FINAL REPORT ON THE RESULTS OF THE PRELIMINARY MARKET CONSULTATION ON INNOVATIVE SOLUTIONS FOR THE INTEGRATION OF PHOTOVOLTAIC ENERGY GENERATION AND STORAGE SYSTEMS OR BATTERIES FOR THE EL HIERRO WIND-PUMPED HYDRO POWER STATION (GOR-14/2020)

INDEX

I. Background

Gorona del Viento El Hierro, S.A. is the company responsible for the running, operation and maintenance of the El Hierro Wind-Pumped Hydro Power Station. The purpose of the facility is to supply El Hierro, the Meridian Island, with electrical energy derived from clean renewable sources such as water and wind.

This ground-breaking system, which is unique in the world, has transformed El Hierro into a flagship for the development of renewable energies and for respect for the environment—all thanks to the high percentage of electricity which it succeeds in generating from clean sources, resulting in a saving on diesel and a considerable reduction in CO_2 emissions.

Currently, the Wind-Pumped Hydro Power Station is close to meeting 60% of the Island's total demand for electricity. To achieve total coverage, there is a need to look at other types of technologies and activities to increase the Power Station's capacity and boost its efficiency, and to develop strategies to maintain the supply over the long term.

In 2019, Gorona del Viento awarded the Canary Islands' Institute of Technology (ITC) a contract to devise an "Action Plan to improve the El Hierro Wind-Pumped Hydro Power Station". On the basis of this Plan, it has been possible to identify strategic routes for future development. Among these routes, the most important is the development of photovoltaic solar energy generation.

In addition, to meet the aim of achieving an effective integration, there will be a need to study the whole range of energy storage technologies that could complement the existing capacity of the Wind-Pumped Hydro Power Station, i.e. water storage through pumping, batteries and chemical (hydrogen) storage.

The use of batteries would contribute to stabilising the electricity network, complementing the flexibility provided by the improvement of interconnectivity, the management of demand, and other energy storage technologies. Therefore, there is a need to explore the different options offered by the market to determine which solutions would enable us to meet our objectives for penetration by renewable energies on the Island between 2030 and 2050.

In addition, the very nature of the Wind-Pumped Hydro Power Station (with its hybrid wind and hydraulic energy generation system plus storage through pumping) makes it essential that any integration system has an innovative element and is subject to careful study, even when it is based on a proven technology such as photovoltaic solar energy generation.

In the light of all this, it is clearly necessary to undertake a preliminary investigation of the market,

with the aim of discovering the advances, alternatives, innovations and prices in order to identify needs and to define the characteristics of each option, its scope, and the specifications to be procured.

To this end, therefore, on 20 July 2020, Mr Santiago González González (Chief Executive Officer of Gorona del Viento El Hierro, S.A.) adopted the Agreement to initiate the process designated GOR-14/2020 "Preliminary Consultation on Innovative Market Solutions for the Integration of Generation and Storage Systems for the El Hierro Power Station by means of photovoltaic energy and/or batteries", in accordance with the terms of Article 115 of the Public Sector Procurement Legislation 9/2017, 8 November.

In order to ensure fair and open competition, the announcement of the tender was published and disseminated in Gorona del Viento El Hierro, S.A.'s Contractor's Profile, and on the Public Sector Procurement Platform (which may be accessed at this URL, and which included the following elements:

- Objective
- Entities invited to participate in the consultation
- Presentation
- Timescale
- Technical group
- Application of the principles of transparency, equal treatment, non-discrimination and fair competition.
- Results of the preliminary market consultation.
- Rules governing confidentiality, protection of trade secrets, protection of personal data and intellectual property rights.
- Public procurement
- Jurisdiction

All these steps were undertaken in order to ensure that all potential interested parties would have access and the opportunity to contribute—in accordance with the terms of Article 115 of Law 9/2017, 8 November, regarding Public Sector Procurement.

In accordance with what has previously been stated with regard to the terms of the "Preliminary Consultation on Innovative Market Solutions for the Integration of Generation and Storage Systems for the El Hierro Power Station by means of photovoltaic energy and/or batteries", and with the deadline for the submission of proposals having expired, the report of the conclusions of the preliminary consultation can now be published.

