GRIDSOL

SMART RENEWABLE HUBS FOR FLEXIBLE GENERATION SOLAR GRID STABILITY

Feasibility analysis of Smart Renewable Hubs in EU islands

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Feasibility and Adequacy of GRIDSOL in the electric power system of European islands

In Europe there are several geographical islands which are isolated (non-interconnected) from the main power grid. These islands rely heavily on oil and gas for their power production, which contributes to expensive and polluting electricity.

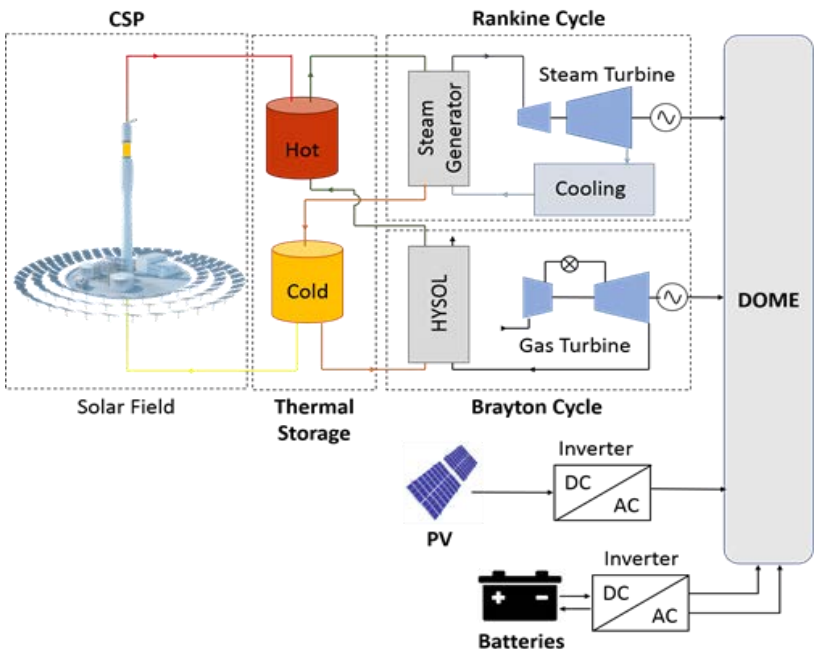
In order to **reduce the cost** and **the polution** due to the electricity production in the non interconnected European islands, there has been an increasing need for **investements in Renewable Energy Sources** and in **Smart Renewable solutions**. Ideas such as having **the whole energy demand or a large part of it** covered by **a power station that uses RES** are being encouraged by the whole community and the EU.

In WP6 there is an investigation on **how GRIDSOL could contribute to solving the problems that non interconnected islands face.**

SMART RENEWABLE HUB

A **SRH modelling tool** is under development including:

- ✓ A decoupled solar combined cycle (DSCC) consisting of a CSP tower with TES, a Gas Turbine, and a HYSOL heat recovery system
- ✓ PV solar field
- ✓ Battery storage system (BESS)
- ✓ Open-cycle gas turbine (OCGT)
- ✓ Combined-cycle gas turbine (CCGT)
- → Wind farm
- → Coal power plant
- → Hydro power plant
- → Biomass power plant



Objectives

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- WP6 aims to study the strategies to choose the best combination of technologies for Non-Interconnected Power Systems, in order to:
  1. **Maximize RES penetration**
  2. **Minimize cost in Non-Interconnected Systems**
  3. **Ensure Power Quality**
  4. **Ensure Safety of Supply**

- Considerations
  - Special Characteristics of the Islands
  - Market Environment
  - Other RES

- Presentation and comparison of the results obtained with ***Energy Planning*** for the Electrical Systems of **Fuerteventura, Madeira, Cyprus and Crete**, **with and without Gridsol for 2030**

The “Energy Planning” tool

GRIDSOL

The Application

The results are obtained with the **Energy Planning Application** developed by NTUA.
In this application the user has the ability to input the appropriate data and parameters according to which a **unit integration algorithm** runs for the hourly participation in the energy balance of **the selected isolated power system**.

The Basic Principles of Energy Planning are to **:**

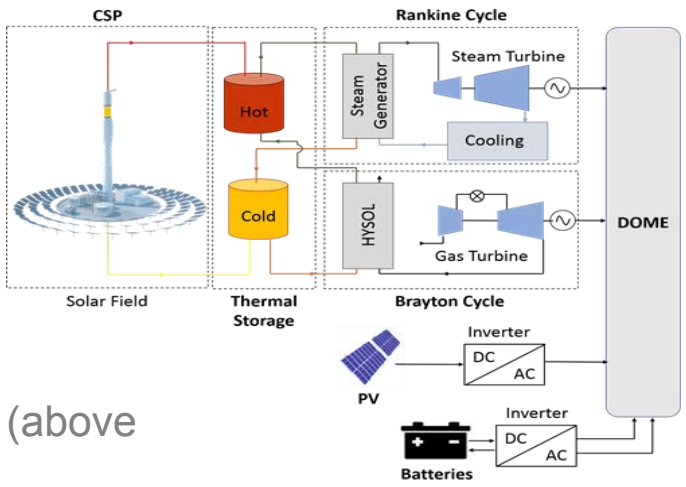
1. Serve the load
2. Maximize RES penetration
3. Minimize the cost of conventional production
4. Satisfy the reserve requirement
5. Follow the Market rules (unit commitment etc.)
6. Respect technical limits (instantaneous RES penetration limit, must run units)

- Sometimes it is possible that one of the above principles is not totally satisfied
- Grid Operator’s goal is to create as smooth residual load curve as possible .
- Residual load is served by the conventional units.

GRIDSOL (SRH) adaptation in "Energy Planning"

GRIDSOL station's configurations include:

- **CSP** with **Thermal Storage System**
- **PV** and **Wind** with **Electrical Storage System**
- **Gas Turbine or BioGas Turbine (*BioGridsol*)**



➢ Wind power was included in GRIDSOL to fulfil the RE content (above 80%) and secure the power system requirements.

The **energy offer of GRIDSOL** (SRH) for the next 24 hours is calculated by taking into account the status of:

a. the storage systems at the beginning of the day,

b. a minimum amount of back-up energy in the storage systems and

c. the foreseen production from the RES units of the station.

SRH CONFIGURATIONS UNDER STUDY

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Simulation	Fuerteventura		Madeira		Cyprus		Crete
	BioGridsol	Gridsol	BioGridsol	Gridsol	BioGridsol	Gridsol	Gridsol
ST Nominal Power (MW)	12	10	3	3	13	13	9
GT Nominal Power (MW)	18	7	4	4	18	9	10
PV Power (MW)	23	27	16	26	42	43	22
Wind Power (MW)	20	18	8	8	0	0	20
BESS Nominal Charge / Discharge Power (MW)	3	3	1	11	3	9	15
BESS Autonomy (h)	3	3	9	4	3	4	8
TES Time (h)	16	19	20	20	9	20	13

Energy and Cost inputs for 2030

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- Energy and Peak demand forecasting for 2030

	Spain	Portugal	Greece & Cyprus
Total Load Annual Increase	1.0%	0.6%	1.5%
Maximum Load Annual Increase	1.0%	1.2%	1.0%

- Thermal Production Cost Parameters for 2030

Heavy Fuel Oil (€/tn)	Light Fuel Oil (€/klt)	Gas (€/tn)	CO2 emissions (€/tn)	O&M (€/MWh)
494	1172	430	84.3	3

- Feed-in Tariffs per Energy Source (€/MWh)

	Fuerteventura	Madeira	Cyprus	Crete
PV	38.4	33.34	250	400
Wind	50.4	88.8	166	99
Hydro	-	112.4	-	-
Biomass	-	-	135	-
Waste Incineration	-	89	-	-
SRH's LCOE	177	173	142	238

Energy Analysis

The optimal GRIDSOL configuration, among many Smart Renewable Hub combinations, was selected based on the following criteria:

- **Minimum Deviation**

The percentage of energy, that the plant failed to inject to the system, compared to the its total scheduled energy injection.

