The Hybrid Power Plant in El Hierro Island: Facts and Challenges from the Wind Farm Perspective

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***Abstract*— El Hierro is the smallest island of the Canary archipelago (Spain), located in the Atlantic Ocean. Similar to other isolated power systems, the electricity demand was fully provided, during many decades, by a conventional power plant (Diesel). In order to reduce to the minimum the dependency on fossil fuels for electricity generation, some local and regional entities, represented by the company Gorona del Viento El Hierro S.A. (Gorona), decided to build a an hybrid generation power plant using as primary energy the unexplored natural resources: wind and water. The hybrid power plant of El Hierro, composed by a wind farm, a hydro power plant, a water pump station and two big water reservoirs, is operating at full capacity since mid-2015*. (Abstract)**

Keywords; wind farm; hybrid power plant; primary energy; hydro power plant; water pump station

I. INTRODUCTION (HEADING 1)

El Hierro is an island of the Canary Archipelago, in Spain, which covers an area of 278 km2 and has a population of 10,679 habitants according to ISTAC in 2017, which since several decades ago is characterized by the search of a sustainable growth model, favoring the conservation of its environmental wealth and matching the use of its own resources within the framework of development actions.

In 1997, El Hierro has approved and implemented a Sustainable Development Plan with the aim of reducing its external dependence and to guarantee the fulfilment of the main needs for the population through the launch of an exploitation cycle of the own natural resources that would allow to reduce the extra costs associated with living in a small island.

The island was declared a biosphere reserve in January, 2000. This distinctive seal was awarded to the island for the special conservation of its environmental cultural richness, as well as for its efforts towards the progress development of its inhabitants. This fact means that any action aimed at reducing the anthropic pressure on its natural habitats through the self-supply of electrical energy via renewable energy is considered of an outstanding importance to the social, economic environmental development of the island of El Hierro.

El Hierro island rises from the waters of the Atlantic Ocean, quickly reaching 1,500 meters above sea level, which causes a peculiar landscape with steep hillsides permanently beaten by the wind. This contribute to an excellent annual average wind speed between 7.24 – 8.42 m/s and maximum wind speed of 30.8 m/s (register of Gorona in 2017).

Within this framework, the Council of El Hierro, Unelco (Distribution system operator) and the Canary Islands Technological Institute (ITC) chose the development of a project called the “El Hierro Hydro-Wind Plant” (HWP), with the aim of making this island the first one to be able to supply itself with electrical energy through renewable energy sources. During the first stage, a technical viability study was carried out to identify the optimal configuration of wind generators, hydraulic turbines, the volume of the water reserves and the respective water pumping equipment to be installed in the new plant.

More than an overall explanation of the HWP, this paper will be focused mainly in the operational aspects of the wind farm installed in El Hierro’s WHP.

The project is promoted by Gorona del Viento El Hierro, S.A., with participation by the Council of El Hierro (66 %), Endesa (23 %), Government of Canary Island (3%) and ITC (8%).

II. EL HIERRO’S POWER SYSTEM OVERVIEW

A. Generation and demand

The annual electricity demand of El Hierro’s island reached 42 GWh (2015) with a daily peak of around 7 MW and a valley of 4 MW. The domestic loads and the distribution of water (including desalination) are the major contributors to the island’s electricity demand.

Besides the HWP that will be described in the next chapter, the electricity in El Hierro has been provided in the last decades by the Diesel Power Plant of “Llanos Blancos”, which is the main (and unique) conventional generation power plant of island. It belongs to ENDESA and it’s located on the east coast of the island, in the municipality of Valverde. It has a maximum generation capacity of 12.73 MW with a utilization factor of 38.2% (Endesa Report 2015). The energy generated by the Diesel power plant is raised to the distribution voltage of 20 kV and injected into the Llanos Blancos substation, from where the different MV lines that supply the entire El Hierro island start. The structure of the MV distribution power system is radial.

B. *Recent milestones achieved*

The year 2018 started with a remarkable hint in the El Hierro electrical system. Between the 25th January and the 11th February the HWP has covered 100% of the island's electricity demand, according to the Figure 1.