II. List of Participants

Within the timescale allowed for the submission of proposals, the following participants completed the form:

PROPOSALS RECEIVED		
Company	**Date**	**Time**
Oleksandr Novykh	**18/08/2020**	**23:25**
Norvento Enerxía, S.L.	**18/09/2020**	**13:42**
SkySails Power GmbH	**19/09/2020**	**00:47**
Adamant Renewables Holding, S.L.	**21/09/2020**	**12:25**
Alfa 90, S.L.	**21/09/2020**	**17:39**

III. Criteria applied in the analysis of proposals

In the analysis of the proposals submitted, the following criteria have been taken into consideration:

- The use of the content of the proposals should be limited exclusively to the definition of specifications for the final procurement process which will follow the preliminary market consultation.
- That, in order to obtain as much information as possible about the proposals, an annex was included within the Consultation with a proposal form, which was to be completed by all the participating companies.
- That special attention should be paid to matters including: the scale and topology of the technical solution; the degree of maturity of the technologies proposed; the useful life and rate of deterioration of equipment; costs; modularity; timescales for delivery.

IV. Technical group

On 1 October 2020, the Chief Executive Officer of Gorona del Viento El Hierro, S.A., Mr Santiago González González, adopted the agreement designating members of the Technical Group for GOR-14/2020 “Preliminary Consultation on Innovative Market Solutions for the Integration of Generation and Storage Systems for the El Hierro Power Station by means of photovoltaic energy and/or batteries”, in accordance

with the following specification:

TECHNICAL GROUP	
Gorona del Viento El Hierro, S.A.	Ms Candelaria Sánchez Galán
Gorona del Viento El Hierro, S.A.	Mr Félix Boda Suárez
University of La Laguna	Mr Ricardo Guerrero Lemus
Canary Islands' Institute of Technology, S.A.	Mr Jesús de León Izquier

V. Analysis of the proposals

In procedural terms, the process of managing information for the stages of the Preliminary Market Consultation has worked correctly; no issues have arisen, and the documents and forms relating to the Consultation have, at all times, been available on the Gorona del Viento El Hierro, S.A. Contractor Profile and on the Public Sector Procurement Platform.

The following observations may be made on the proposals submitted within the set deadline:

- The Consultation received eight proposals: one for Question 1, two for Question 2, one for Question 3, and four for Question 4.
- Five entities took part in the Consultation, of which:
    - Four are private companies (two Spanish, and two international companies).
    - One proposal is from a university researcher.
- For the most part, the participants claim to have experience in functional and technical developments related to the project in question.
- Similarly, the majority of the participants demonstrate previous experience in development or technological projects similar to those required by the Consultation.
- The majority of the proposals are innovative.

Below is a summary and explanation of the technologies and solutions proposed by the entities participating in the Preliminary Market Consultation (according to the results obtained from the forms submitted), which have been grouped according to the questions to which they responded.

CONSULTATION 1. Integration of a 1 MW photovoltaic solar plant on land in the vicinity of the El Hierro Wind-Pumped Hydro Power Station.

One single proposal has been received with a technological solution based on a photovoltaic solar plant. This would have a maximum power capacity of 1.13 MW with a 'Plug & Play' storage system with an

integrated 500 kW/712 kWh battery. The plant would occupy a 15,150 m^2 area in the Llanos Blancos area.

This solution also recommends 450 WP, 144-cell monocrystalline silicon solar panels with an approximate efficiency of 21.3% and a 92% guaranteed capacity after 25 years. This system would achieve a net annual production of 1,929,591 kWh, the equivalent of 1,715 hours.

The open circuit voltage is 1330V. It is sized with 25 modules in series and 100 in parallel. It proposes a 1250 kVA power transformer station with a working voltage of 690/20000 kV as the most suitable solution to minimise loss from the plant. (It will be necessary to study whether this level of power would affect the network in the magnetisation transition.)

The proposed structure would be built from S275, galvanised S355 EN10025. It does not take into account the high salt level in the Llanos Blancos area.

The proposal would require a budget of up to €1,664,500.00, including the solar panels, Lithium NMC batteries, power converter, monitoring systems and auxiliary systems, and has a timescale of six months.

