Renewable energy integration in Small and Isolated Power Systems in Spain (SIPSS). Case study of the hydro-wind power station on El Hierro Island

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CNMC Spain's National Authority for Markets and Competition

Context: Mainland Spain vs SIPSS

Mainland Spain

Balearic Islands:

- Mallorca – Menorca
- Ibiza – Formentera

Canary Islands:

- Gran Canaria
- Tenerife
- Lanzarote – Fuerteventura
- La Palma
- La Gomera
- El Hierro

Ceuta & Melilla

Macroeconomic measures, 2014	Mainland Spain	SIPSS	Balearic Islands	Canary Islands	Ceuta & Melilla
Population (MM)	43	3	1	2	0.165
GDP/cap (k€)	23	21	24	20	18
Unemploy. (% active pop.)	24%	27%	19%	31%	33%

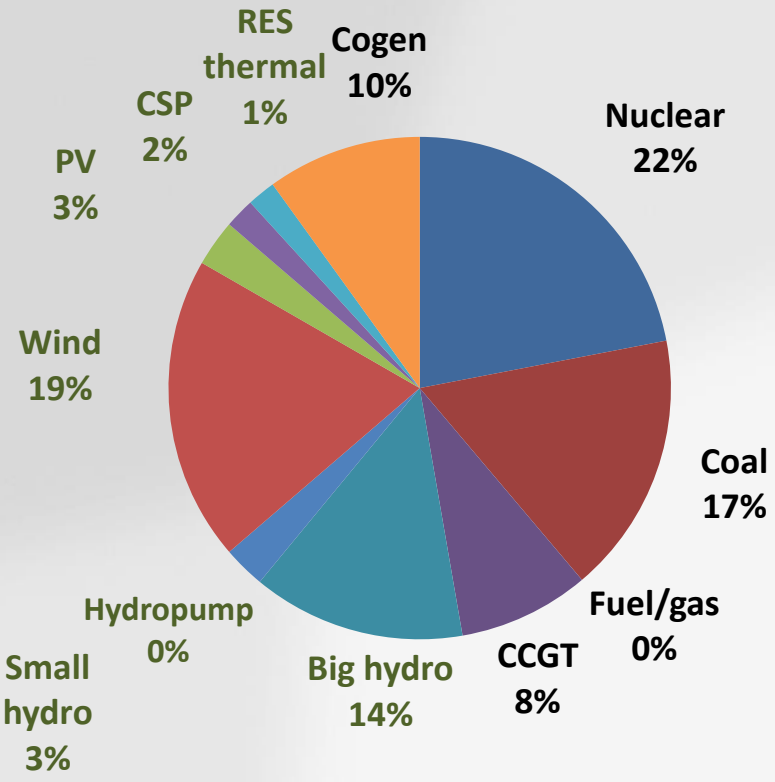
Source: INE

Mainland Spain vs SIPSS in figures

Power sector: Gross power generation, 2014

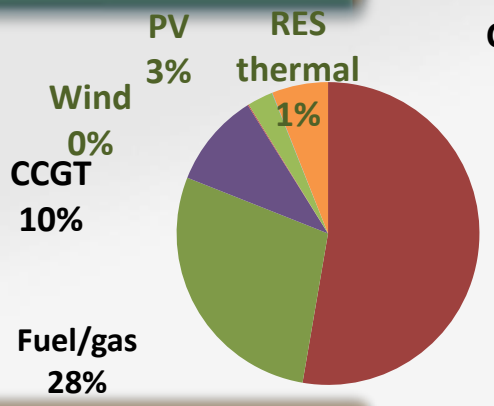
Mainland Spain (260TWh)

RES-E: 43%



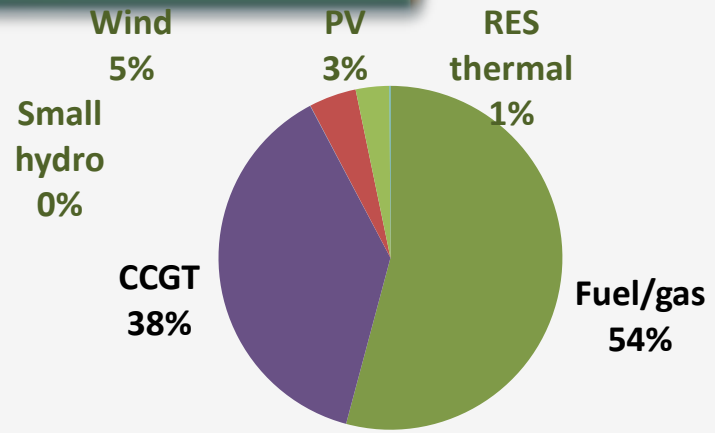
Balearic Islands (4.6 TWh)

