# Synchronous Energy Storage

*Malta´s 100MW Pumped Heat Electricity Energy Storage*

June 15th, 2022

# Thermal Long Duration Energy Storage typically offers two major value propositions

## Energy shifting

| Time horizon | Role of storage | Typical solution |
|---|---|---|
| **Intraday** | Balance variable daily generation with load | **8-24 hours LDES** |
| **Multiday, multiweek** | Support multi-day imbalances<br>Absorb surplus generation to avoid grid congestion | **24+ hours LDES** |
| **Seasonal duration** | Support during seasonal imbalances<br>Mitigate extreme weather events | **Hydrogen** |

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## Grid services

**Grid services offered by LDES**

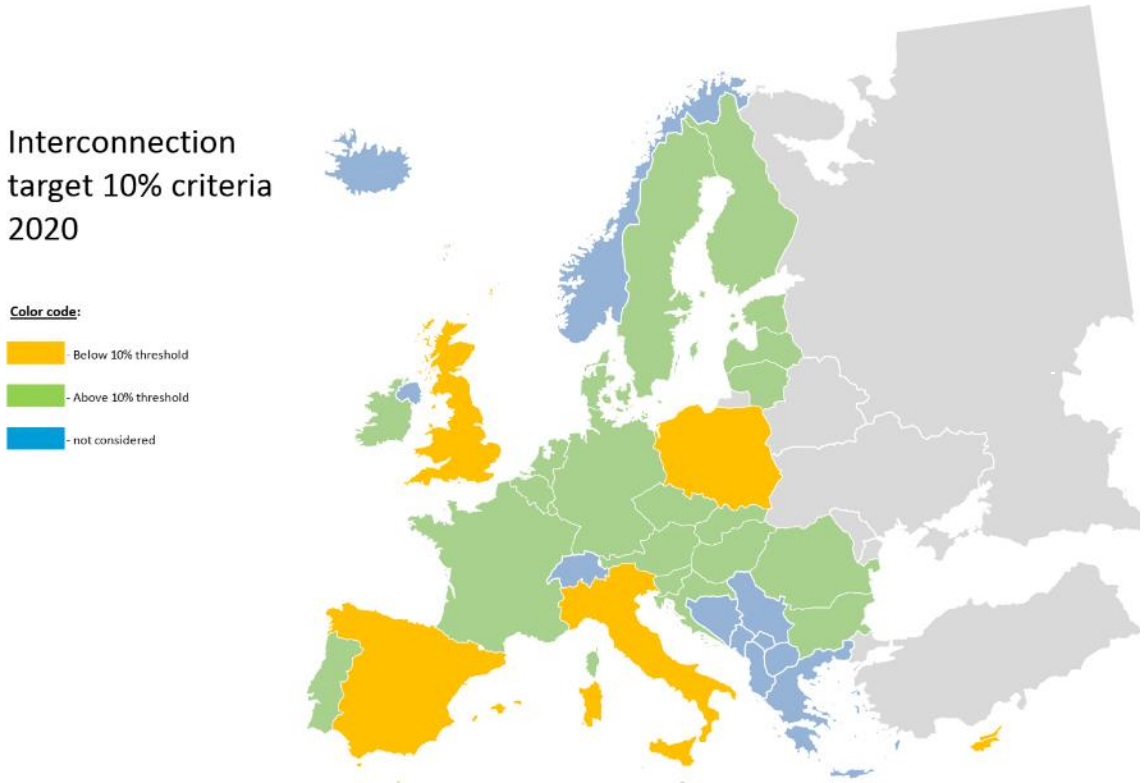
- **Synchronous Inertia**
- **Fast frequency response (FFR)**
- **Primary/secondary/tertiary reserve**
- **Reactive power/voltage control**
- **Short circuit level improvement**
- **System restoration/ black start**

*Note: services are technology-specific*

McKinsey & Company

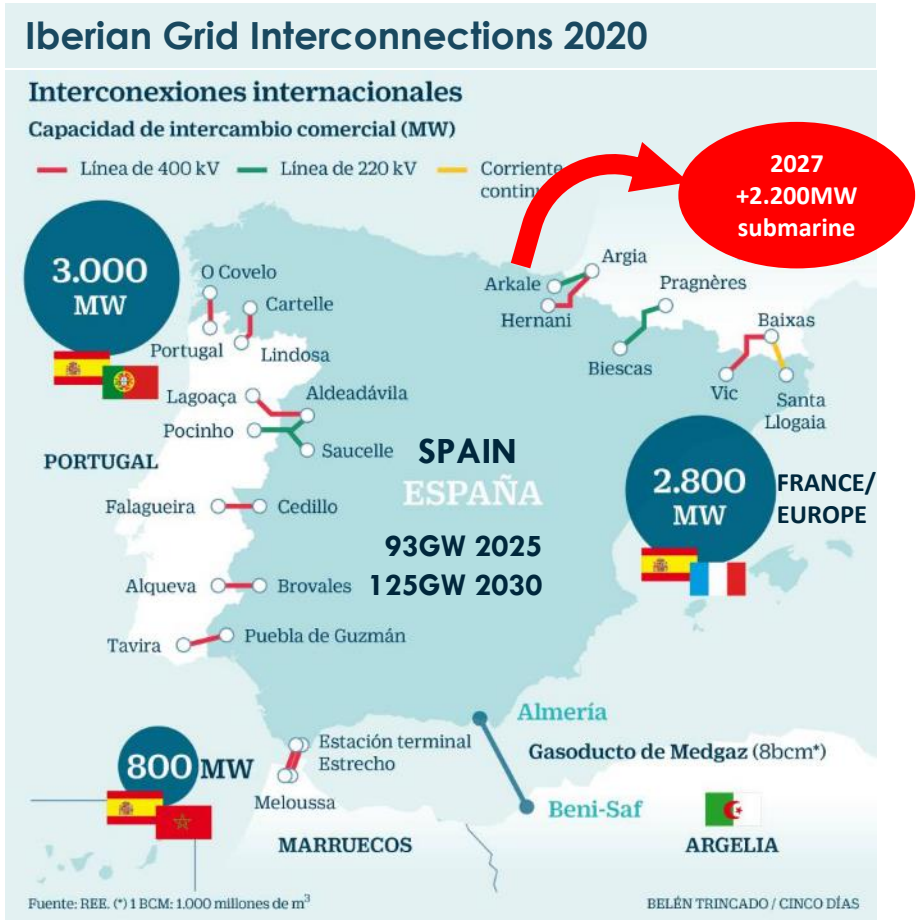
Source: Long Duration Energy Storage Council

