and PV plants that are integrated as assets into the IEE.vpp and used to perform the use case demonstrations. These assets are assigned to regions, substations or clusters, and wind or PV farms. The controllable and non-controllable capacity for the demonstrations are also indicated.

No.	Region	HV/MV Substation, cluster	Plant name	No. of assets	Installed capacity [MW]		
					Wind		PV
					Usable	Read-only	
1	Hauts-de-France	Mohet-Transloy	Couturelle, Transloy	5 Wind	18	71	
2	Occitanie	Lodeve-Bedarieux	Cabalas, Treviols, Saumont le Bosc, Terres rouges 2	3 Wind 3 PV	30.15		21.3
3	Provence-Alpes-Côte d'Azur	Saint-Auban	Cigalettes, Chateauneuf	2 PV			14.5
4	Hauts-de-France	Roisel-Ham-Beautor	Epivent, Champs Vert,	3 Wind	22	10	
5	Auvergne-Rhône-Alpes	Langogne-La Palisse-Pratclaux	Cham Longe, Source de la Loire, Deves	4 Wind	57	6	
6	Schleswig	WP 1	Bromay (Sörup), Handewitt V, Rodautal	5 Wind	13.66		
7	Holstein	WP 2	Neuratjensdorf-Rossee	9 Wind	27		

Table 2 : Key figures of the IEE.vpp assets (power plants) used for the REgions project

2 IEE.vpp implementations

2.1 Smart Dispatch

The project's use cases make it necessary to develop a procedure that, in the event of failure or poor operation of a plant, assigns its task of set point fulfillment to another suitable plant in the pool. This process is referred to as Smart Dispatch and reduces the gaps between the set point and the actual value of the VPP's feed-in.

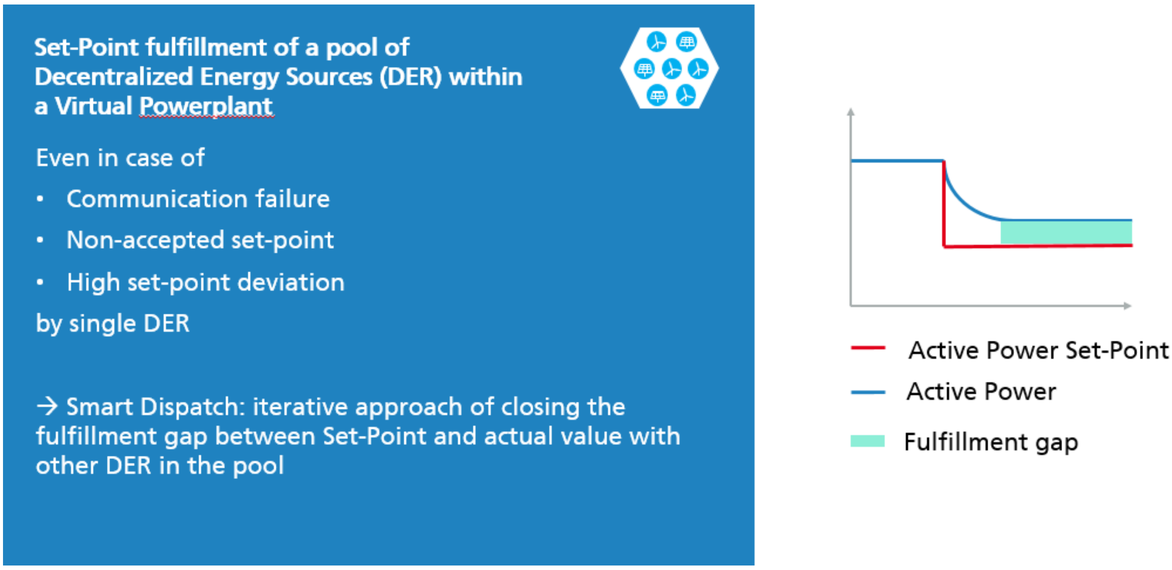


Figure 2 : Introduction to Smart Dispatch

Smart Dispatch starts with the preparation of a merit order list of the marginal costs of the plants. After that, for each plant, the SCADA communications status and controlability is checked, the past and present acceptance of set points is considered (latest set point success), and the integral of the past deviations from the set point (performance indicator) is determined. If a plant does not meet the requirements, it is excluded from the smart dispatch process and the set point is distributed among the remaining plants according to the prioritization list (priority sequence), which is calculated from the marginal costs and the performance indicators (see Figure 3). Ramp operation (see UC3 and chapter 4) can also be specified as an option in smart dispatch. The drop or deselected plants from the priority sequence can be either receive a reset signal (back to normal operation) or a turn-off signal (set-point to zero MW).

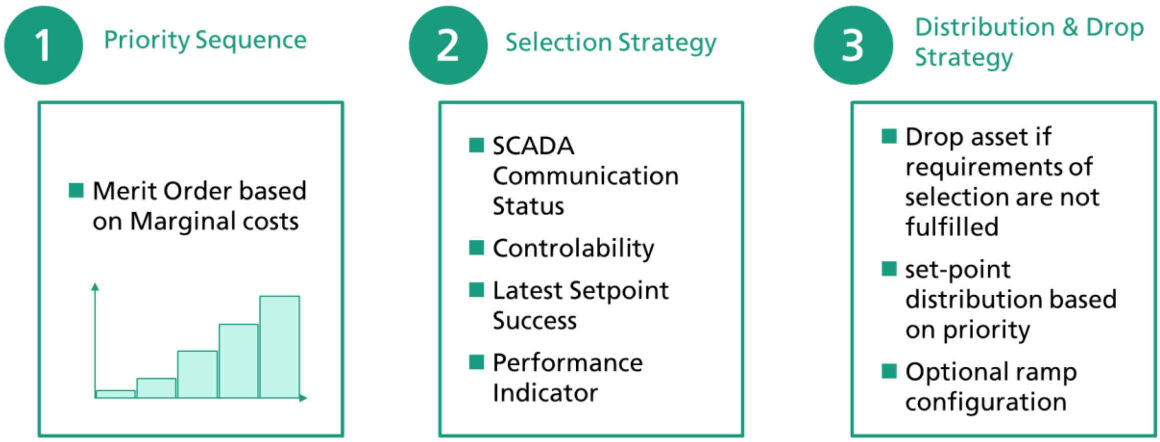


Figure 3 : Smart Dispatch - Set-Point Disaggregation Strategy

Figure 4 to Figure 6 illustrate the procedure of smart dispatch. In Figure 4 the plant #2 is showing a communication error meaning the SCADA connection is interrupted. Then, in Figure 5 plant #4 is facing a set point writing error and finally plant #5 has performance issues, meaning too high deviations between set-point and actual power value. In each case the set points are redistributed among the remaining plants in the pool.

