Sistemes d'emmagatzematge pel model energètic renovable.

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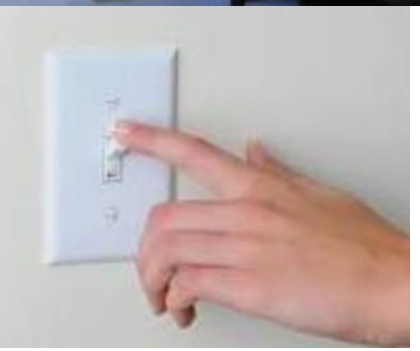
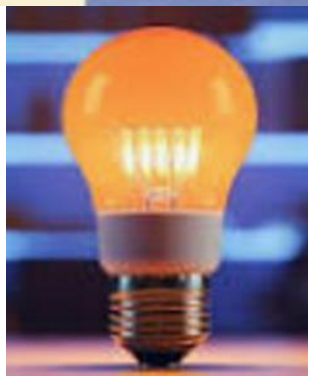
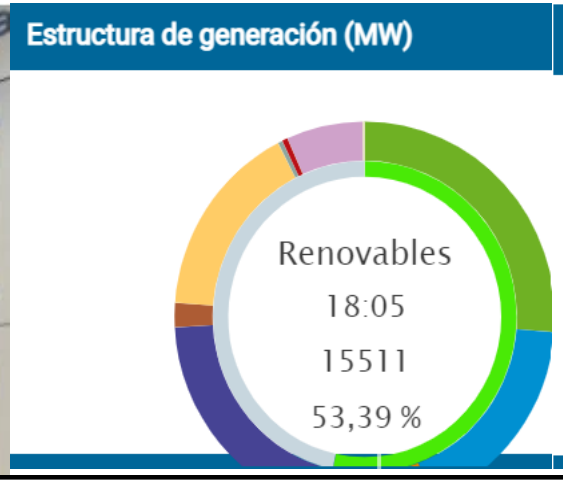
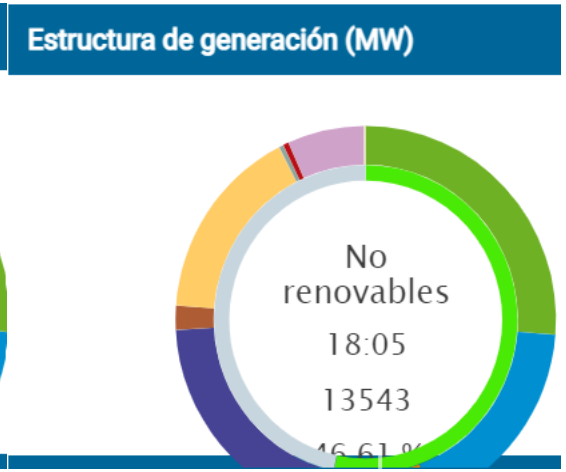
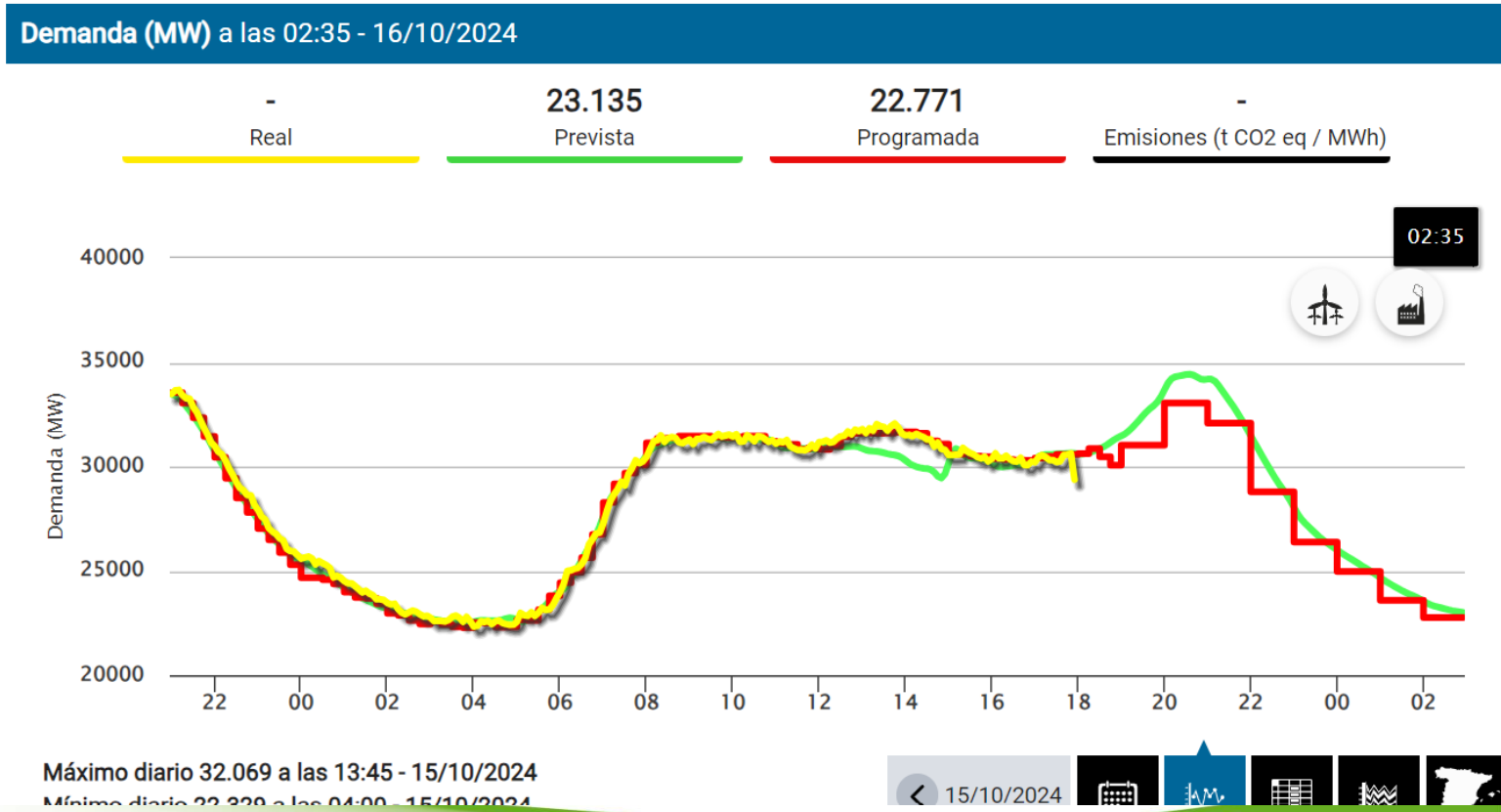