RES-E: 3%



Canary Islands (9 TWh)

RES-E: 8%

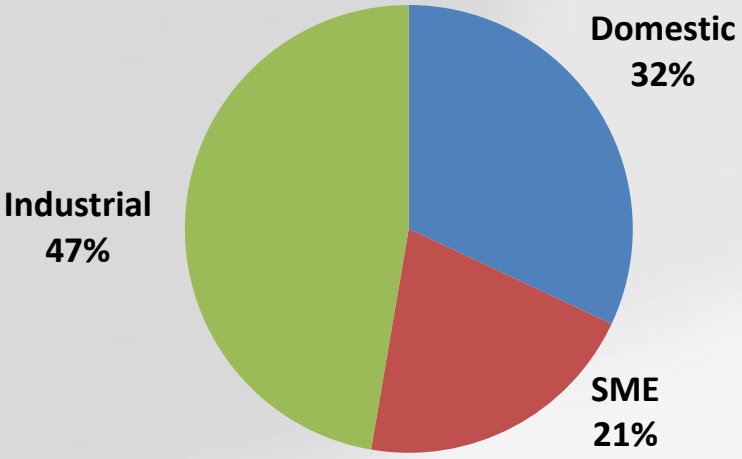


Source: REE

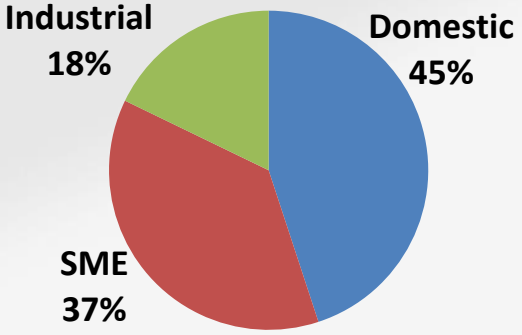
Mainland Spain vs SIPSS in figures

Power sector: Consumption by segments, 2014

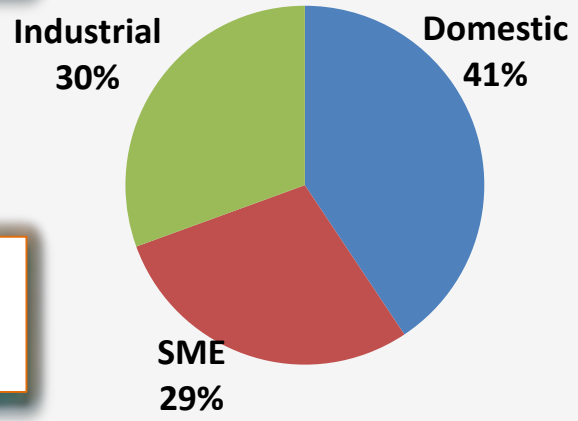
Mainland Spain (219 TWh)



Balearic Islands (5 TWh)



Canary Islands (8 TWh)



SIPSS:

- Domestic consumption with higher share
- Industrial consumption significantly lower

Source: CNMC

Regulatory comparison

Some regulatory features

Mainland Spain

Liberalization 1998

Markets processes (MIBEL):

- Forward contracts
- **Day ahead market (D-1)**
- Intraday market (D)
- Balancing market (TSO)
- Bilateral contracts

Common aspects

TSO

DSO

Supply

RETAIL PRICE

RES-E

SIPSS

Traditionally Rate of Return Regulation

Effective unbundling since 2007

Cost Plus regulation with incentives (IPC-X)

NO MARKET & No bilateral contracts

TSO: owns and controls network ≥ 66 kV and establishes hourly power dispatching

Compensation for generation

Power generation in SIPSS

Conventional generation (thermal) and hydro-wind power station

- Cost plus regulation with standardized two-part tariffs (FC + VC)

$FC = INV + COMT_F + GRLL + RA$

$VC = C_{fuel} + C_{start\text{-}up} + C_{res} + C_{om} + C_{reg}$

  - Fuel cost updated every 6 months
  - Anual indexation (IPC-X or IPRI-X) on fuel logistic costs, start-up cost, $COMT_F$ & C_{om}
  - Useful life of installations: 25 years, in case of hydro: 65 years (lineal depreciation)
  - Rate of Investment return: 10 year State bonds + 200 bp