# European needs for synchronous storage



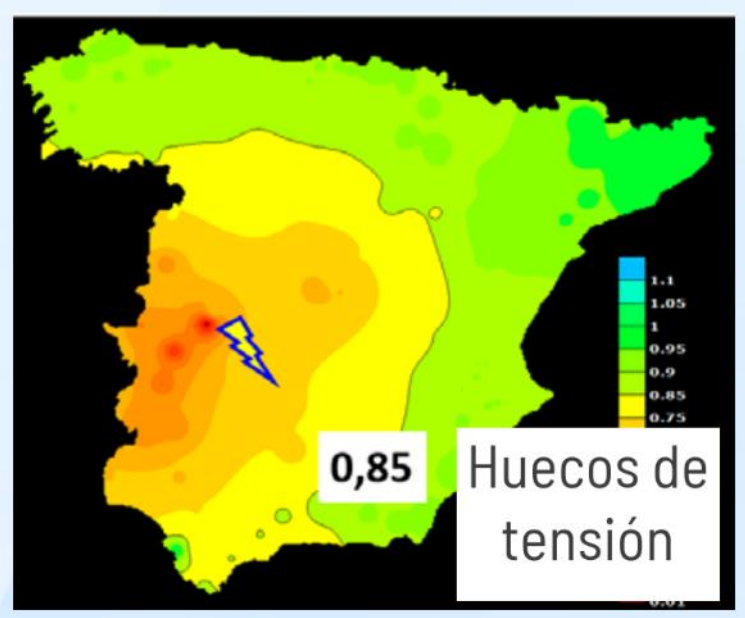

Fullfillment of the 10% interconnection target in 2020

https://eepublicdownloads.entsoe.eu/clean-documents/tyndp-documents/TYNDP2018/rgip_CSW_Full.pdf




https://cincodias.elpais.com/cincodias/2017/07/10/companias/1499700974_956333.html

# 15GW new synchronous generation open in Spanish Grid




**Almost 15.000MW excess capacity available for synchronous generators like Malta PHES**

https://www.ree.es/sites/default/files/01_ACTIVIDADES/Documentos/AccesoRed/Presentacion_SG_CG_10Sept20.pdf

**MGES**
**(Generadores síncronos conectados síncronamente)**

**MPE**
**(Generadores conectados de forma "no síncrona")**

RED ELÉCTRICA DE ESPAÑA
Grupo Red Eléctrica

Dirección General de Operación

Fecha de publicación: 1 de julio de 2021

Información sobre capacidad de acceso [MW] disponible y ocupada en los nudos de la red de transporte

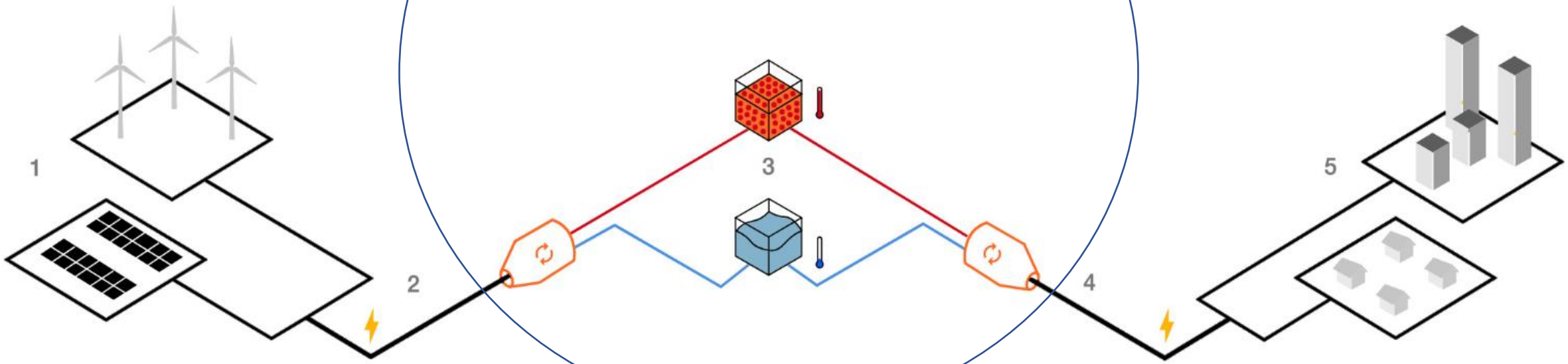
**CAPACIDAD DE ACCESO DISPONIBLE A LA RED DE TRANSPORTE**

| Criterio limitante MGES | Capacidad de acceso disponible para MGES [MW] | Criterio Limitante MPE | Capacidad de acceso disponible para MPE [MW] |
|---|---|---|---|
| E_Nudo | 0 | WSCR | 0 |
| D_Nudo | 0 | WSCR | 0 |
| E_Nudo | 0 | WSCR | 0 |
| E_Nudo | 638 | WSCR | 432 |

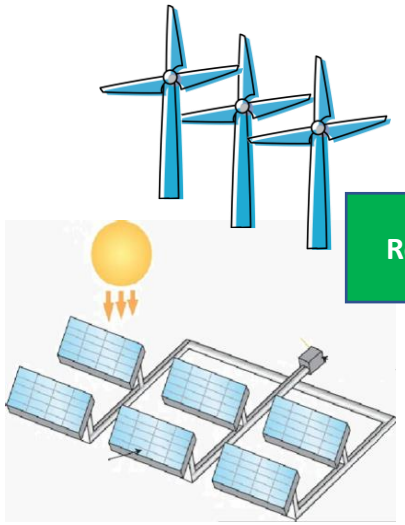
https://www.ree.es/sites/default/files/12_CLIENTES/Documentos/Capacidad_de_acceso_a_RdT_ED_1sep21.pdf

