6,000MWhr/day

ENERGY STORAGE HUB

GLINSK MOUNTAIN, COUNTY MAYO

TARGET DATE TO ENERGISE 2016

ORGANIC POWER LTD

Responsible Energy for a Sustainable Climate

OP18 Project Brochure Issue 3, AUGUST 2011

PROPOSED SEA WATER PHES SCHEME

What is the project?

The scheme is conceived to provide energy storage for windpower and ocean power, transforming these unpredictable energy sources into reliable power available on demand. It will expedite the long awaited potential to develop wind generated electricity in Mayo at a large scale. It will be ready to also accept wave energy at large scale when this technology comes of age. It will link the best wind resource in Europe to the UK market, delivering clean power when it is needed. The €680,000,000 project is competitive at €700/kW. It will generate 200 jobs for 3 years and justify the immediate rollout of a dedicated grid connection to the UK interconnector by 2016.

Where is the Scheme to be Located?

Glinsk, Co. Mayo has been selected for this project because of its almost unique qualities as a high, flat-topped, mountain beside the sea, composed of very hard, impermeable, and immensely stable schist rock. The location is not in an SAC, NHA or other environmentally designated site.

What is a Sea Water Pumped Hydroelectric Energy Storage Scheme?

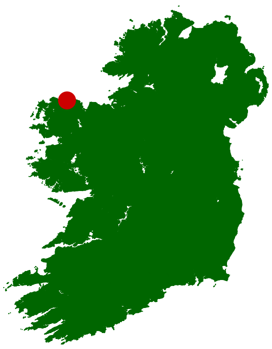
A pumped hydroelectric storage scheme (PHES) is a device for storing energy. It is used to accept excess energy from the electricity grid when production is high relative to demand, and deliver energy back to the grid when demand is high and production is low. It is an established technology worldwide, with hundreds of schemes such as Turlough Hill in Wicklow, in successful and safe operation. A similar type sea water PHES has been functioning successfully in a National Park in Japan since 1999 and several schemes are in development around the world. Using sea-water allows for larger and more economical schemes without the need to use valuable and limited freshwater resources.

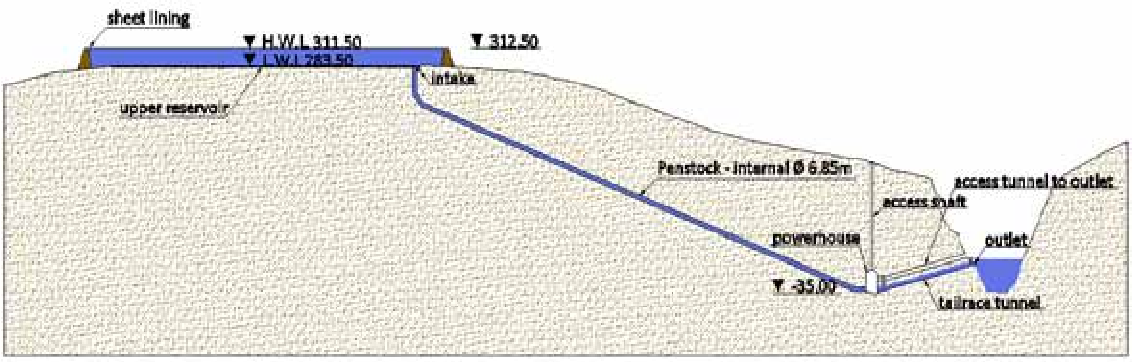
How will the Proposed Sea Water PHES at Glinsk work?

The Glinsk project will use the sea as the lower reservoir. The facility will accept power, primarily excess wind power, during off peak night time hours or when generation exceeds demand and use it to pump sea water to a reservoir on the top of Glinsk Mountain. The stored energy will be returned to the grid through turbines for use during peak times. It will also accept sea water pumped to the reservoir by ocean energy pumps.