- **Maximum RES energy integration**

The percentage of energy injected by the RES units of the station compared to the station's total annual injected energy.

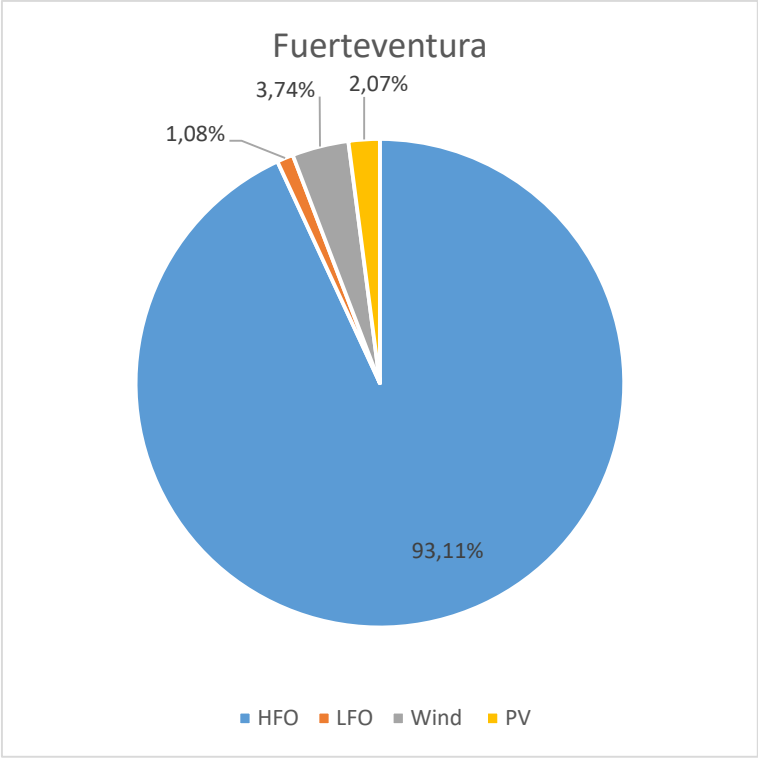
- **Minimum Energy Curtailment**

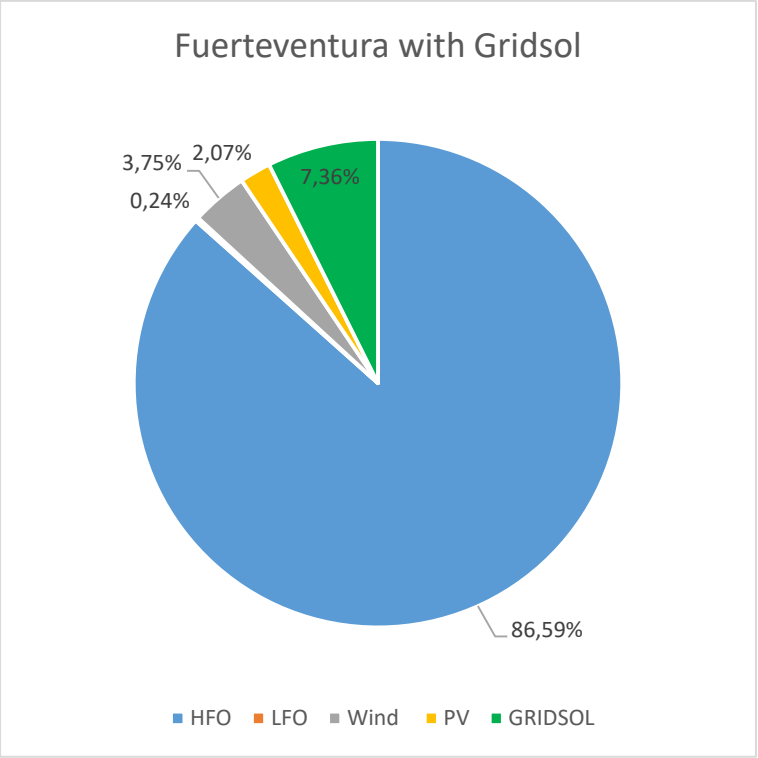
The percentage of energy that is primarily available for use by SRH's units but is not finally injected to the grid. It highly affects the financial sustainability of the Hub.

- **Maximum Capacity Factor**

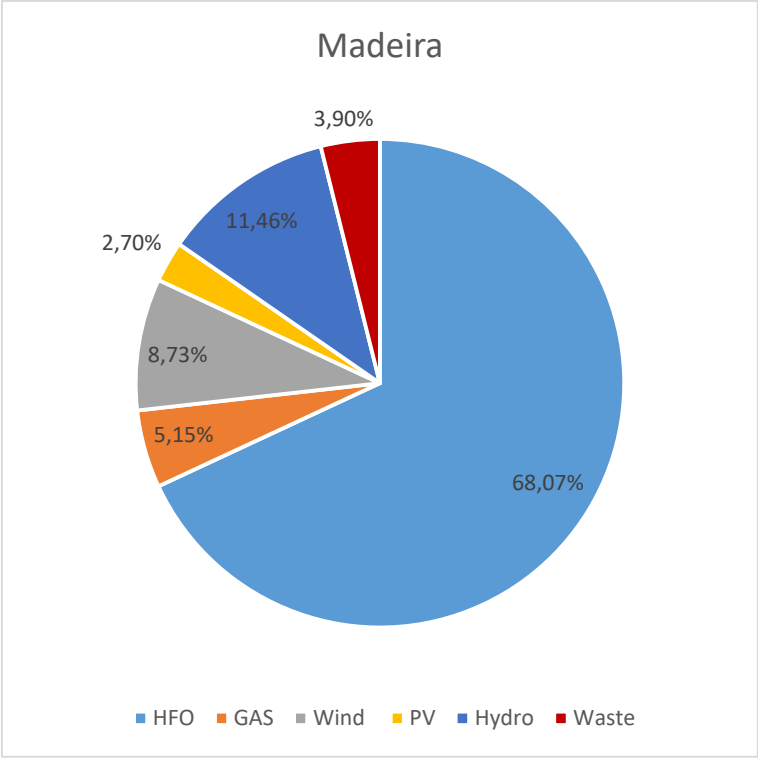
The energy that the plant produced annually divided by its annual energy capacity.

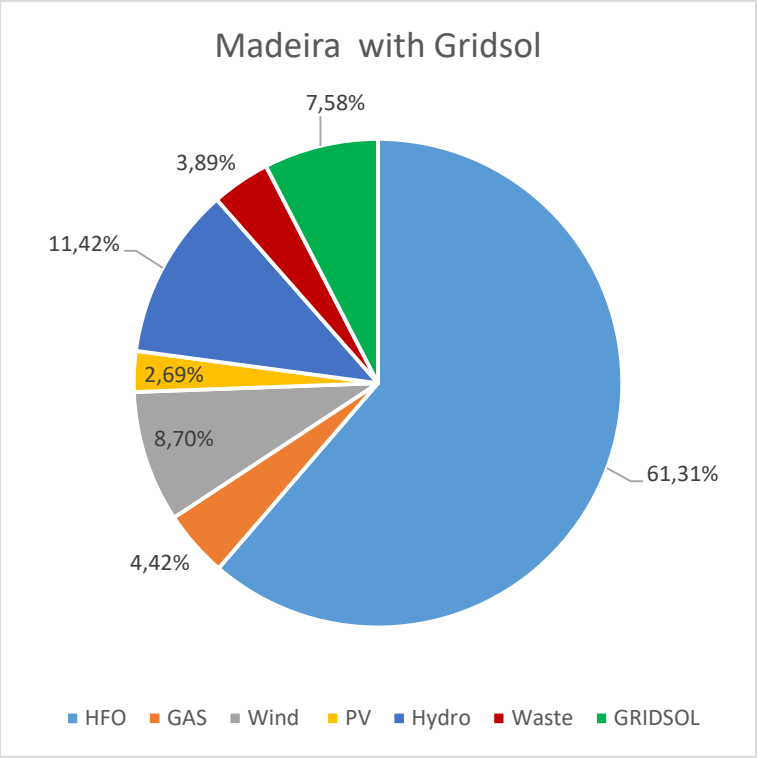
Results : 2030 annual results for Fuerteventura's power system without and with GRIDSOL