# Breakthrough Grid-Scale Energy Storage

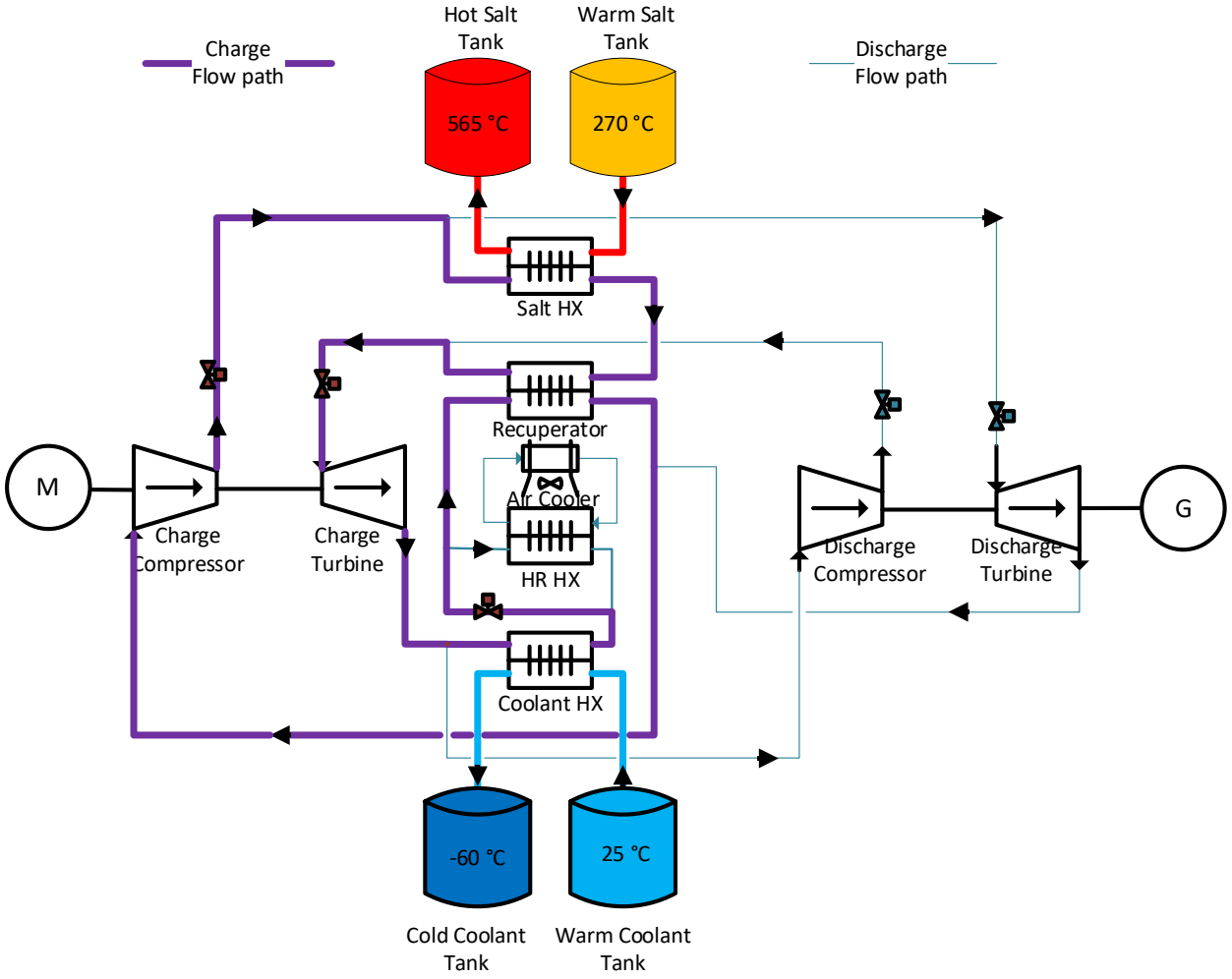
Low Cost (€100/kWh)
Long Duration (10 -150 hrs)
Grid Scale (100+ MW)