Seawater PHES at Okinawa, Japan

PHES at Turlough Hill, Co. Wicklow



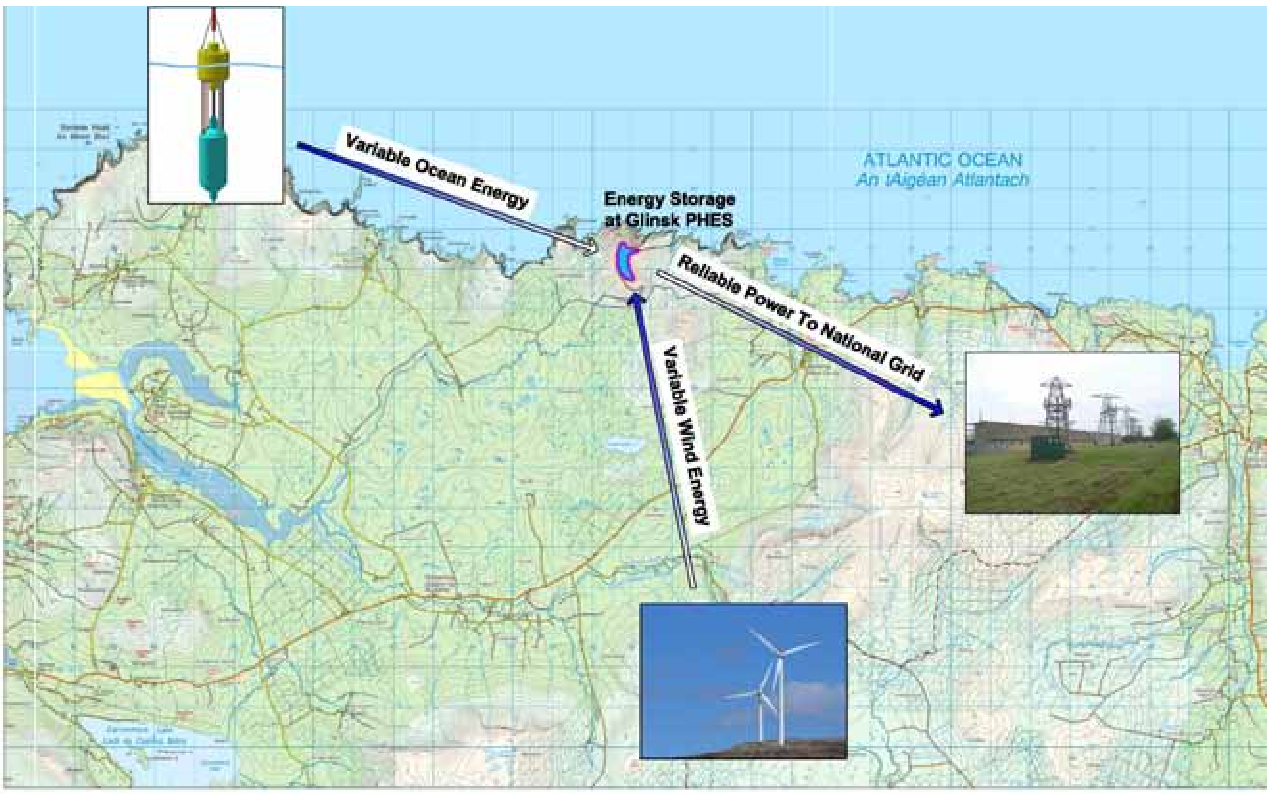


Profile of Waterways

Organic Power Ltd

BENEFITS OF THE PHES SCHEME

- It will accept 960MW of clean but unpredictable energy from planned local windfarms and ocean energy projects, and transform it cost-effectively into a high quality predictable green electricity product by storing it for use when needed.
- The project will, in its own right, justify the installation of a dedicated High Voltage Grid connection loop to North Mayo from the East-West interconnector for the export of renewable energy to the UK.
- Over a short time frame it will unlock the potential to develop at a minimum 1500MW of planned wind farms in North Mayo.
- This level of windfarm construction will allow the manufacture of wind turbines to be undertaken locally, creating at least 500 jobs and €3 billion in local revenue.
- Construction of the project will create 200 jobs and €20,000 per day spend on local services for 3 years.
- It will significantly reduce the national need for imported fossil fuels that are required to keep gas, coal and oil fired power stations running.
- It can accept one third of the projected surplus night time wind power that will be produced in Ireland when the national target of 6,000MW of wind turbines is achieved by 2020.
- The project will be a tourist attraction to the area with an on site visitor and environmental centre.