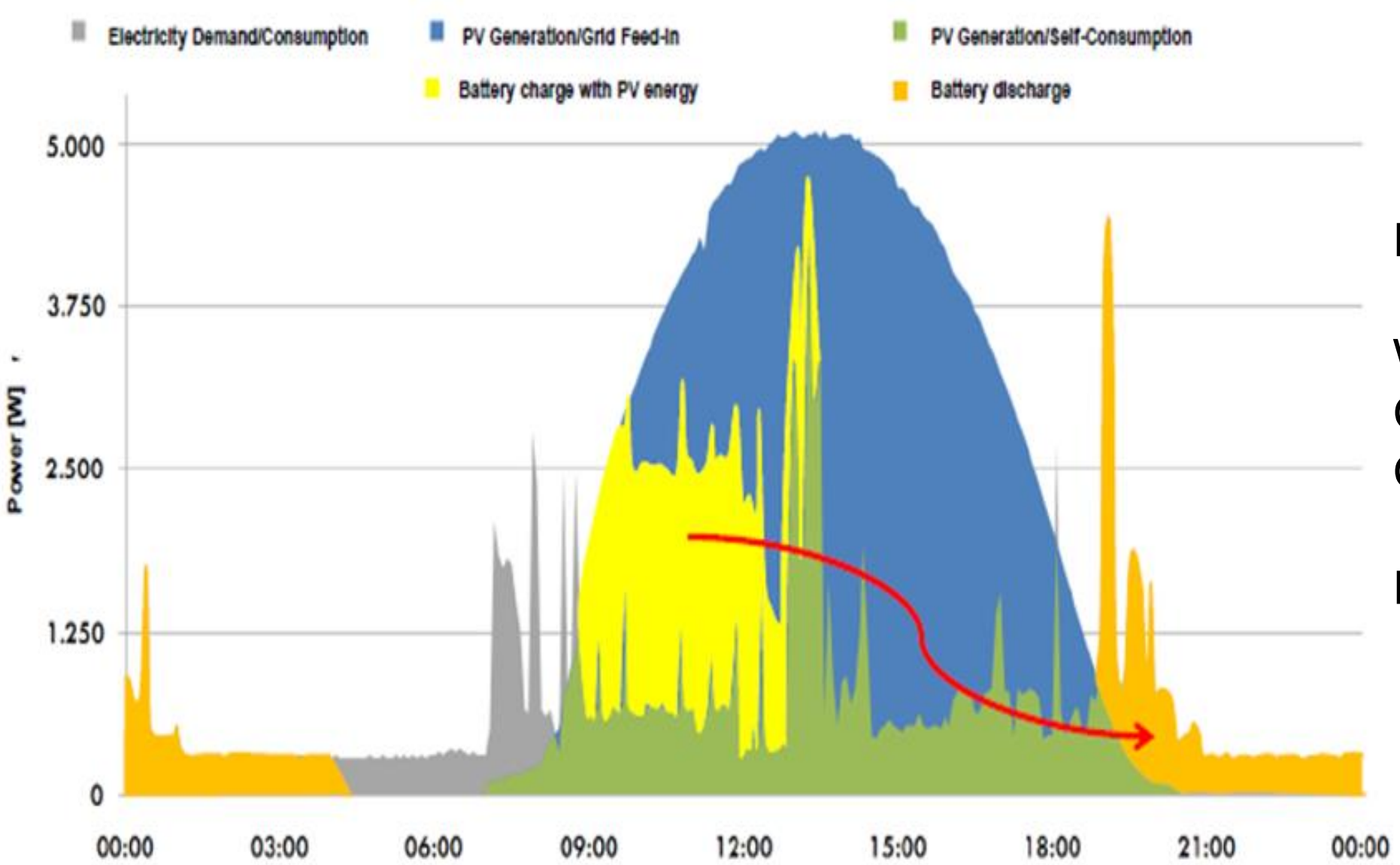


Immediatesa?
Estabilitat? (220V)







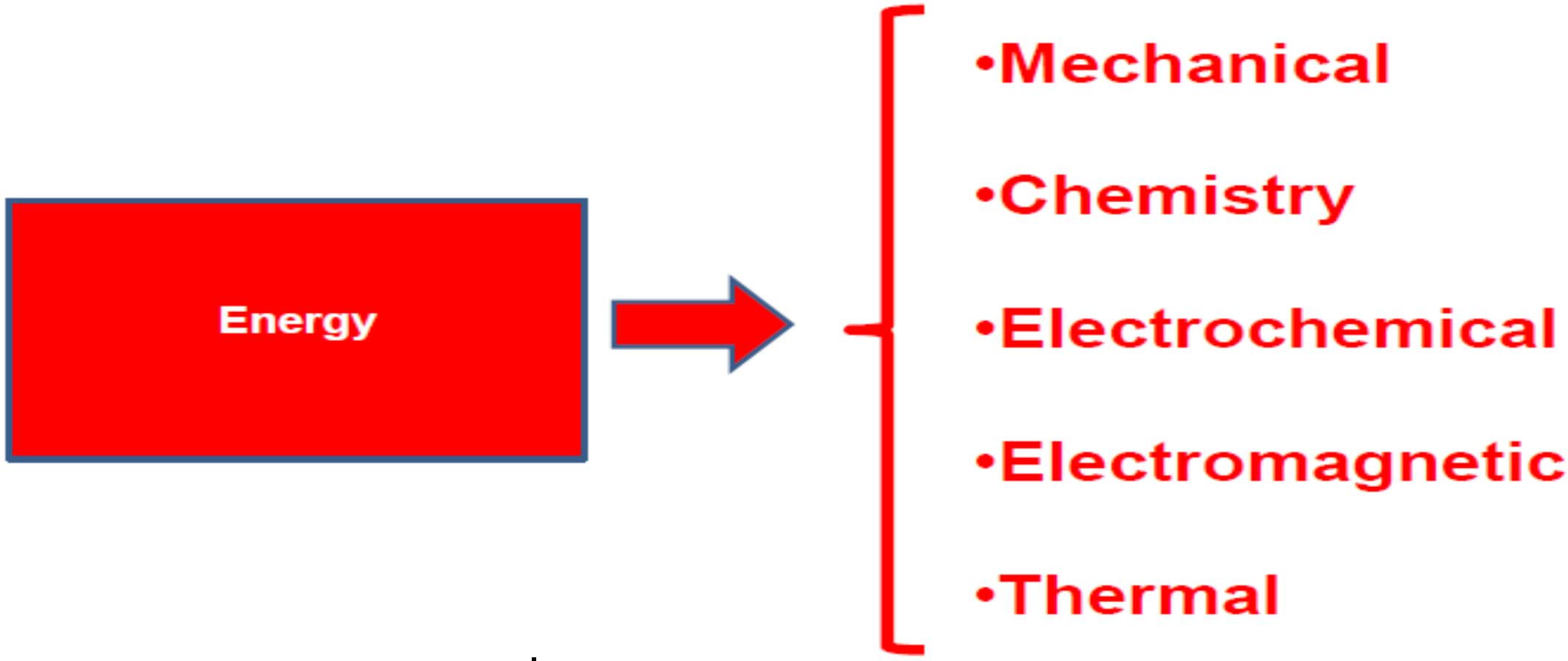


PV <2000 hours/year

WIND:
On shore ~ 3300h/y
Off shore ~ 4500h/y

Nuclear > 8000 h/y

Emmagatzematge !!!!