In addition, the integrated battery system is modular, and therefore allows a variation of installed energy of between 279 and 712 kWh. It is estimated that at the end of its life, the battery would still have 70% of its capacity, i.e. 498 kWh.

The proposer states that the batteries would have the following characteristics:

- The battery would have the facility to control and cap spikes, to load transfer, and for a smooth transition to the island.
- Ramp control. The system has an overload capacity of 110% over normal capacity for 10 minutes, as well as an active and reactive power flow control of below 1 second.
- A back-up generator in the event that the connection holding the load is lost.
- Input fault detection, using protection against excessive current or directional firing.
- It is capable of providing voltage and frequency references.
- It can act as an additional synchronous machine.
- It can integrate with any component from any manufacturer, applying standard protocols.

CONSULTATION 2. Integration of a 1 MW floating photovoltaic solar plant with the El Hierro Wind-Pumped Hydro Power Station.

Two proposals were received, amounting to €1,664,000 and €2,087,480 respectively, with delivery timescales varying from between 15 days and 3 months.

According to the information supplied to the Consultation, the proposals present a common

solution in the installation of a 1 MW photovoltaic solar plant on a floating structure to be sited on the stretch of water that is the Wind-Pumped Hydro Power Station's lower reservoir.

Each of the proposals suggests a different orientation for the panels: the first proposal recommends a southern orientation, and the second an east-west orientation.

The panel models vary between 325 Wp and 405 Wp, and would be installed on floating modules. The proposals suggest different solutions for the modules:

Proposer 1: A floating solution that would enable the use of large-size solar panels; greater flexibility in the connections; a 5º angle; a double float made of high-density polyethylene (virgin HDPE) with UV and antioxidants, and manufactured by plastic injection, which will give the float greater precision and durability.

Proposer 2 states that it could be installed so that it has zero contact with the float, and that they have taken into account that the minimum surface area offered by the reservoir is 6,000 m^2. The ballast could be attached to the outside of the float, either on the bottom or on the embankments, so that there would be zero contact with the water.

In answer to the question about the theoretical saving caused by the reduction in loss via evaporation, the proposers estimate 80% and 15% respectively.

This system would achieve a net annual production of 1,713,000 kWh, the equivalent of 1,523 hours.

In relation to the batteries, only Proposer 1 details the following features:

- A 'Plug & Play' system, thereby optimising both local civil engineering works as well as installation and transport costs. High modularity (varying between 279 kWh and 712 kWh).
- A back-up generator in the event that the connection holding the load is lost.
- The battery would have the facility to control and cap spikes, to load transfer, and for a smooth transition to the island.
- Inertia simulation capacity.
- Frequency regulation.
- Management of peak demand.
- Renewable generation ramp control.
- Voltage and/or power output factor control.
- Control of load levels and a rolling reserve.
- The capacity to act as a back-up generator (off-grid).

CONSULTATION 3. The technical and economic viability of a self-consumption photovoltaic plant for the Wind-Pumped Hydro Power Station pumping station.

A single proposal was received offering a technological solution based on a self-consumption photovoltaic solar plant with a peak power capacity of 100 kW, to be installed on the roof of the Wind-Pumped Hydro Power Station's pumping station.

This solution recommends 325 WP, 60-cell monocrystalline silicon solar panels with an approximate efficiency of 19.5% and inverters with a nominal 50 kW power output. The solution includes a dynamic power controller that could regulate the power generated, although it would also have the function of energy monitoring and management.

The nominal power output would have a linear performance guarantee of 25 years (with a maximum drop in performance of 0.7% per annum).

This system would achieve a net annual production of 184,900 kWh, the equivalent of 1,849 hours.

The turnkey budget goes up to €122,739.51, with a timescale of two months, and would result in an annual saving of €16,083. It would prevent the emission of the equivalent of 67.03 tonnes of CO_2, with an estimated payback of 6 years, an NPV of €521,011 and an IRR of 18.17%.

CONSULTATION 4. A storage solution as a tool integrated into the current configuration of the El Hierro Wind-Pumped Hydro Power Station

Proposals were received from companies, varying between almost €500,000 and €850,000 with delivery timescales ranging from one month to one year (an average of 6.3 months).

