Increasing Renewable Energy Integration in European Islands with Storage Stakes

A Case Study of Evia, Greece

Summer 2023 Semi-Annual ETSAP Meeting

Nikolaos Papastefanakis  Sophie Chlela
Sandrine SELOSSE  Nadia MAIZI

15 June 2023 – Regular Workshop Day 1
Outline

1. Project Background
2. Focus and purpose of the study
3. Evia’s energy system
4. Main results
5. Conclusions
Project Goals

The main objective of the GIFT (Geographical Islands FlexibiliTy) project is to **decarbonise the energy mix of islands**.

1: Allow a high level of **local renewable energy** sources penetration
2: Provide visibility of the energy grid to better manage its **flexibility and plan its evolutions**
3: Develop **synergies** between the electricity, heating, cooling, water and, transport networks
4: **Reduce** the use of **hydrocarbon-based energies**
5: Ensure the **sustainability** of the solutions and their **replicability** in other islands
Focus and purpose of the study

• Research questions
  ➢ Impact of storage systems to the island’s self-sufficiency
  ➢ Impact of Renewable Energy Sources to the island’s electricity exports / imports

• Focus
  ➢ Electricity sector
  ➢ Year: 2050
Evia – Follower island

Evia’s Electric grid and interconnections
Source : ADMIE

Future Interconnections

- Transmission
- Distribution
- Submarine cable

RES Plant

Installed and/or licensed RES plants, source : CRES

+ 1 200 MW
Evia – Energy Profile

Electricity supply

- CCGT: 417 MW
- Wind: 224 MW
- PV: 17 MW

Total Capacity: 656 MW

Electricity consumption

- Domestic use: 29.73%
- Commercial use: 38.97%
- Industrial use: 6.93%
- Agricultural use: 2.65%
- Public and Municipal Authorities: 1.45%

Total Consumption: 1380 GWh
Modelling Framework

Reference energy system (RES) of TIMES - EVIA
# TIMES-EVIA Scenarios

<table>
<thead>
<tr>
<th>Scenario Name</th>
<th>Description</th>
</tr>
</thead>
</table>
| **BAU**       | Current policies  
Low demand EV. |
| **LOW**       | Low renewables development scenario.  
Low demand EV. |
| **HIGH**      | High renewables development scenario.  
High demand EV. |
| **HIGH_STG**  | High renewables development scenario.  
Deployment of Storage technologies.  
High demand EV. |

### Electric vehicles share

- **Low**
- **High**
- **Poly. (Low)**
- **Poly. (High)**

### Electricity demand evolution

- **Electricity demand (GWh)**
- **Years**: 2020 to 2050
TIMES-EVIA RESULTS
System's capacity evolution

2040: Phase out of n.gas plant

- **BAU**:  
  - 1.5 GW RES in 2030  
  - 700 MW in 2050  

- **LOW in 2050**:  
  - 380 MW PV  
  - 2 GW wind  

- **HIGH in 2050**:  
  - 750 MW PV,  
  - 3.28 GW wind
Storage systems

High_stg scenario

11 MW batteries

- 10 MW electric grid battery
- Building batteries
  - Residential: 0.8 MW
  - Tertiary: 0.15 MW
  - Public: 0.05 MW

Batteries capacity evolution
Electricity self-sufficiency by sector
Electricity exports & imports

Electricity exports

Electricity imports
Conclusions & Lessons learned

➢ Exploitation of wind potential can provide:
  • Significant quantities of electricity exports

➢ Storage integration can provide:
  • High shares of sectorial self-consumption
  • Less electricity imports
REFERENCES

Thank you for your attention!

Q&A

e-mail: nikolaos.papastefanakis@mines-paristech.fr
Annex

Total discounted system cost

Total System Cost (€)

- bau: 11.32662
- low: 2.25675
- high: 3.03714
- high_stg: 3.04979
Annex
Annex

25% imports
- BAU: Addition of 200 MW wind => + 3 b.Euro
- Low: same electricity exports
- High: -1000 GWh exports
- High stg: same electricity exports

0% imports
- BAU: Addition of 400 MW wind => + 9 b.Euro
- Low: -500 GWh exports
- High: -1000 GWh exports
- High stg: same electricity exports
Annex

Modelling of EV charge demand

Daily consumption share

➢ Total fleet dimension
➢ Technical parameters
➢ Human behavior

Results

Electricity demand per time-slice

- Total fleet dimension
- Technical parameters
- Human behavior
Annex

Load curve of Evia

Electricity (MWh)

summer
spring
autumn
winter
The project’s solutions

- **Grid IT platform** for KPI visualisation, geographic visualisation, grid observability, **prospective modelling and long-term assessment**.
- **VPS system**, a decentralised automatic demand response trading platform
- **Prosumers** or smart energy consumers that postpone energy demanding tasks or select alternate sources for energy to reduce the load on the power grid, thus providing flexibility.