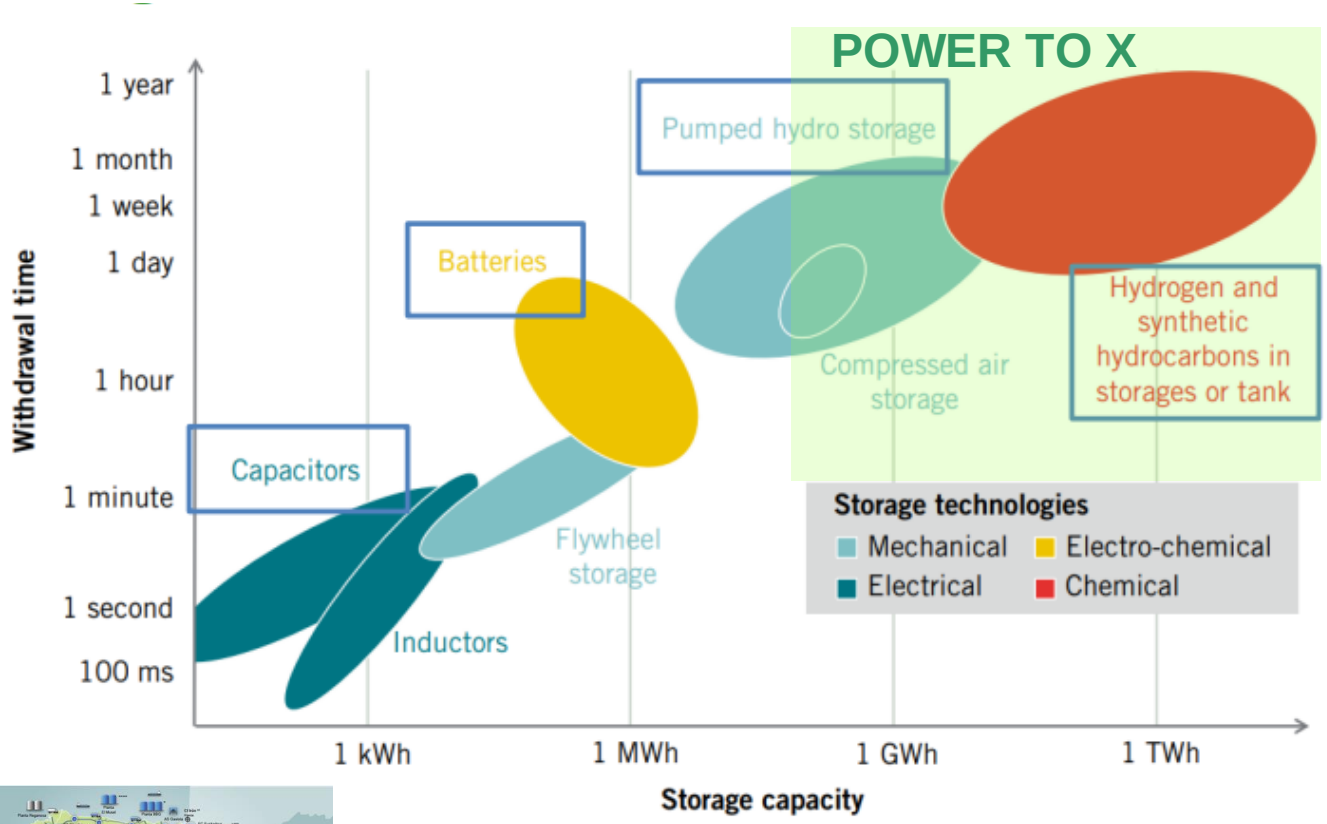


ELECTRICAL ENERGY —μ1→ losses ELECTROCHEMICAL ENERGY —μ2→ ELECTRICAL ENERGY

Round trip

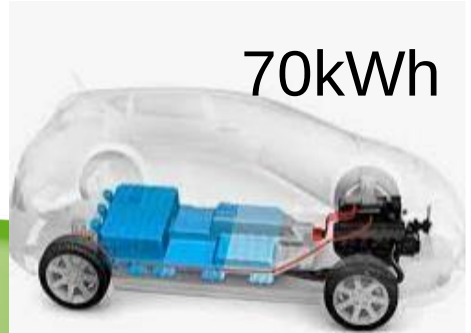
ENERGY DENSITY
ROUND TRIP EFFICIENCY
(Energy versus Power)

