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Effects of Introducing a Pumped Storage Hydroelectric Facility on Energy System Emissions in Gran Canaria

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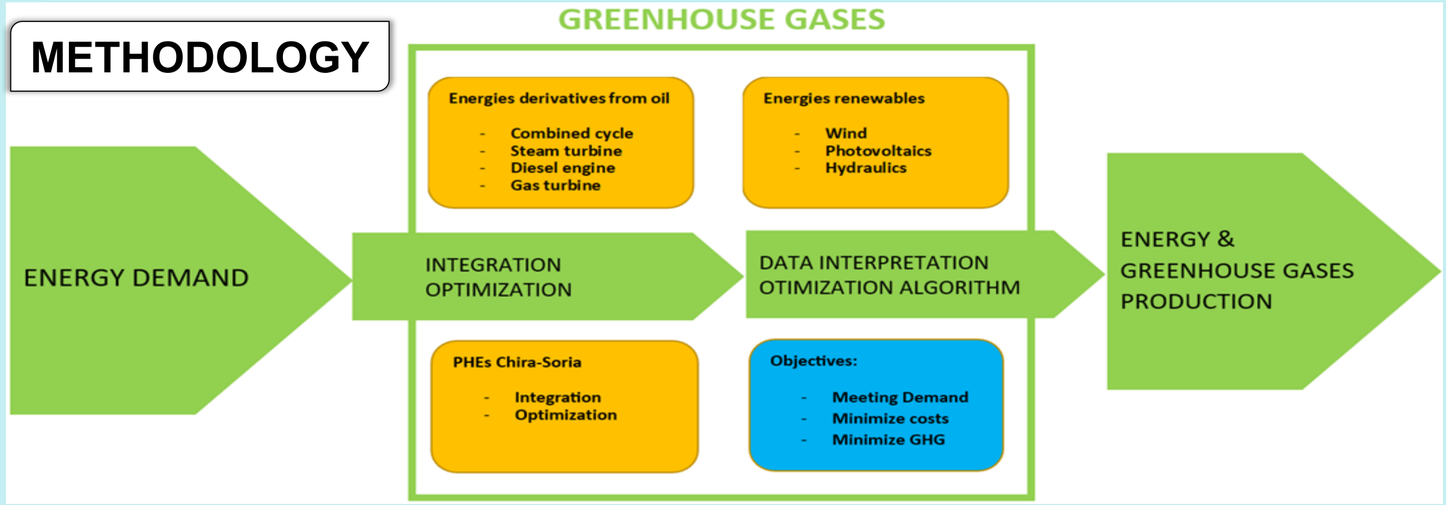
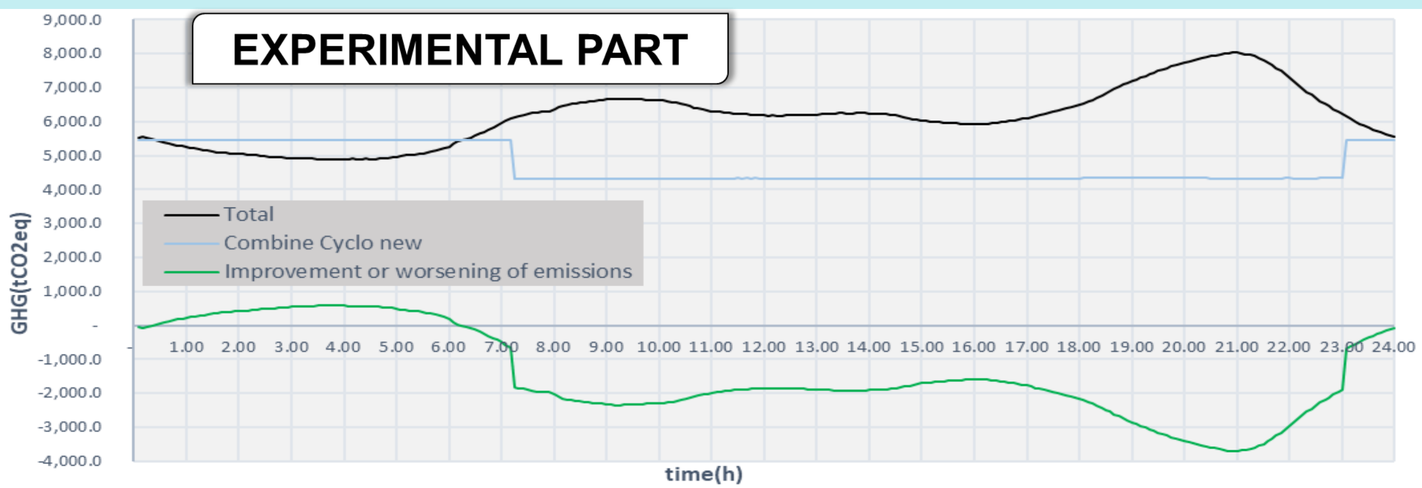
ABSTRACT

The Chira–Soria Pumped Hydroelectric Energy Storage (PHES) project in Gran Canaria represents a pioneering approach to energy storage in isolated island power systems. This installation stores surplus renewable electricity by transferring water to an elevated reservoir, later releasing it to generate power during peak demand periods [1]. The initiative aims to achieve a notable reduction in greenhouse gas emissions, with estimated daily cuts of 1,432.98 tons of CO_2 equivalent and annual reductions reaching 523,038.12 tons—equivalent to a 23.32% decrease in total emissions. The PHES system is expected to enable a sharp increase in renewable energy penetration, from 20.6% in 2021 to 75.9% by 2030 using current technologies and potentially approaching full renewable integration with future developments. This evolution represents a key milestone toward achieving a sustainable and resilient energy framework for Gran Canaria. Furthermore [2], the project will enhance grid flexibility, overcoming the constraints of existing fossil-based technologies in accommodating variable renewable inputs. By reinforcing grid stability and reliability, the Chira–Soria PHES could serve as a reference model for other isolated energy systems pursuing decarbonization and large-scale renewable integration [3].

METHODOLOGY



EXPERIMENTAL PART



CONCLUSIONS

OPTIMIZED ENERGY INTEGRATION

- The integration of the Chira-Soria Hydroelectric Plant improves renewable energy management and grid stability.
- Enables more efficient use of renewable sources and reduces dependence on fossil fuels.

ENVIRONMENTAL IMPACT

- CO_2 emissions reduced by 23.32% → equivalent to 523,038 tons less CO_2/year.
- This reduction results from lower fossil fuel generation and more efficient thermal system operation.
- The optimized scenario estimates:
  - Daily emissions: ↓ from 6,145.61 to 4,712.78 tons CO_2 eq/day
  - Annual emissions: ↓ from 2.24 to 1.72 million tons CO_2 eq/year

SYSTEM IMPROVEMENTS

- Enhances grid flexibility and supports greater renewable energy penetration.
- Promotes optimal use of the combined cycle, the lowest-emission combustion technology.