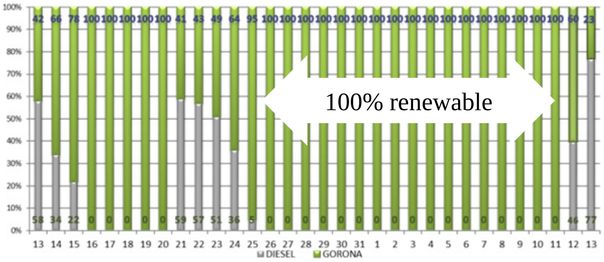

Figure 1. El Hierro's electricity demand coverage by Diesel (grey)and by the HWP (green)

In 2017, 46.5% of the electricity demand came from the renewable sources, which means from the HWP. Therefore, the coverage of electricity demand via renewable energy sources in El Hierro already far exceeds the goals set by the European Union by 2030.

C. *Environmental impact*

The environmental benefits, from the point of view of energy HWP for El Hierro will be vital to this project. The HWP project in El Hierro is and it will be an example to be replicated in similar isolated power systems around the globe.

In 2017 a significant amount of fuel savings has been achieved: 6,000 tons of diesel, which is equal to 40,000 barrels of oil that would have to be imported by boat to the island, thus creating savings of over 1.8 M€/year.

Environmental impact	**2015** (from Summer)	**2016**	**2017**	**TOTAL**
FUEL SAVINGS (Tons of Diesel)	2,099	5,366	6,070	13,535
EMISSIONS AVOIDED (Tons of CO_2)	4,352	11,629	13,150	29,131

III. HYBRID POWER PLANT DESCRIPTION

A. *The hydro power plant*

The hydro power plant uses the potential energy of the water storage, guaranteeing both electrical supply and grid support, like primary frequency control. It´s equipped with 4 Pelton groups with 2830 kW of rated power each, which means a total power of 11.32 MW. The active power in each group can be controlled in a range of 280kW up to 2830 kW.

The bottom water reservoir has a capacity of 149,000 m^3 made up of a dam built for this purpose, with loose materials PVC-sheet waterproofing, while the upper water reservoir is located at the "La Caldera" crater and it has a maximum capacity of 380,000 m^3. The two reservoirs are connected to each other by two ducts with PVC-sheet waterproofing.

B. *The pumping system*

The task of the pumping system in the HWP is to pump the water from the bottom to the upper reservoir, taking advantage of the electricity produced by the wind farm. The pumping system (Flowserve) is composed by two 1,500 kW pump sets and six 540 kW pump sets, with a total pumping power of 6 MW, using 1600kW converters. The technical configuration of the pumps, allows this system to pump until 2500 m^3/h.

C. *The wind farm*

The wind farm consists of five wind turbines (Enercon E-70) with 2.3MW of power each, totalizing 11.5 MW. The role of the wind farm is to be the primary source of energy. The design of wind farm has taken in consideration the expected future power demand of the island. The wind resource that was used on site corresponds to a production to 2,700 equivalent hours (from 2017).

D. *Hybrid power plant control concept*

The wind farm feeds power into the island's MV power system, out of which the loads are supplied, and also the rest of generation and pumping system is connected.

The historical series of data provided by the meteorological mast installed in 2009 is used by Gorona's wind forecast tool.

It's important to mention that the hydro and the diesel power plants cannot be used as a source of pumping supply. The pumping system is fed exclusively by the wind power. The combination of wind and hydro generation converts a variable source of energy (wind power) in a controlled source of energy.

The Figure 2 summarizes the electrical diagram of the HWP.

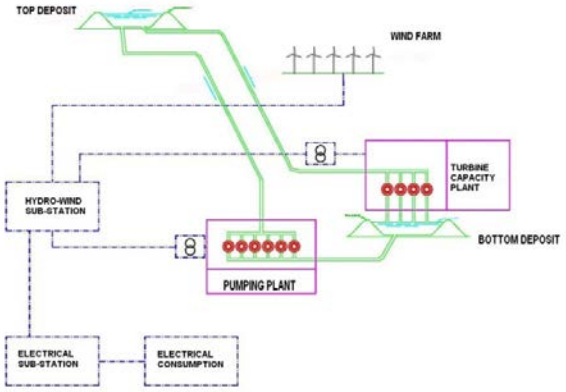

Figure 2. Electric diagram of the HWP in El Hierro including the two water reservoirs connection (in green)

The HWP's control system is organized in different levels: Scheduled operation, primary and secondary regulation, and pump shedding.

REE (Red Eléctrica de España), the Spanish transmission system operator (TSO), is the entity responsible for the stable power supply on the island too. REE prepares a daily dispatch schedule which determines the generation and pumping units that must be connected to the system each hour. Moreover, it also establishes the active power setpoints for each power plant. The planning is adapted to the actual wind resource.