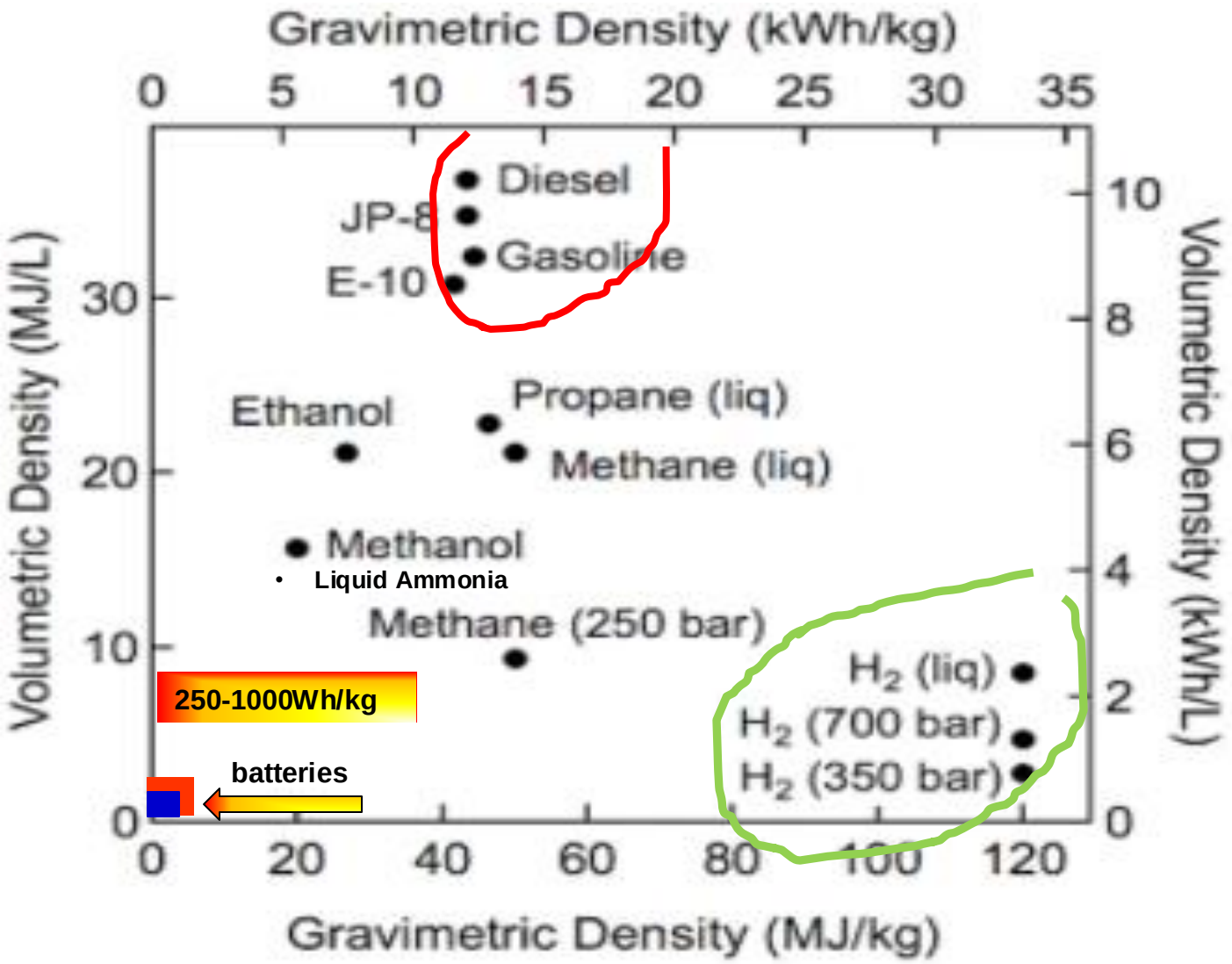
Tecnologies d'emmagatzematge



7Wh

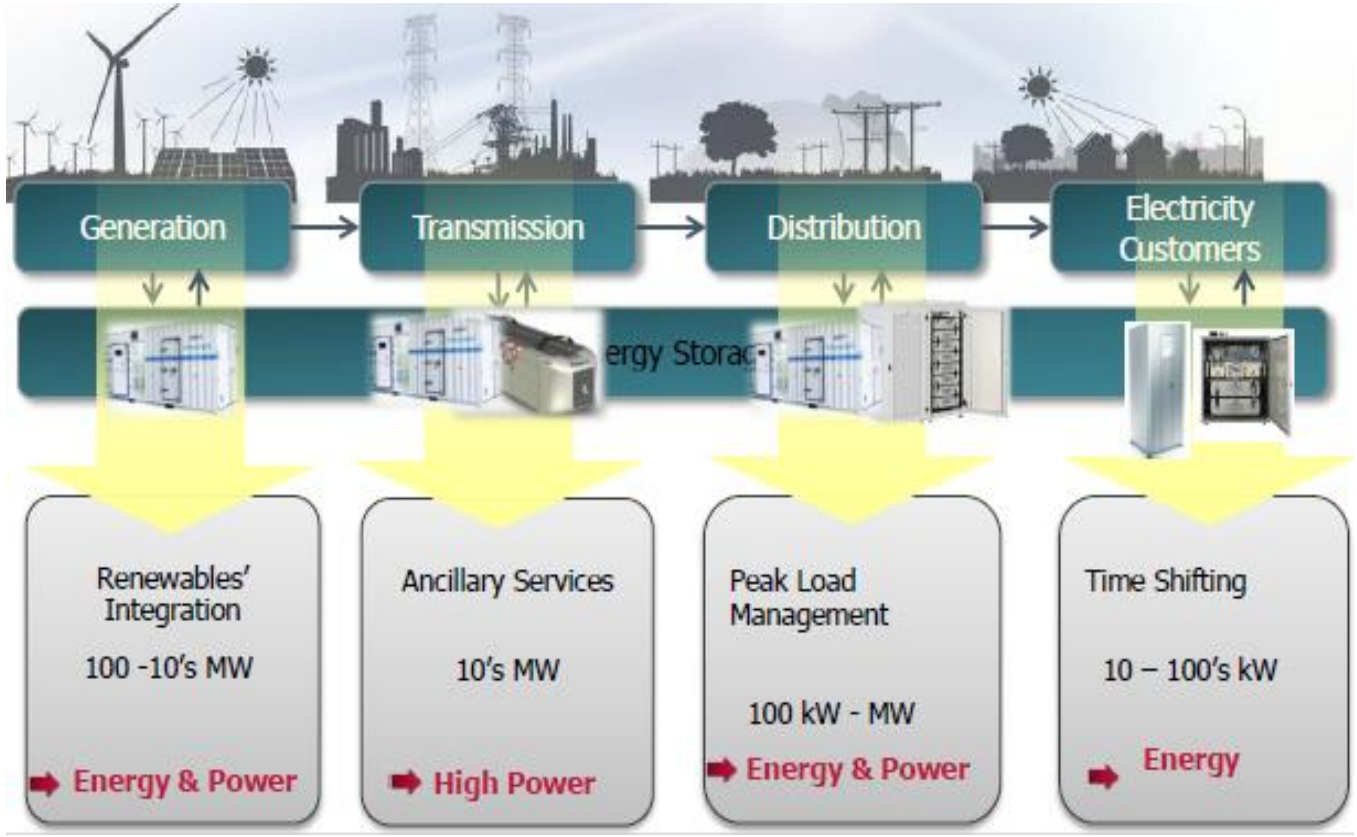
7-21kWh

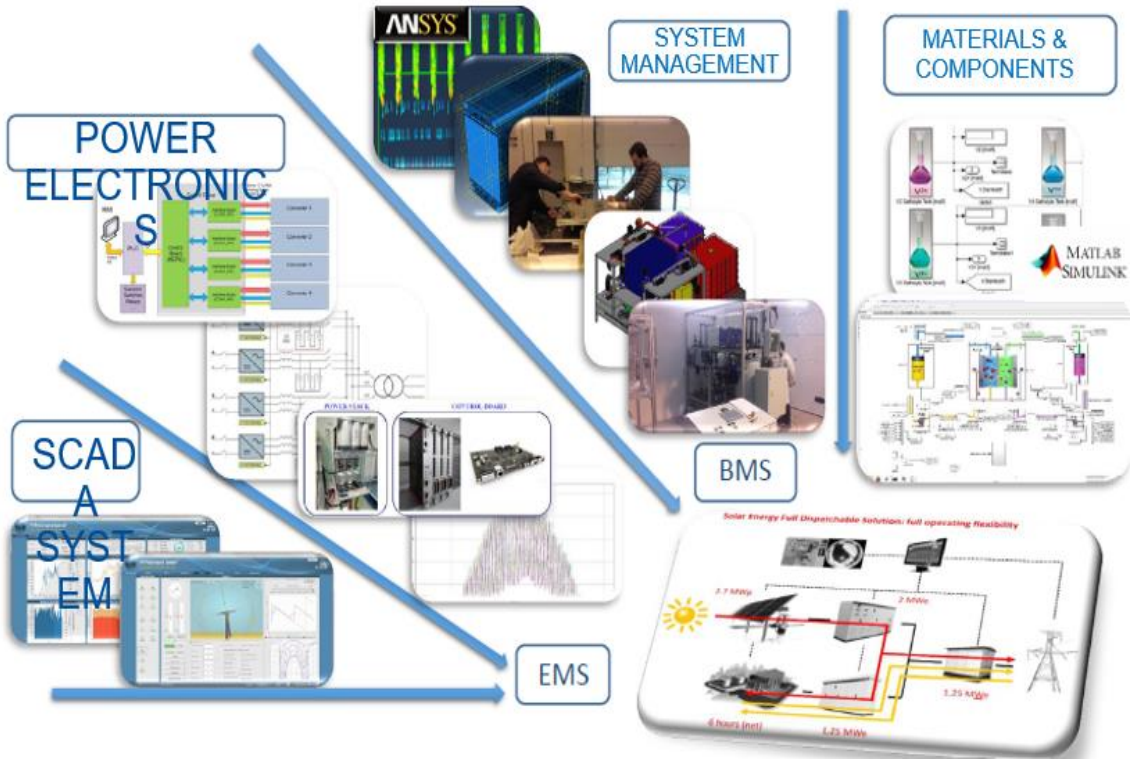




ENERGY DENSITY

IREC
Shaping Energy for a Sustainable Future





Diferents ubicacions diferents funcionalitat

Bateria+BMS+EMS

Energy communities
Industrial arees

Energy storage technologies : four main categories considering preferentially energy instead power

- **Mechanical Storage** :

  Pumped Hydro (>70%)

  Compressed Air (~50%) (~ 70%)

  (Fly Wheels)

- **Electrochemical + Electromagnetic Storage** :

  Batteries (over 65% round trip efficiency up to more 90%)

  (Super Capacitors, SMES)

- **Chemical Storage** : Power to Gas, Hydrogen, SNG, Synthetics fuels….

