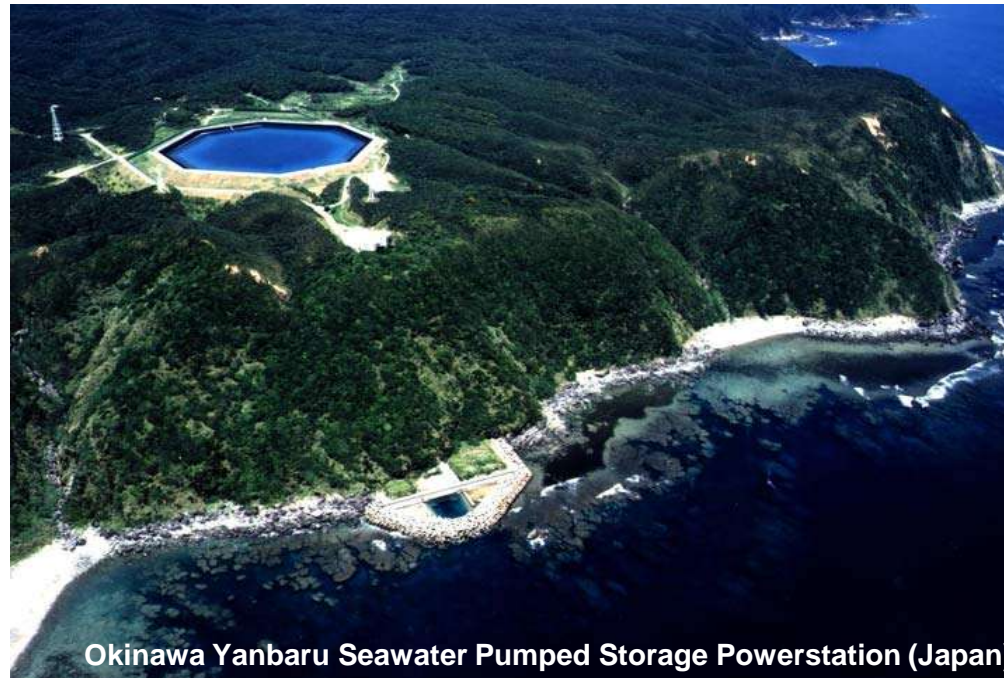


Support for Morocco's energy policy *Development of seawater pumped storage in Morocco*

Technology Review & perspectives of development





0. Introduction

1. Energy challenges & objectives in Morocco

2. Technology review of seawater Pumped Storage PowerPlant (PSPP)

3. Perspectives of Seawater PSPPs in Morocco

4. Conclusion



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Overview of SETEC group

Profile

- multidisciplinary engineering company
- **261 M€** (turnover 2014), **2 420** associates, **1700** engineers
- Created in **1957**, 60 years of experience
- **Capital owned by the company's managers and engineers**
- **Subsidiary in Morocco: Semartec**

Services

- ✓ Economic and technical studies
- ✓ Project management assistance
- ✓ Project management
- ✓ Engineering
- ✓ Project development and operation management
- ✓ Expertise and consulting
- ✓ Maintenance and operation

Focus Energy and Environment



Spheres of activities

- ✓ Transport
- ✓ Energy
- ✓ Construction
- ✓ Water and environment
- ✓ Industry
- ✓ Sustainable city

Viaduc of Millau. Architect Sir Norman Foster.