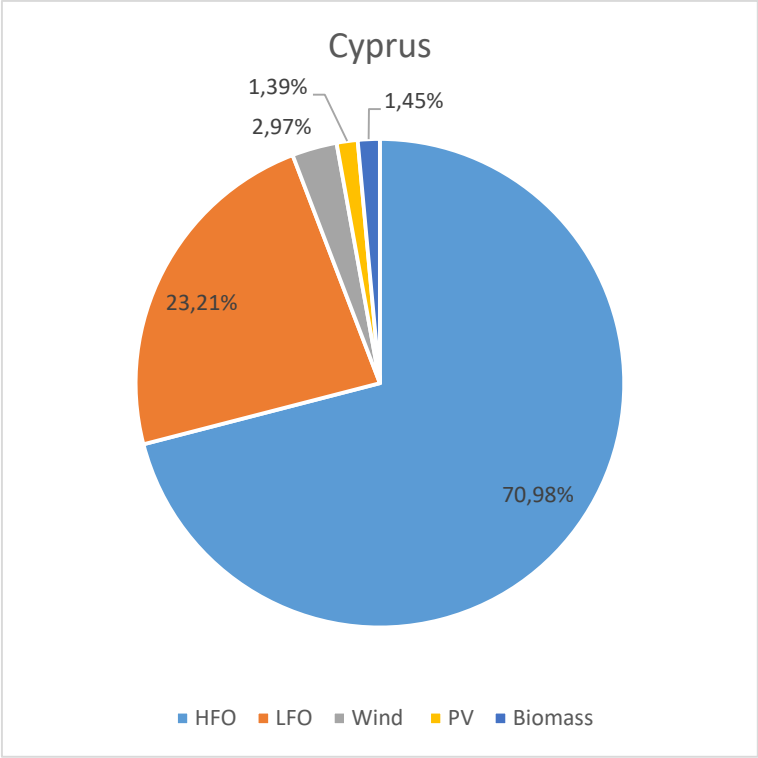


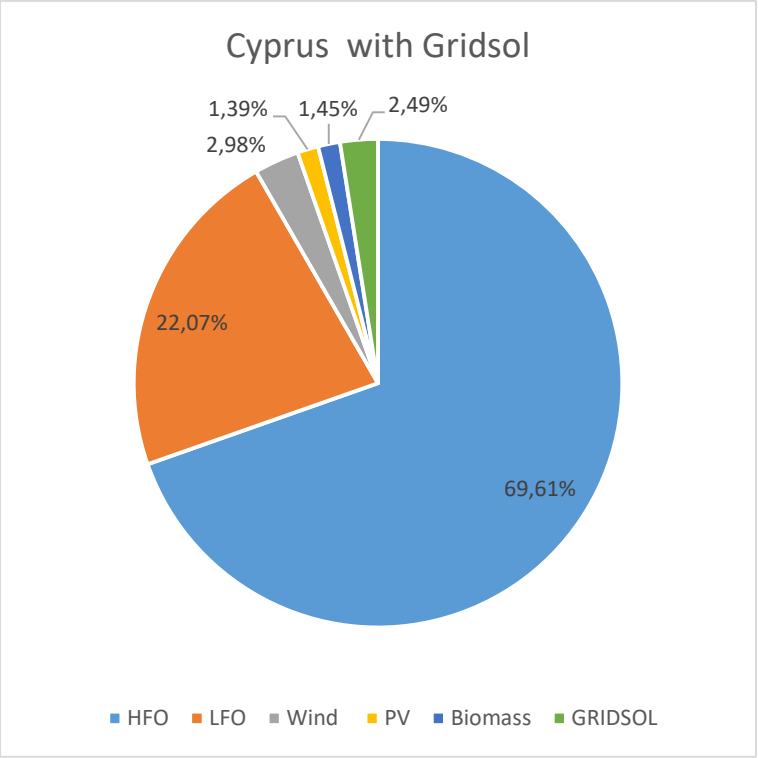
RESULTS : 2030 ANNUAL RESULTS FOR MADEIRA'S POWER SYSTEM WITHOUT AND WITH GRIDSOL



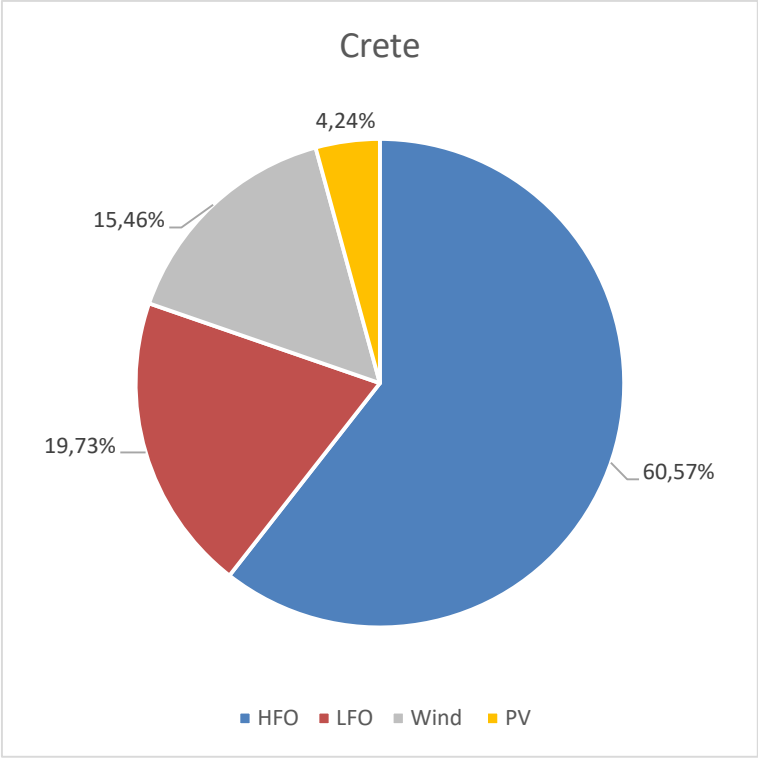


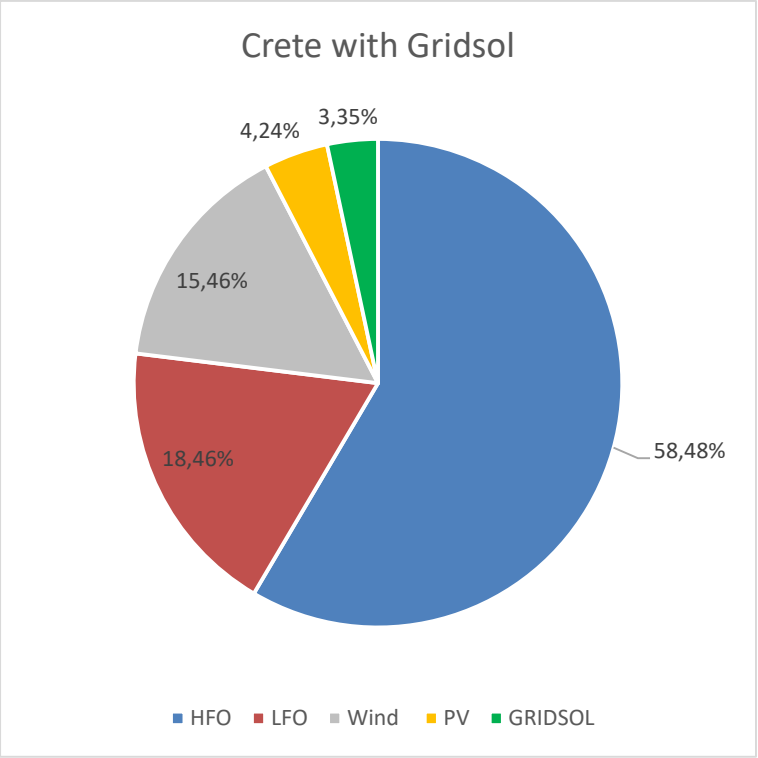
RESULTS : 2030 ANNUAL RESULTS FOR CYPRUS' POWER SYSTEM WITHOUT AND WITH GRIDSOL





Results : 2030 annual results for Crete's power system without and with GRIDSOL





SRH Comparison for the different locations –Economy, environmental & security issues