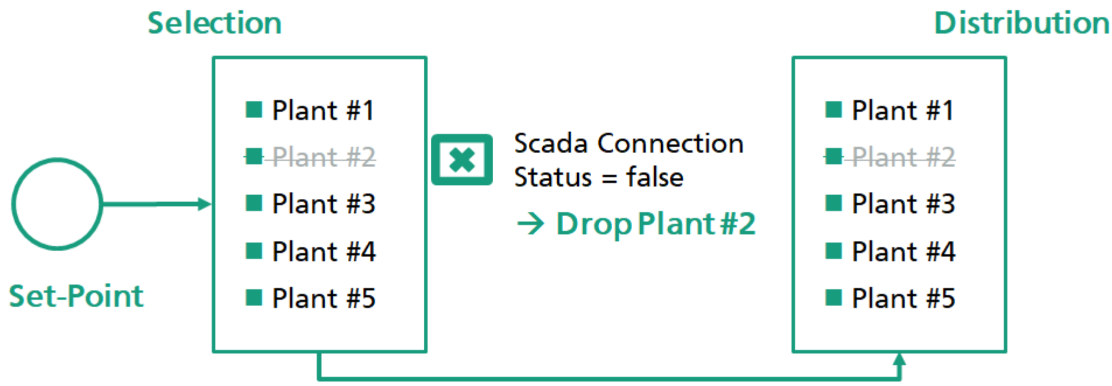


Figure 4 : Smart Dispatch – Communication failure

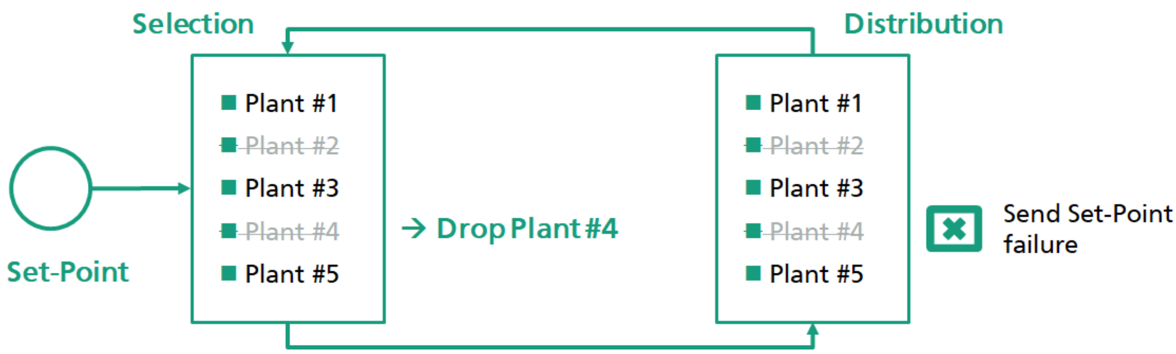


Figure 5 : Smart Dispatch – Set point failure

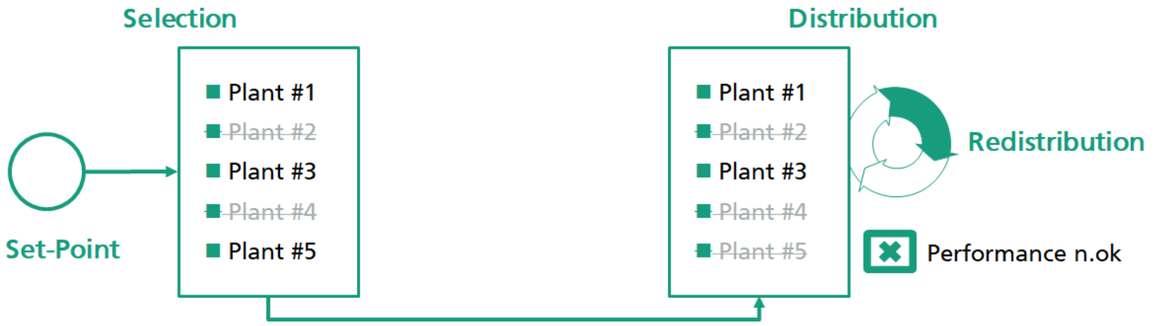


Figure 6 : Smart Dispatch – Performance failure

2.2 Web interface

The web interface of the IEE.vpp was further developed in the REgions project to provide simplified access for the project partners involved. The project partners have now the possibility to monitor the plant behavior, to test the plant control via a user-friendly and intuitive web interface. The interface also allows to perform the smart dispatch as well as setting the ramp options e.g. for the redispatch 2.0 use cases. Additionally, the web application provides access to various data points e.g. (available) active and reactive power, production forecasts as well as set-point signals.

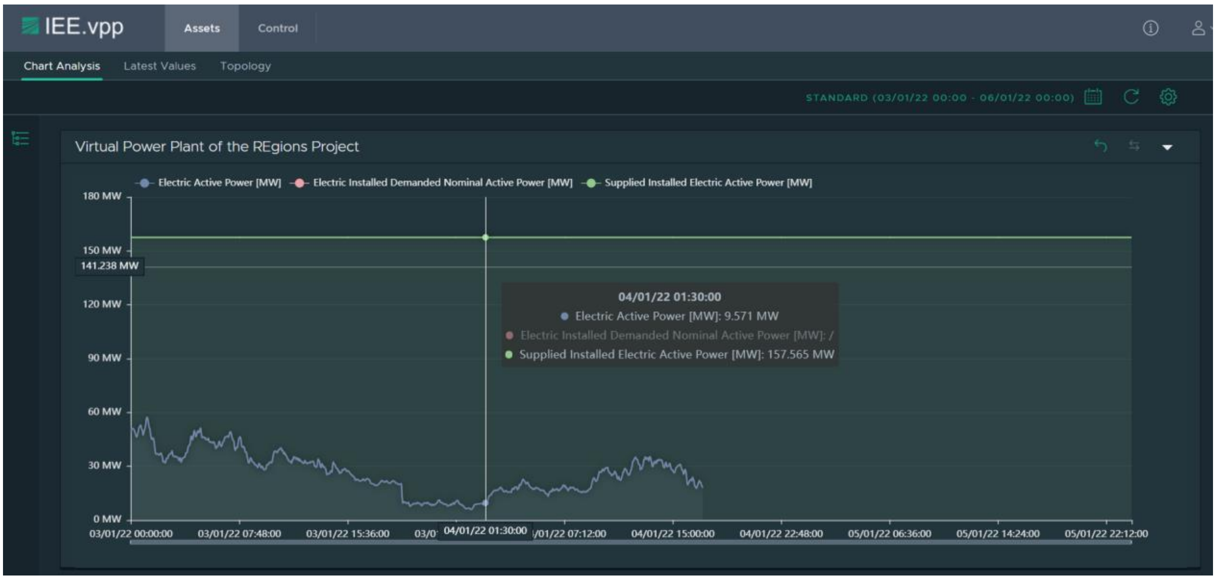


Figure 7 : REgions VPP -Webinterface

3 French VPP

The French VPP is part of a macro system that includes not only the VPP and the power plants, but also components for generating weather and power generation forecasts and a model of the local flexibility market. Figure 8 shows this macro system and indicates the responsible project partners for each component as well as information flows between the components.

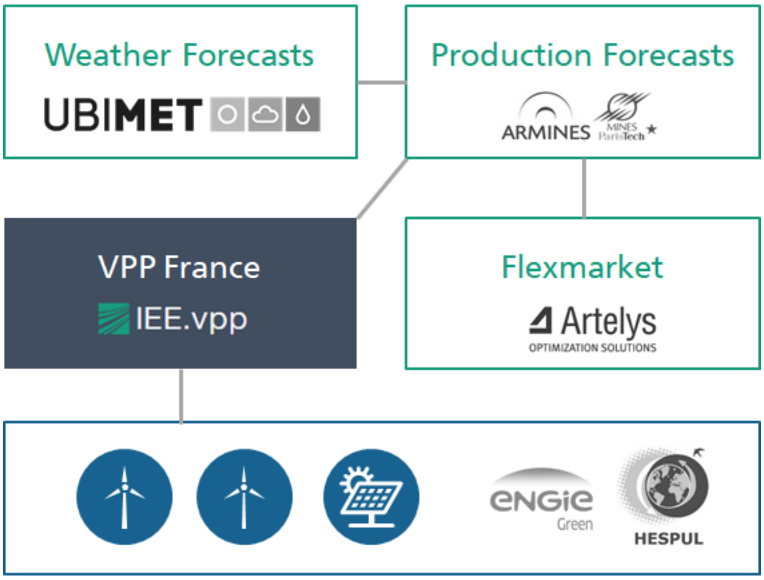


Figure 8 : Macro System Architecture for France

The power plants of the French VPP are distributed over five regions in France (see Figure 9).). The power plants of each region can be operated as an autonomous cluster. UC1 is planned to be performed in every region/cluster, UC2 only in a selection. The French power plants are numbered 1 to 5 in Table 2.

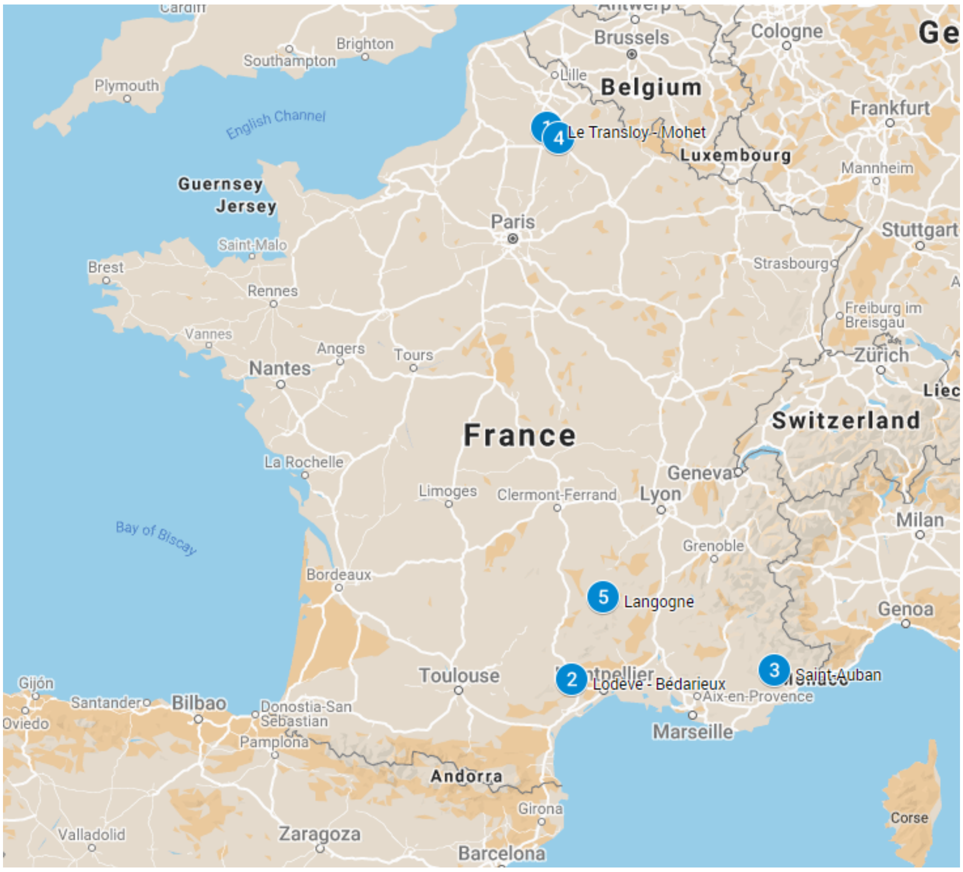


Figure 9 : Regions of the power plants of the French VPP

Table 3 : Key figures of the power plants of the french VPP

3.1 Plant integration

A plant integration process was further developed in order to integrate new power plants into the VPP. This process is explained in Figure 10 and Figure 11.