  Low round trip efficiency

- **Thermal Storage** :

  Sensible, Latent,

  Thermochemical

- **Mechanical Storage** :

  Pumped Hydro (>70%)

  Compressed Air (~50%) (~ 70%)

  (Fly Wheels)

PROJECTE
RIBA ROJA--LA FATARELLA
Potencia 3GW

Can this be done with electrochemical storage?

- 1872 MW output (21.5 GW total in U.S.)
- 15,000 MWh stored energy
- 2.5 x 1 mile, 842 acres
- 0.04 Wh/L energy density
- Elevated 400 ft above Lake Michigan

Energy storage will play a key role in enabling the development of a low-carbon electricity system.

In this way, it can ease the market introduction of renewables, accelerate the defossilitzation of the electricity grid.

Pumped Hydro Storage Systems (PHS) for large scale electricity storage represents almost 99 % of current worldwide storage capacity

.

https://www.idae.es/conozcanos/proyectos-de-excelencia/central-hidro-eolica-de-el-hierro-gorona-del-viento 700m
(using desalinated wáter)

APPROPRIATE IN PLACES WHERE THE OROGRAPHY PRESENTS APPROPRIATE ABRUPT DIFFERENCES IN HEIGHT

Compressed Air Energy Storage

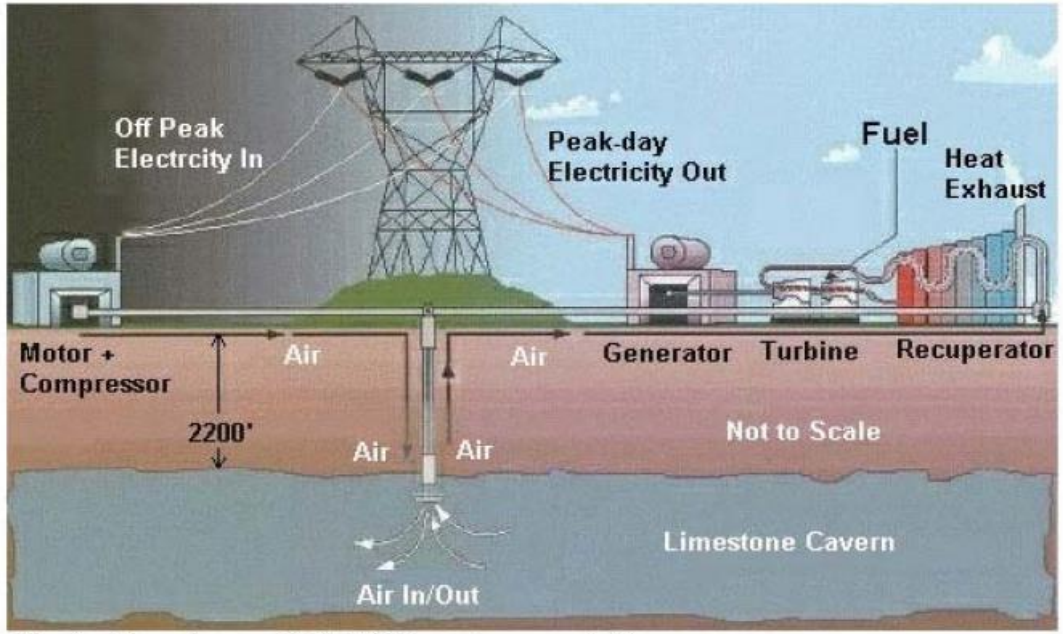
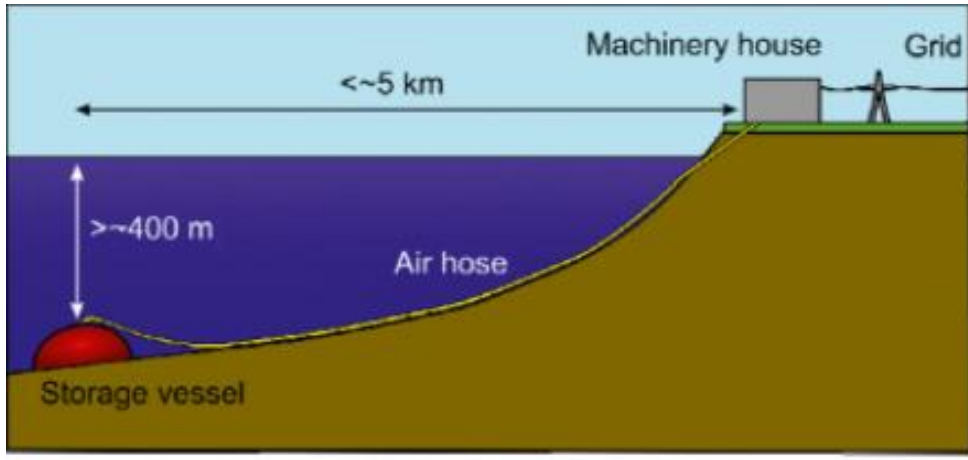
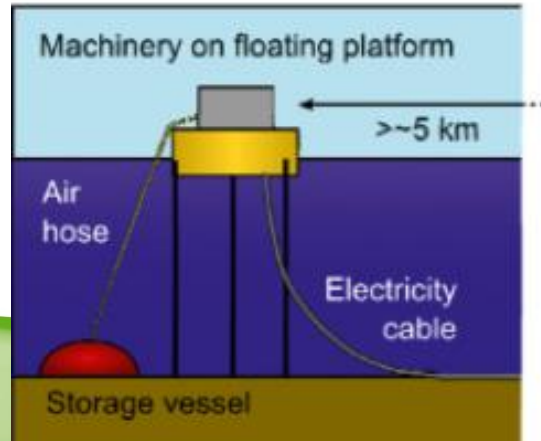


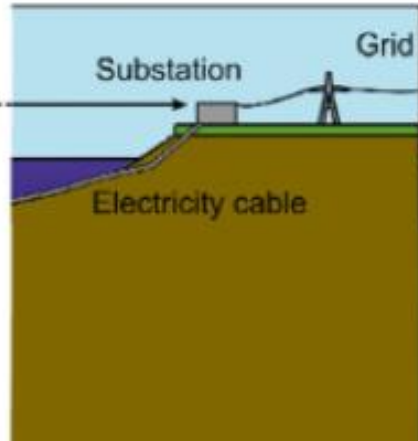
Photo Courtesy of CAES Development Company

IMPROVING EFFICIENCY from 50% to 70%
INCREASING ITS RELEVANCE AS
ENERGY STORAGE TECHNOLOGY

AIR or (CO2)