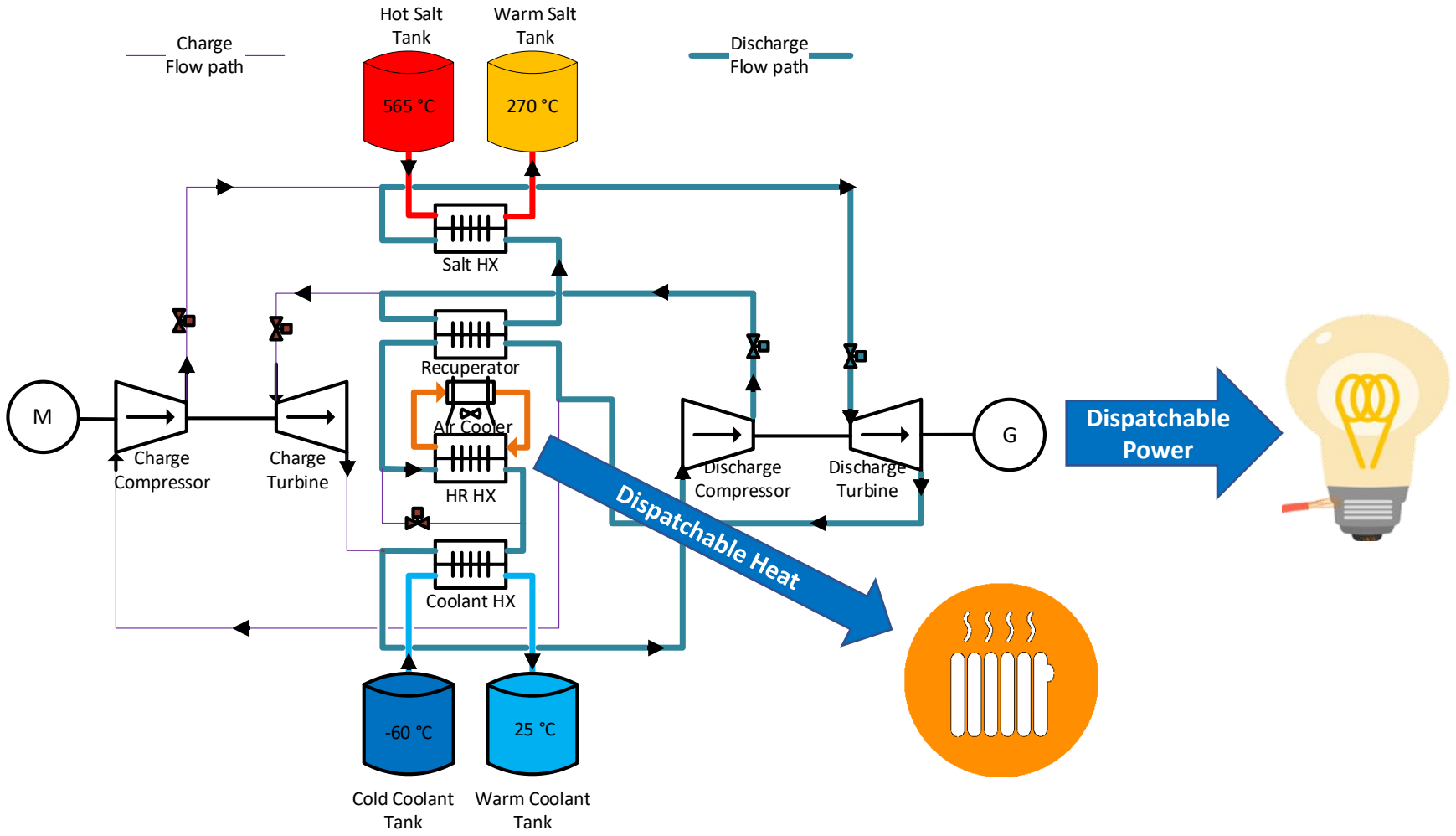
# Malta Electricity Charging Cycle



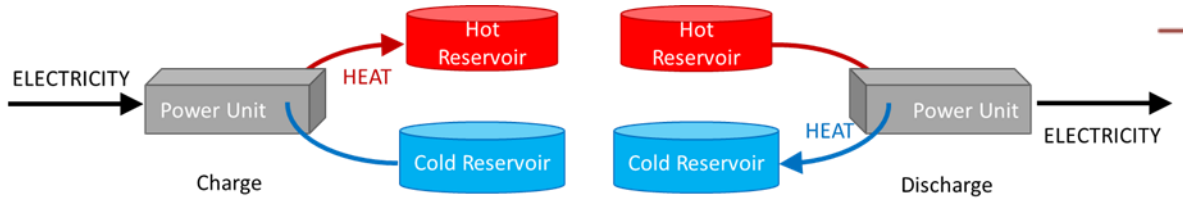
Variable Renewable Power



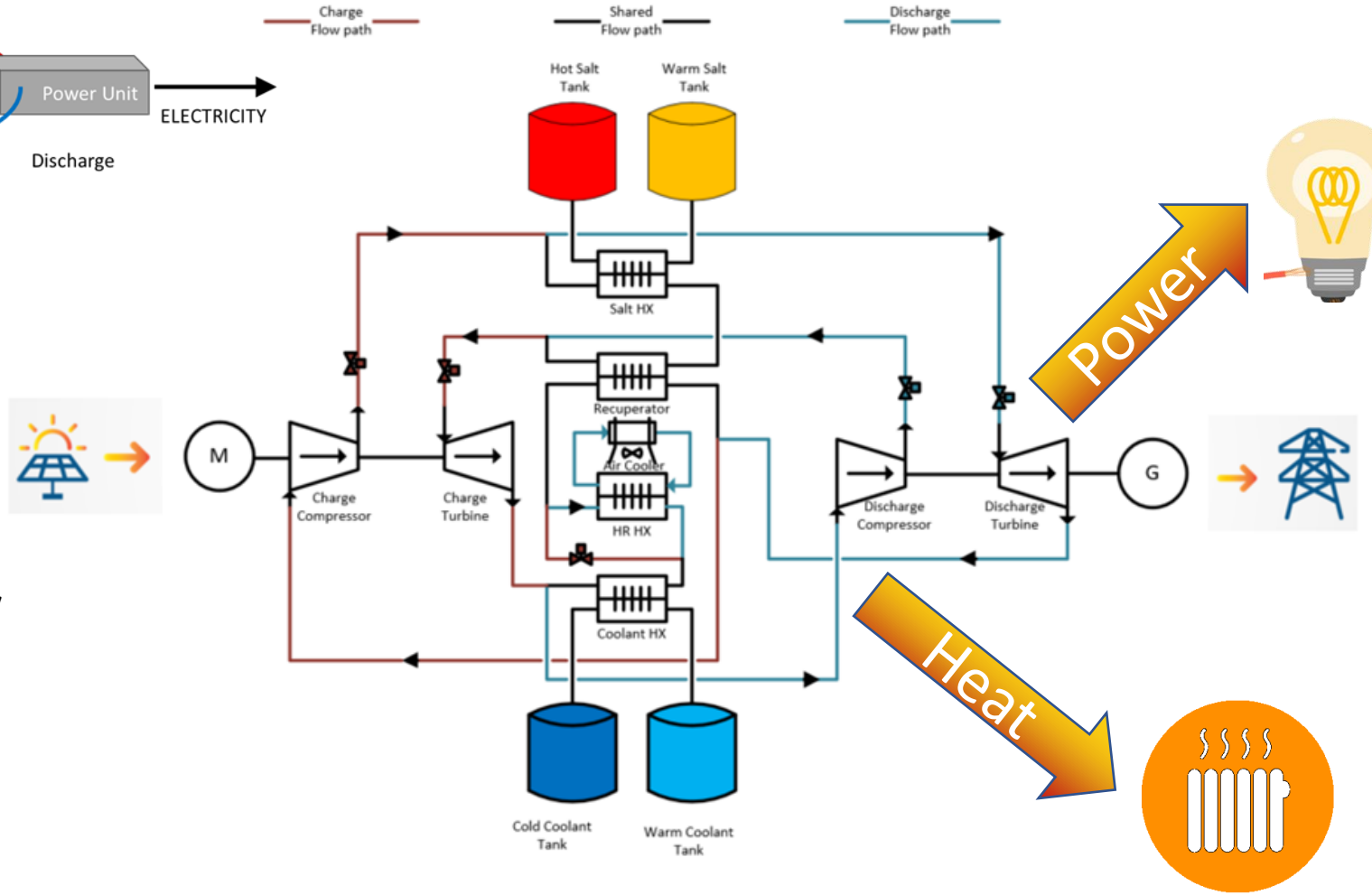
# Malta Electricity and Heat Discharging Cycle