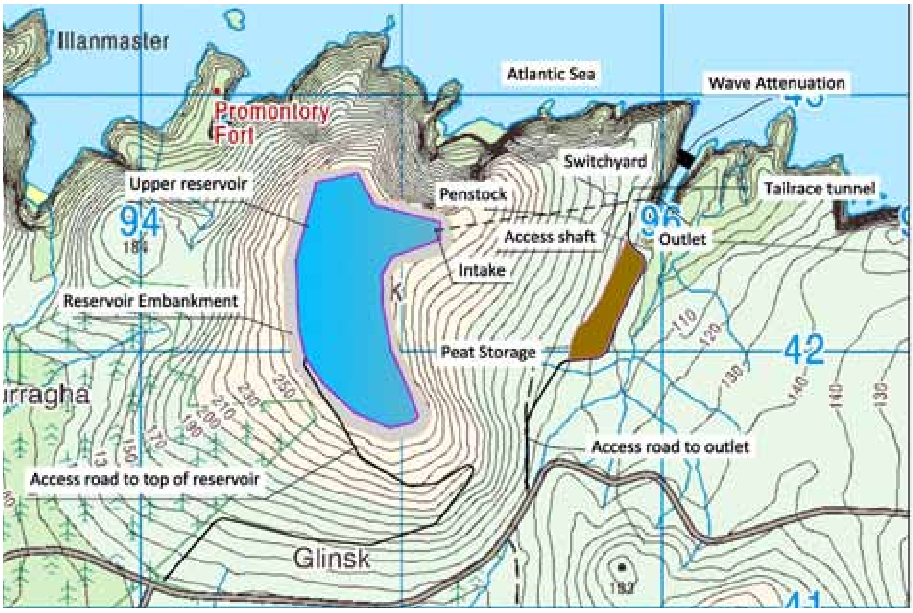
Input electricity will be preferentially sourced from grid connected wind and wave energy projects. The process will transform unpredictable and variable wind and wave power to reliable, dispatchable power delivered to the grid.

OUTLINE OF THE PROJECT

The Site

The site of the project faces the Atlantic Ocean and the upper reservoir is located on the plateau of Glinsk mountain, 295.5 metres above sea level and about 700m from the coastal intake. To preserve the landscape in the area, the penstock and powerhouse will be excavated underground, and the profile of the mountain will be landscaped to minimise visual impact from the protected views from the Ceide Fields.

Glinsk Mountain



Site layout at Glinsk, Co. Mayo

The Upper Reservoir

The upper reservoir will be 28m deep with a surface area of 315,258m^2. It has an effective storage capacity of 8.9 million m^3. The shape and location of the upper reservoir was determined based on topography and a minimum volume of earth works with an optimum balance between excavation and embankment volumes.

Example upper reservoir

The Power House

The powerhouse will be located 50m below sea level, adjacent to a protected sea chasm at the north eastern part of the site and will consist of a cavern containing the 4 number 240MW pump turbines. This cavern will be accessed by a vertical 150m deep access shaft from the surface of the ground above.

Intake Structure

The cavern will be connected to the sea by a 120m long intake structure located below sea level in the east facing cliff of the sea chasm. The water in the chasm will come from the open Atlantic through a tetrapod mound wave attenuation structure located at the mouth of the sea chasm. The sluiced water intake structure will be constructed below sea level from re-inforced concrete to allow water to be extracted and pumped to the reservoirs. The intake structures tail race pipe will be constructed to a depth of approx. 35m below sea level to provide sufficient back pressure on the pump-turbine to eliminate cavitation. Appropriate sluice controls and trash racks will be included.