The hydro power plant and the pumping system of the HWP receive the active power settings in their speed governors and frequency converter controllers, respectively. The pump shedding is the last level of frequency control, being used if the previous levels cannot restore the frequency of the system. The elements in El Hierro power system that can be activated for shedding are, in a first step, the HWP's pumping units and, in a second level, the 20 kV distribution lines/feeders. The pumping units are disconnected when the rate of change of frequency (df/ft) or the minimum frequency reaches a certain value.

IV. WIND FARM DESIGN

A. *WF's medium voltage system*

El Hierro wind farm (WF) comprises 5xE-70 ENERCON wind energy converters (WECs) with 64 meters hub height tower and 2300 kW of nominal active power each. In order to increase the availability of the WF, the MV internal grid was designed in a way that each WEC feeds the grid with an independent MV (medium voltage) feeder. Each WEC integrates inside the tower a 2500 kVA 0,4/20 kV transformer. These power transformers have a KNAN cooling type and Dyn5 electrical configuration.

One of the subjects to take in consideration for this relatively big WF to the island's grid dimension was the negative effect in case of a simultaneous energization of the five MV feeders with the corresponding WEC transformers. With the purpose of minimizing the electrical voltage drop during the magnetization/ connection, the WEC's power transformers were designed with a low inrush current (<5*I_rated).

A particular detail on the electrical configuration of the wind farm is the connection of the 20kV feeders to the main substation through a 20kV double busbar, which is represented in the Figure 3.

The operation of the HWP can be done with any of the two busbars connected to the island grid or with both coupled at the same time. Thus, the electrical design allows for one busbar decoupled from the main island grid in order to proceed with the trafo's magnetization in a controlled way. This procedure is achieved by using a voltage transformer (variac) which produces a smooth voltage ramp-up from 0 to 400V in the low voltage side of an auxiliary 0,4/20 kV power transformer. Consequently, one of the medium voltage busbars (04BBA10), where the new WEC to be magnetized is connected, sees a smooth voltage ramp-up at 20kV side. In this way the inrush current is minimized and the transient voltage drop is avoided. Once the nominal voltage and the synchronism are reached, this busbar is re-coupled again to the island main grid.

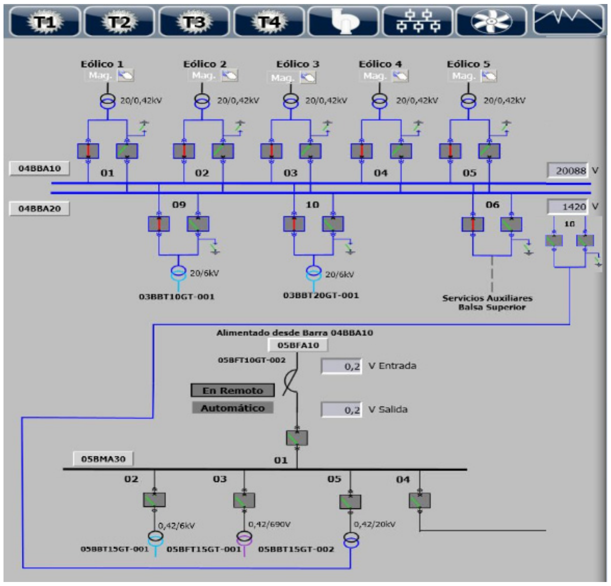

Figure 3. WF's electrical layout and magnetization process

B. *WEC electrical characteristics*

The WECs installed in El Hierro include the standard electrical configuration of ENERCON wind energy converters (WECs) with its direct-drive and full converter concept. The ENERCON FACTS (Flexible AC transmission system) technology allows the WECs to provide important features to the grid, such as:

Reactive power capability: each E-70 WEC provides up to 980 kVAr of nominal reactive power, in both directions (inductive and capacitive). The reactive power capability of this WEC type is represented in Figure 4:

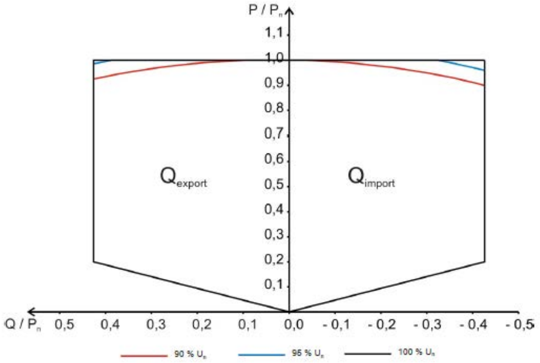

Figure 4. E-70 E4 reactive power capability (PQ diagram)

Fault ride through: these WECs are equipped with fault ride through (FRT) capability. This feature allows the WEC to stay connected to the grid, up to a maximum of 5 seconds, during undervoltages or overvoltages in the grid. Moreover, during the voltage dip the WEC can be configured either to not inject any current or to support the grid - as it is presently configured - with a capacitive reactive current injection proportional to the voltage dip, being the WF compliant with the Spanish grid code annex about FRT response by generating power plants (in Spain called "PO12.3").

