Pumped hydro storage moroni

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SuperGrid Institute is an independent innovation company with expertise both in hydraulic storage solutions & power systems. They provide advanced technologies enhancing the flexibility of hydropower, making it a more profitable and reliable energy source.

Shifting to cleaner electricity is challenging, especially with isolated networks struggling to maintain stable frequency due to low grid inertia. Pumped Storage Plants (PSPs) combined with the right technologies can make a big difference.

Often located in sunny parts of the world, surrounded by water and swept by strong winds, islands are often ideal locations for renewable energy production. When suitable water sources exist, small-scale hydro systems are used to generate power. However, their remote location often means these power sources are connected to a network with little or no inertia. To combat this, the network is often secured by introducing more stable, but pollutive generation sources to ensure the system"s inertia. Ideally, these generation sites should be replaced by cleaner sources.

Meridiam is an international investor and asset manager who create transformational infrastructures around the world. They produce innovative low carbon solutions to bring renewable power to communities, improve countries" energy mix and help bring down global greenhouse emissions. B Corp certified, Meridiam is extremely sensitive to maximising the economic, environmental & social benefits of each of their projects.

In 2022, Meridiam launched a greenfield project in Martinique, a French island in the Caribbean. Their team was working to construct a pumped storage plant (PSP) in Saint Pierre with a turbine capacity of 7 MW and a pumping capacity of 4.6 MW, which would enable it to supply electricity during 4 hour cycles and enhance the reliability of Martinique's electricity network. After drawing up their first plan, the team was soon faced with highly demanding constraints from the local power regulation board which posed a significant challenge in such an isolated context.

In the French Overseas Departments and Territories, many of which are islands, EDF SEI (the local TSO) imposes a very fast response time for new PSP projects to respond to the reduced system inertia of islanded grids in its territories.

Meridiam"s design allowed them to generate power from their PSP but lacked the technology that would provide a Fast Frequency Response (FFR). The Pelton turbine used in their design would not be fast enough to respond to the changes in intermittent energy production in the island"s network and without the FFR, they were missing out on one of the three key pillars of a PSP"s revenue stream: frequency reserve, energy shifting and inertia.

Meridiam"s PSP project development team came to the SuperGrid Institute to strengthen their business case for the 7 MW Saint Pierre PSP plant and find the solution to their FFR problem.

The main objectives of SuperGrid Institute"s work were to: Enhance the PSP design to meet its revenue objectives and make the business model sustainable by studying different possibilities of how to meet the grid code requirement.

By integrating super capacitors, SuperGrid Institute offered a more sustainable design choice as this equipment is not electrochemical and supercapacitors provide faster response times and a longer life cycle.

A key point of innovation in the new design proposed by SuperGrid Institute was the Energy Management System (EMS) that pilots the turbine, variable speed pump and super capacitor technology. SuperGrid Institute"s expertise and understanding of each technology used in a flexible PSP enabled their team to develop an EMS which closely controls every piece of equipment involved in such a design. This EMS was developed and used to validate the design using numerical simulation. It is now ready to be implemented into the digital controller of the future PSP.

The Meridiam Martinique case study demonstrates the benefits of hybridisation of PSPs in isolated networks. The final design provided the perfect balance between inertia, supercapacitors and hydraulic short circuit to respond to the demanding local grid code requirements.