EuroMCM Sample Problem Ω : Island Energy Autonomy

1 Background

Islands are often viewed as paradise destinations, but behind the scenic views lies a difficult energy reality. Most inhabited islands from the remote Pacific to the Mediterranean are powered almost exclusively by imported fossil fuels. Diesel generators are the standard, leading to electricity costs that are often 3 to 10 times higher than on the mainland, not to mention the significant carbon footprint and the risk of supply chain disruptions caused by weather or geopolitical events.

In response, initiatives such as the European Union's "Clean Energy for EU Islands" have launched ambitious goals to help islands wean themselves off fossil fuels. Real-world pioneers, such as El Hierro (Spain) and Samsø (Denmark), have attempted to run entirely on renewables. However, the path to "Net Zero" is fraught with engineering and economic contradictions.

The central challenge is intermittency. The sun does not always shine, and the wind does not always blow. However, the island's demand for electricity (load) is rigid. Hospitals, hotels, and homes need power 24/7. Achieving 100% renewable penetration requires not just generation (solar panels and wind turbines), but massive energy storage systems (batteries or pumped hydro) to bridge the gaps.

2 Requirements

Your team acts as lead consultants for an island council. You must select a specific island (real or constructed) to serve as your case study. Your island should have a defined population, geography, and economic profile.

Develop a mathematical model to represent the island's electricity system over the course of a full year. Your model may use actual data where available, and reasonable assumptions or constructed parameters where data are missing.

Some questions you should consider include, but are not limited to:

- How does electricity demand vary seasonally, particularly in response to tourism, heating, or cooling needs?
- How do local weather patterns influence renewable output throughout the year?
- The trade-off between oversizing renewable generation capacity and expanding storage capacity. Under what conditions is one strategy more cost-effective than the other?

- Assuming the island government seeks to reduce carbon emissions significantly over the next 15 years, what level of annual renewable generation capacity and energy storage would be required to achieve this goal, and how should these investments be phased over time?
- Discuss the scalability (to larger or smaller islands) and adaptability (to other regions) of your model.

3 Submission

Your PDF solution (≤25 pages) should include:

- One-page Summary Sheet
- Table of Contents
- Complete Solution
- References
- Report on Use of AI Tools (if applicable; excluded from the 25-page limit)

There is no mandatory minimum length. Teams may submit incomplete solutions. The use of AI tools is allowed but optional; compliance with EuroMCM AI usage policy is required.

4 Links

Clean energy for EU islands

Clean energy vision to clean energy action

EU geographical islands as leaders of green energy transition

Assessment of medium and long term scenarios for the electrical autonomy in island territories: The Reunion Island case study

Sustainable Energy System of El Hierro Island

Statistical information and data, El Hierro

Samsø Energy Vision 2030

5 Glossary

Intermittency: The irregular nature of renewable energy sources (wind and solar) which cannot be turned on or off at will to meet demand.

Diesel Generator: A machine that uses a diesel engine and an electric generator to generate electrical energy.