# Malta PHES storage for delivering power and heat



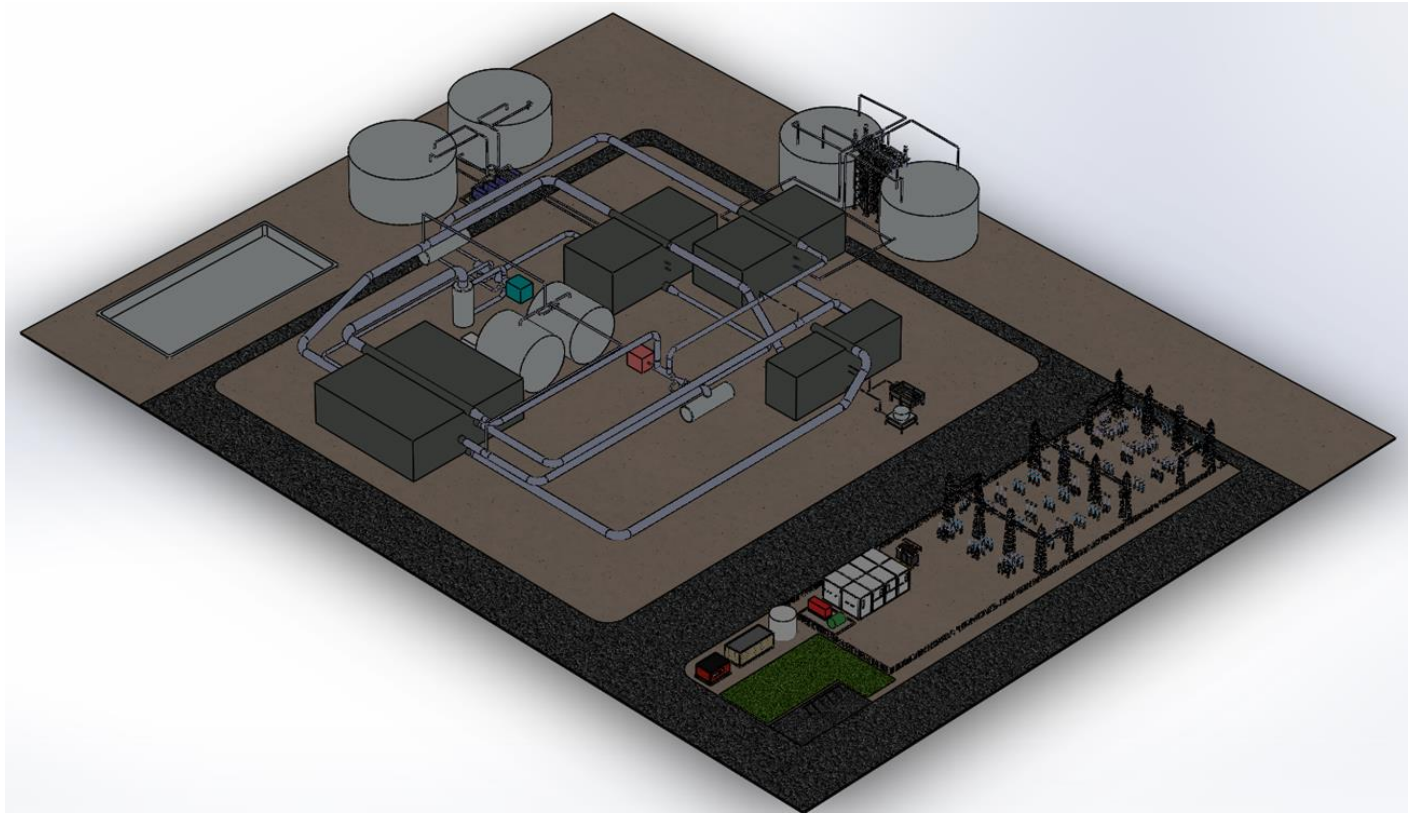

- **Long-Duration -** 4 to 24+ hours
  **Low-Cost -** 100 MW systems < €200/kWh short term down to 100€/kWh mid term
- **Long Useful Life -** Over 25 years w/o storage capacity degradation
  **Rotating Inertia -** Malta provides inertia to the grid as fossil/nuclear plants retire
  **Separation of Charge / Discharge Capacity and Duration**
- **Ideal for Trading by Decoupling of Charge from Discharge**
- **Presence of Waste Heat**



