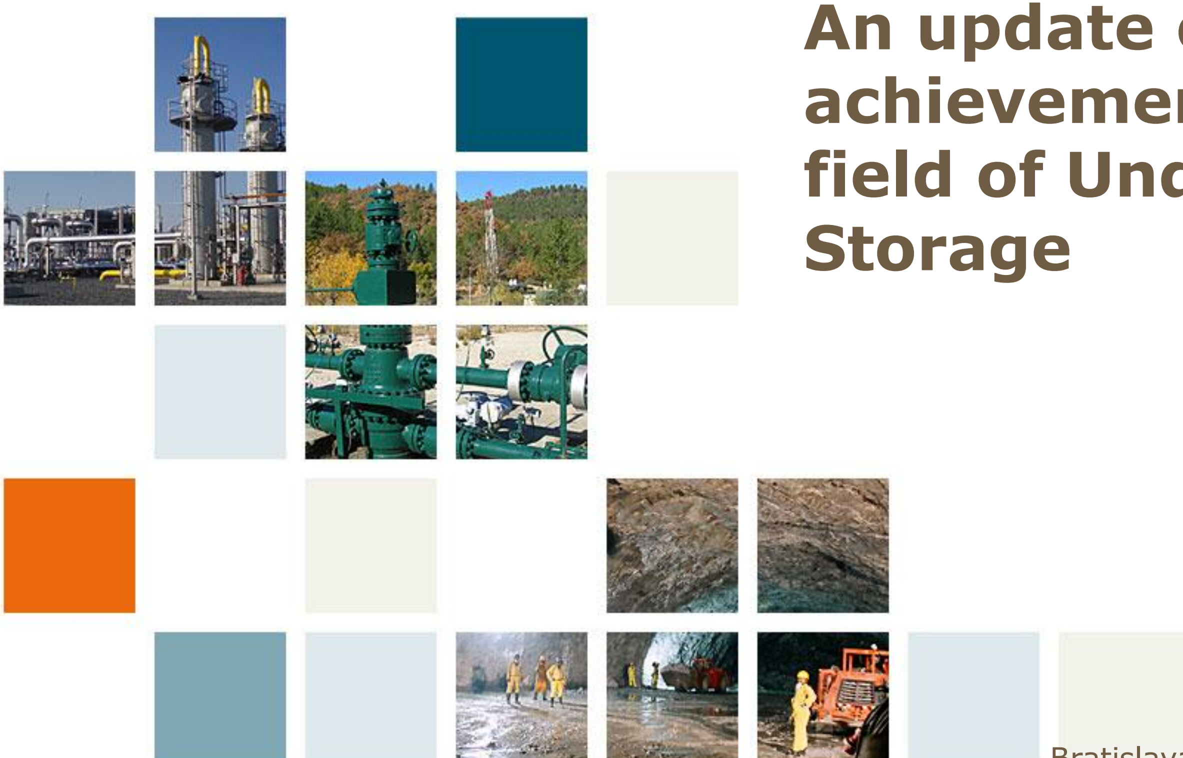
The international key player in underground storage

An update of GK recent achievements in the field of Underground Storage



Bratislava. IGU WOC2 Meeting. Oct. 2012

GEOSTOCK Group

geostock

- **Shareholders:** TOTAL 50% ENTREPOSE CONTRACTING 50%

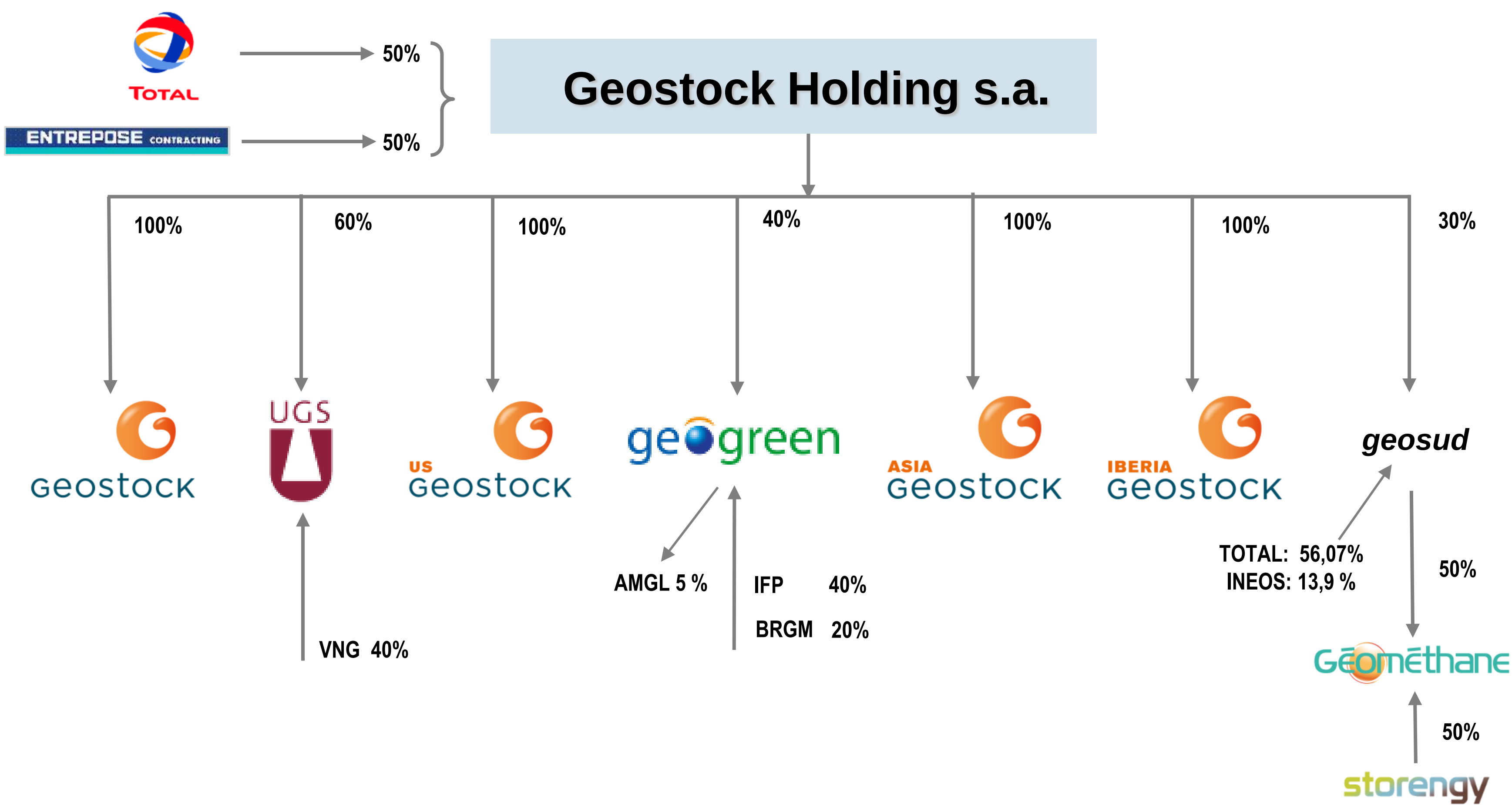
- **Activities:**
  - Consultancy and Engineering
  - Construction
  - Operation and Maintenance