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	Fuerteventura	Madeira	Cyprus	Crete
Reduction in Thermal production(%)	7.9%	9.9%	2.6%	4.2%
Increase of RES penetration (%)	7.4%	9.0%	2.5%	3.4%
Reduction in CO_2 emissions(tn)	134,760	53,128	141,814	116,858
NSL with SRH (% of the overall load)	0.10%	0.09%	0.24%	0.00%
Reduction in system cost (%)	5.39%	9.49%	0.61%	1.51%

SRH Comparison for the different locations –Economy, environmental & security issues

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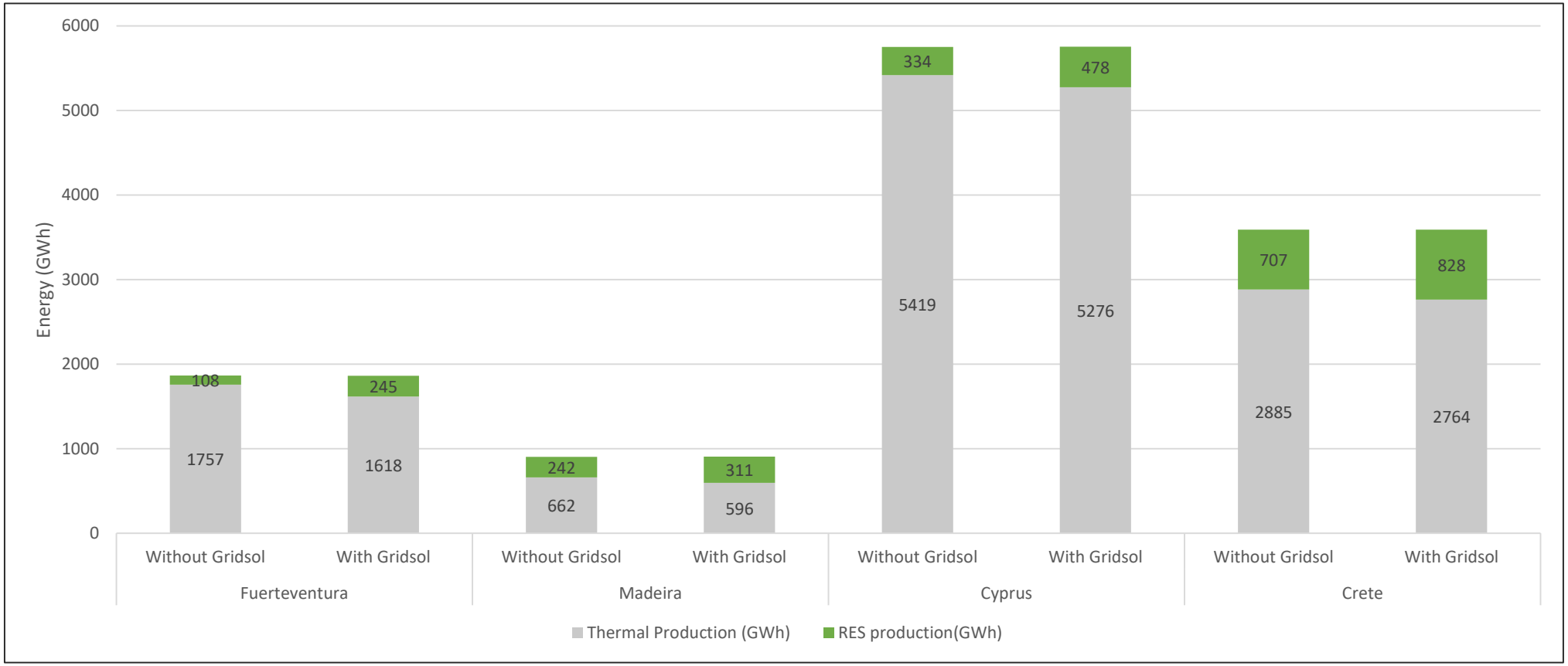
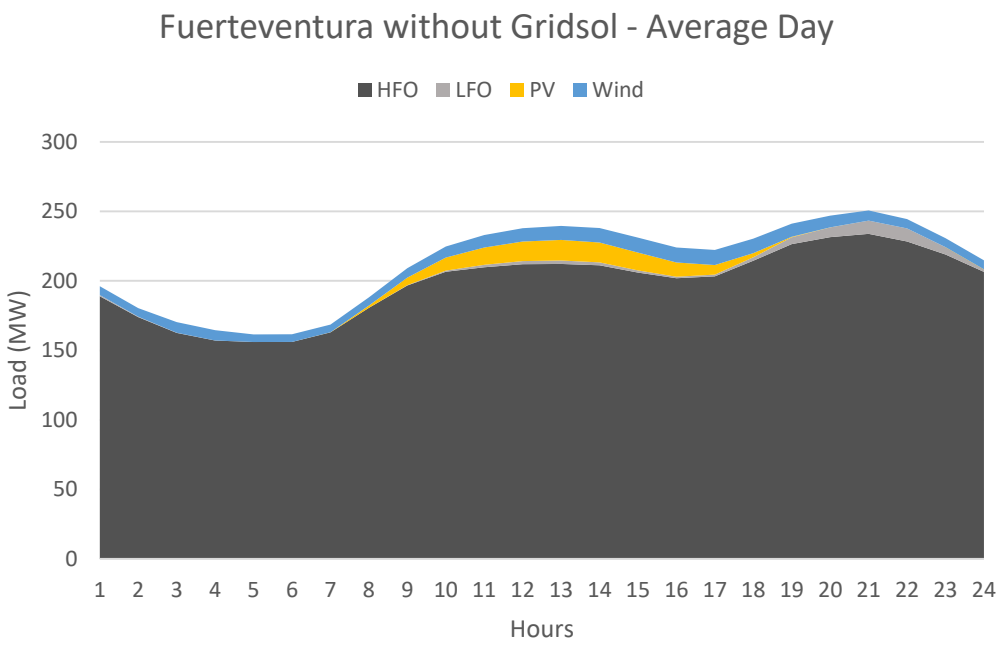
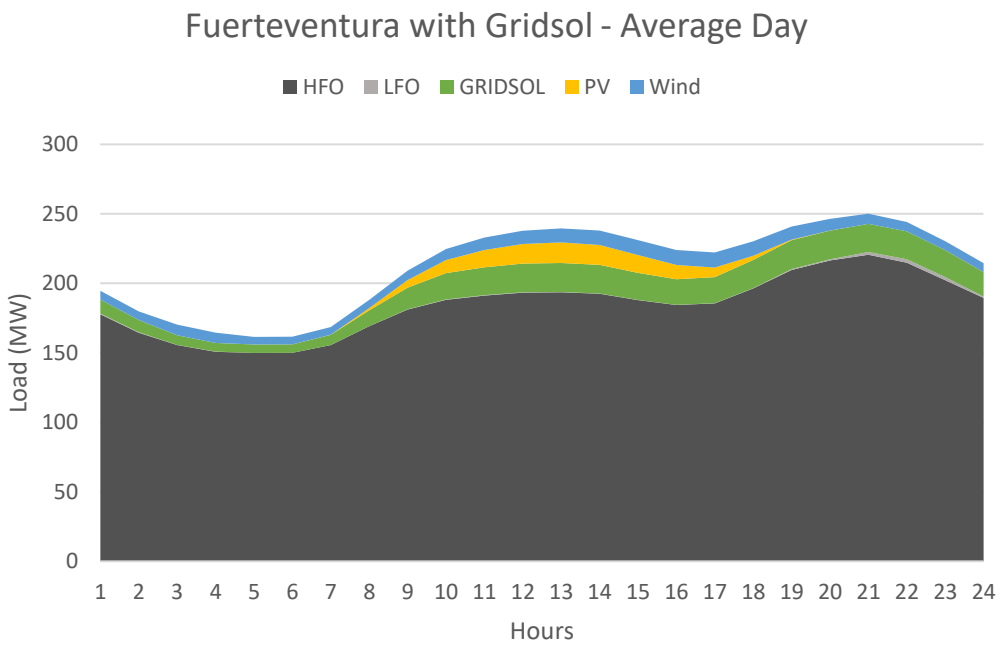
System	Annual Revenue (M€)	LCOE (€/MWh)	Energy Curtailment (% of available energy)	Capacity factor (% of nominal energy)
Fuerteventura	24.3	177	14.28	70.71
Cyprus	20.4	142	14.54	67.75
Crete	28.7	238	2.85	59.7
Madeira	11.9	173	13.7	58.7