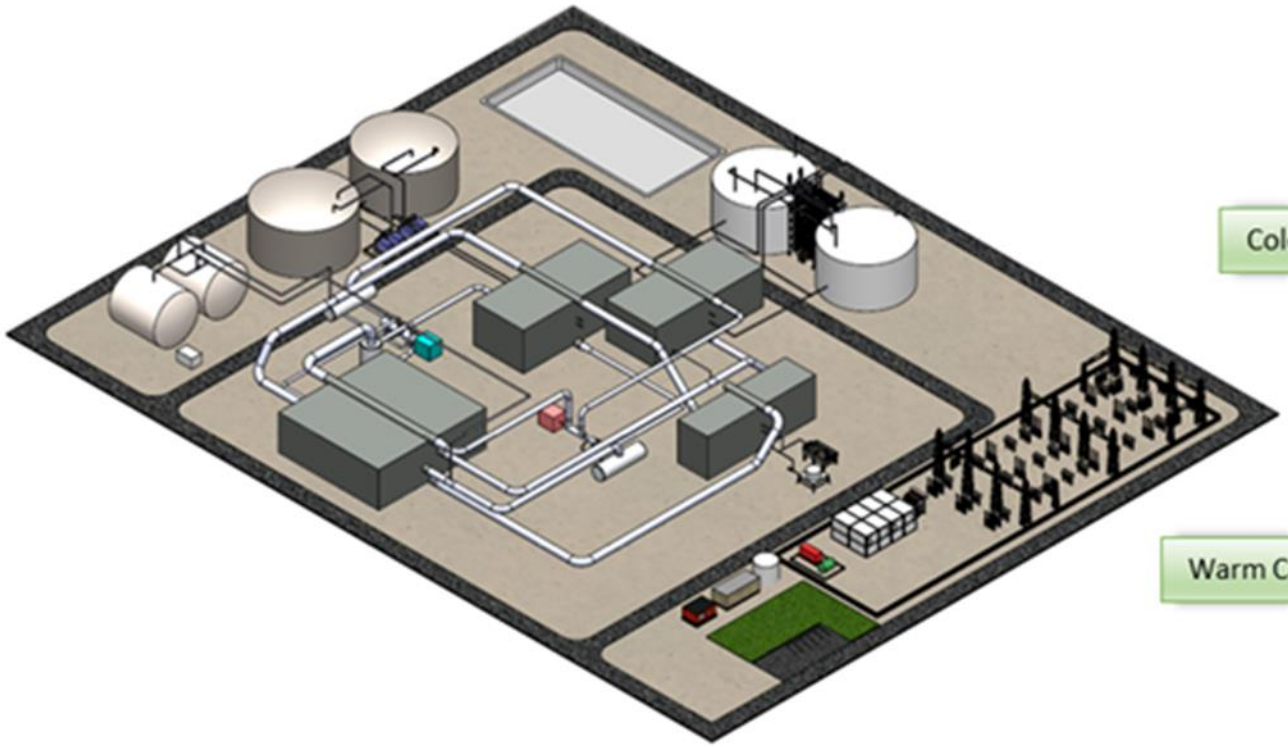
# Proven Sub-Systems - Safe & Reliable

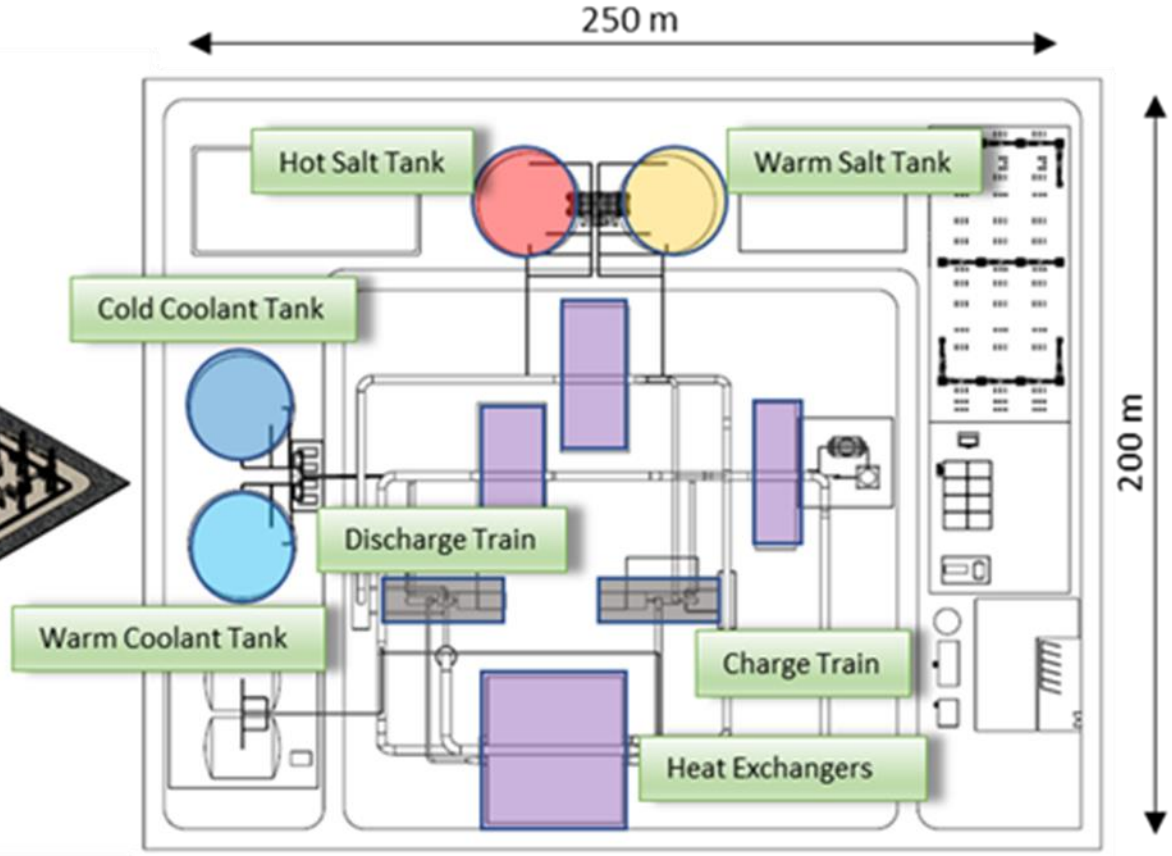
- **Commercially-proven sub-systems** and equipment
- **Safe & reliable** operation
- **Low-cost option** based on intrinsic cost advantages
- Ability to **decouple power (MW) from energy (MWh)**
- **Flexible charge-to-discharge** ratio enables location- and application-specific solutions
- Malta projects **"look like" CCPP assets to the grid** (dispatchable, inertia)