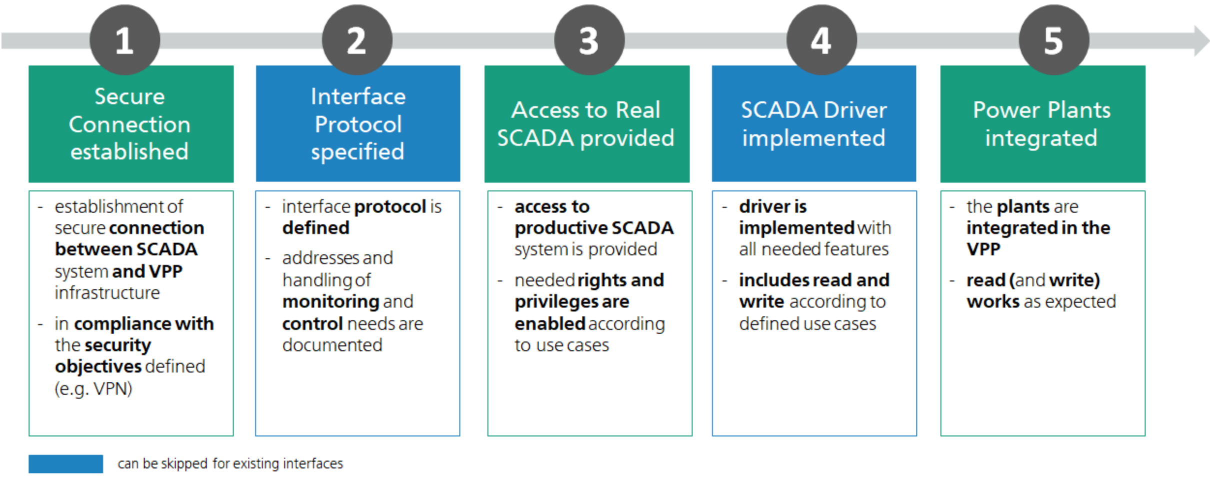


Figure 10 : RE integration process of the VPP

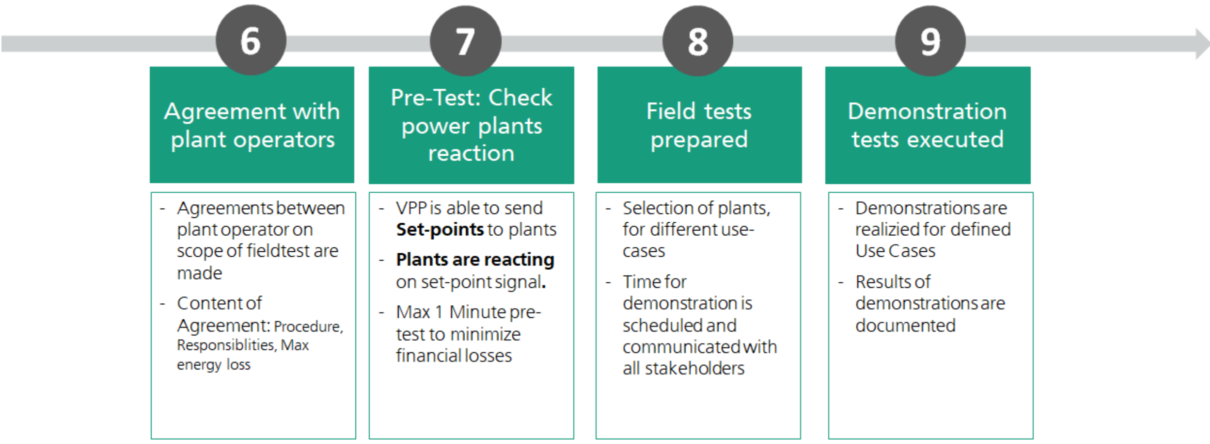
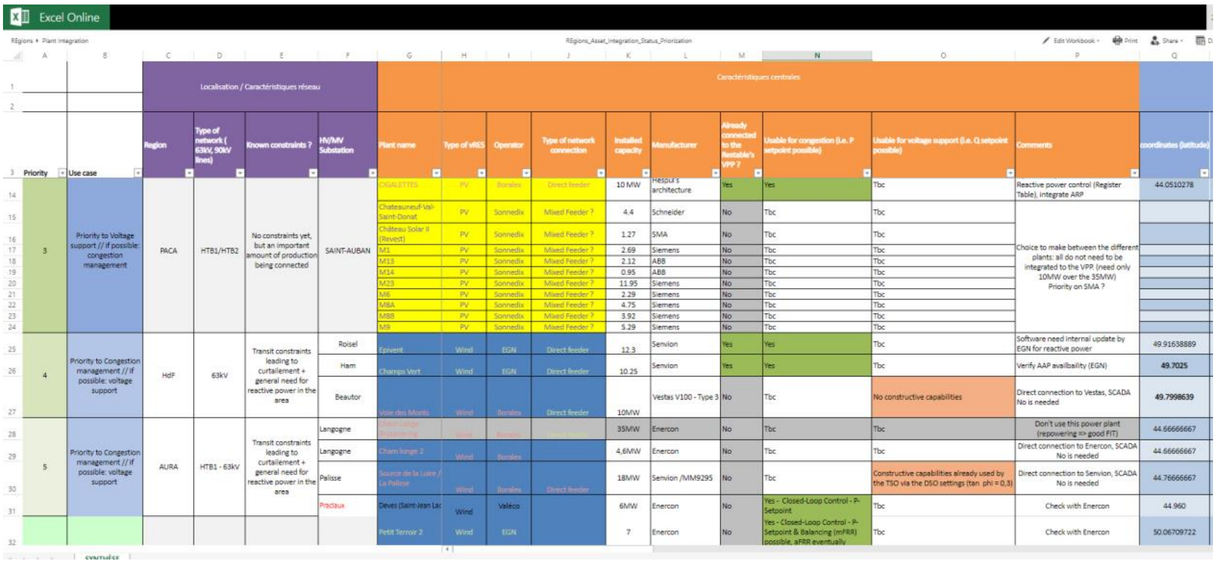


Figure 11 : Field tests preparation and execution

A large number of different power plants have been selected for integration into the VPP. A detailed table was kept to check the progress of the integration and to carry out a prioritization (see Figure 12). The integration of power plants can be very work-intensive due to the lack of standardized interfaces and the establishment of new secure communication connection via an virtual private network to the different plant operators; some interfaces had to be invidually customized and extended according to the use-case requirements. The interfaces used are shown in Figure 13. Consequently, not all of the numerous power plants selected could in the end be integrated into the VPP. Figure 13 shows an extract of the finally integrated power plants and the various interfaces developed for this purpose.



Priority	Use case	Region	Type of network (63kV, 90kV lines)	Known constraints ?	HV/MV Substation	Plant name	Type of vRES	Operator	Type of network connection	Installed capacity	Manufacturer	Already connected to the Restable's VPP ?	Usable for congestion (i.e. P setpoint possible)	Usable for voltage support (i.e. Q setpoint possible)	Comments	coordinates (latitude)
3	Priority to Voltage support // if possible: congestion management	PACA	HTB1/HTB2	No constraints yet, but an important amount of production being connected	SAINT-AUBAN	CIGALETTES	PV	Boralex	Direct feeder	10 MW	Hespul's architecture	Yes	Yes	Tbc	Reactive power control (Register Table), integrate ARP	44.0510278
						Chateauneuf-Val-Saint-Donat	PV	Sonnedix	Mixed Feeder ?	4.4	Schneider	No	Tbc	Tbc	Choice to make between the different plants: all do not need to be integrated to the VPP. (need only 10MW over the 35MW) Priority on SMA ?	
						Château Solar II (Revest)	PV	Sonnedix	Mixed Feeder ?	1.27	SMA	No	Tbc	Tbc		
						M1	PV	Sonnedix	Mixed Feeder ?	2.69	Siemens	No	Tbc	Tbc		
						M13	PV	Sonnedix	Mixed Feeder ?	2.12	ABB	No	Tbc	Tbc		
						M14	PV	Sonnedix	Mixed Feeder ?	0.95	ABB	No	Tbc	Tbc		
						M23	PV	Sonnedix	Mixed Feeder ?	11.95	Siemens	No	Tbc	Tbc		
						M6	PV	Sonnedix	Mixed Feeder ?	2.29	Siemens	No	Tbc	Tbc		
						M8A	PV	Sonnedix	Mixed Feeder ?	4.75	Siemens	No	Tbc	Tbc		
						M8B	PV	Sonnedix	Mixed Feeder ?	3.92	Siemens	No	Tbc	Tbc		
						M9	PV	Sonnedix	Mixed Feeder ?	5.29	Siemens	No	Tbc	Tbc		
4	Priority to Congestion management // if possible: voltage support	HdF	63kV	Transit constraints leading to curtailement + general need for reactive power in the area	Roisel	Epivent	Wind	EGN	Direct feeder	12.3	Senvion	Yes	Yes	Tbc	Software need internal update by EGN for reactive power	49.91638889
					Ham	Champs Vert	Wind	EGN	Direct feeder	10.25	Senvion	Yes	Yes	Tbc	Verify AAP availbaility (EGN)	49.7025
					Beautor	Voie des Monts	Wind	Boralex	Direct feeder	10MW	Vestas V100 - Type 3	No	Tbc	No constructive capabilities	Direct connection to Vestas, SCADA No is needed	49.7998639
5	Priority to Congestion management // if possible: voltage support	AURA	HTB1 - 63kV	Transit constraints leading to curtailement + general need for reactive power in the area	Langogne	Cham Longe Repowering	Wind	Boralex	Direct feeder	35MW	Enercon	No	Tbc	Tbc	Don't use this power plant (repowering => good FIT)	44.66666667
					Langogne	Cham longe 2	Wind	Boralex		4,6MW	Enercon	No	Tbc	Tbc	Direct connection to Enercon, SCADA No is needed	44.66666667
					Palisse	Source de la Loire / La Palisse	Wind	Boralex	Direct feeder	18MW	Senvion /MM9295	No	Tbc	Constructive capabilities already used by the TSO via the DSO settings (tan phi = 0,3)	Direct connection to Senvion, SCADA No is needed	44.76666667
					Pradaux	Deves (Saint-Jean Lac	Wind	Valéco		6MW	Enercon	No	Yes - Closed-Loop Control - P-Setpoint	Tbc	Check with Enercon	44.960
						Petit Terroir 2	Wind	EGN		7	Enercon	No	Yes - Closed-Loop Control - P-Setpoint & Balancing (mFRR) possible, aFRR eventually	Tbc	Check with Enercon	50.06709722