Underwater storage of pressurized air

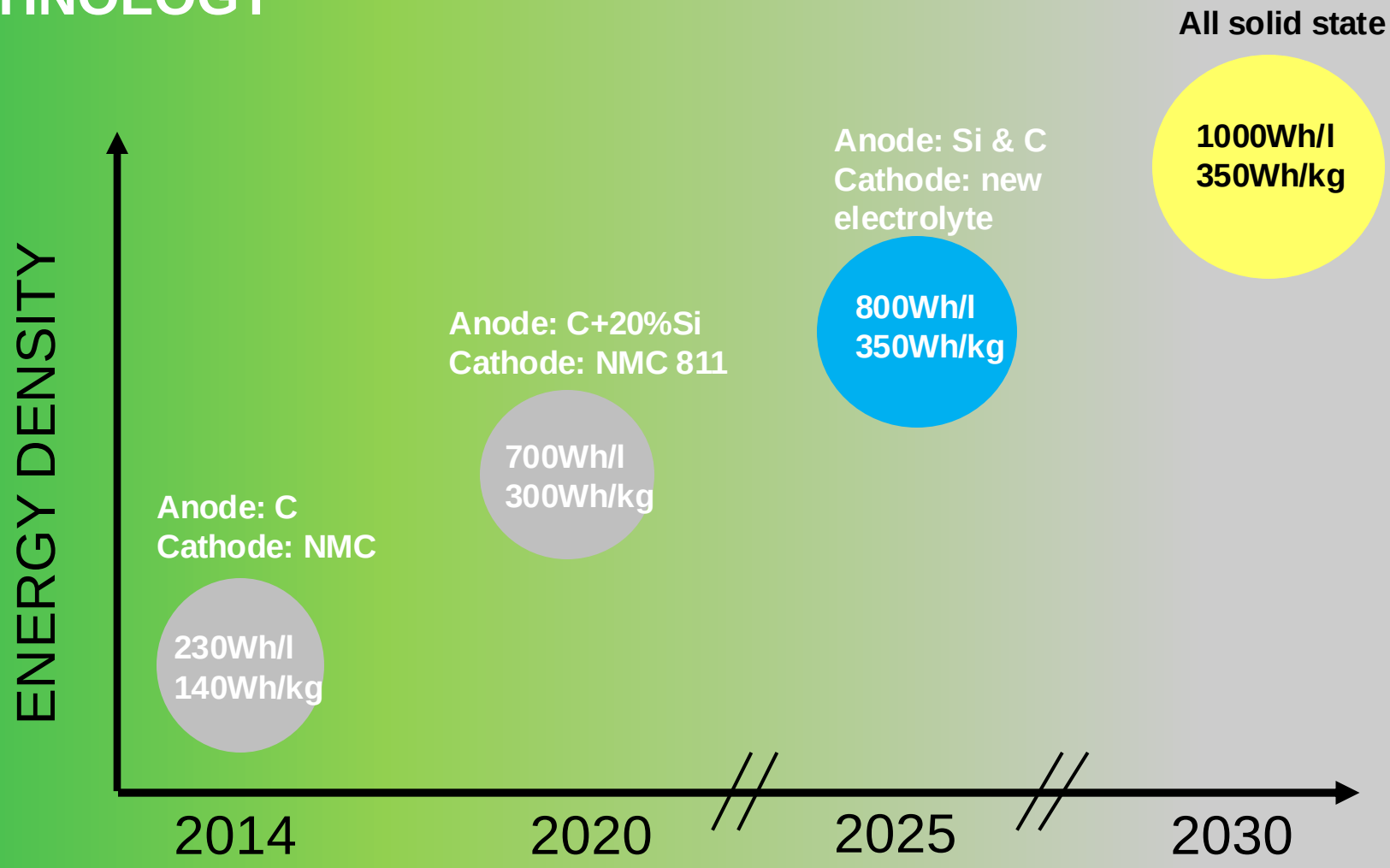
(1) it has the potential to achieve very low cost per unit of energy stored,
(2) it naturally tends to exhibit an isobaric (constant pressure) characteristic of pressure versus fill-level,
(3) in stark contrast to underground air storage, it is feasible in many locations to establish economically competitive compressed air stores at relatively small scales—measured in tens of megawatt-hours rather than gigawatt-hours.

- **Electrochemical + Electromagnetic Storage** :

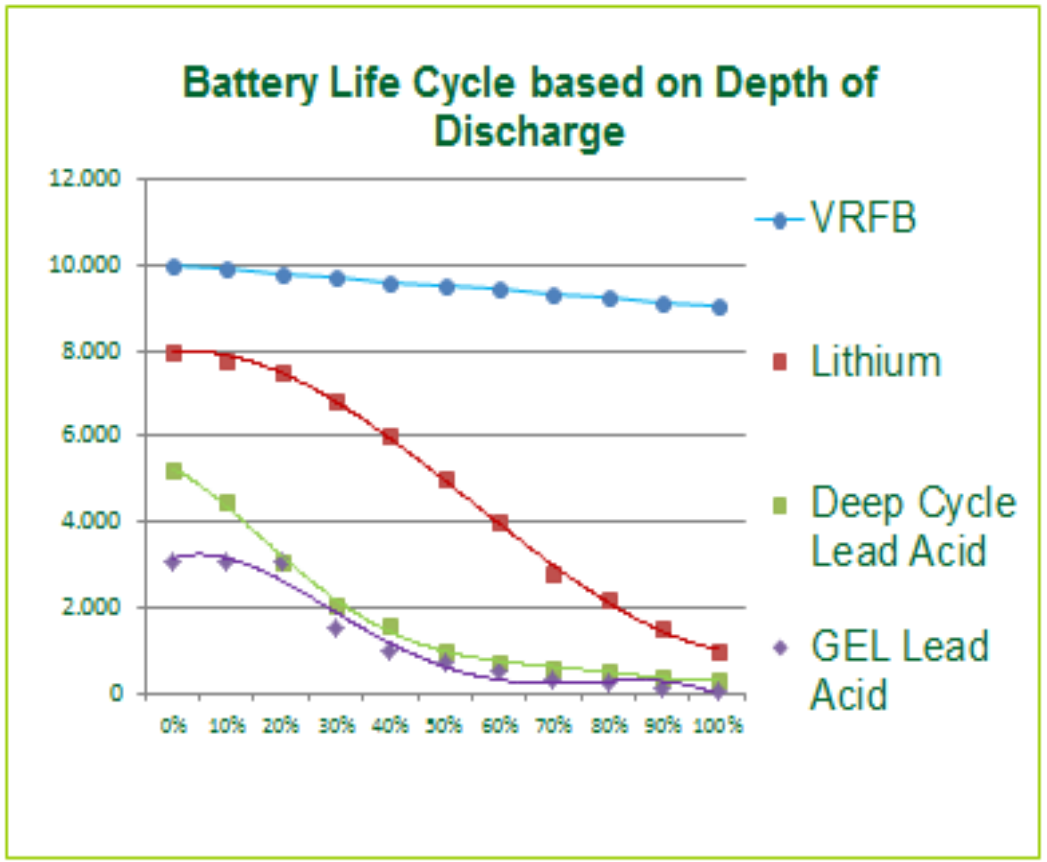
  Batteries (over 65% round trip efficiency up to more 90%)

  (Super Capacitors, SMES)