The WECs in El Hierro count also with one feature which makes them well suitable for isolated systems with very demanding wind conditions: ENERCON Storm Control®. The ENERCON storm control system allows the WEC to keep generating at reduced active power levels in the event of extreme high wind speeds in the range of 25-38 m/s. The power injected at 38m/s is zero. As soon as the wind speed decrease below 38m/s the WEC ramps up again. For safety reasons the WEC shuts down in case of wind speeds above 40m/s.

C. *WF control system*

The monitoring and control regulation of the Wind Farm is performed by means of the ENERCON SCADA Server and the ENERCON Farm Control Unit (FCU), which are depicted in Figure 5.

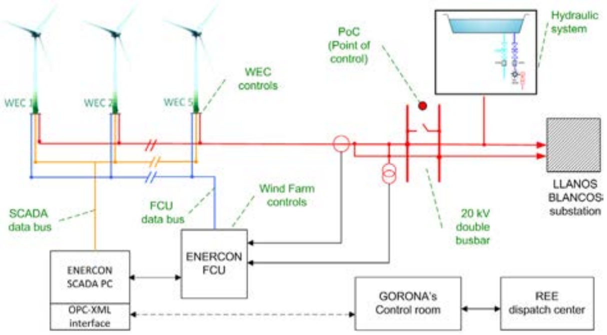

Figure 5. WF's control system scheme

The ENERCON SCADA Server is an industrial computer used to store and monitor the WF data. Every 24h a data replica is stored in an ENERCON server in Germany. For communication purposes, it operates also as an OPC-XML interface to exchange online data and control setpoints with the REE's dispatch center.

The FCU is an advanced wind farm controller, equipped with a grid analyzer and a PLC (programmable logic controller). It has the task to measure the relevant electrical variables at the point of connection of the WF and control them based in the predefined control settings or in setpoints received from dispatch center (via OPC XML interface). In this way, the FCU establishes a closed-loop control between the WECs and the 20kV substation, which is the predefined point of connection (PoC).

1) *Controllers using the active power*

At present the following two controllers on WF-level are activated: a) Active power limitation controller (Pmax) that limits the amount of active power that the WF injects in the grid. The WF receives from the dispatch center an active power setpoint via OPC-XML protocol; b) Active power gradient controller (dP/dt) limits the change of active power per second that the WF injects in the grid. This dP/dt regulation is working simultaneously at WEC level and at WF level.

At WEC level, the active power ramp control can be programmed in 4 operational scenarios: dP/dt during normal operation, after mains failure, after overfrequency event and after external stop.

At WF level, the dP/dt can be parameterized in order to achieve flexibility in certain WF events (e.g. faster active power compensation done by the operative WECs, after one of them enters in sectorial curtailment). The dP/dt can therefore limit the increase of active power very accurately; however, in case the wind speed decreases very fast, the decrease of active power can't be limited always, as the WF itself has no energy storage built in. In chapter V we address this specific scenario.

Presently both WEC and WF active power ramps are set at 10kW/s and 50kW/s, respectively. In fact, these active power ramps were selected to a rather small value due to strong impact that the active power behavior of the WF represents in the island's frequency control. This variability is notorious in two major events: short-time maximum active power setpoint changes and the variable wind speed (e.g. wind gusts).

Nevertheless it is foreseen a gradual increment of these ramps, that the WF can contribute faster to the active power recovery.

2) *Controllers using the reacive power*

The reactive power selected mode in this WF is the voltage droop controller Q(ΔU). The dispatch center selects the voltage setpoint at the PoC and the FCU controller gives the order to the WECs to inject or absorb reactive power according to a settable deadband and droop. As long as the measured voltage equals the voltage setpoint, a power factor of 1 (cos phi=1) is trying to be achieved at the PoC, being the WECs only compensating the MV cables capacitance in-between. Any deviation of the voltage setpoint higher than the deadband (± 3% of the nominal voltage) causes the reactive power injection or absorption with a 15% droop.