Figure 12 : RE integration priorization table

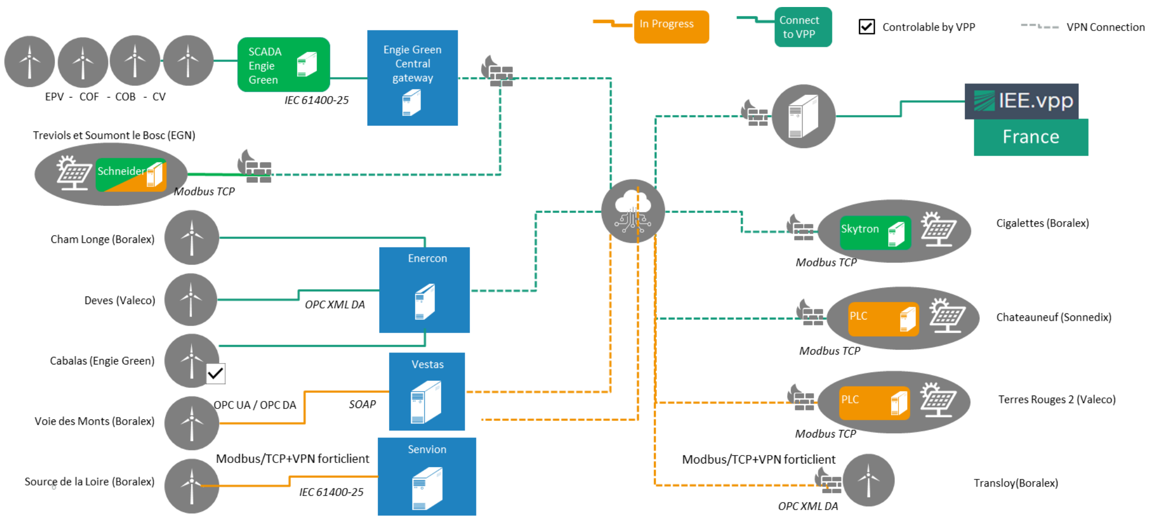


Figure 13 : Plant integration Status Quo in France - Wind & PV Parks integrated in IEE.vpp

3.2 Production forecast integration

Especially for UC1, it is necessary that the VPP receives production forecasts for the connected plants. The VPP retrieves this production forecasts from the project partner ARMINES via an sFTP server, i.e. an FTP server secured through a SSH tunnel accessible via credentials authentication.

The forecasts are provided as csv-files for each plant. To train its forecast service, ARMINES received historical production data from the VPP as file exports.

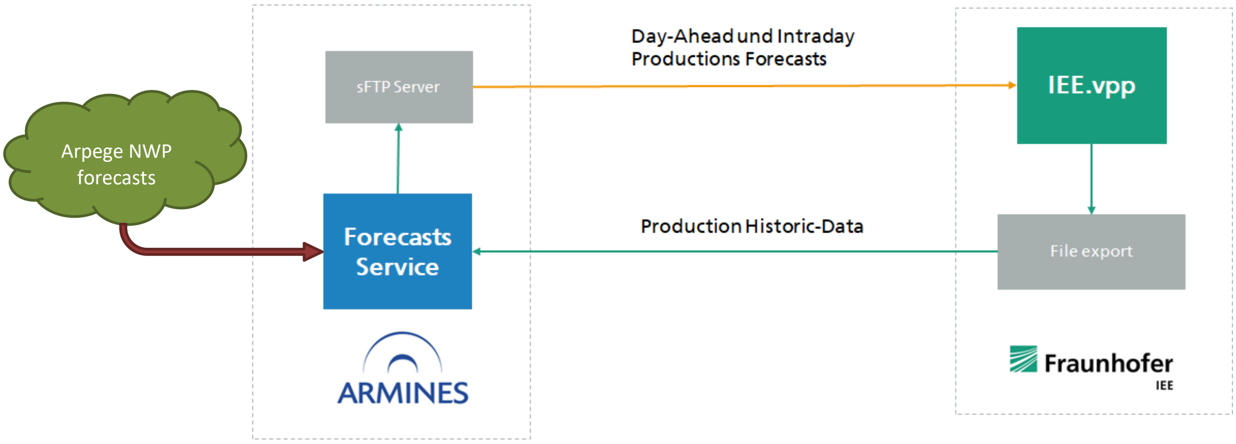


Figure 14 : Forecast Integration (current status)

The forecasts service uses NWP forecasts from the ARPEGE model of MeteoFrance, which are downloaded every day for the current day and the day after. The production forecasts, output of this service, consist of intraday and day-ahead forecasts. The former are being transmitted hourly and have a temporal resolution of 15 minutes. The latter are pushed once a day on the sFTP server at around 10:30 am. This is necessary to ensure retrieving the NWP forecasts from MeteoFrance before executing the forecasts service.

3.3 New SCADA features

The control to be tested during the French Demo (UC 1 and 2) required new features to be developed and implement on PV SCADA sites.

Such SCADA are related to producer strategy and cannot be generalize to all sites used for REgions project but Figure 15 illustrates one example, with presence of several key component needed to control the plants:

- A **PLC Scada** (XLRIO here) as an interface for data acquisition from Inverters, controller, meteo station and exchange with external parties by the internet
- A **Controller** ("Automate Onduleur") which assume the respect of the setpoint that IEE will send to the plant.
- A **Meteo Station** that measure real-time meteo parameter such Irradiance (GHI and GTI), temperature and wind speed.