Example of an intake structure

Wave and Flow Attenuation Structure

A revetment of tetrapods (precast concrete blocks) will be laid at the mouth of the inlet, with 2 main functions: a) to minimise wave action and reduce water level fluctuation during pumping and b) to dissipate the energy of the exiting water post generation and protect marine habitat.

Example of a power house and turbine

Example of tetrapod structures

PROJECT SPECIFICATIONS

Description	Unit	Data
Upper Reservoir		
High water level	m	311.5
Low water level	m	283.5
Available drawdown	m	28
Water surface area	m^2	315,258
Gross storage capacity	m^3	8,900,000
Type	-	Embankment dam (HDPE rubber sheet and asphaltic lining)
Height	m	29
Crest length	m	2560
Embankment volume	m^3	1,400,000
Waterways		
Waterway intake	-	Sluiceway Type
Penstock (Inside dia. x length)	m x m	8.5 x 850
Tailrace tunnel (Inside dia. x length)	m x m	9 x 100
Power generation		
Normal headwater level	m	297.5
Normal tailwater level	m	+2
Normal effective head	m	295.5
Maximum discharge	m^3/s	400
Maximum output	MW	960
Transmission line		
HVDC	MW	1000 (2 x 500)
Length	km	approx. 270

POWER GENERATION

Pump / Turbine and Motor / Generator

Once operational the PHES project will supply electrical power using 4 identical pump/turbines. A total of 8,900,000m^3 of sea water will be pumped to an average elevation of 288.7m above sea level, using 960MW of electric power sourced from wind and ocean power during off peak hours of electricity demand.

When released, the water from the reservoir will generate electrical power at 960MW from the four turbines. This power will be delivered to the grid via twin dedicated undersea and underground cables to the Irish Grid at Woodlands near Dublin during peak demand hours.

The PHES scheme can deliver power at maximum output for 6 hours per day, corresponding to peak demand in the UK and Ireland. The scheme will accept energy off peak for 4 up to 20 hours per day depending on the available wind energy.

Materials for the pump-turbine runner and the guide vanes will be made from austenitic stainless steel which has anticavitation, antiwear and anti- which has anticavitation, antiwear and anticorrosive characteristics.

For high efficiency power generation and pumping, a state of the art variable speed pumped storage power generation system will be used, based on a gate turn off thyristor converter - inverter AC excitation system. This system reduces the impacts on the power system by minimising input power operation at the beginning of the pumping operation.

Power Import Cables

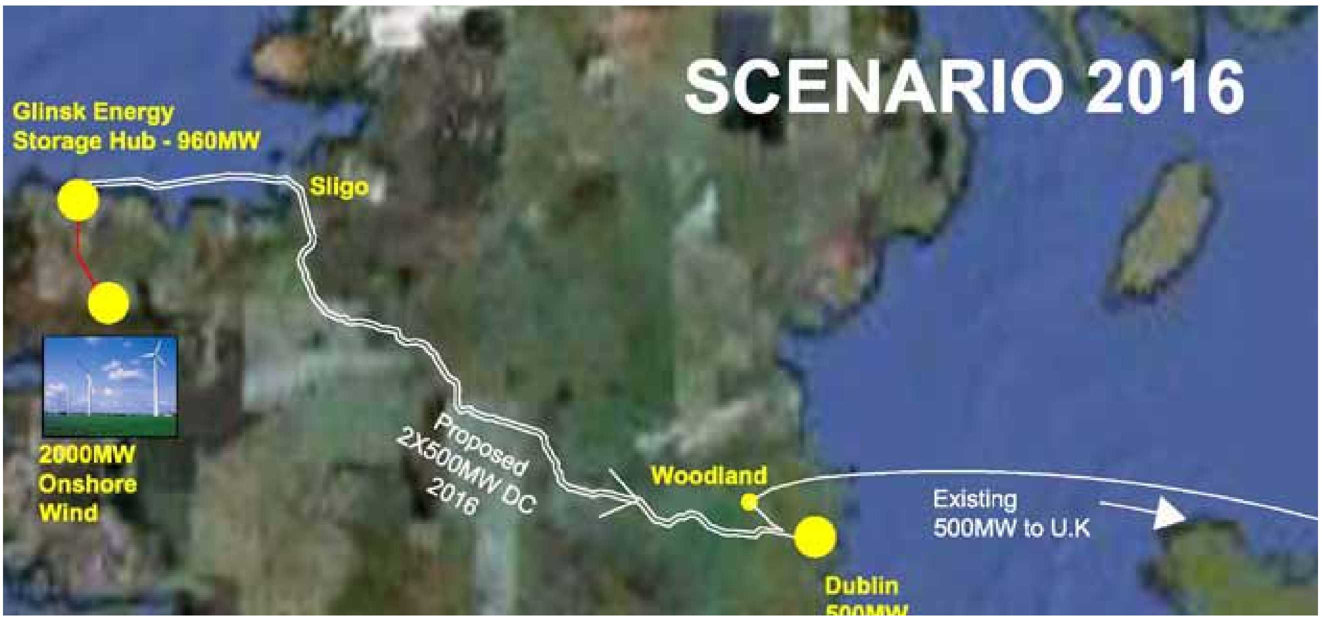
The 400kV alternating current (AC) import cables connecting wind farms to the project will be laid under the access road and will not pass near residential areas. The cables will be undergrounded in sensitive areas.

