When the whole is better than the sum of its parts

Hybrid power technologies

Synergy of energy systems

Battery and pumped storage technologies are increasingly being used to stabilise power systems with a high penetration of renewable generation, helping to bridge the gap between supply and demand at peak times. But what if storage runs low?

The addition of backup thermal generation, such as diesel engines or gas turbines, can provide power and recharge the batteries, ensuring a reliable and resilient system.

Such hybrid systems are necessary for the switch from centralised to distributed energy, which is closer to the customer and encompasses a diverse array of generation, storage, energy monitoring and control solutions. It can serve a single building, one community or an entire town or city, and offers opportunities to reduce cost and carbon emissions, while improving efficiency and reliability.

"As the proportion of solar and wind rises in the overall electricity generation mix, a hybrid system is increasingly seen as the future."

Each hybrid system needs to be optimised, taking account of hourly, daily and seasonal loads as well as an assessment of all renewable and non-renewable power supply sources. It is managed by a control system that can incorporate demand response to balance supply and demand in a safe and optimal way. Smart controls ensure assets generate power, cooling, heating and lighting only when and where they are needed. Maximising energy yield from intermittent renewable generation by installing storage systems requires careful selection and sizing (capacity and hours of storage) of the right combination of technologies and a full understanding of operational behaviour of electric power systems.

With more than 30 years' experience in power generation alternatives and system studies, we have proven capability, competency and expertise in tackling the technical and economic challenges of hybrid systems. From combining renewable generation with storage systems or more conventional power plants to optimising energy supply and improving grid stability, we have worked on every technology and in different environments around the world. We have the full range of skills required to help you plan, engineer, implement and manage your hybrid project.

Hybrid systems are the future and we can help you deliver the best technical and cost-effective solutions.

Project
Security and Resource Efficiency in Somaliland (ESRES) programme

Location
Somaliland

Client
Government of Somaliland, Ministry of Energy & Minerals

Expertise
Policy and regulatory advice, capacity building, programme management

Piloting renewable energy in Somaliland

Electricity costs in Somaliland are some of the highest and least affordable in the world, and are a significant barrier to economic growth. We are supporting the government to develop a policy and regulatory framework to promote renewable energy solutions through the piloting of six hybrid mini-grid projects, combining renewable and non-renewable energy sources. The projects, located across the country, including in some of the most remote areas, will increase capacity by 3.3MW and provide about 10,000 customers with access to reliable electricity and lower tariffs. The pilots will also form the basis of a funding platform for green infrastructure aimed at encouraging private sector investment into renewables in Somaliland, ensuring the long-term sustainability of energy supply in the country.

3.3MW
increase in capacity

10,000
customers

Image credit: ESO/José Francisco (josefrancisco.org)

Power options for observing the universe

Project
Power supply options for the European-Extremely Large Telescope (E-ELT)

Location
Cerro Armazones, Atacama Desert, Chile

Client
European Southern Observatory

Expertise
Power options study

The E-ELT, dubbed the ‘world’s biggest eye on the sky’, is being built in the remote Atacama Desert in Chile. We provided technical services for a comparative study for powering the observatory and related infrastructure, looking at the feasibility of supplying power from the grid, a thermal generation plant combining gas turbines and diesel engines or a renewable-hybrid system consisting of solar PV, solar thermal, wind and fuel cells. Our work included a risk analysis, study of lifecycle costs, safety and environmental assessments, and the development of supporting documents. A further assessment tested reliability. The E-ELT is due to begin operating in 2024.

Storage for smart grids

Project
Battery storage for electricity networks

Location
China

Client
Tianjin Lishen Battery Corporation

Expertise
Technical advisory services

Developing an integrated solution to large-scale battery energy storage for electricity networks in China required our technical assistance, including the creation of a battery management system for data collection, monitoring, protection, control and communications. We also identified lessons learned from the UK, including a review of market mechanisms, technical standards and grid code requirements – the conditions a facility connected to an electricity network has to meet to ensure the safe and secure functioning of the system.

Leading innovations to market

Project
Energy Entrepreneurs Fund

Location
UK

Client
UK Department for Business, Energy & Industrial Strategy

Expertise
Incubation management, technical and commercial support, market analysis

The Energy Entrepreneurs Fund is a competitive scheme to support the development of technologies, products and processes in energy efficiency, power generation and storage. We provided independent technical and commercial advice and market analysis for several projects. One was a patented cryogenic storage system and our specialists looked at the benefits of integrating liquid air electricity storage into various kinds of industrial processes, and more generally the best sites for the technology. The main study identified revenue opportunities and how these would be affected by the type of site (industrial host), point of connection to the network, power supply contracting options and geographical location.