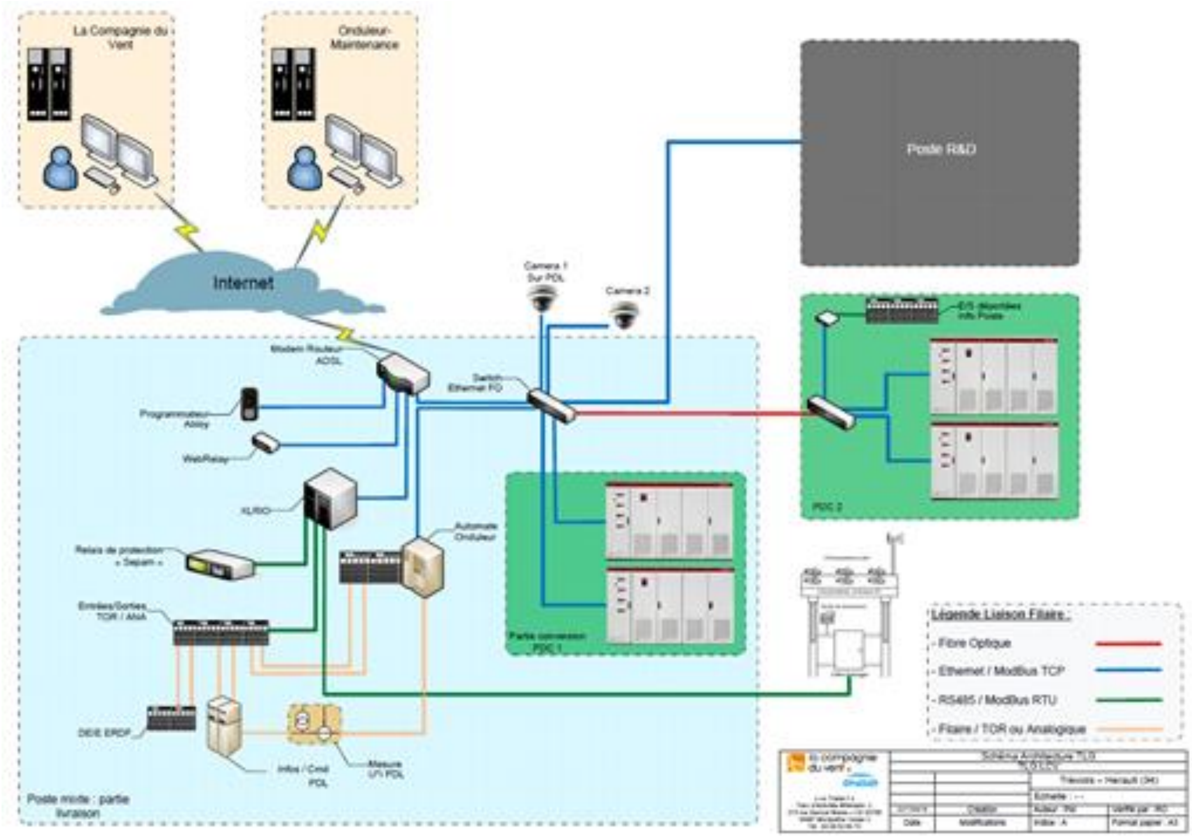


Figure 15 : Communication Synoptic of a Engie Green PV plant.

This architecture allows the producer to develop an algorithm to estimate the expected production of the PV site and consequently create a new real time parameter: the Available Active Power (AAP).

The evaluation of this parameter uses two simple arithmetical calculation, first estimating the temperature of the PV cell and secondly the estimation of the AAP that illustrates the output power of the plant on "normal operation mode" (without external control).

$$Temp_{cell}(t) = Temp_{amb}(t) + \frac{\alpha * Irradiance_{25}(t) * (1-\eta)}{Uvalue}$$

$$AAP_{brute}(t) = Coeffk * Irradiance_{25}(t) * Pwc * (1 + \frac{\tau_{temp}}{100} * (Temp_{cell}(t) - Temp_{NOCT}))$$

Figure 16 - Model used by Engie Green to estimate the Available Active power in Real time.

These formulas require the definition of constants parameters that depend on the materials installed on site and cannot always be precisely known.

Such algebraic modelw often need a calibration to correct the first estimation that which, in our case, were not accurate (see Figure 17 and Figure 18).

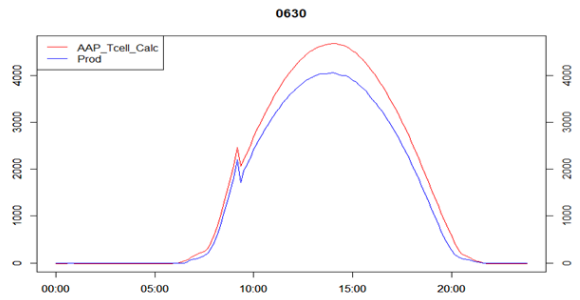


Figure 17: Non-calibrated AAP estimation and power production [kW] – 30/06/2021

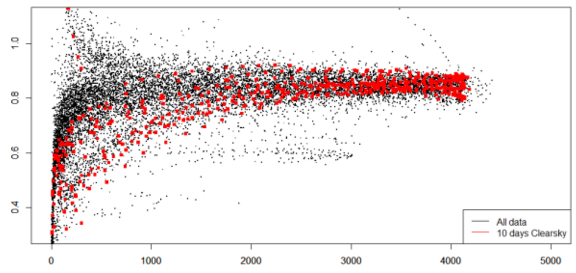


Figure 18 : Power production/Non-calibrated AAP ratio vs. Production [kW]

Figure 18 shows the fact that a simple correcting factor could improve the model. The definition of this factor is made using statistics bias evaluation over a 6-month historical period that permitted to define the "best" correcting factor to apply to the model.

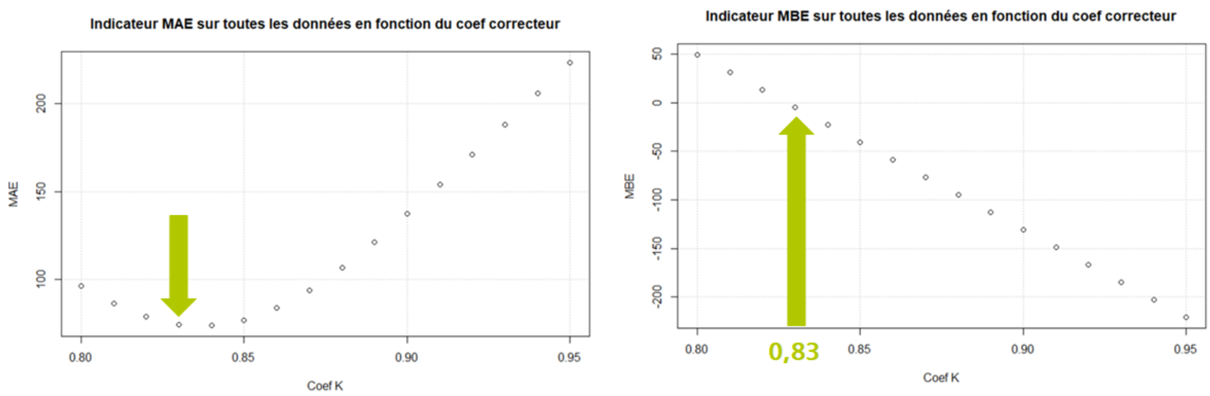


Figure 19 : Model calibration via MBE/MAE analysis over 6 months

The calibrated model has been implemented on the SCADA and exchanged with IEE (see Figure 19 and Figure 20).

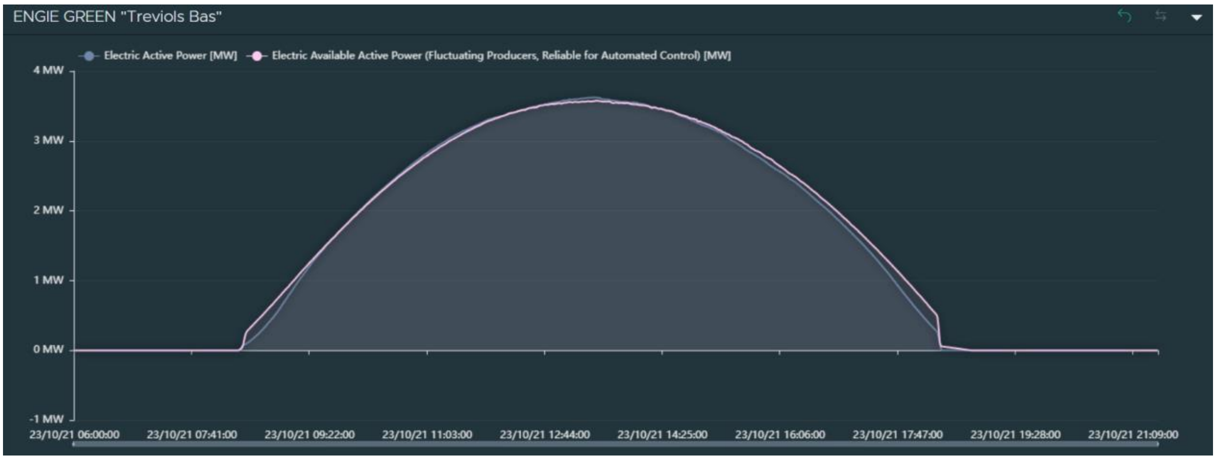


Figure 20 : Calibrated AAP estimation and power production – 23/10/2021

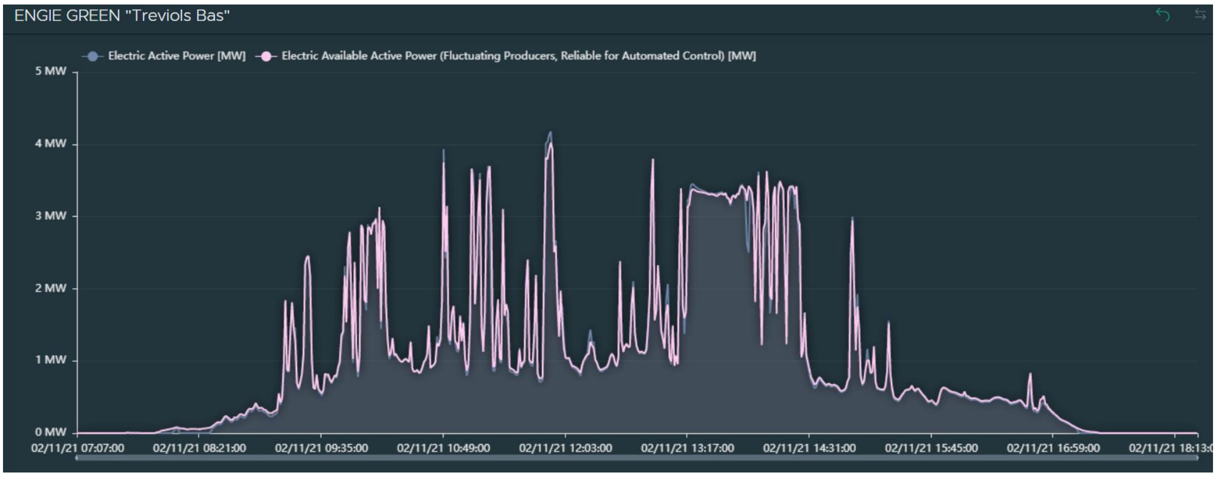


Figure 21 : Calibrated AAP estimation and power production – 02/11/2021

This model will be used to accurately estimate the loss of production during a curtailment and to control the plants using a "Delta" setpoint : i.e. defining a reserve of a constant power below the Available Power.