Power Export Cables

The energy storage hub will accept tail fed input power initially, until a local interface with the National grid is available post 2019. This way, the connection at Dublin will be a "shallow contestable" cul-de-sac connection allowing it to be built by private venture by 2016.

A power invertor on site will transform both incoming tail-fed wind and ocean power which is going directly to market, and the output from the energy storage hub from alternating to direct current (AC to DC). The DC power is then sent accross the country via buried High Voltage Direct Current Cable (HVDC).

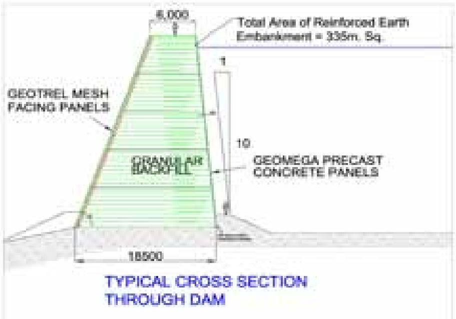
The proposed twin 500MW HVDC export cables will be laid undersea and make landfall at Sligo from where they will be laid underground all the way to the National Grid Woodlands substation North of Dublin, At Woodlands an existing interconnector from the UK terminates. Using this route, 500MW of power can be directly exported to the UK by 2016, with the remainder supplying Dublin.



SAFETY

Mountain Stability

Geophysical and geotechnical surveying has been carried out as part of the Environmental Impact Statement to confirm the stable bedrock characteristics of Glinsk Mountain. The reservoir embankment will be an earthquake resistant reinforced earth system gravity retaining structure constructed with rock and depositional soils from within the site.



Peat Storage

Peat will be removed from the top of Glinsk mountain during the construction of the reservoir by pumping to a stable storage area at the bottom of the mountain.
The peat storage embankment will be constructed using the same stae of the art reinforced earth technology. A Peat Landslide Risk Assessment has been carried out as part of the Environmental Impact Statement and will be monitored closely at all stages

Peat on Glinsk Mountain

Sealing the Reservoir

A High Density Polyethylene (HDPE) synthetic rubber sheet will be used for the lining of the inner dam slopes of the upper reservoir, and asphaltic liner used to seal the reservoir floor, in order to prevent water leaking from the reservoir into the surrounding environment. HDPE has excellent material properties and weather resistance characteristics and is commonly used to line PHES reservoirs.