Three of the five proposals were analysed together, as the solutions they proposed were similar, while the other two were analysed separately.

Electrochemical storage systems:

	Proposer 1	Proposer 2	Proposer 3
SOLUTION	1 MWh storage system	A system with two 500 kW/712 kWh (1 MW/1.4 MWh).	A hybrid, 1.4 MW/1.3 MWh storage system.
	A LiFePO4 battery, including supply and installation.	Power converter, control system, Lithium NMC batteries and auxiliary systems.	Power converter, container, ion-Li battery and auxiliary systems.
TRANSFORMER		20/0.4 kV 1.2 MVA	20/0.4 kV 1.2 MVA
BUDGET	€498,875.00	€797,535.00	€850,000.00
CAPACITY OFFERED	1 MWh	713 KWH	1.3 MWh
TECHNOLOGY	LiFePO4	Li-Ion, NCM	Li-ion
TIMESCALE	1 month	6 months	6.5 months

The proposal puts forward examples of installations which, although they do not have the unique nature of the Wind-Pumped Hydro Power Station, present similarities to enable comparisons of functionality under extreme conditions to be made.

Proposer 1's system has the following characteristics:

- A rechargeable lithium iron phosphate battery. These batteries possess a somewhat lower energy density than the more common LiCoO2 batteries, but offer greater durability, higher power output, and are inherently safer.
- The battery system would enable the delivery of auxiliary services such as the regulation of frequency/voltage, spare frequency/voltage, and black-out prevention.

Proposer 2's system has the following characteristics:

- High-capacity Lithium NMC batteries.
- 70% end-of-life capacity, which translates into installed energy of 498 kWh (712 x 0.7) at end of life.
- A 'Plug & Play' system, thereby optimising both local civil engineering works as well as installation and transport costs. High modularity (varying between 279 kWh and 712 kWh).
- A back-up generator in the event that the connection holding the load is lost.
- The battery would have the facility to control and cap spikes, to load transfer, and for a smooth transition to the island.
- Inertia simulation capacity.
- Frequency regulation.
- Management of peak demand.
- Renewable generation ramp control.
- Voltage and/or power output factor control.
- Control of load levels and a rolling reserve.
- The capacity to act as a back-up generator (off-grid).

Proposer 3's system has the following characteristics:

- A hybrid storage system, based on energy batteries and ion-Li power technology, governed by a converter designed and manufactured by the company itself—and which works whether connected to a network or with disconnected or off-grid installations.
- Batteries installed on two sea containers.
- The inverters have a useful life of 20 years.

- The data recording and monitoring tools, as well as the modular design, make the work of maintaining the equipment easy, wherever they are installed. The option of remote maintenance also reduces costs and time investment.
- Virtual inertia to the system. Bringing real inertia to act as a network builder (ms response).
- The capacity to perform active and reactive power control, generating or saving energy according to its frequency derivation, by following dP-Df-programmable curves from the control centre.
- Offset of reactive power.
- Load capacity (as a builder): Programmable (up to twice the nominal current).
- Emergency start / Black start.

Wind power generation system with electro-chemical storage

This solution brings together a wind power generation system set at a height and a bank of 400 kW/78 kWh batteries. The budget goes up to €2,000,000.00, includes a power converter, container, Lithium Titanium battery and auxiliary systems, and has a timescale of 6 months.

This system is still in its test phase. It is estimated to generate 3,200 MWh per year, with a peak power output of 50 kW, the equivalent of 6,800 hours. According to the data provided, this solution has a superior performance, as it needs less wind to reach 75% of its maximum capacity.

It has a lower visual impact, the noise produced is below 45 dB, and they estimate an 11-year depreciation period on the investment. The proposal does not include any environmental studies, nor details of access or connection to the electricity grid.

Virtual electric power station

The solution is a virtual electrical power station which, unlike the other proposals, would act according to demand. To that end, devices to control load receptors from the island network will be required. According to the proposal, these operations will require a budget of €250,000 and will take a year to complete.