**100 MW Reference Plant Rendering**

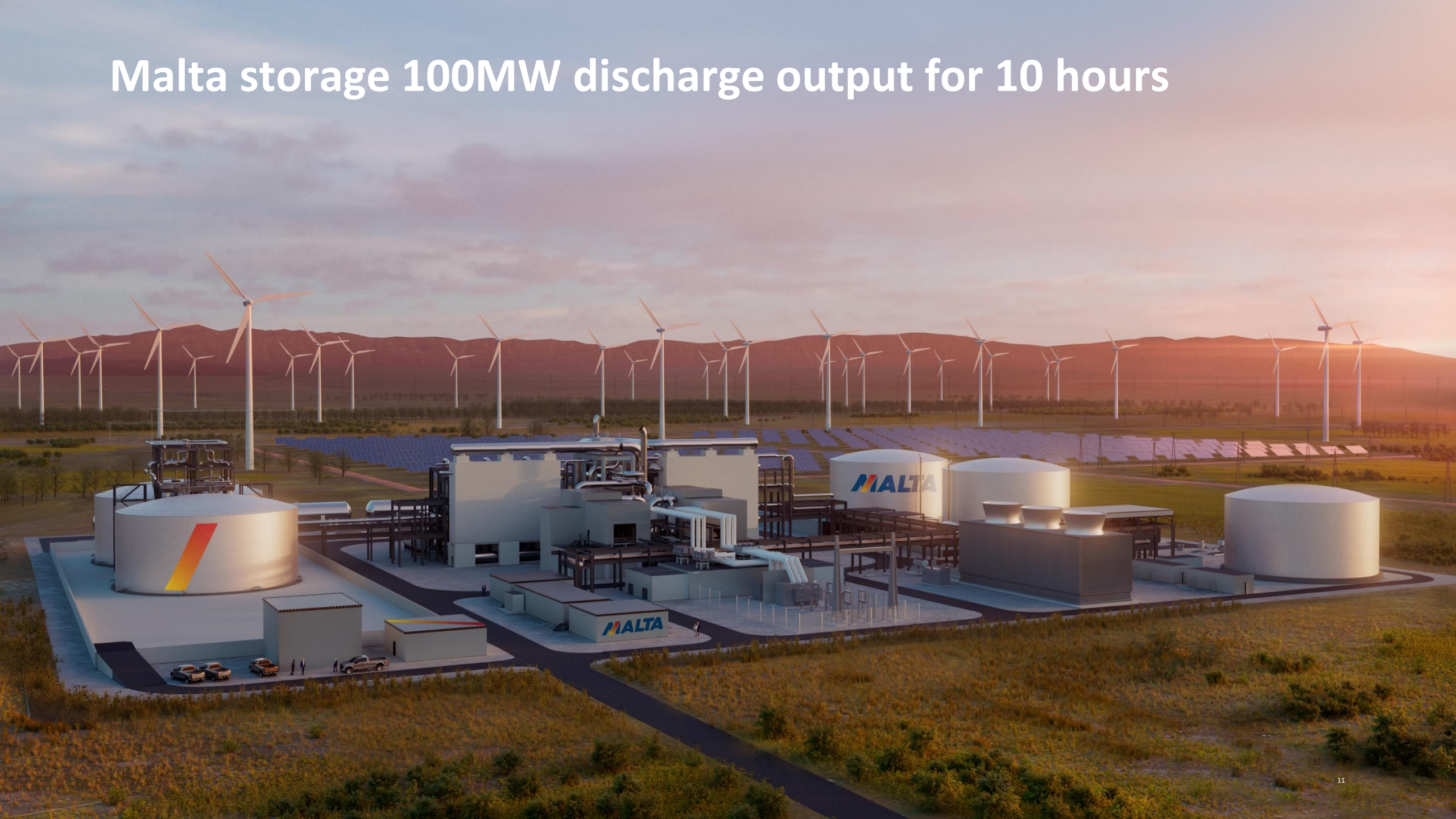


# Malta M100 3D View and Footprint





# Malta storage 100MW discharge output for 10 hours

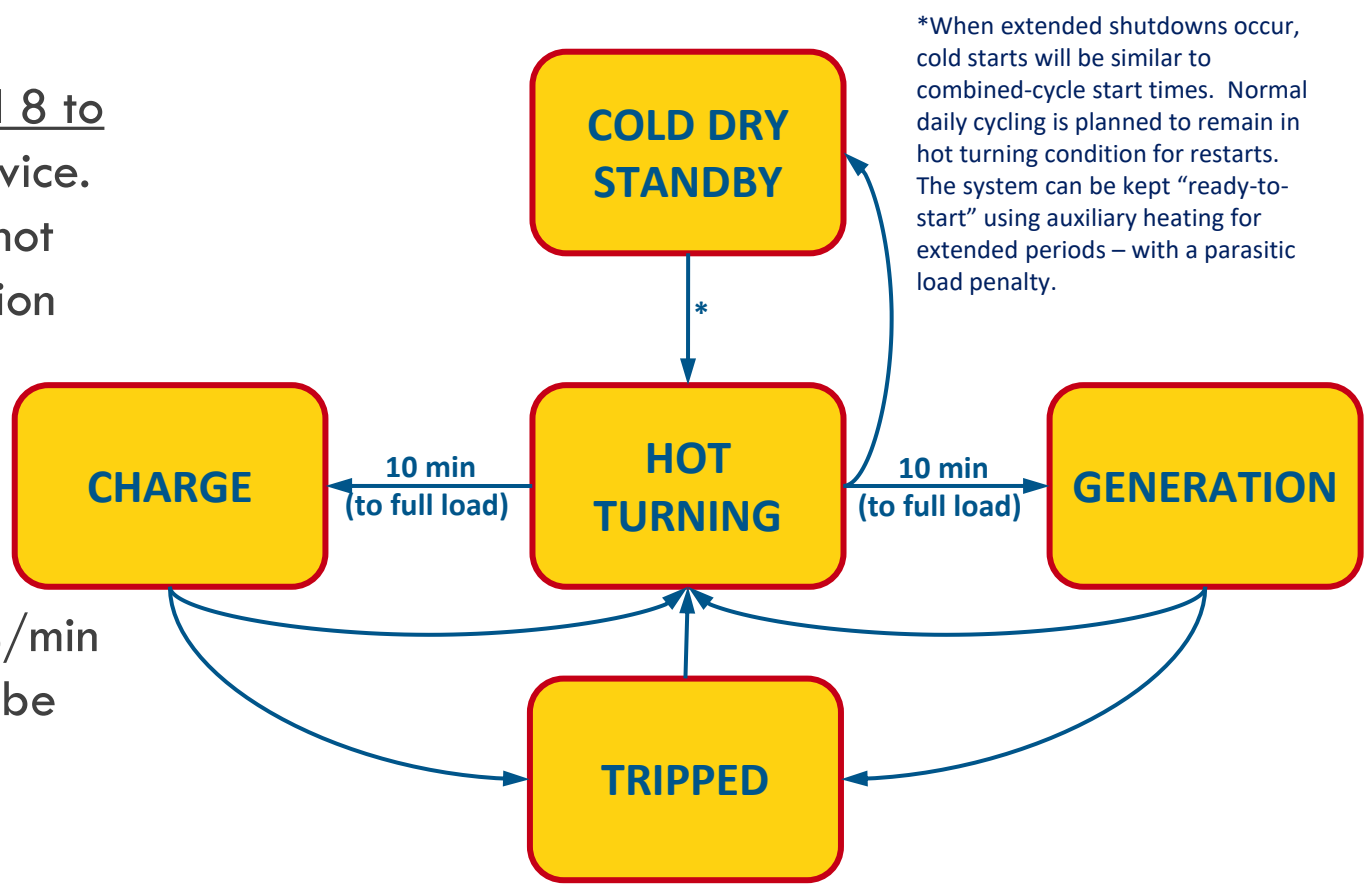


# Malta M100 Pumped Heat Electricity Storage System

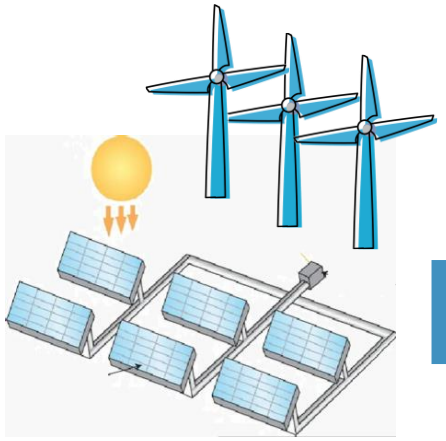
| | |
|---|---|
| **Rated discharge power** | **100 MWe** |
| **Rated charge power** | **200 MWe** |
| **Charge to discharge duration ratio** | **1:1** |
| **Discharge capacity** | **10-24+ hours** |
| **Electric storage capacity** | **1000-2400 MWhe** |
| **Footprint** | **5-7 hectares** |
| **Minimum load (charge and discharge)** | **27% of rated power** |
| **Overall net system efficiency (input-output)** | **55-60%** |
| **Heat loss per day with system fully charged** | **<1%** |
| **Asset lifespan** | **25+ years** |
| **Hot start up time** | **<10 minutes** |
| **Cold Start-up time** | **<2 hours** |

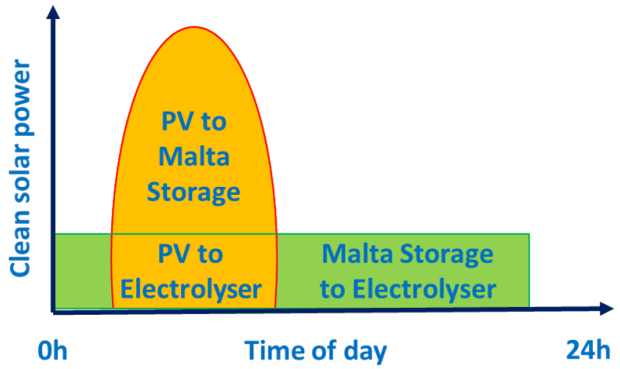
# Efficient Mode Switching – Modeled After Industry

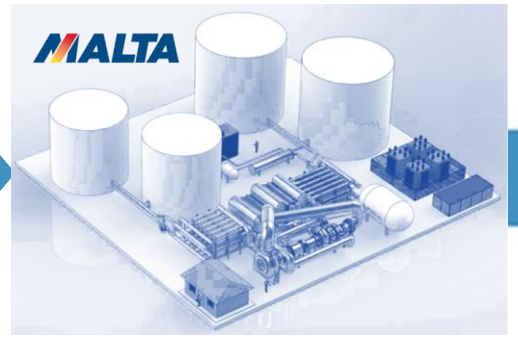
- The Malta design is modeled after typical simple-cycle gas turbine performance.
- Gas turbines start times range from around 8 to 15 minutes to minimum load in peaking service. Combined cycle plants are often slower if not dry-stacked, largely due to steam generation system limitations.
- Ramp rates range from 50%/min to 100%/min on gas turbines while Malta is targeting to be competitive in the 25%/min range.