Replacing Shetland's generating assets

Project
Shetland Island generation assets

Location
Shetland Isles, UK

Client
Scottish Hydro Electric Power Distribution (SHEPD)

Expertise
Institutional design, capacity building

Energy regulator Ofgem required SHEPD to develop a market-based tender process for replacing Shetland's generating assets. Our specialists drafted tender documents and co-operated with the client's legal advisors to develop agreements covering supply reliability, intermittent renewable generation, and ancillary and demand management services.
We evaluated the proposed solutions – thermal generation, wind power, battery storage, interconnector and hybrid systems – and engaged with stakeholders to develop one that was cost effective, acceptable to Ofgem, technically feasible and practical to implement. The procurement process provided new opportunities for developers in the isles, with commercial operation of the proposed solution due to begin in 2021.

Project
Pilot wind-diesel hybrid

Location
Bonaire

Client
Rabobank

Expertise
Technical advisory services

Reliable power for an island nation

Connecting a large wind-diesel project to a small autonomous network presents unique technical challenges. We were the lender's engineer for a pilot hybrid wind-diesel system on Bonaire designed so that 40% of the Caribbean island's total power demand would be met by wind energy. The financial success of the project hinged on raising the amount of wind capacity and establishing a robust control system for power limitation and optimisation. At the time there was no comparable working example so we used power system simulations to develop an effective control strategy. The project is now the largest operational power plant of its kind in the world and represents a major engineering achievement in the integration of wind and diesel power. It consists of 12,900kW wind turbines and five 3MW medium speed diesel units. The overall system is controlled by a state-of-the-art power management system.

Making connections in the desert

The Iron Horse project in Arizona comprises a 2MW solar PV farm and a 10MW energy-storage system. Our client required a single point of interconnection to protect both systems and co-ordinate output in line with the needs of the local utility. Our engineers collaborated with all stakeholders, including equipment vendors, the general contractor and owner as well as the grid and transmission operators to design a medium-voltage outdoor switchgear assembly with integrated protection and control equipment.

Project
Iron Horse PV solar and energy storage

Location
Pima County, Arizona, USA

Client
Westwood Professional Services

Expertise
Switchgear design, protection and control design, protection co-ordination, system studies

Improving the grid stability of a PV plant

Project
Hokkaido Chitose solar PV plant

Location
Japan

Client
Korea Development Bank

Expertise
Technical advisory services

A utility-scale lithium-ion battery to limit the rate of change of power from a proposed 38.9MWp solar PV plant in Chitose, Hokkaido, Japan, required a technical review by our engineers. The battery aims to minimise any adverse impacts from the PV plant on grid stability. We provided technical advisory services, including due diligence to the lenders during financing of the project. The plant started generating power in 2017.

A hybrid world first

Termosolar Borges is a hybrid biomass-parabolic trough solar thermal power plant generating 22.5MW of electricity – enough power for about 27,000 households and avoiding 24,500t of carbon emissions. Located in Lleida, about 100km west of Barcelona, it is the first hybridisation power plant in the world that combines thermo-electric power and biomass. The plant runs 24-hours a day by using solar power during the day and biomass at night.

We reviewed agreements, contingencies and operational risks prior to development, and later monitored construction.

Project
Termosolar Borges concentrated solar power (CSP) and biomass project

Location
Lleida, Spain

Client
Potential investor

Expertise
Technical advisory services

Fast-start station to balance troughs in wind energy supply

800MW
gas-fired power plant

3000
wind turbines

Gemma Power Systems operates a cluster of 3000 wind turbines in the arid California desert. To balance supply and demand, an 800MW simple-cycle gas-fired power plant provides supplementary energy when there is insufficient wind power. Our engineers provided the complete design (in 3D) and engineering for the gas plant as well as a 12-breaker 230kV switchyard and interconnection. Major mechanical systems include providing the eight GE LMS100 aeroderivative gas turbines with evaporative cooling. The turbines are lighter and can be fired-up more quickly than industrial turbines, enabling the plant to achieve its full load in just 10 minutes. The turbines can also be used flexibly, allowing the plant to vary its production between 50MW and 800MW.