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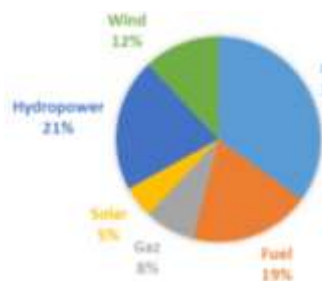
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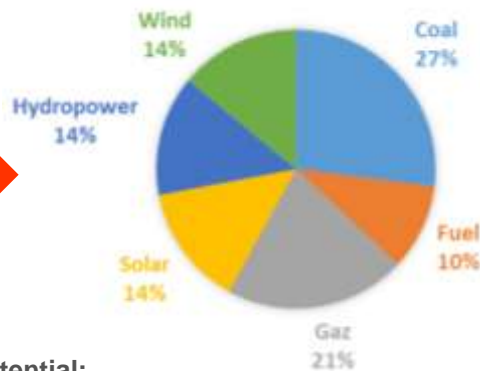
Energy situation in Morocco

Electricity: installed power capacity:

2015: 8 156 MW, 38% RE



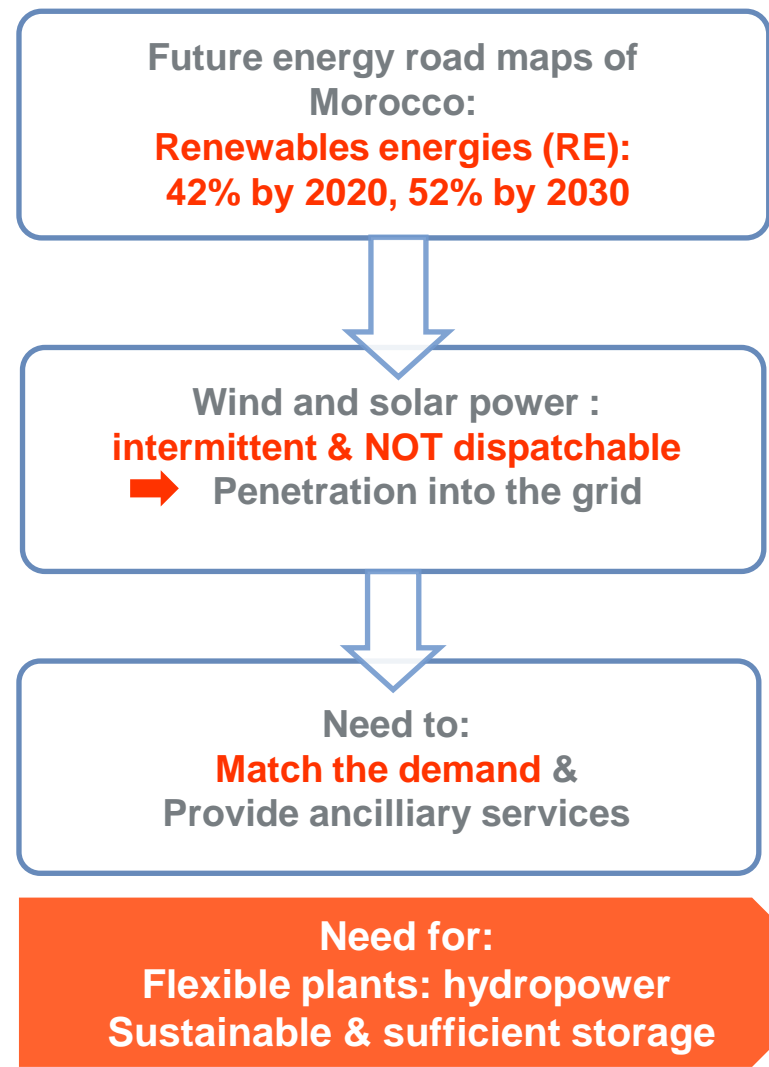
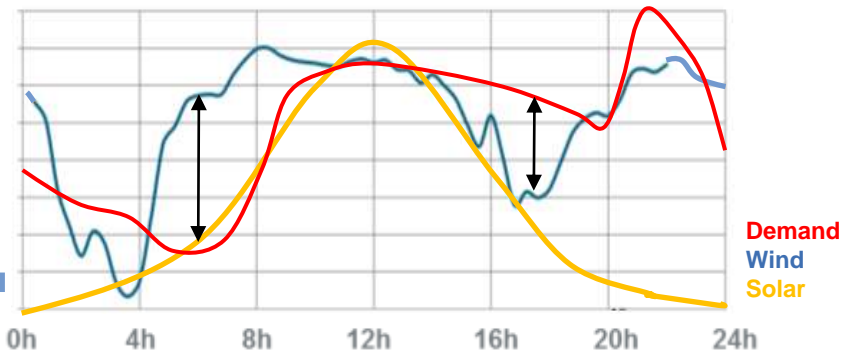
2020: 14 286 MW, 42% RE