- Costs covered by: Mainland MP_{D-1} + Compensation

Non-controllable RES-E generation: Same on Mainland & SIPSS (priority access)

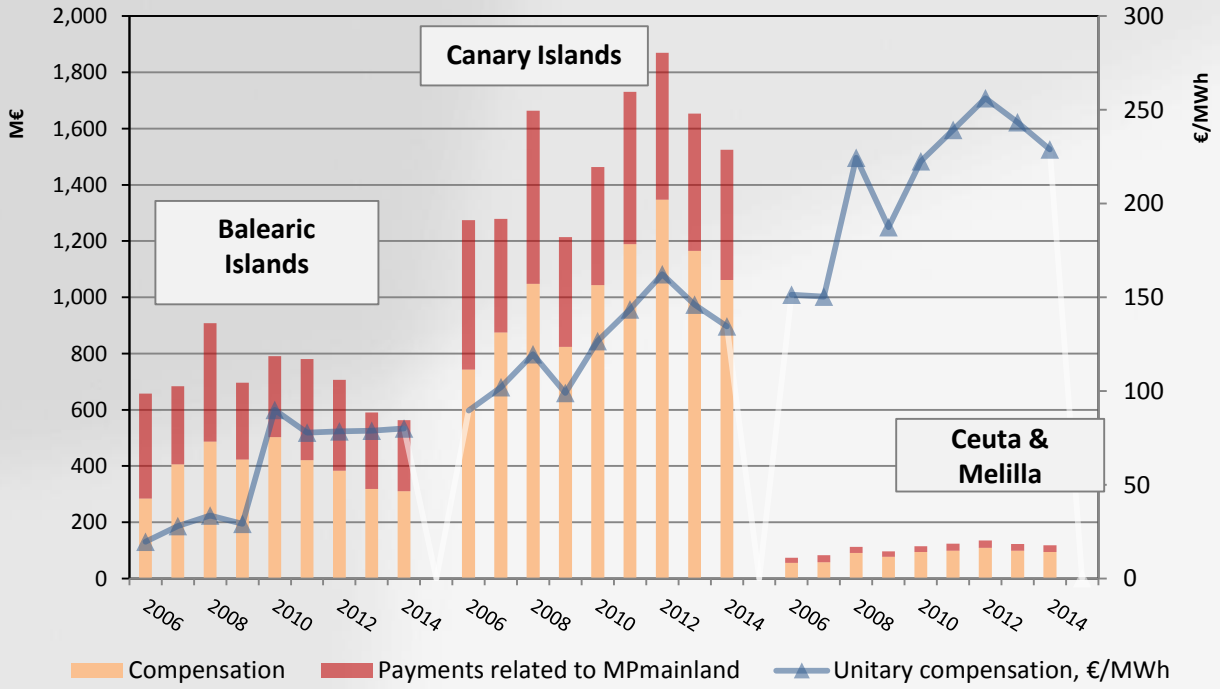
- Feed-in Tariff & Feed-in Premium until June 2013
- New framework (Royal Decree 413/2013):
  - **Additional payments linked to INVESTMENT** of each INSTALLATION TYPE (1,500) defined according to technology, age, power system, installed capacity
  - Regulatory period of 6 years; current rate of return = 7.398%
  - Future installations to be decided via tenders / auctions

Power generation in SIPSS

Major regulatory concern #1

- HIGH exploitation cost & compensation

Total generation costs in SIPSS in two parts [M€]
& unitary compensation [€/MWh]



Source: CNMC

Mayor drivers of high costs :