ENERGY ANALYSIS

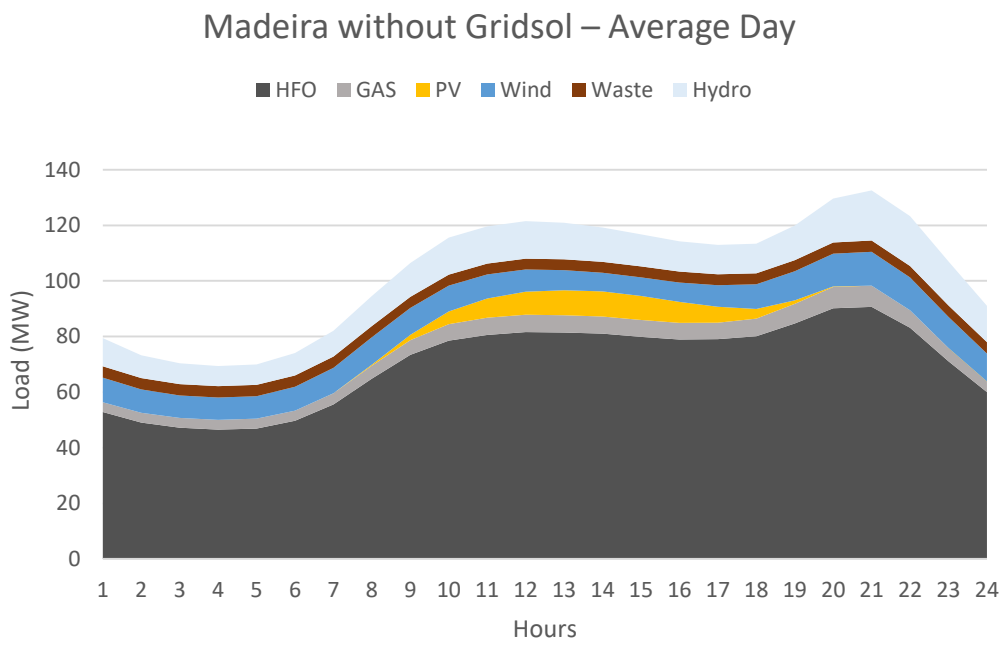


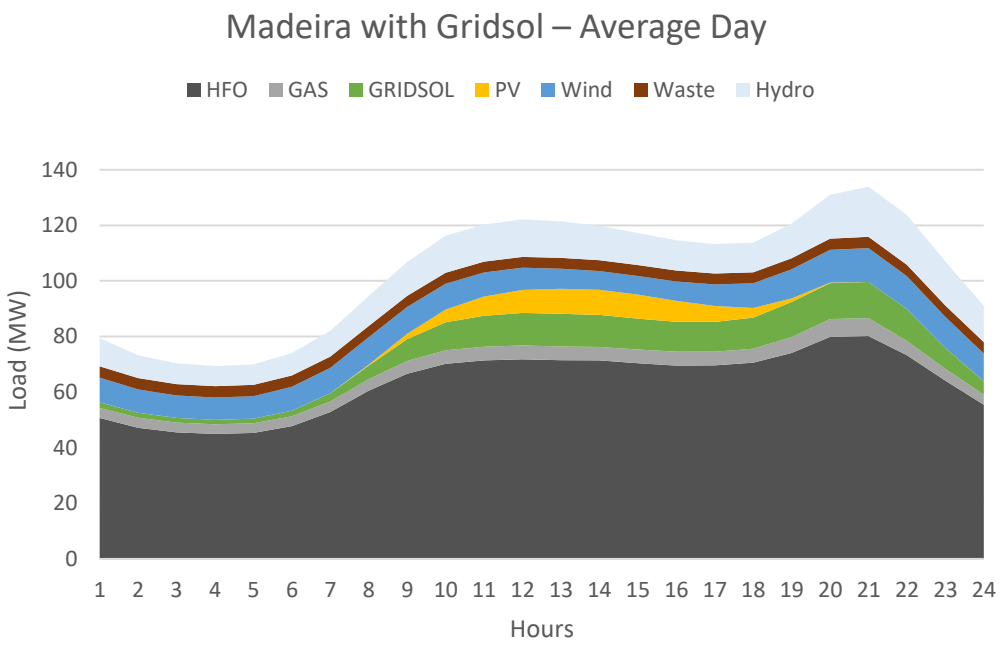
FUERTEVENTURA – AVERAGE DAY



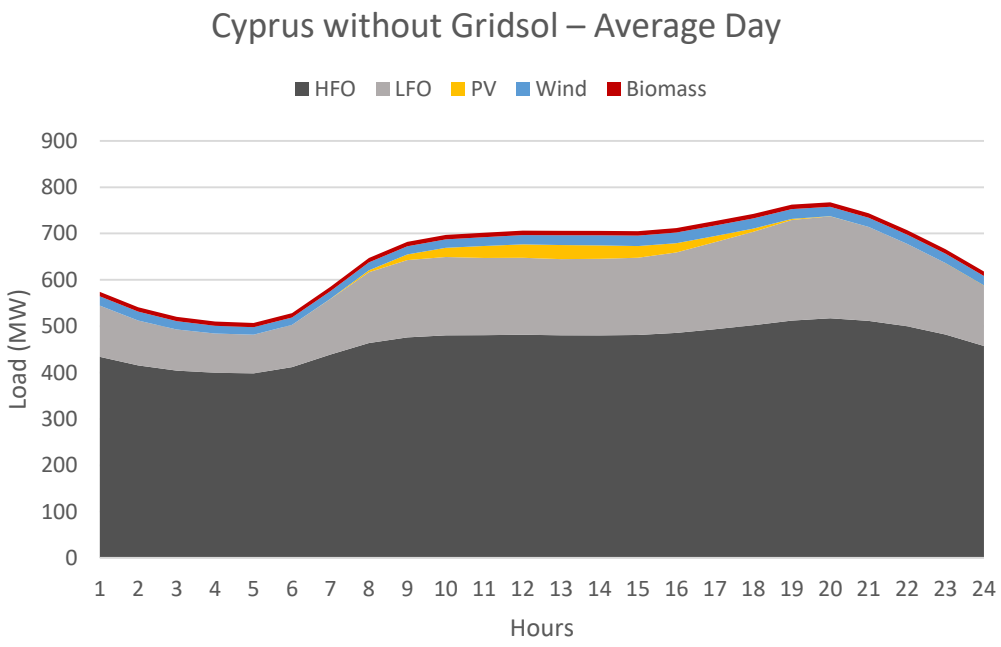


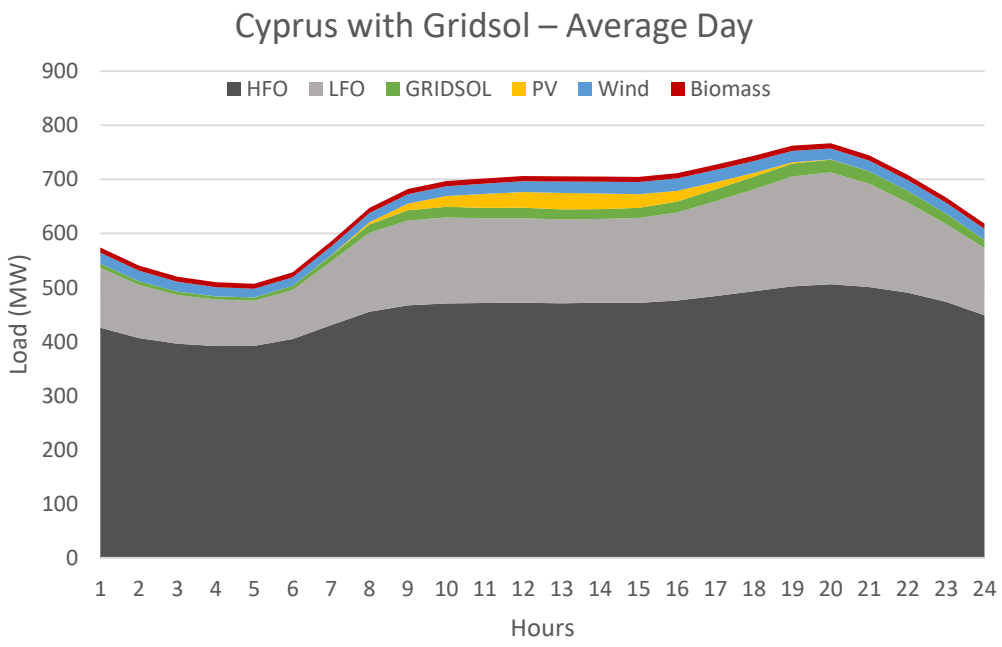
MADEIRA – AVERAGE DAY



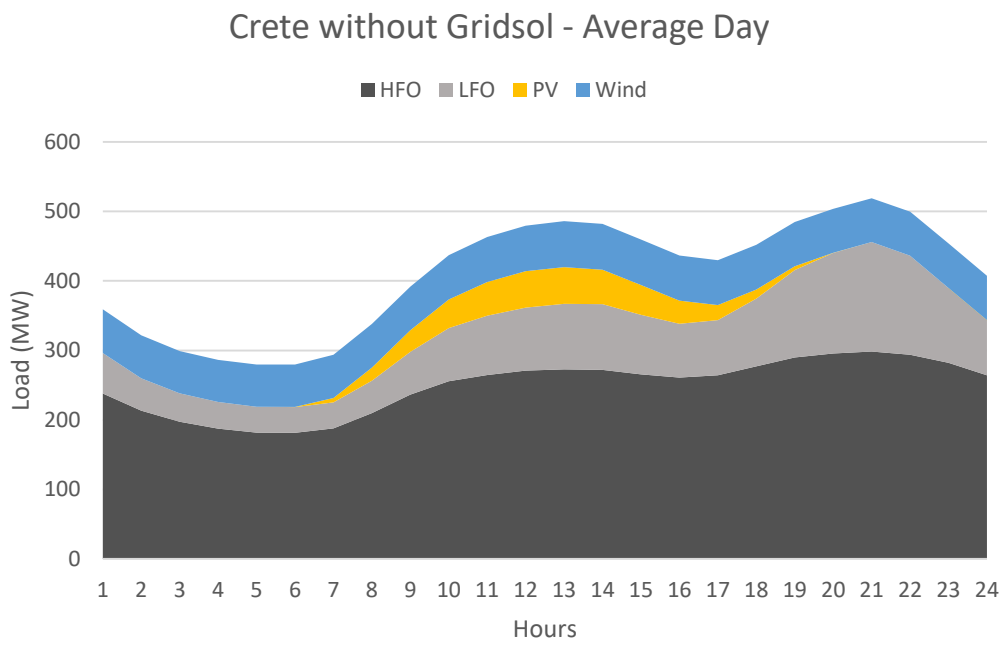