Geographical breakdown of RE potential:



Average daily variations of power generation and consumption:



Energy - Future trends and objectives

Project: Support for Morocco's energy policy

Commissioned by



Lead executing agency



GIZ mission: Improve the legal and institutional framework for RE development

Objectives: *Enhancing the penetration of Renewable Energies into the grid*



PUMPED STORAGE SYSTEM DEVELOPMENT

First step: Definition of available capacity

- On-shore : **Limited**
- Off-shore (seawater) : **3500 km of coastal line**



Review of seawater pumped storage plant (PSP)



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Overview

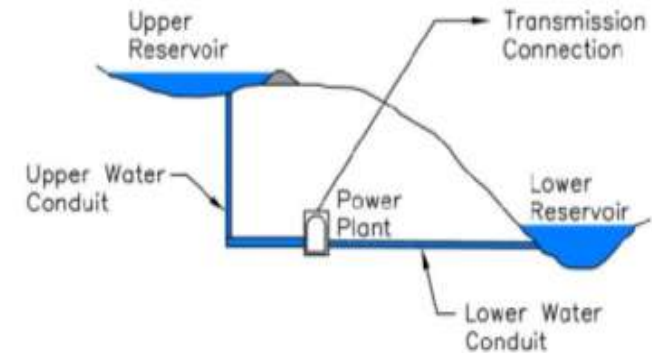
- Hydropower plant & a pumping station
- **Lower basin = sea or ocean**
- **Daily**, weekly or monthly storage

Technology available (equipment)

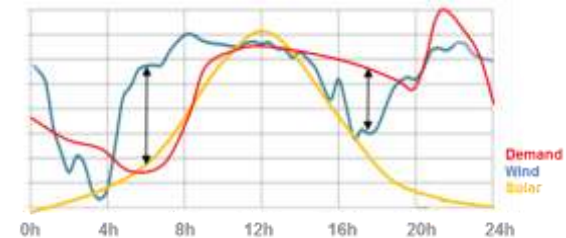
- Separate turbines and pumps
- Ternary units
- **Reversible pump-turbine** ← New technology
- **+ Adjustable speed drive**

Environmental issues mitigation and resilience:

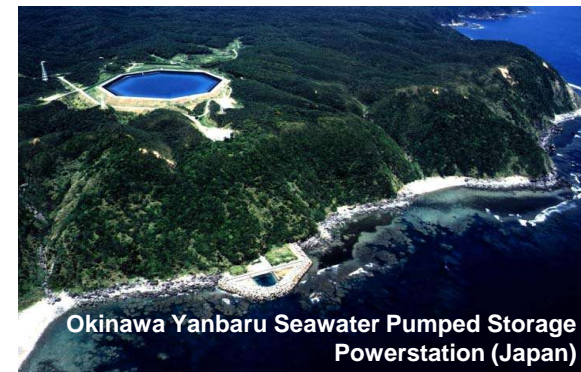
- Small amount of space needed for development
- Mainly underground system (power plant, waterway..)
- Waterproof membrane at the upper basin



Storage demand:
depends on production and consumption



Only 1 site developed to date in Japan



Okinawa Yanbaru Seawater Pumped Storage Powerstation (Japan)