For El Hierro WF the following Q(ΔU) curve applies:

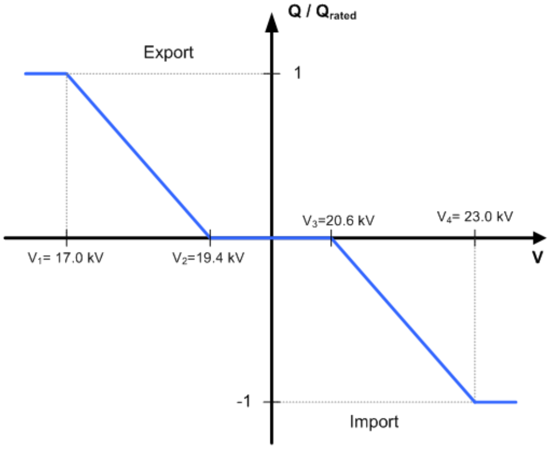

Figure 6. Q(ΔU) profile for a voltage setpoint equal to 20kV (Qrated=4900 kVAr)

D. *WF communication interface*

The ENERCON SCADA Server also operates as an OPC XML Server enabling the grid operator to read, monitor and control a wide range of different control signals. Among them, WEC and WF data such as the wind direction and speed, nacelle position, current active and reactive power, power factor, energy produced as well as electrical variables such as the phase currents and voltages.

Every WEC comprises a control folder where each turbine can be individually stopped or re-started.

Particularly useful in this project is the maximum available active power from the wind farm. With this signal, the HWP operator knows every time the maximum active power that it can be produced by the WF according with the present wind condition.

V. WIND FARM OPERATION ANALYSIS

El Hierro WF is located in a site with a very complex orography. This results in harsh wind conditions, which together with the relatively high power of the WF compared to the islands overall demand, lead to a challenge for the electrical integration into the isolated power system. The wind conditions in this site are heavy: the annual average wind speed is >9m/s, which classifies this site as class I (by IEC 61400 series).

During the operational phase of the WF had been identified several typical wind conditions that lead to a challenging operation due to the WF active power fluctuations and the resulting impact to the islands power system. These scenarios are described in the next points with focus on the wind farm control.

A. WF operation under unstable wind scenarios

1) Wind power below the active power setpoint

At certain periods, the WF was operating with a Pmax setpoint provided by the dispatch center which, due to the wind instability (e.g wind gusts) could not be followed permanently. This situation leads to periods of active power fluctuation.

For the grid operation, the wind fluctuation represents the first challenging situation to handle, especially in cases of unexpected wind cease.

In Figure 7 is possible to see that when the available active power from the wind (red curve) decreases under the given power setpoint (black curve), the frequency (magenta curve) is dragged slightly down. This means that the power system is not balanced in power any more, as the load is exceeding the generation. Despite this, the WF controller struggles to keep the WF active power (blue curve) after those sudden changes in the wind speed.

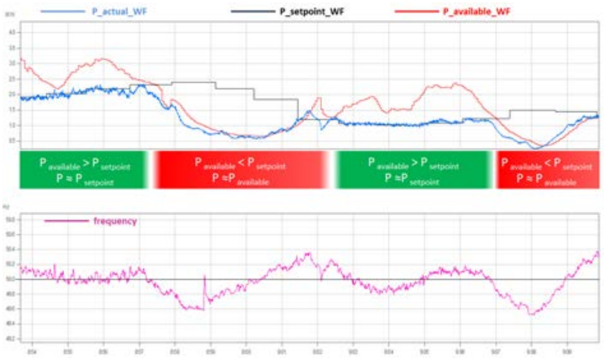

Figure 7. Impact on the grid frequency when Pavailable_wind < Pmax_setpoint

2) WF power curtailement due to wake effect mitigation

Another challenge for the operation is to withstand the sectorial power curtailments. The sectorial power curtailment is a feature of the ENERCON Sector Management (ESM) that limits the power of the WEC based on the actual nacelle position and wind speed, in order to avoid high level of mechanical loads on the WECs due to very high wind turbulence.

The ESM was necessary to be activated in all WECs due to the complex orography and accessibility restrictions on site. In fact, the site restrictions to erect the WECs in terms of orography and accessibility resulted in a layout where the only valid alternative was to install the WECs in one East-West line array, without the chance to keep the minimum usually recommended distances between the WECs. Without this minimum distance ensured and in order to prevent the undesirable wake effect which endangers the mechanical structure integrity of the WECs, the ESM was activated in the five WECs. The ESM is therefore active when the wind blows along the line of WECs from East to West and vice versa. The WF layout can be seen on Figure 8.