DEVELOPMENT OF LITHIUM ION BASED BATTERY TECHNOLOGY



LIFETIME: nombre de cicles DoD/SoC



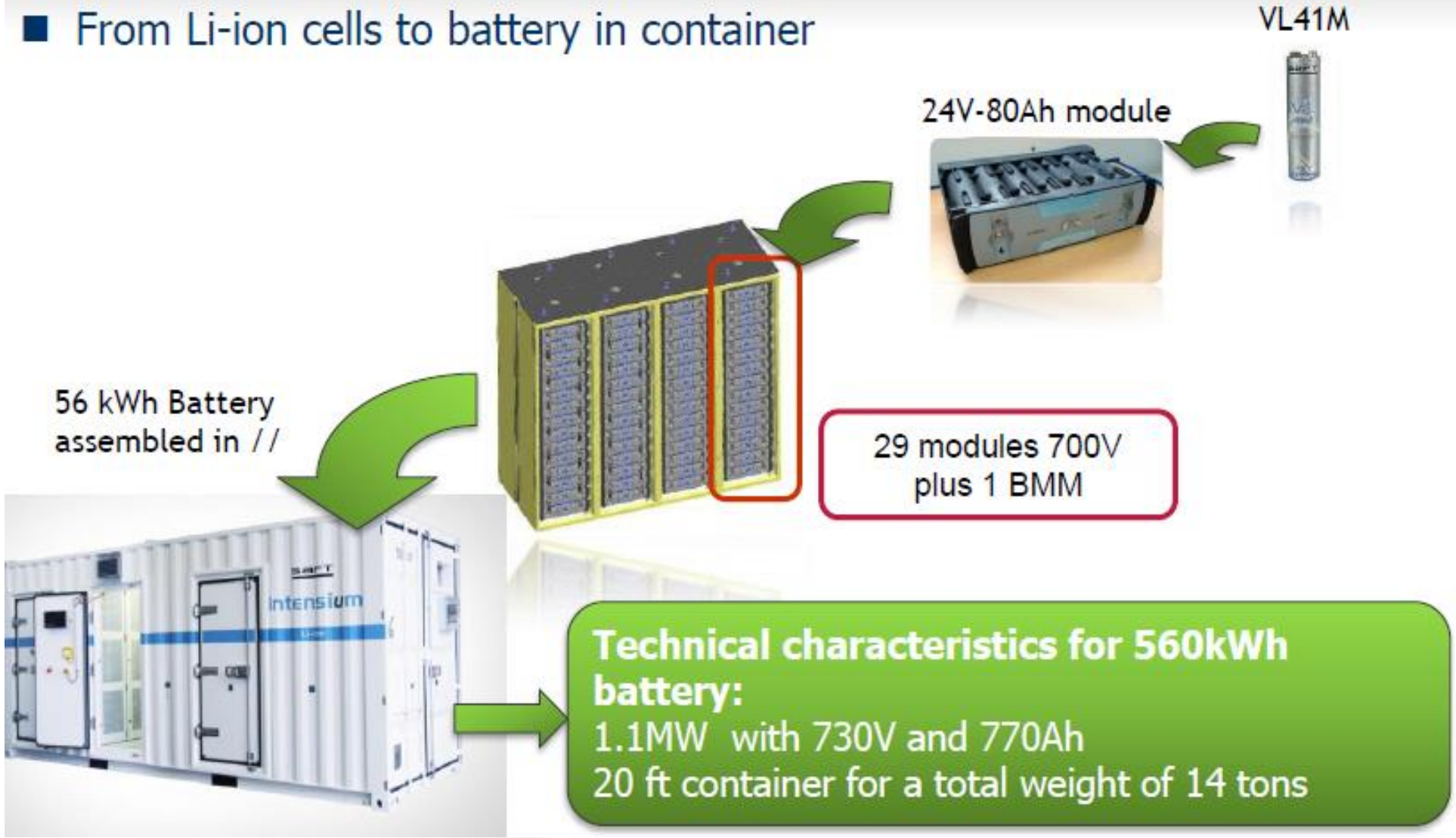
- **Low LCOE >20 year life**
  - Lowest cost over life in class
  - Modular from 5kW to 5MW to match loads, scale duration from hours to days
  - Stack life > 10,000 cycles, electrolyte indefinite life, re-usable & recyclable
- **Performance**
  - Deep discharge cycles, uses 100% of available capacity
  - Charge retention, almost indefinite in standby mode
  - 75-85% round trip efficiency
  - Partial cycles have 0 effect

Costos: 175€/kWh BMS i EMS

Pes: 4quilos 1kWh 1MWH ~ 4tones

The challenge of 1 Megawatt in 20 foot container

- From Li-ion cells to battery in container



Source: SAFT

20ft Container frame

20ft heavy duty container frame, fully adapted to various climate and location (insulation -painting).
Quickly deployable without heavy civil work.

Distribution cabinet for power and comm

One 19in cabinet dedicated to control and auxiliary devices.
Main power, supply and communication terminals

Fire suppression system

Peoples and system security fully guarantee by embedded fire suppression system

Multi corridor layout

Battery storage system on 19in cabinet locate along 4 corridors.
All data and power connections on front face.
Easily access to hand-liftable battery modules (20kg)

Bardzour PV+ Battery project (La Réunion Island)

Akuo Energy is one of the first IPPs to develop and operate a PV+Battery plant in a commercial manner

9MWp PV Plant with ESS to meet EDF SEI requirements

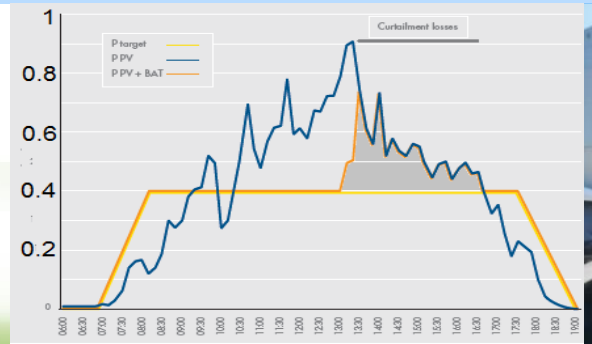
- Shaping at 40% of maximum power
- Primary reserve : 10% of maximum power / 15 minutes
- Voltage control with reactive power

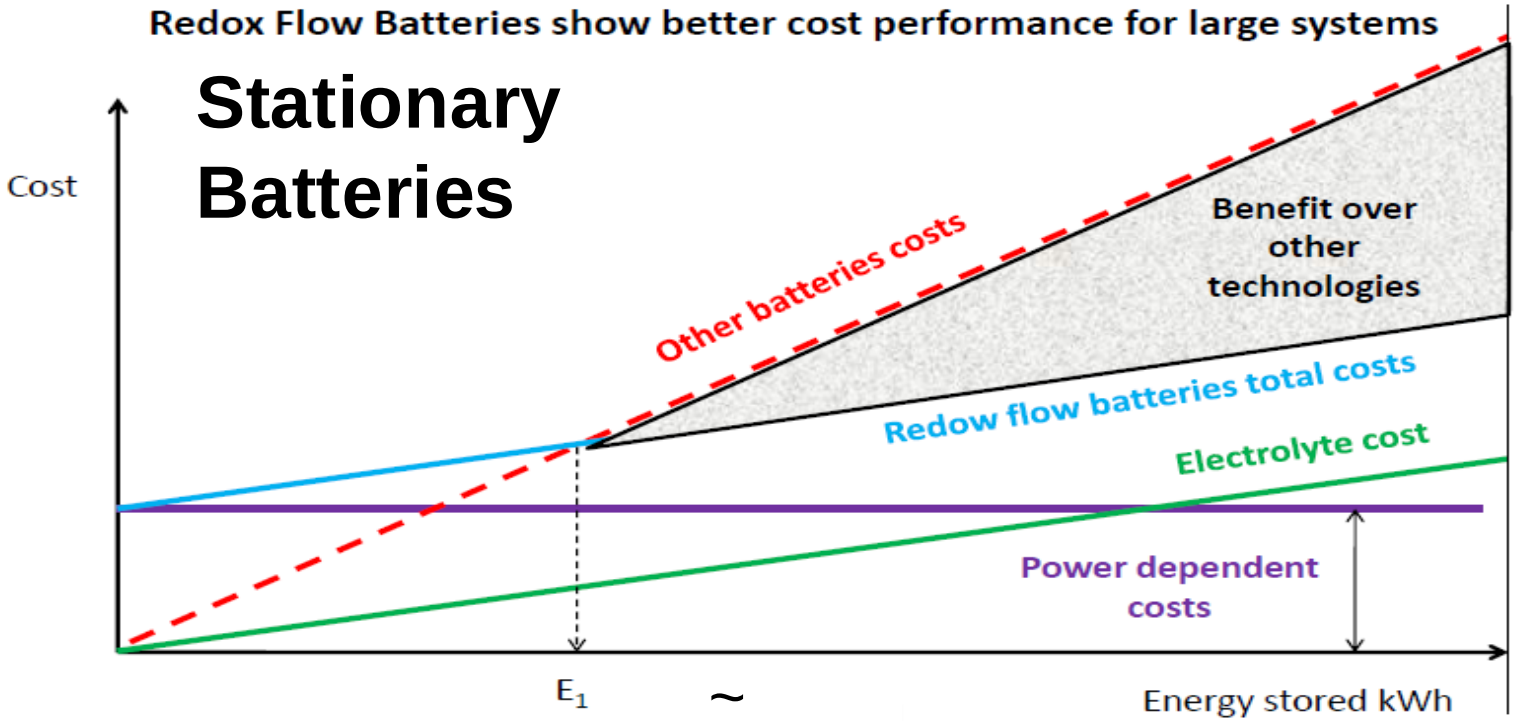
Optimum sizing is 9MWh/4.5MW Li-Ion system