Further analysis of the model will be performed during WP6 KPI's evaluation.

3.4 Retrofits feedback

Hespul brings and assists three producers (Boralex, Valeco et Sonnedix) in retrofitting 3 photovoltaic plants (PV) to integrate them in the REgions project. Major feedbacks are described hereafter:

<u>Knowledge availability: Open format rather than closed formats.</u>

Retrofitting PV plants to update their control system remains a long and winding road: Documentation is hardly fundable and design developers are sometimes not any more in the supplier. We could not indeed add the Terres Rouges 1: Thought we started working with the supplier (owner of the close format communication protocol) who set up the control system, we have to drop the integration of the PV plant: the developer with the knowledge in such protocol had left the company.

While retrofitting a control system of a power plant, design system with documented open communication protocol rather than close formats.

Shortening the command chain:

We had to add a PLC (Programmable Logical Controller) to enable the control system of PV plants Cigalettes and Chateauneuf to meet the requirements of REgions.
While integrating PV plant Terre Rouges 2, We could contract the control system supplier to retrofit the PV plant. In this a case, we shortened the command chain: no additional material (no PLC) was added to achieve the Regions requirements. This resulted in a more reliable command chain, especially regarding the external priority orders coming from the grid operators.

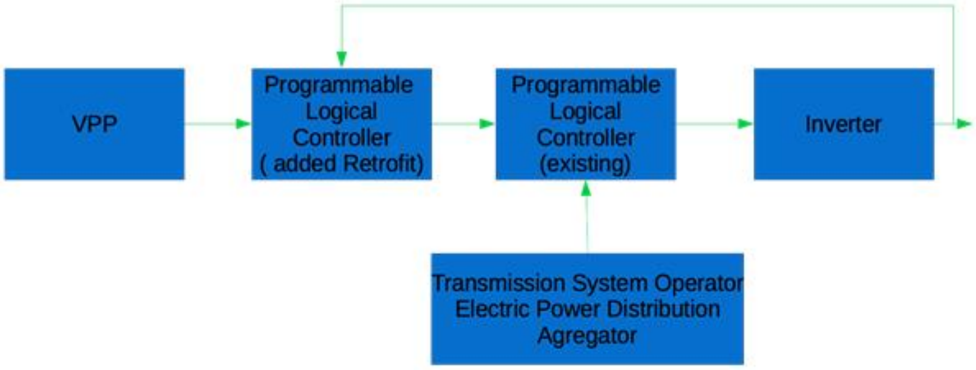


Figure 22 : Chateauneuf and Cigalettes command chain

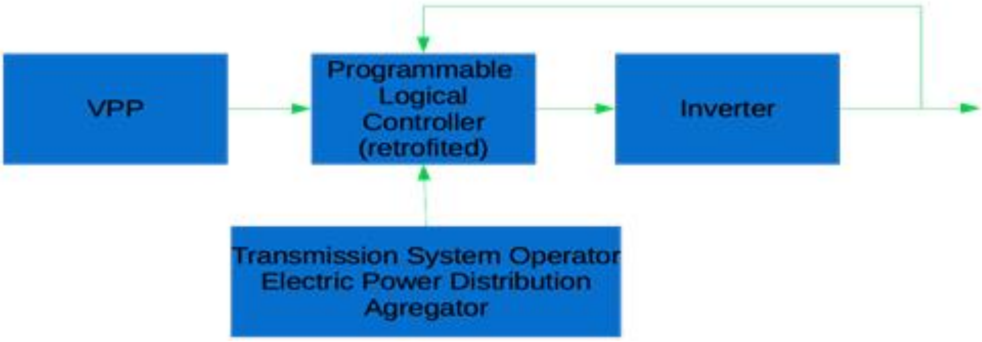


Figure 22 : Terres Rouges 2 command chain.

AAP Used Model

The setup AAP model for the Hespul pool is a mix of Physics (transfer function of the photovoltaic cell) and Materials (constructive characteristics of PV modules and inverters). We added a short algorithm to offset the availability of the inverters. The details of the model and its accuracy will be given in deliverable 6.

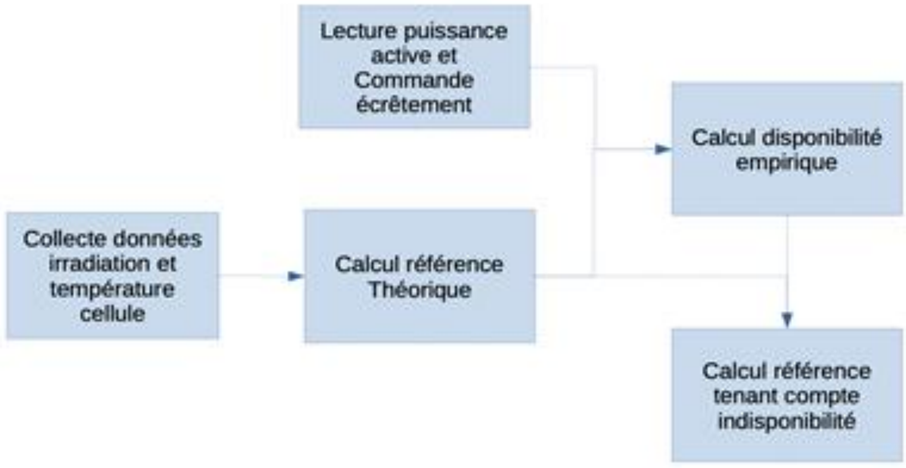


Figure 23 : Simplified diagram of available active power calculation

Security

Security becomes a major issue for the power plants operators. In REgions, such subject was considered in setting up an OPEN VPN connection to access the PV plants. Yet, this secured connection was hard to set, and the operators existing security infrastructure were sometimes difficult to cope with.

4 German VPP

As shown in Figure 24, the plants of the German VPP are located in Northern Germany. They are assigned to two wind farm clusters, one of which is located in a region with very high (WP 1) and one with moderate (WP 2) grid congestions. The German power plants are numbered 6 and 7 in Table 2.

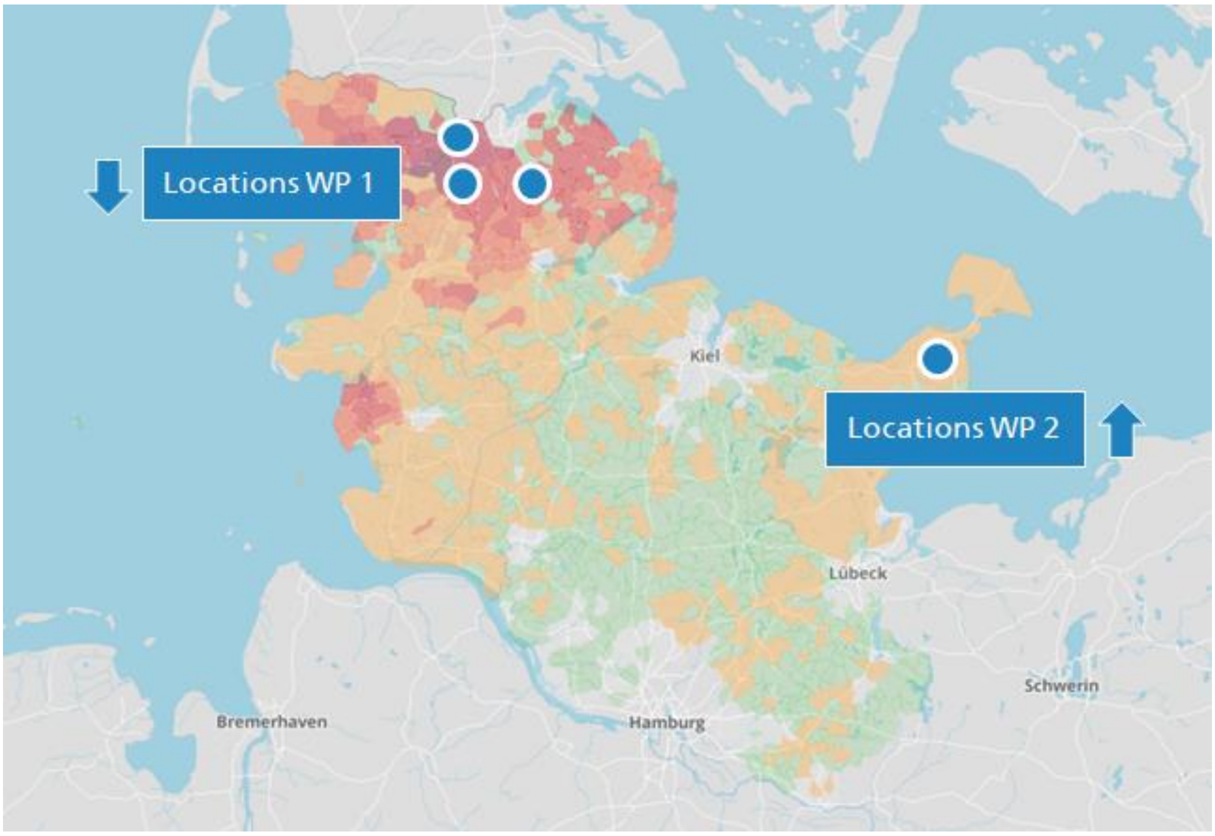


Figure 24 : Locations of the UC3 demonstrations. The map is taken from https://www.netzampel.energy/shnetz, which also provides congestion forecasts

In addition to the plants, the German VPP is also connected to the Connect+ platform, which is used as the data exchange platform of the German Redispatch 2.0 process.