Sea Water Detection System

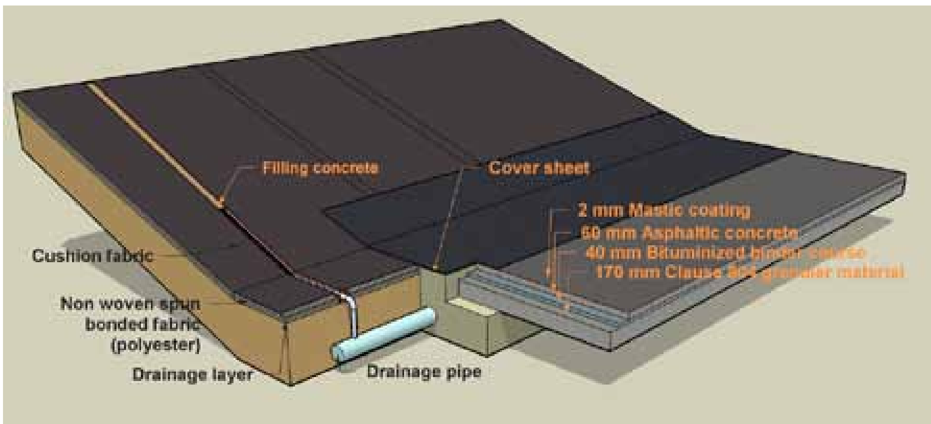
If damage to the sheet occurs, seawater leakage will be detected by a Leakage Monitoring and Detection System. Underneath the sealing systems of the reservoir a drainage system will be installed in order to intercept possible leakage water. A fibre-optic leakage detection and localisation system will be fitted to pinpoint possible leaks at critical points. This system will enable immediate automatic action in case of the occurence and/or in case of changes in the level of leakage water. It will also prevent sea water from leaking into the neighbouring environment. Also, as the rubber sheet is the top layer of the lining structure, it can be repaiMl

Noise

Noise sensitive locations have been identified and the Environmental protection Agency (EPA) Guidelines for noise limits have been followed in project design. During construction it is expected that there will be some noise from plant and equipment on site. All noise limits will be adhered to at the nearest residence and noise sensitive locations. No significant noise impact will result as a consequence of the development. During operation the only significant source of noise will be from the pump turbines. However, as these are located deep underground they will not be audible to receptors outside of the site.

Construction Traffic

The project will use on site materials as much as possible and there will be no rock or soil imported or exported from the site. Access roads and reservoir have been designed to balance rock cut and fill volumes. This will significantly reduce the amount of construction traffic to and from the site. Heavy vehicle access to the site will be via a new access road, designed in consultation with local residents to avoid built up areas.



Schematic of the rubber lining system for the upper reservoir.

ENVIRONMENTAL CONSERVATION

How can we limit the impact of the development on the Natural Environment?

In designing the proposed pumped hydroelectric scheme, we have adopted the following basic policies in pursuit of harmony between development and preservation of the environment.

- The extent of alteration of the site has been minimised to ease the impact on the natural environment.
- Damaged environment will be restored where possible to assist habitat diversification.
- An Environmental Impact Statement has been prepared and includes exhaustive studies over 2010 and 2011 to assess the impact of the project on the local flora and fauna, birds, and marine life as well as geology, noise, traffic and cultural heritage both during construction and operational phases. It details mitigation measures that will be followed to minimise the impacts identified.

The following measures will be implemented to conserve the land and sea, and the flora and fauna occupying those areas:

Location of sea water intake

Reduction in discharge velocity

To mitigate the impact of sea water discharge on marine life from power generation, a breakwater of precast concrete blocks will be installed at the mouth of the sea chasm, to reduce water velocity during operation significantly.

Proposed breakwater at Glinsk

Treatment of muddy water

For the purpose of preventing damage by muddy water as a result of earthworks and peat relocation, all muddy water generated at the construction site will be stored in sedimentation ponds and treated before discharging into natural streams.

Conservation of small animals (From best practice at Yanbaru SWPHES, Japan)

Fences (30cm in height, made of polyethylene) will be installed around the construction area so that small animals can not enter the construction area, thus protecting them from accidents involving construction vehicles.

Slope side ditches will also be installed. This structure enables small animals to exit by way of the slope in the direction from which they entered, even when they fall into the side ditches.