Figure 8. Wind Farm layout (image taken from Nordwest)

The Figure 9 shows an example of the sectorial curtailment concept that is possible to be parametrized in a WEC.

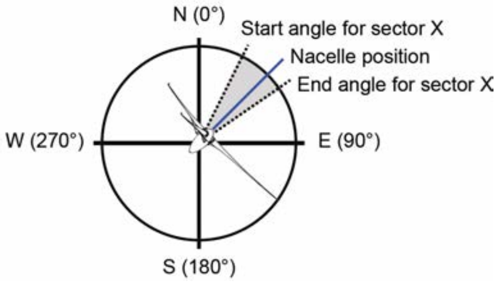

Figure 9. Example of a sectorial curtailment in a WEC

Every time a WEC connects to the grid in El Hierro, the impact in terms of voltage and frequency is almost negligible, as the power ramp up is done in a gradual and controlled way.

The opposite situation, like the disconnection or sectorial curtailment of one or more WECs in operation represents a stronger impact on the frequency due to the sudden loss of active power. This situation is illustrated in the Figure 10. Nevertheless the wind farm controller (FCU) manages to ramp up the WF active power (blue curve) as fast as possible to the desired setpoint and follow it in further up and down power setpoint orders given by the dispatch center.

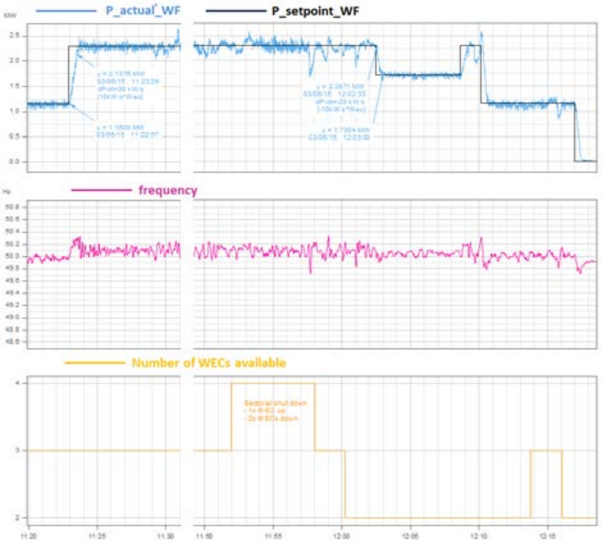

Figure 10. Impact due to WEC sectorial curtailment (ESM)

Making a zoom on what happened every time a WEC entered in ESM, it can be observed in Figure 11 a sudden decrement on the measured active power (in this case, around 300 kW) which led to a frequency drop. As a response, the FCU controller sent an increment of the power setpoint (it can be as fast as possible or, as defined in El Hierro, by means of a ramp up gradient) to the WECs that are available to compensate. As a consequence, the frequency returned gradually to the normal operational range.

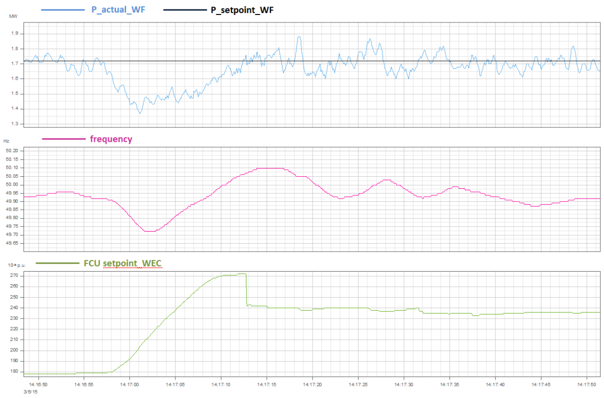

Figure 11. Zoom on the active power response of FCU after ESM

The functionality of this closed-loop controller is triple: maintain the active power setpoint after a sudden loss of active power, contribute to frequency stability and send a gradient increment-up for a linear recovery.

In order to minimize the impact of the ESM on the control regulation, in July 2015 a complete new strategy with 4 measures was implemented:

1) the nacelle position angle ranges at which the WECs should be curtailed were reduced after a deep site assessment research.

2) the WEC's ramp-down gradient when entering in ESM was smoothened from the previous 590 kW/s to a maximum gradient of 50 kW/s.