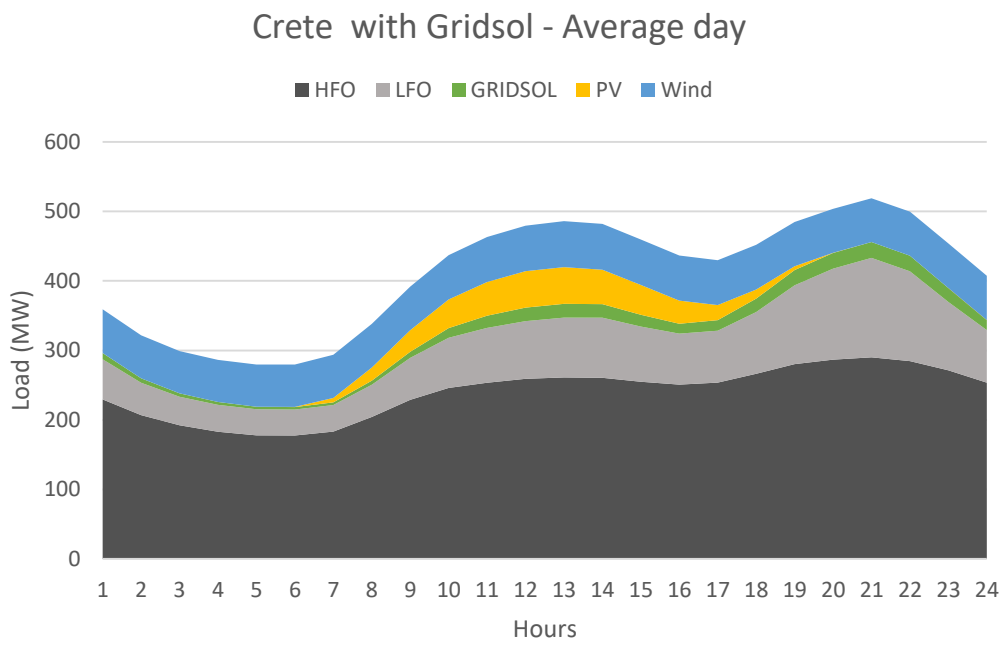
Cyprus – Average Day



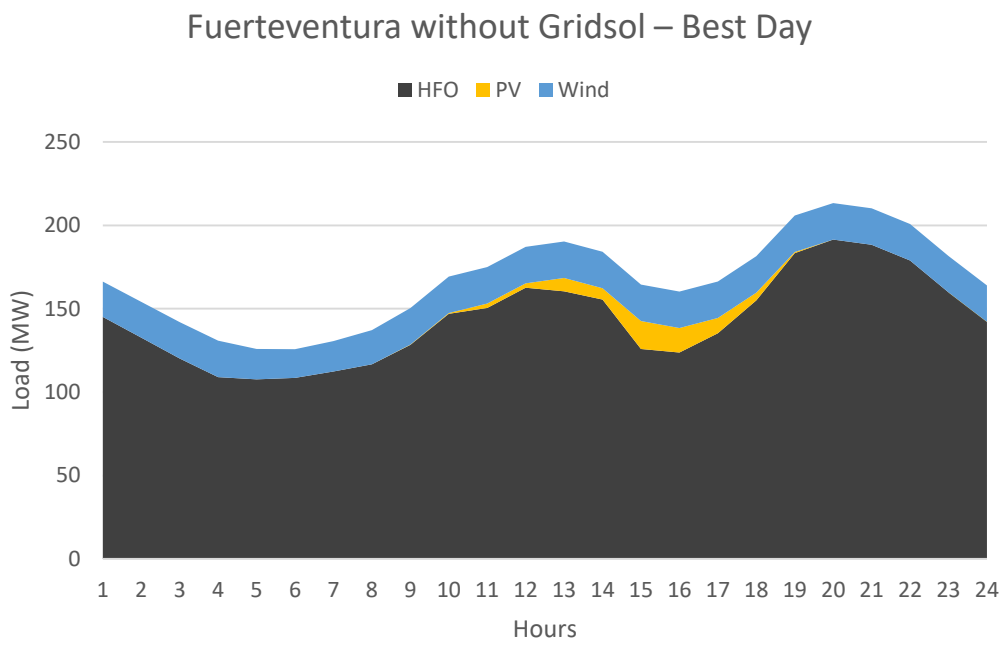


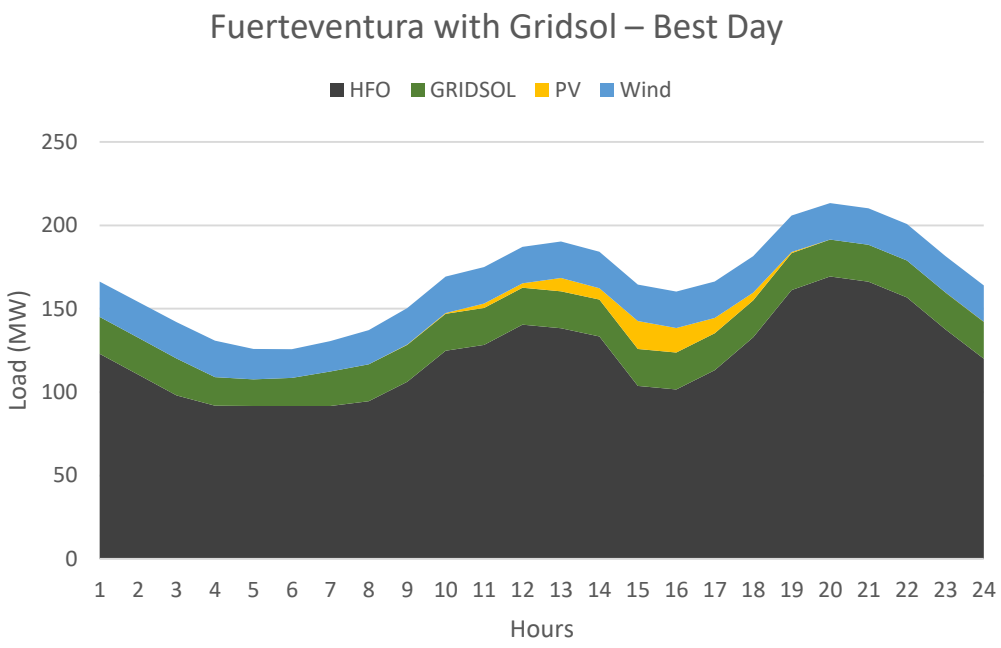
CRETE – AVERAGE DAY



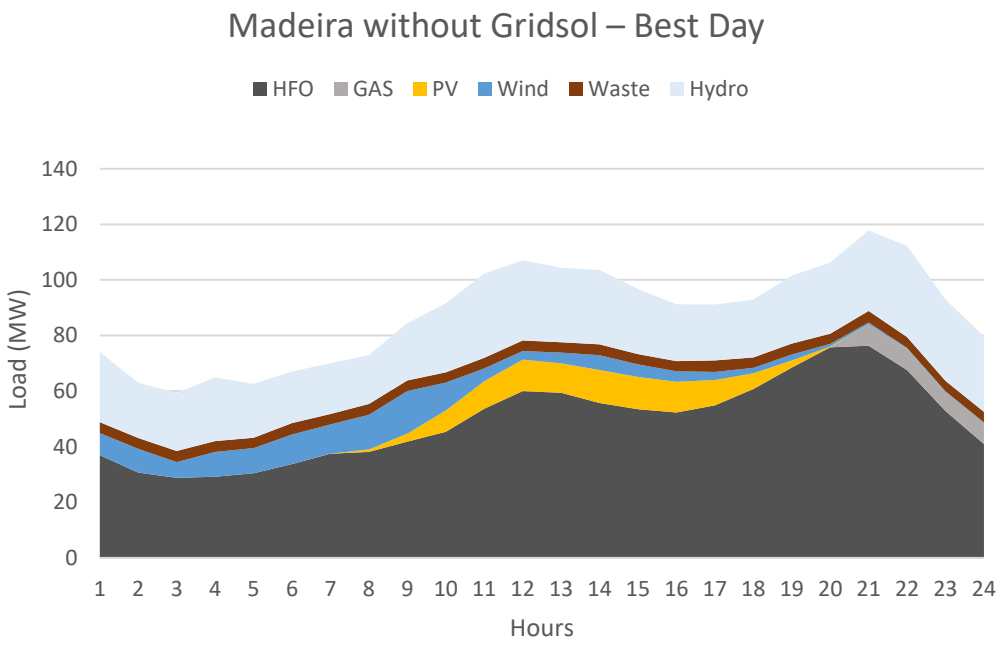


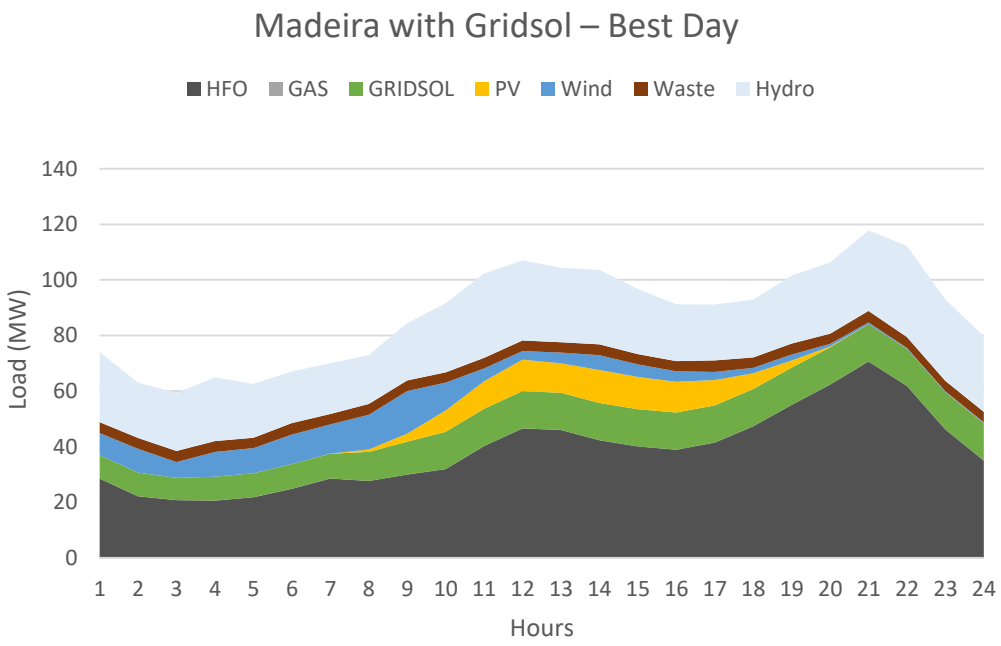