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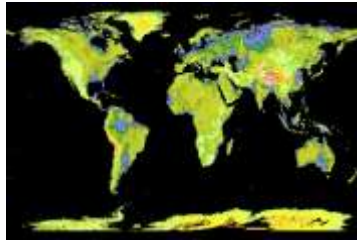
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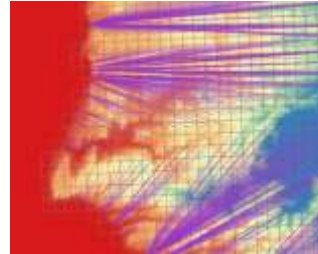
4. Conclusion

1. Potential assessment methodology (conducted by setec)

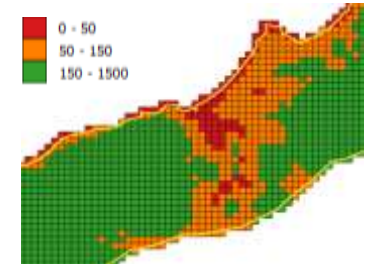
- ✓ Topographical data from METI and NASA ✓ Geographic information system (GIS) ✓ Multi-criteria analysis



ASTER GDEM



Calculations of minimal distances to the coast



Head criterion

Site attractiveness parameters

- Distance to the coast L
- Head Height H
- Volume of the reservoir (energy capacity) V
- Flatness of the upper reservoir area



Analysis criteria

Short waterway	$L/H < 6$
H	Highly favorable : $H \geq 150m$ Favorable : $50 \leq H < 150 m$
V	$= 1hm^3$
Mean slope	$< 15\%$

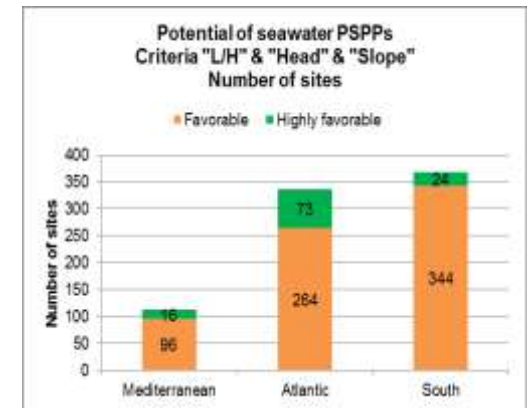
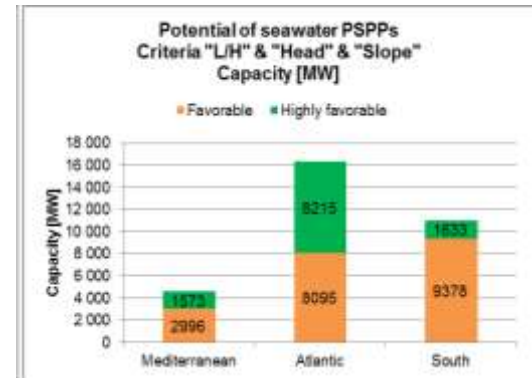
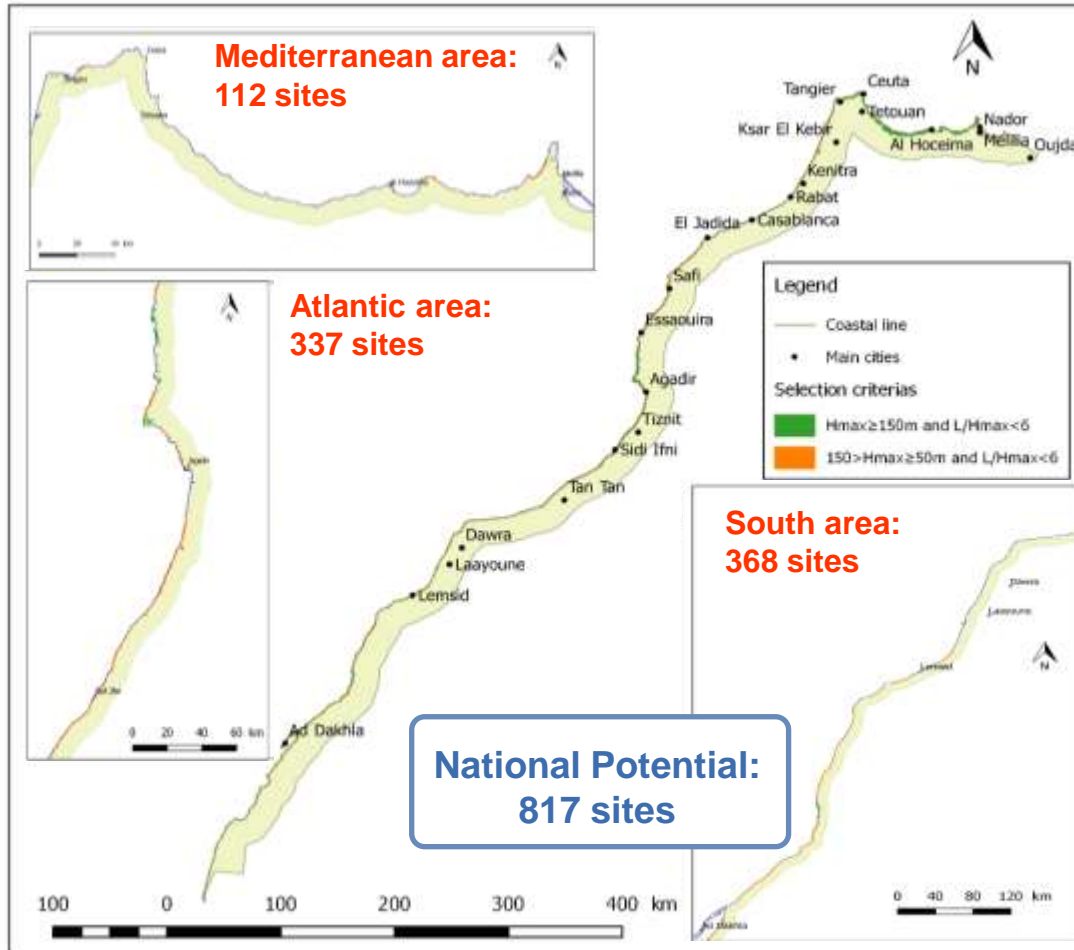
Hypothesis