3) instead of stopping the WEC completely during the ESM, a designed minimum operational level (DMOL) of 20 kW was defined in order to keep the WECs ready for a quick recovery as soon as the nacelle position moves out of the curtailment sector.

4) these ESM restrictions would only apply for wind speeds higher than 5m/s.

These 4 measures together with the FCU closed-loop controller have made possible to achieve a more "grid friendly" WF operation without compromising the safety and integrity of the WECs.

B. *Power-frequency control*

Another important topic was whether the WF should contribute to the frequency control proactively (via FCU Power-frequency controller) or only indirectly (via the already explained maximum active power and active power gradient controllers). Tests on the P-f controller performed in August 2014 during the FCU commissioning showed an active power contribution of the WF after simulating some frequency events. The Figure 12 represents one of the tests, where firstly an underfrequency event was simulated between 21:25 and 21:35 (time period in green). Then, it was simulated an overfrequency event between 21:37 and 21:44 (time period in red), where the measured active power was curtailed below the active power setpoint - according to a predefined 2% droop and a deadband of ±0,1Hz - reaching almost 0 kW at 51 Hz. This allowed a recovery on the frequency at 21:44. In both events is visible the prioritization of the active power increase or decrease over the actual active power setpoint.

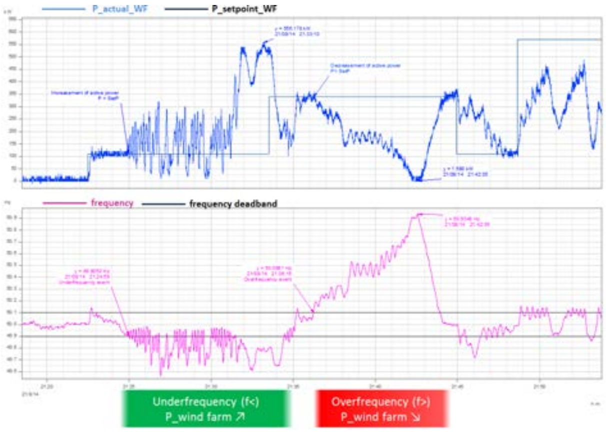

Figure 12. Tests of the Power–frequency controller in August 2014

Nevertheless, the active power increase/decrease in response to frequency disturbances was in most of the cases not fully satisfying. Power and frequency fluctuations had been observed, on top of the expected level due to the variability of the wind. The main reason was the interaction of the P-f controller of the WF with the hydraulic system. Under certain circumstances the two controllers entered into oscillations.

Different parameters in the Proportional Integral Derivative (PID) controller of the WF had been tested, but resulted not to be stable under all circumstances. So it was decided not to implement this PID-controller. For the time being the P-f controller is implemented not at WF level (FCU), but only at WEC level and only for overfrequency events. The underfrequency events are covered by the primary regulation of the system (hydraulic system) and, when necessary, with the sequential disconnection of the water pumps (pump shedding).

Since December 2017, new control parameters in the speed regulator of the Pelton turbines lead to an improved performance. As a consequence, the number of pump shedding events was reduced from 56 per month (March 2016 – October 2017) to only 5 events (period December 2017- March 2018). The discussion is ongoing about how to optimize the P-f control of the WF in combination with the control of the hydraulic system.

C. *Voltage control*

The reactive power capability of the WF is used with the voltage droop controller, as already explained in chapter IV. Different tests for over- and undervoltage conditions were performed during the WF commissioning period, as seen on Figure 13. The results met our expectations.

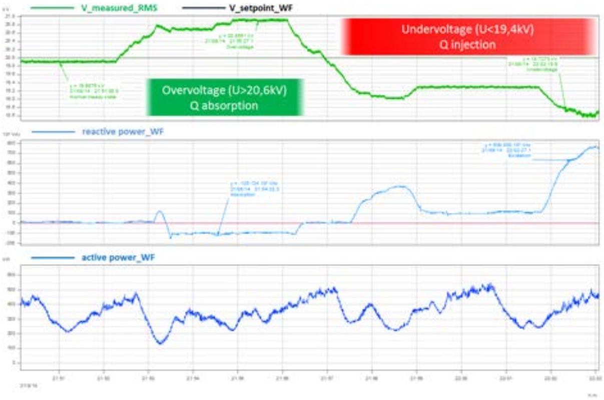

Figure 13. Voltage droop controller tests performed in August 2014

D. *Usage of the wind resource*

The Figure 14 shows the evolution of the WF's active power generation in the last 3 years.