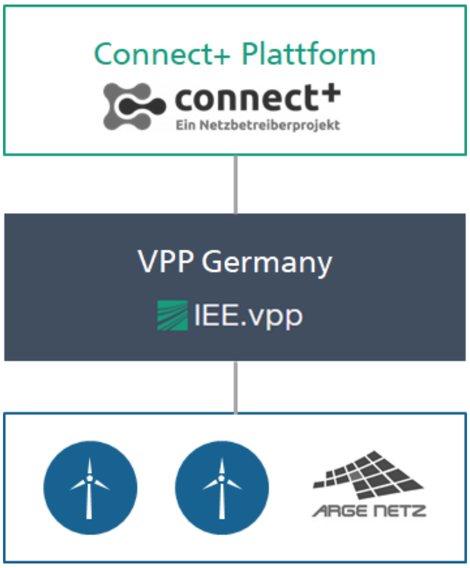


Figure 25 : Macro System Architecture for Germany

Three tests will be carried out with these two wind farms. The first test will examine the antimetric operation of the two wind farms. The second test checks whether the curtailment request via Redispatch 2.0 activation document is executed. During the 3rd test it is checked, whether the entire Redispatch 2.0 process is executed by the VPP. The tests are based on each other. The exchange of master data is done via the energyDataManagement system.

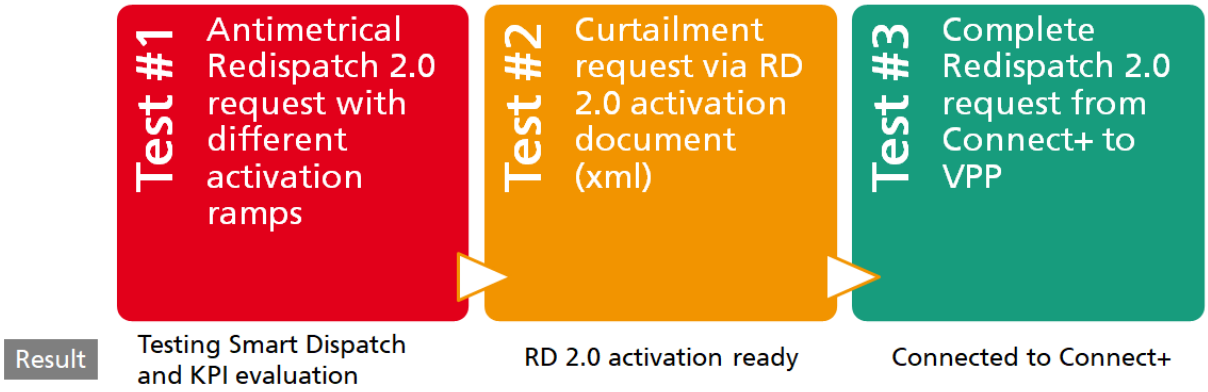


Figure 26 : Tests of UC3

In the following, the three tests will be explained in more detail.

Test #1 works without the ARGE Netz and connect+ platform. The VPP sends the set points directly to the plants.

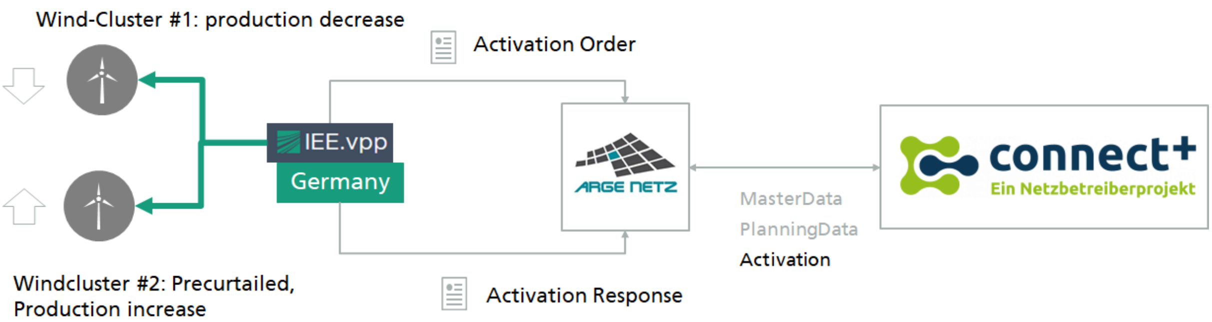


Figure 27 : Fieldtest #1 Antimetrical Redispatch

The test procedure is planned as follows.

1. Checking https://www.netzampel.energy/shnetz for congestion forecast for WP1 (hours ahead)
2. Precurtailing WP2 (one minute ahead)
3. Decreasing WP1-feed-in and increasing WP2-feed-in at the same time, by the same amount and with inverse ramps (antimetric Redispatch). Smart dispatch is used for this purpose.

Figure 28 shows the set points for testing the antimetric redispatch (see D6.1 for more details).

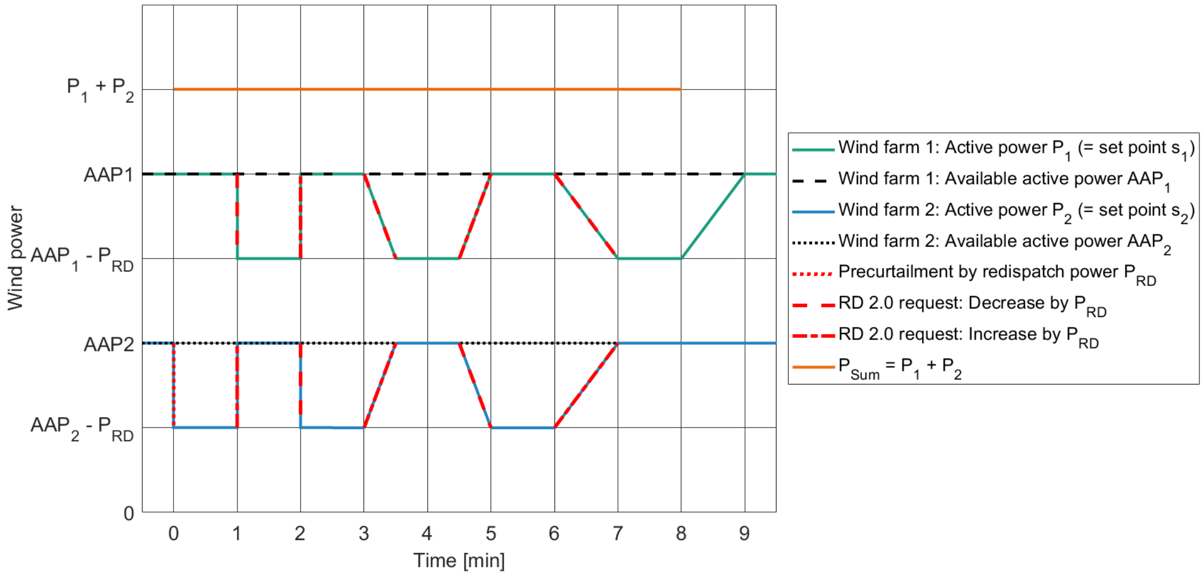


Figure 28 : Illustration of Antimetric REdispatch by two wind farms

In Test #2, the VPP is connected with ARGE Netz platform. It receives an activation order from ARGE Netz and passes it on to the plants of wind farm 1.