- Potential assessment only based on technical criteria
- Environmental + Urbanistic constraints not considered at this stage

Results of analysis

2. Main results

Theoretical Potential: 31 890 MW
 Mediterranean area: 4 569 MW
 Atlantic area: 16 310 MW
 South area: 11 011 MW



Conclusions



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Conclusion

Potential assessment only based on technical criteria : **31 890 MW**

Next step: Environmental and urbanistic assessment of Seawater PSPPs

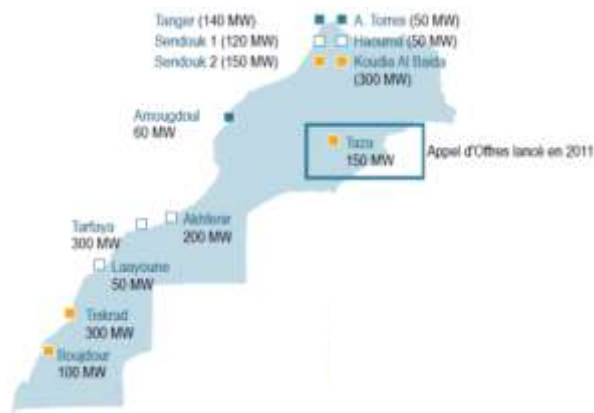
- Marine work area
- On shore work area

Perspective of Seawater PSPPs as an efficient storage

- **Financially** attractive for large storage and capacity
- **Geographically & technically** attractive compared to RE development

➔ Compatibility with wind power sites and solar sites

Wind power projects



Solar power projects





Thank you for your consideration

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