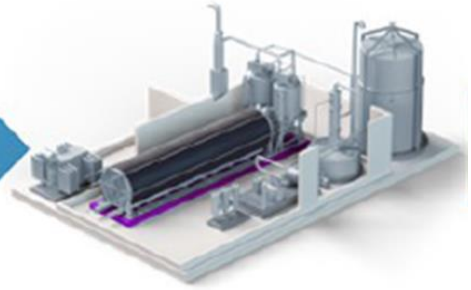
# Malta storage for 24/7 green hydrogen production

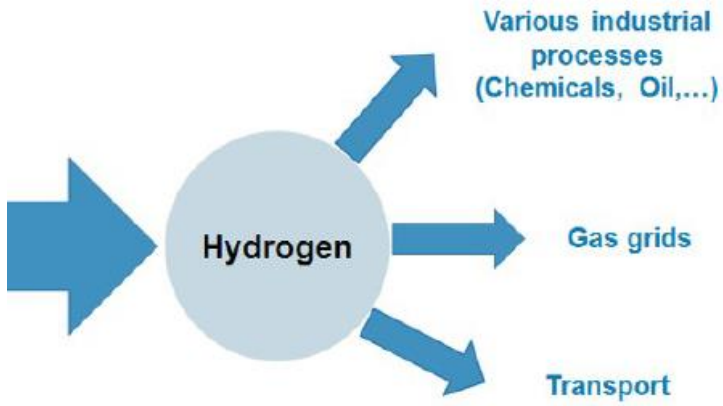





Water



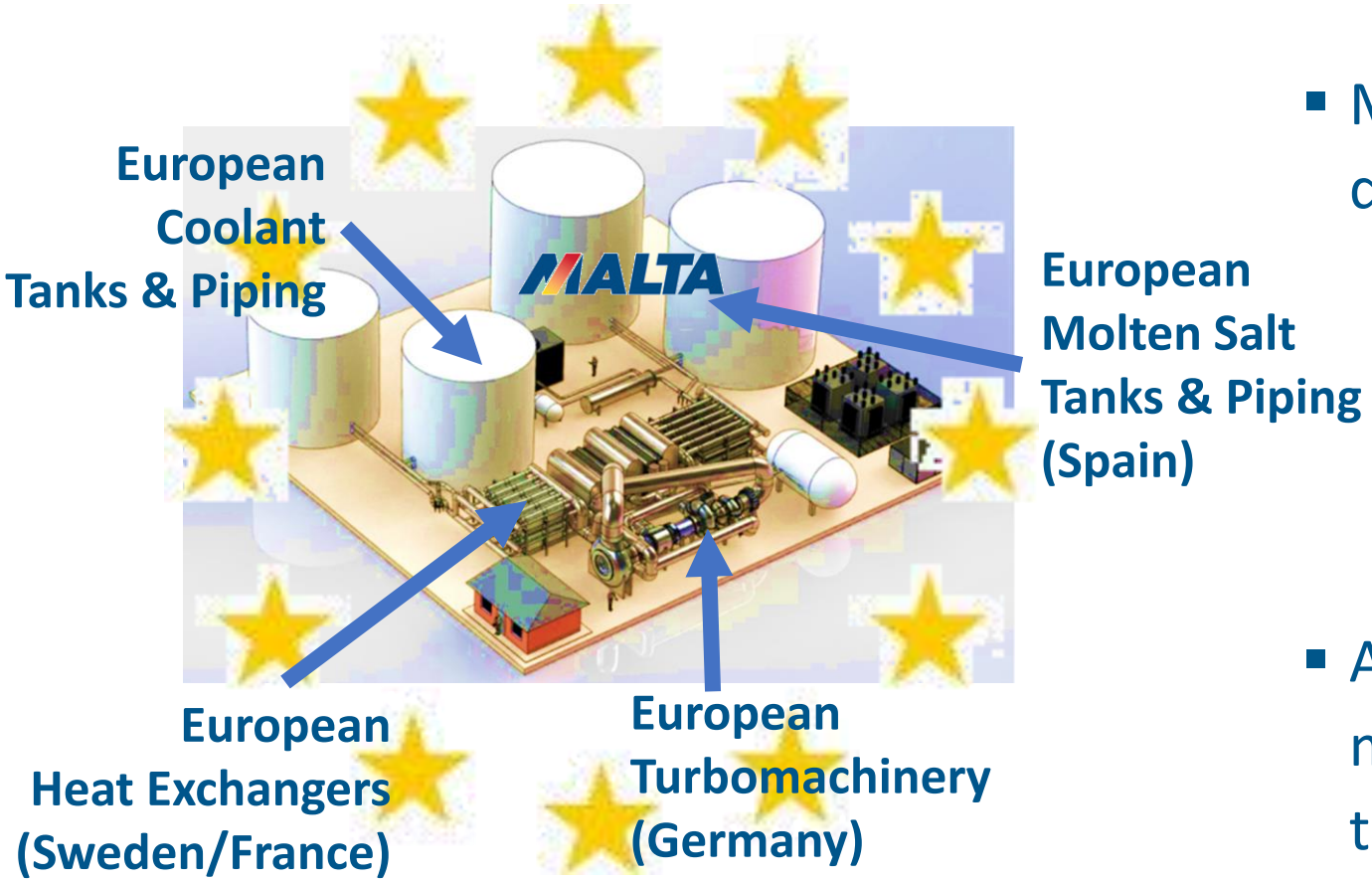



**Wind and PV supplies variable renewable power**

**Malta Storage supplies solar power 24/7 to electrolyser**

**Electrolyser capacity used 24/7 to generate solar hydrogen**

# Malta M100: European sourcing creates European jobs




- Malta M100 will create the following direct jobs:
  - Planning & Construction: 230 person years over 12 months
  - Operation: 25 person years per year over 30 operating years
- Additional jobs will be created for the manufacturing of the heat exchangers, turbo-machinery, and other key components

# Thank You

**Long-Duration**
8 - 24+ Hours

**Grid-Scale**
10 - 100 MW+

**Low-Cost**
<€100/kWh