FUERTEVENTURA – BEST DAY



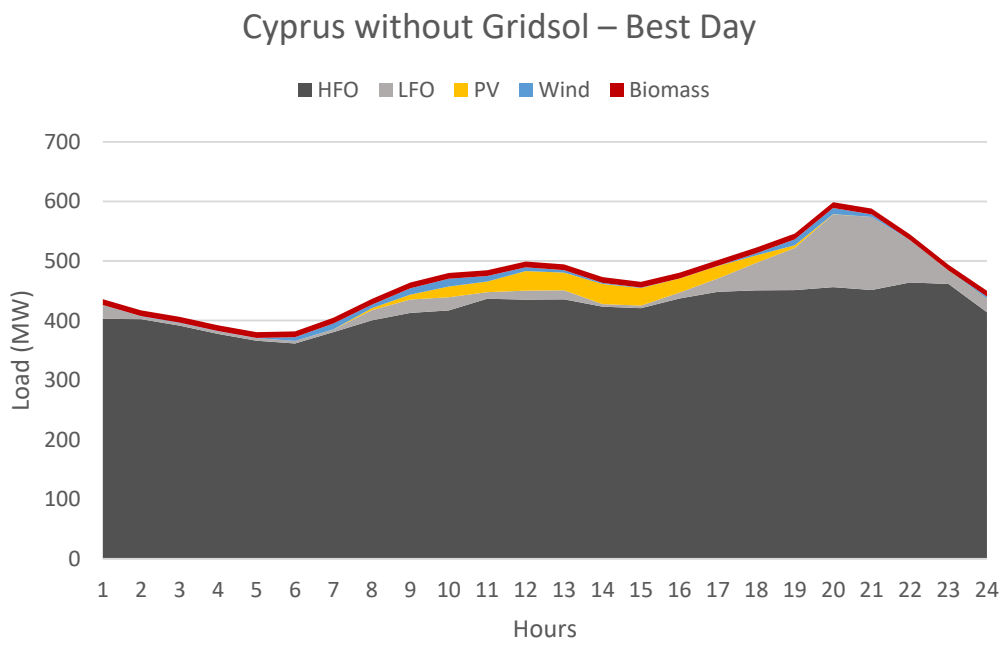


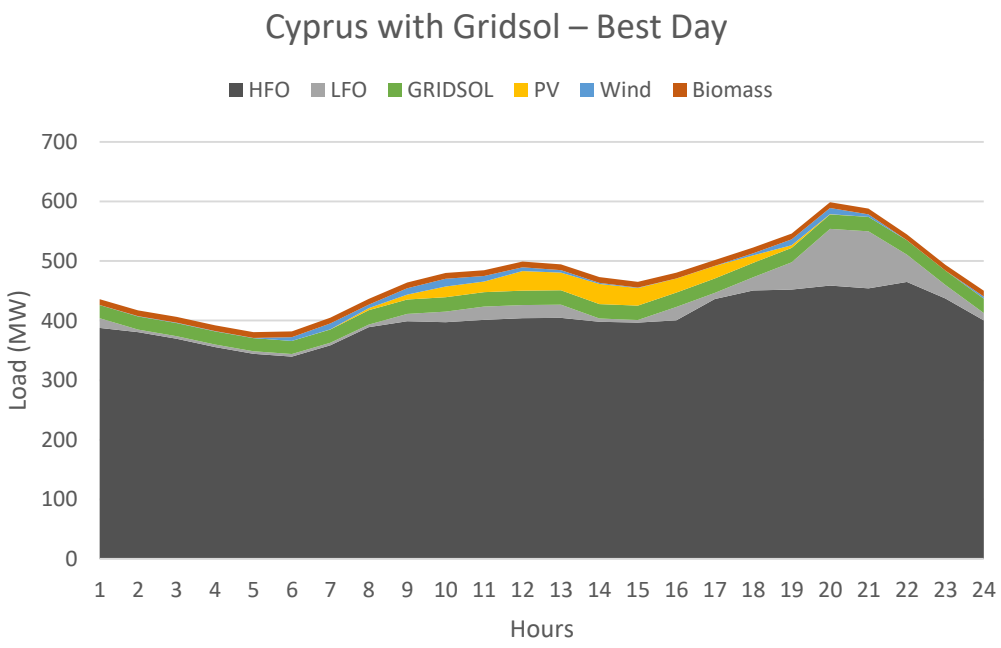
MADEIRA – BEST DAY



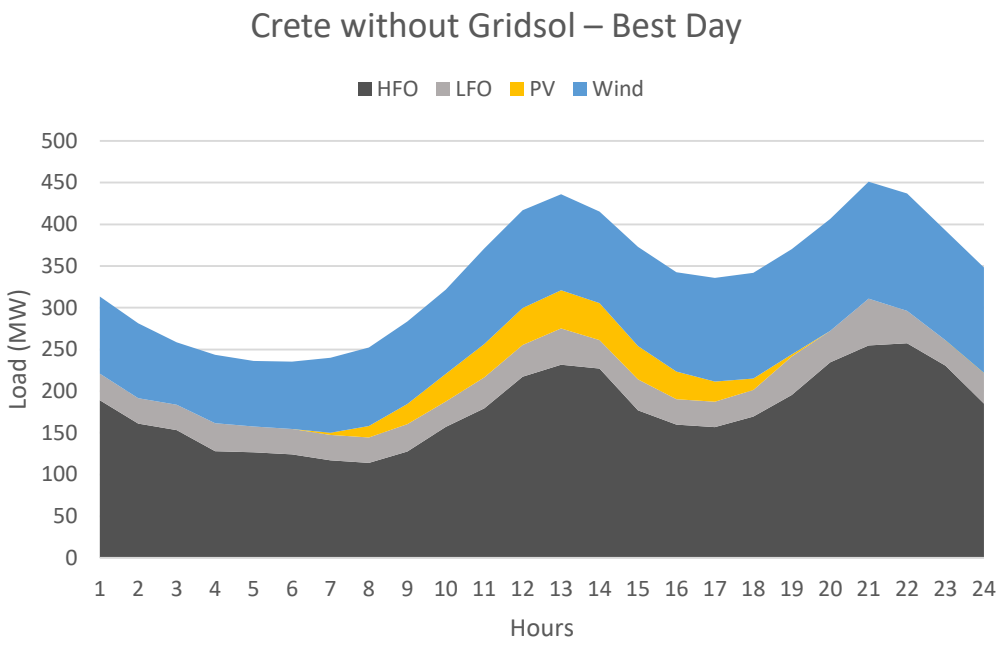


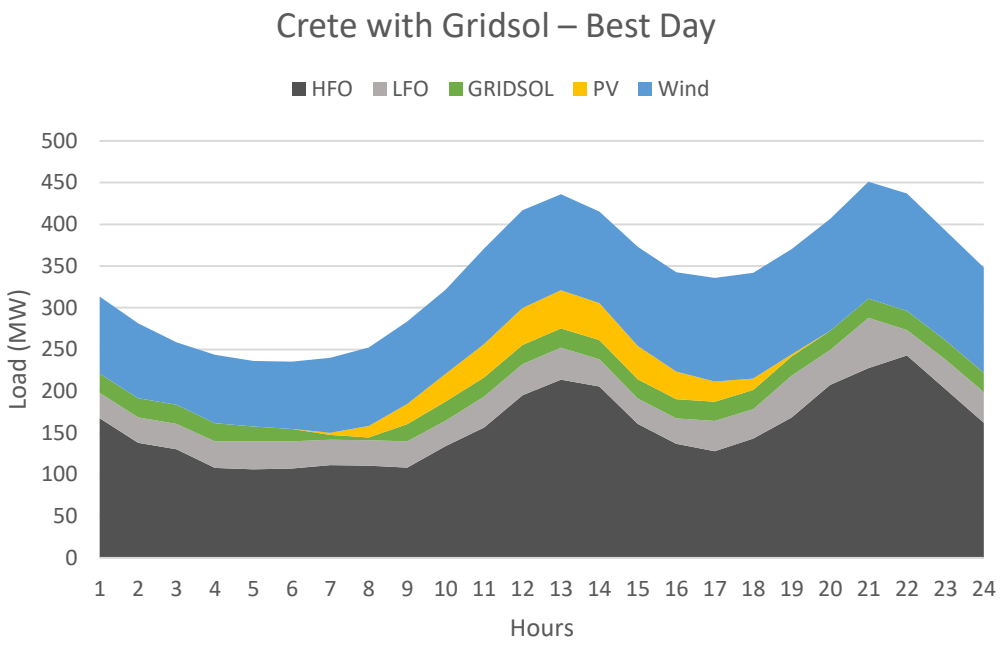
Cyprus – Best Day





CRETE – BEST DAY





Conclusions

Results show us the effect of GRIDSOL on its power system:

- Reduction of fuel consumption
- Reduction of CO2 emissions
- Increase of RES integration
- Overall reduction of the system's annual cost

THANK YOU FOR YOUR ATTENTION

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