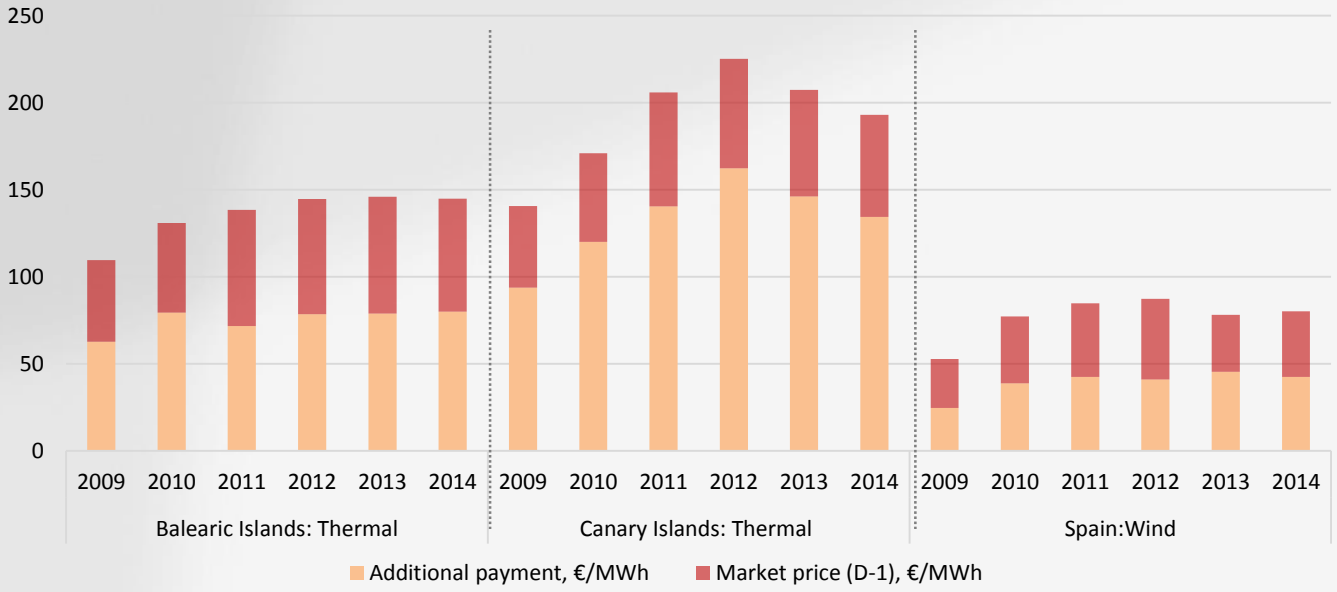
- Dependence on petrol
- Rigid standardised cost system
- Low penetration of RES-E
- Dispatching of TSO
  - Criteria #1: min ENS
  - Criteria #2: min cost
- Final consumers dominantly residential
- Environmental restrictions

Power generation in SIPSS

Major regulatory concern #2

- Low level of RES-E penetration despite of lower cost

Remuneration of thermal plants in Balearic and Canary Islands vs wind installations in Spain, €/MWh



Source: CNMC

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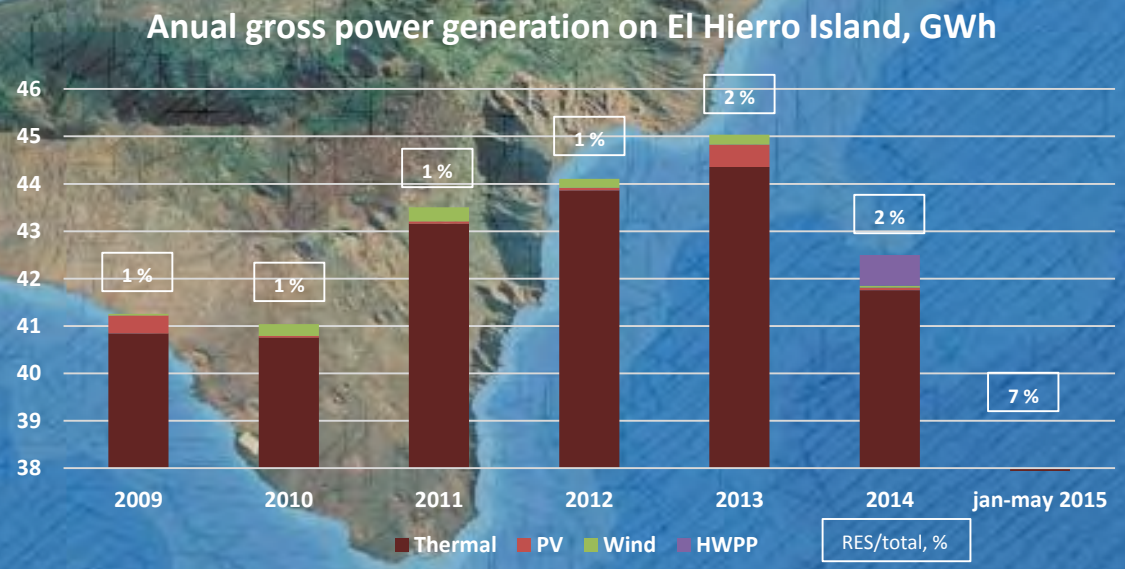
On-going reforms in SIPSS