Project
Sentinel energy project

Location
Palm Desert, California, USA

Client
Gemma Power Systems

Expertise
Detailed engineering and design with field support

24-hour power for remote locations

Project
National park PV systems

Location
South Africa

Client
National Department of Tourism

Expertise
Owner's engineering services

The Kruger National Park in South Africa has installed solar PV systems at four sites to help meet its energy needs. This consists of two grid-connected PV systems – Skukuza 825kWAC and Lower Sabie 525kWAC – and two off-grid hybrid PV systems using batteries and diesel generators – Nkuhlu 125kWAC and Tshokwana 375kWAC. Our feasibility studies identified the most suitable solution for each of the sites, based on demand. We also provided input into the procurement process, including the development of technical specifications for bidders, and supervised construction and commissioning. All four plants are operational, reducing by 95% the amount of diesel used by the park at its off-grid sites.

Hybrid PV substitution

A small region in the Philippines with a population of about 20,000 receives its electricity from an old diesel generation facility. Advances in hybrid technology now make it possible to harness the high levels of solar resource in the area to generate power. We looked at the feasibility of PV hybrid solutions, which will need to meet variations in the load consumption of around 1MW, and the high demand for electricity during the morning and in the evening. Our work included a high-level energy yield and load assessment, a concept design consistency analysis and a review of preliminary plant design and operation modes.

Project
PV-diesel-storage plant

Location
Philippines

Client
Solar Philippines

Expertise
Feasibility study, technical advisory services

Innovative energy solution in the world's driest desert

Project
Valhalla integrated PV and seawater pumped storage project

Location
Atacama Desert, Chile

Client
Potential investor

Expertise
Technical advisory services

The proposed 650MW PV plant covers 1650ha and is 60km south of Iquique, a port city in northern Chile. The pumped storage element will be located on the coastal cliffs about 40km away and will have an installed capacity of 300MW. The objective is for the two schemes to operate in conjunction and deliver constant power to the grid. Half the power produced by the PV plant will be used to pump seawater to the upper reservoir of the storage facility. Outside solar hours, the storage scheme will deliver energy to the grid. We undertook a technical and business case review of this innovative project.

Achieving Grenada's clean energy goals

Project
Wind-diesel hybrid project

Location
Carriacou Island, Grenada

Client
Grenada Electricity Services Ltd (Grenlec)

Expertise
Institutional design, technical review

Grenada in the Caribbean Sea has a target to generate all its energy from renewable sources by 2030. Carriacou is one of the smaller Grenadine islands and its electricity is generated by a 1.6MWe power station. We prepared the technical specification and invitation to tender documents for a 1MW wind farm and flywheel battery system to integrate with the existing power plant. This involved negotiating with suppliers of medium-scale (200kW-2MW) wind turbines, as well as producers of battery and control systems. The key technical challenge was to integrate synchronous generators – typically engines or gas turbines – with renewables.

Hybrid off-grid supply system

Project
Storage supplies solutions studies

Location
UK

Client
Agrekko UK

Expertise
Systems studies, dynamic modelling

We evaluated the technical viability of a generic off-grid supply system combining PV with conventional generation for providing electricity to isolated load centres. We identified the main technical challenges and operational interactions caused by adding PV to the generation mix. We also evaluated the benefits of including energy storage into the hybrid off-grid supply system, demonstrating that it could play a major role in increasing the PV generation instantaneous share in the generation mix. Detailed dynamic modelling of the PV and energy storage systems was used in the system studies completed for this project.

Storing energy in salt mines?

300MW
storage capacity

Project
Larne salt caves energy storage project

Location
Ireland

Client
Green energy developer

Expertise
Feasibility study, technical advisory services

On average, more than 20% of Ireland's electricity is generated each year by wind and the target is to double this by 2020. A major issue for a grid heavily reliant on wind is generating power when the wind doesn't blow. We are involved in a project to use compressed air to store energy in underground salt deposits at Larne, Northern Ireland. The caverns will hold air compressed to 19,000kPa before releasing it to drive turbines and create power for the grid. The proposal uses the wind power generated at night when there is no demand to pump air into the salt caverns, creating energy stores that can be released during the day to generate power when it is needed. The Larne salt caves could provide storage capacity for about 300MW compared with 10-20MW typically provided by batteries.

Opening opportunities with connected thinking.

Talk to us: power@mottmac.com

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