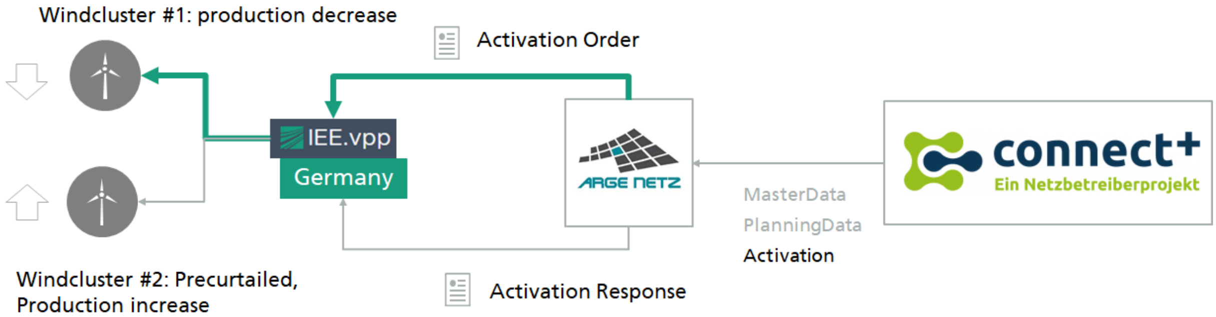


Figure 29 : Fieldtest #2 Redispatch Activation Order

In Test #3, the VPP is connected to the connect+ platform via the ARGE Netz platform. It receives an activation order from connect+ platform and passes it on to the plants of wind farm 1 and sends an activation response to the connect+ platform via the ARGE Netz platform.

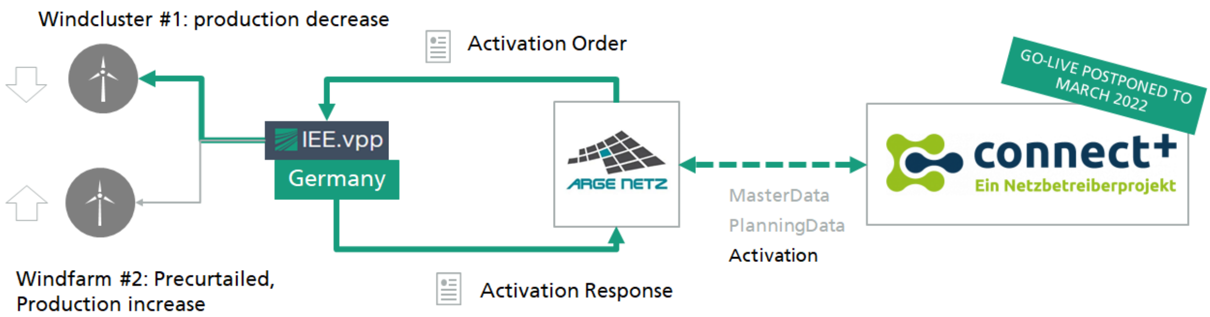


Figure 30 : Fieldtest #3 Complete RD 2.0 Activation Order and Response

5 Interregional VPP

The interregional VPP is used to perform UC7 “international collateralisation of balancing reserve during congestion“. It consists of the German and the French VPP. However, it accesses only one German and one French wind farm, namely parts of Cabalas and Neuratjensdorf-Rossee (No. 2 and No. 7 respectively in Table 2).

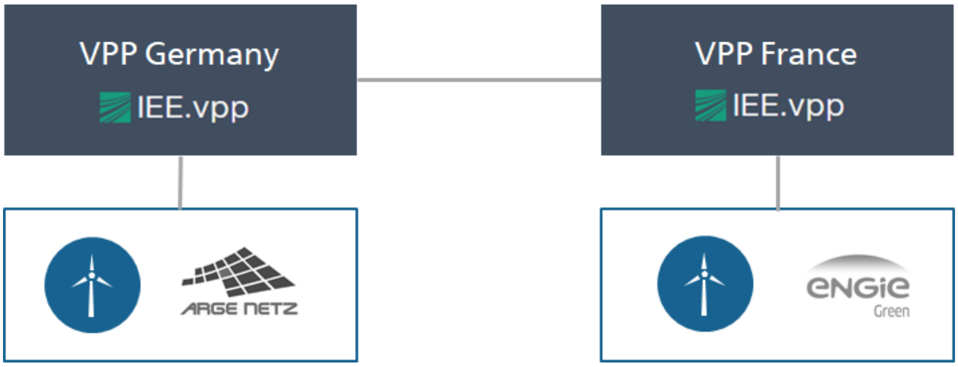


Figure 31 : Macro System Architecture of the interregional VPP

The connection between the German and the French wind farm is realized via an OPC XML DA interface. The German and French wind power plants are grouped into an interregional pool, which is accessed by Smart Dispatch during the demonstration process. Smart Dispatch (see 2.1) thus acts as an interregional controller.

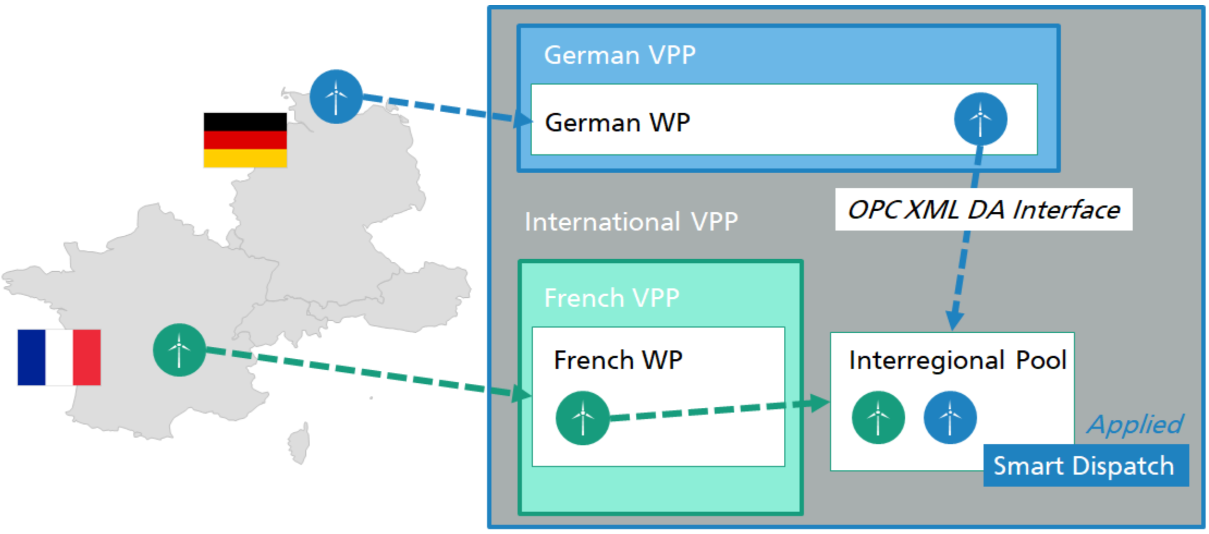


Figure 32 : Implementation of interregional controller: Approach & Set-Up

The demonstration process of UC7 is shown in Figure 33 (see D6.1 for more details).

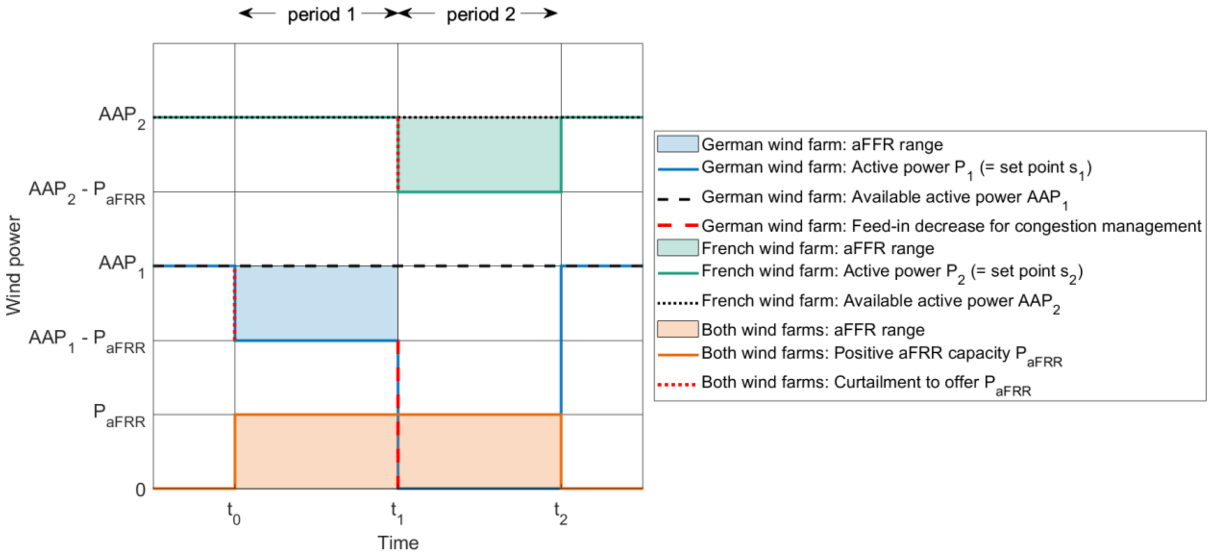


Figure 33 : Illustration of the demonstration process for international collateralisation of balancing reserve during congestion (UC7)

6 Conclusions

This deliverable described the architecture of the French VPP, the German VPP, and the interregional VPP, all of which are part of the IEE.vpp. It became clear how the different VPPs are composed and which regions they cover. High efforts were necessary to get especially older wind/PV plants ready for secure VPP integration and to make them controllable.

This deliverable also described the new VPP functionalities that enable the IEE.vpp to provide regional services and the demonstration of the project's use cases.