Slope side ditch at Yanbaru

Planting

The reservoir embankments and surrounding areas will be re planted with natural grasses and plants from the site in keeping with the local flora. This will also prevent soil erosion. Any dwarf Juniper plants (Endangered species present on site) encountered in construction areas will be relocated on site.

Dwarf Juniper on Glinsk Mountain

ENVIRONMENTAL CONSERVATION

Conservation of Birds

The following Annex 1 Bird species: Merlin, Chough, Peregrine and the Red Data book species Twite are present in the vicinity of the site and in the wider the northwest Mayo coastal area, within which the site is located. In order to help the conservation of these bird species the following measures will be implemented:

- During excavation of the reservoir, low impact blasting techniques will be used and no-blast periods enforced to minimise disturbance of seabird colonies on Illaunmaster.
- Stock proof fencing will be erected on the cliff edge to allow cliff vegetation to grow properly and provide excluded nesting areas for sea birds and Twite.
- Wet grassland will be created in peat storage areas to encourage nesting sites for the Golden Plover.
- A dedicated feeding habitat for the Twite will be created on site.
- Tussock Heather and Dwarf Juniper growth will be encouraged through stocking management on site to enhance habitat for raptor foraging.
- Birds will be a theme in the interpretative centre at the site and public pedestrian access to the cliffs provided to enhance birdwatcher access to the sea cliffs, with fixed binoculars to observe Illaunmaster.
- An environmental monitoring program to study the ongoing status of ecology, flora and fauna, and the environment locally and in the wider area, as well as assessing any habitat evolution resulting from the development will be permanently staffed based on site at the interpretative centre.

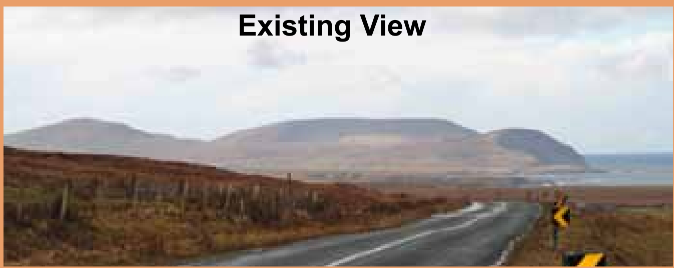

Merlin


Chough

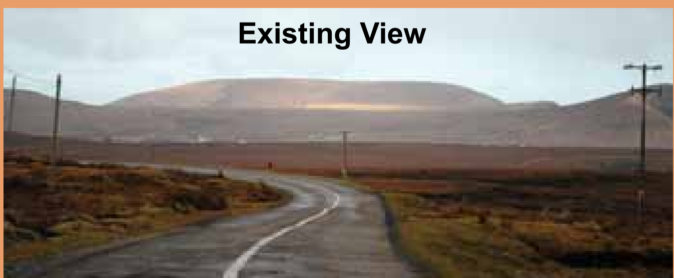

Peregrine


Twite

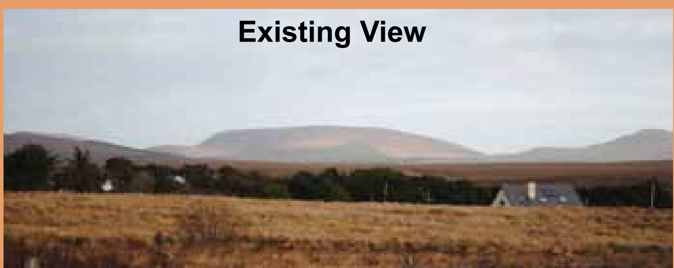
PHOTOMONTAGES



Protected View from Céide Fields



View from R314 Ballycastle to Belderg Road



View from Glenamoy, Southwest of Glinsk

PHOTOMONTAGES

View from R313 approaching Bellanaboy

View at Chasm for Inlet Structure





Carrying out Publc Consultation for the project



Organic Power Ltd Team Surveying on Glinsk Mountain

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