VI. Conclusions

According to the information received from the market, it has been established that, in this context, there are various solutions based on existent technologies, although they do not always meet in full all the requirements detailed by the study. Therefore, consideration is being given to the possibility that specific

adaptations and/or technological development will be needed for the completion of the project. For this reason, it seems appropriate to include the following technical and functional requirements in the final public tendering process:

- The control system for photovoltaic inverters must be integrated on the battery control platform itself. In addition, there needs to be a guarantee that the system will work in a stand-alone form and will have the capacity to provide short-circuit power and frequency-power control.
- The control system must be compatible with, and capable of integration with, the Wind-Pumped Hydro Power Station El Hierro's SCADA system, and must allow external setpoints for the production of active and reactive power.
- Given that panel technology is at a mature stage, a minimum power must be stipulated in relation to the surface of the panel, and a performance of 20% or higher required.
- The criteria must include the use of materials suitable for a predominantly marine environment (an atmosphere saturated with salts; a coastal area), as well as the subsequent maintenance tasks required under these environmental conditions.
- The dimensioning must be calculated according to the end of the system's useful life. Guarantees for the equipment must apply to the estimated useful life of the system.
- The capacity for intra-hour management.
- In order to ensure that bids in any public tender for storage systems are able to be compared, it will be necessary to provide a time series of power outputs and spare inertia data. It will be a requirement that the solution guarantees maintenance of the frequency, and that it specifies the time frame of this guarantee.
- It will be a requirement that the company has previous experience in the development and implementation of installations with a similar configuration, even if they have been of a lower power output.
- Any proposals must be 'turnkey' offers, to prevent any aspect of the project (whether of a technical nature, or relating to tax or customs, etc.) exceeding the budget.

Finally, the following recommendations should be noted:

- Before the public tender is issued, the usability criterion for the storage system should be assessed. In the event that it is decided to use the system as a means to regulate the systems already installed to generate power from renewable sources, the preferred option may be to opt for batteries with a lower-cost technology. The particularly interesting integration of further

renewable energy sources (photovoltaic, solar, wind) would mean improved conditions for storage systems (Li-NMC technology batteries, electronic power converters, etc.).

- Following an analysis of the proposed solutions for the integration of a floating solar energy plant, the need has become apparent for a deeper study into the convenience of this particular option: the materials to be used; their interaction with the elements and materials existing in the reservoirs; and their maintenance. Therefore, if it is considered necessary, a study may be undertake to assess the technical and economic viability of installing the panels on a semi-fixed structure in the Lower Reservoir. This system would also achieve a reduction in losses via evaporation and the deterioration of the HDPE sheet.
- Given that currently, several regulations are in the process of being passed that could affect the technical criteria and the financial viability studies, it is advisable to undertake a review of the national and local legal framework.
- Among the proposals submitted, and taking into account the requirements of the consultation, the most homogeneous and readily comparable offers are those relating to the storage system.
- The summaries of maximum costs made by the companies, which would presumably guarantee competition in any forthcoming public tender process, are listed below:

COMPARISON ACCORDING TO PROPOSALS RECEIVED		
Price	**Average of all the proposals submitted**	**Average of the most complete and comparable proposals**
PV 1MW-CHEH Plant		€1,664,500.00
PV 1 MW Floating Plant	€1,875,740.00	€1,875,740.00
Pumping Station Plant		€122,739.51
Storage System	€879,282.00	€823,767.50

It is proposed that the maximum bid prices should be estimated with reference to the “Average of the most complete and readily comparable proposals”, and excluding any proposals considered abnormally low or high due to their significant deviation upwards in comparison with

the average, and those whose features mean they cannot be compared.

For questions 1 and 3 of this consultation, the installation of a 1 MW photovoltaic solar plant in the El Hierro Wind-Pumped Hydro Power Station and the installation of a self-consumption photovoltaic solar plant on the roof of the pumping station, only one proposal was received with maximum public tender prices. In relation to question 1, it is estimated that an upward deviation of up to 25% exists, which cannot be verified with the data received.

In any case, it is recommended that a new review of maximum prices is undertaken before the final publication of the tender.

Signed:

_____ Mr Félix Boda Suárez	_____ Mr Ricardo Guerrero Lemus
_____ Mr Jesús de León Izquier	_____ Ms Candelaria Sánchez Galán