New regulatory differentiation of power plants	• Controllable generation • Intermittent generation • Hydro pumping stations (for system security)
Improve productive efficiency & Reduce exploitation costs	• Stricter control over operation of plants • Penalisation of thermal plants if availability <30% • Possible curtailment of RES-E for economic reasons • **New price signals in final consumer tariff reflecting system costs** • **Additional payments for PV & wind if ($0,55*Vc_{system}$) > VC_{system}**
Market elements	• **Tenders / Auctions** for new **PV and Wind capacity** • **Tenders / Auctions** for **fuel** supply of thermal plants
Strengthend role for TSO	• Demand forecast for all time frames • Proposing necessary new capacity (technology & location) • Ownership of pumping stations for balancing purpuses

HWPP on El Hierro Island

- Population of the island: 11 thousand inhabitants
- Power generation on El Hierro Island is based on diesel:
  - Thermal plant: Llanos Blancos (11 MW: 9 units with 0,7 – 2 MW)
  - Renewable: Wind (280 kW) & PV (≈5kW)
  - HWPP (6 MW + 11 MW), starting operation in June 2014



HWPP on El Hierro Island

Technical characteristics

- Windmills (11.5 MW) with lifetime = 20 years
- Turbination (11.32MW) [65 years]
- Pumping (6 MW) [65 years]
- One connection point with the network: joint operation & remuneration of windmills and pumping – turbination.

Ownership structure (Consorcium)

- Cabildo (Insular Authority) 60%
- Endesa 30%
- Instituto Tecnológico de Canarias 10%

Financing

- Total Investment ≈ 80 M€
- State aid: 35 M€

HWPP on El Hierro Island

Main regulatory goals:

- Improve economic and energetic efficiency of power generation on the island
  - Lower overall exploitation costs of the island
- Integration of RES-E: storage of wind energy
  - Store excess wind energy for pumping
- Control for electrical network frequency and stability
  - HWPP absorbs reserve capacity requirements, thus allowing for more efficient exploitation of the thermal plant
- Reduction of GHG emissions
- Less dependency on petrol products (volatility)

HWPP on El Hierro Island

Operation of HWPP

Integrated operation of HWPP

- Windmills exploited jointly with pumping station

TSO: operates the whole power system on El Hierro.

Given storage capacity, HWPP is dispatched according to:

- Relationship between instantaneous demand & wind generation
- Reservoir levels

Diesel plant (Llanos Blancos) cannot be used for pumping

- The upper reservoir can only be filled up by wind energy.

Currently, pumping covers 2 days of demand in a month

- Due to technical problems, reduced operation in the first year.

HWPP on El Hierro Island

Remuneration

Although HWPP is a renewable plant, its remuneration is similar to that of a thermal plant.

- Fixed payment on the basis of net hydro capacity

$$FC = INV + COMT_F + GRLL + RA$$

  - GRLL = cost of filling the reservoir for the first time
  - RA = additional payment (max. 122,079 €/MW_{hydro})
  - Audited values of investment and fixed O&M costs should be evaluated *ex-post* due to lack of experience in this kind of installations.

- Established variable cost = 15,57 €/MWh
- Rate of return: state bonds + 200 bp (7.398%)
- Due to integrated exploitation of hydro & wind parts, the internal energy consumption of HWPP used for pumping is not remunerated (directly).

HWPP on El Hierro Island

Key aspects of regulation:

Pumping exclusively with wind energy

- The diesel plant cannot be used for pumping, neither for security reasons is it permitted.
- If diesel plant were allowed to pump, it would imply paying twice for the corresponding turbined energy.
- This setup allows for maximising REE-E integration.

Efficiency factor of pumping station

- Its variation can have a significant effect on variable costs and on the hours of operation.

Min. # hours of operation for pumping station

- Established at 2,688 h/year
- In case it is too low, the remuneration could be excessively high.

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Lessons learned in SIPSS

Singularity of SIPSS

- Adopt measures that recognise the singularity of each and every power system.
- Operation and retribution should not necessarily be linked to Mainland Spain.

Foster RES-E penetration through tendering

- Given abundant resources and in order to avoid economic distorsions, instead of direct subsidies for RES-E, it is preferable to apply competitive tendering. Key issue: DEMAND FORECAST
- In order to alliviate potential risks of "over-remuneration", competitive auctions or tendering can adjust better to future incurred costs.

Administrative ease

- Urgent need for accelerating burocratic paperwork / cut the redtape

End-user prices should reflect generation costs

- Efficient price signals can foster penetration of new technologies and distributed generation.

Thank you

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