- 2 systems in 20 years

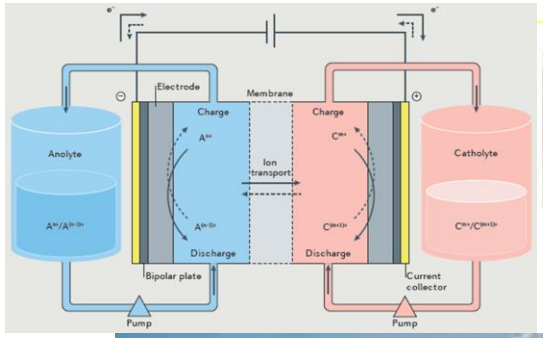
Energy capacity	Losses	Average DOD	Lifetime
9 MWh	11.3%	69.8%	>12 years
14 MWh	3.5%	56.3%	>17 years
21 MWh	0.7%	44.9%	>20 years

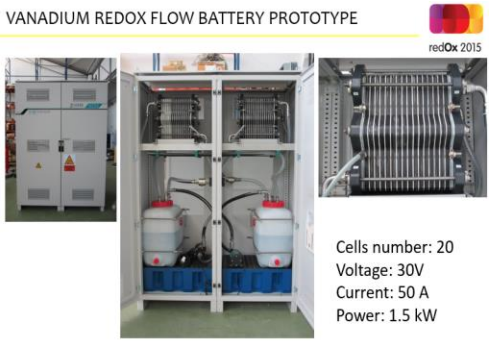
DoD / SoC

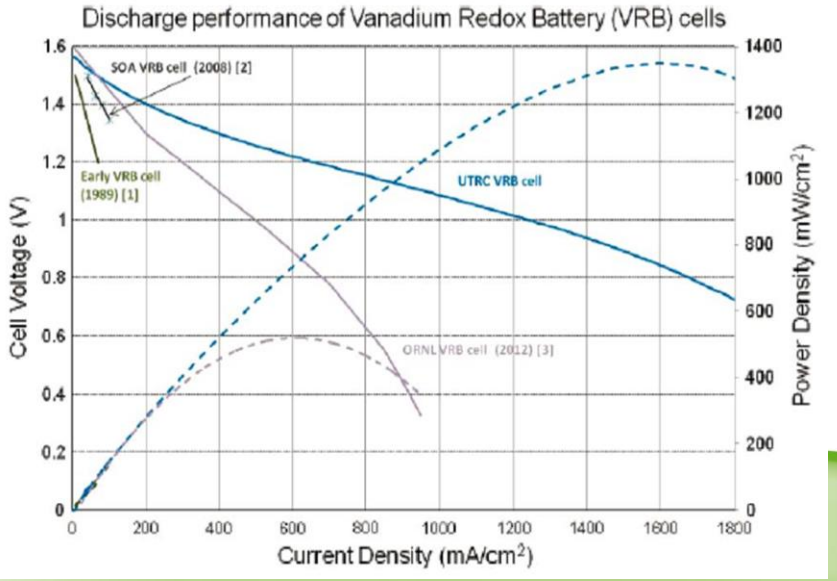




10KWh







Redox-flow battery (RFB) is a type of rechargeable battery that stores electrical energy in two soluble redox couples

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Catalonia Institute for Energy Research

- **Chemical Storage** : Power to Gas, Hydrogen, SNG, Synthetics fuels….

  Low round trip efficiency

EMMAGATZEMATGE ENERGIA ELECTRICA EN ENERGIA QUIMICA

- HIDROGEN.
- METANOL.
- AMONIAC.
- SINTENTICS (NEUTRES I BIOGENICS).
- BIOMETÀ,

……

EFICIENCIA DEL “ROUND TRIP”: **BAIXA**
AVANTATGE: **TRANSPORTABILITAT/MOBILITAT**.

GREEN HYDROGEN + GREEN OR NEUTRAL CARBONS for producing SUSTAINABLE CARBON CHEMISTRY

+

Green Carbon's biogenic origin

DAC direct air carbon capture

DOC direct ocean carbon capture

Renewable fuels and chemicals

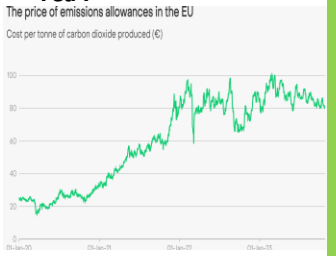
Renewable-driven circular economy

challenges

H2O → Green H2 2 to 7€/ Kg

Green or Neutral CO2 Capture cost: From 20 € to more than 300 € by tonne

CO2 emission Tax



Green H2 + CO → Syngas → F-T → Sustainable Synthetic Fuels (> 5€/L ??)

Syngas → fermenters → alcohol

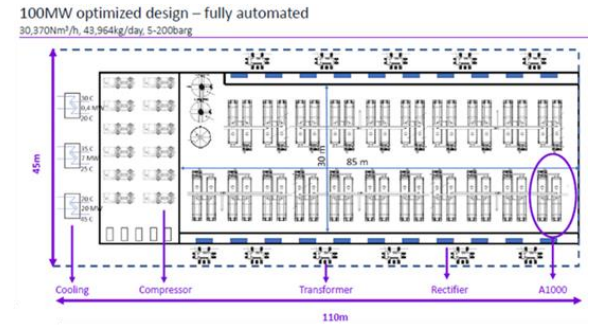
Green or Neutral CO2 → alcohol

Green or Neutral CO2 → C2-C3 → plastic

+H2 → Sabatier Reaction → CH4

Green or Neutral CO2 → formic

Nitrates, N2 → NH3 → fertilizers



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$CO_2 + H_2O$

$CO + H_2$

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Thank you.

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CERES
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