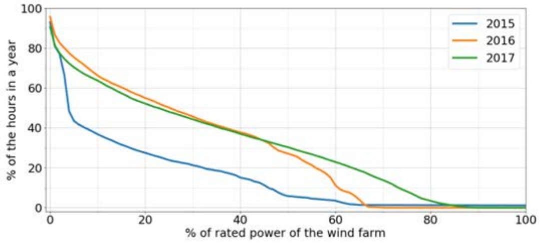

Figure 14. WF active power duration curve in 2015/2016/2017.

These curves show that there was a big improvement between 2015 and 2016. However, in these specific years the WF was not allowed to inject ever more than 7.5MW (65% of WF's maximum power). In 2017, it's visible that the WF was requested to produce longer periods at mid-high active power levels, until 10MW (85% of WF's maximum power).

Thanks to all the parts that work in the HWP operation, it's possible nowadays to operate more and more times the WF close to the available active power from the wind and therefore maximizing the wind penetration, without compromising the grid stability.

The grid operator (REE) has developed an interesting user friendly website where is possible to see and follow the electrical dispatch in El Hierro and also other regions of Spain:https://demanda.ree.es/movil/canarias/el_hierro/total.

Historical data is easily accessible in this tool.

The Figure 15 represents a screenshot of the REE tool where is possible to see the load diagram of El Hierro and the generation mix contribution from the different power plants in the island.

Figure 15. REE hourly power generation mix on the 27nd January 2018. Green: WF active power production

VI. NEXT STEPS AND CHALLENGES

Although the operation of the WF has shown a remarkable progress in the last 3 years, all the parts that are involved in the HWP project are committed to keep collaborating in this project and bring a gradual and consistent increase of RES in the El Hierro power system.

For El Hierro WF, two proposals are under evaluation to be implemented in the near future. Both of them address the contribution or participation of the WF in the frequency regulation, particularly on underfrequency events. Here a short description of both proposals:

A. *Inertia Emulation capability*

The WECs installed in El Hierro have integrated the ENERCON Inertia Emulation (IE) feature, which is also designated in the modern literature by "synthetic inertia". The IE is implemented using a control system that responds to a drop in grid frequency by temporarily increasing the active power beyond the available power from the wind. The energy for this increase is drawn from the rotating masses of the WECs such as the annular generator, the rotor hub and the blades [1]. This functionality was never tested or activated in El Hierro.

B. *Power frequency control concept*

Gorona is evaluating the introduction of a new concept of P-f control that was developed for the WF controller (FCU).

Until a certain extent, the WF can contribute more to the primary regulation of the system, especially during the underfrequency events. The idea of this new P-f control concept is to use the active power reserve, which results from the difference between the available active power and maximum active power setpoint, to support the grid in case of frequency drops.

The Figure 16 represents the proposed control, where the green labels correspond to the settable parameters: frequency deadband, statism (droop) and DMOL (design minimum operational level).

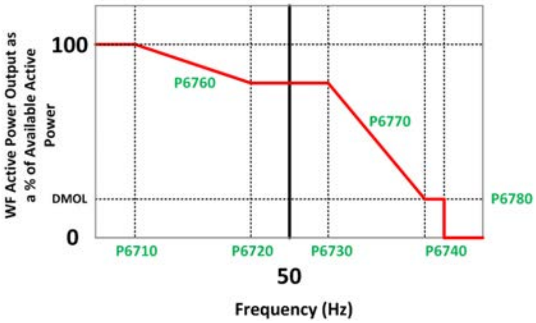

Figure 16. Proposed Power-frequency control by the WF

VII. CONCLUSIONS

The El Hierro project is one of the most interesting and challenging projects worldwide concerning the replacement of conventional diesel power plants with renewable energy sources. This conceptual change has not only an environmental impact but also an economical one, since the fossil fuel generation is more expensive than the RES in the Canary Islands.

El Hierro wind farm is in full operation since summer 2015 and registers a consistent increase in the island's energy mix. The WF has a major participation on that, being the primary source of energy of the HWP. In 2017, the HWP was already responsible for 46,5% of the annual electricity demand.

The experience gathered in the operation of this WF, with its coordination with the local hydro-pump system and the particularities described in this article, makes all the parts involved in this project willing for a further work and coordination in order to achieve higher levels of the HWP penetration in the El Hierro power system.

Besides the system services already provided by the WF, like the Voltage-droop control, the maximum active power control and power gradient control, it's desired a more active participation of WF in the primary regulation, either using the Inertia Emulation capability by the WECs or the WF's power-frequency control. Both are under study with concrete proposals.

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