for Underground Storages of :

- Natural Gas
- Liquid hydrocarbons
- Liquefied hydrocarbons

- **Technologies:**
  - Reservoir storage (aquifer and depleted oil and gas fields)
  - Salt caverns
  - Hard rock caverns

GEOSTOCK Group structure

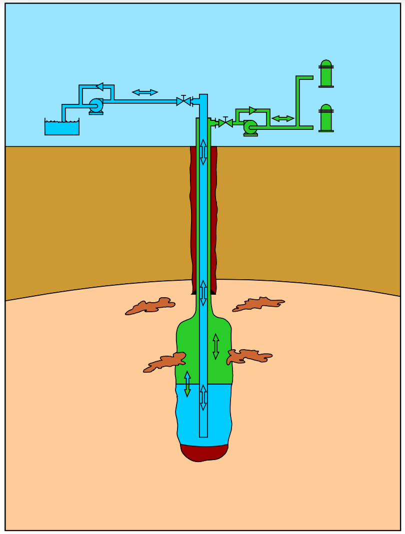


Main Underground Storage Techniques

GEOSTOCK

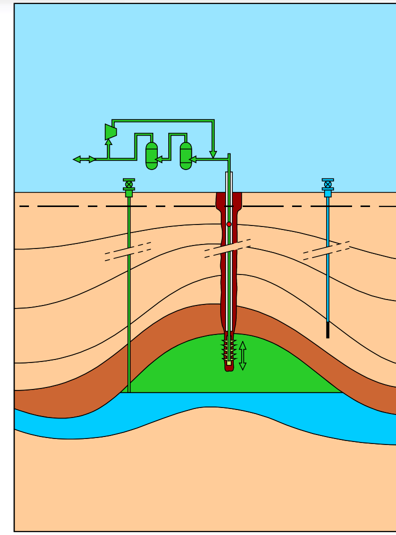
LEACHED SALT CAVERNS

- Natural Gas
- LPG
- Crude oil & distilates
- Air
- Hydrogen



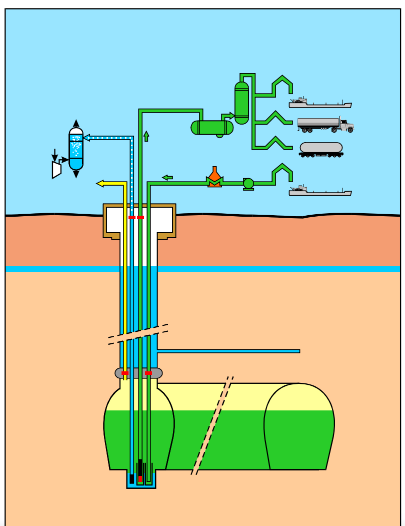
AQUIFERS DEPLETED FIELDS

- Natural Gas
- CO2



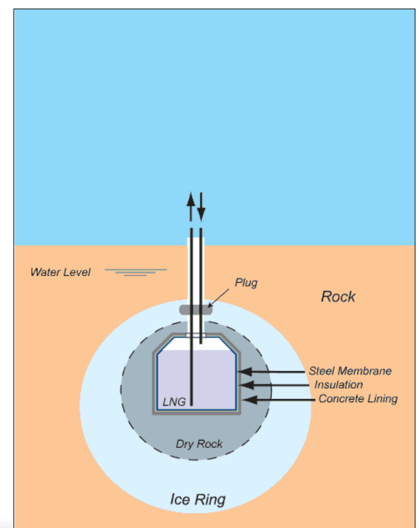
MINED ROCK CAVERNS (UNLINED) DISUSED MINES

- LPG
- Crude oil & distilates

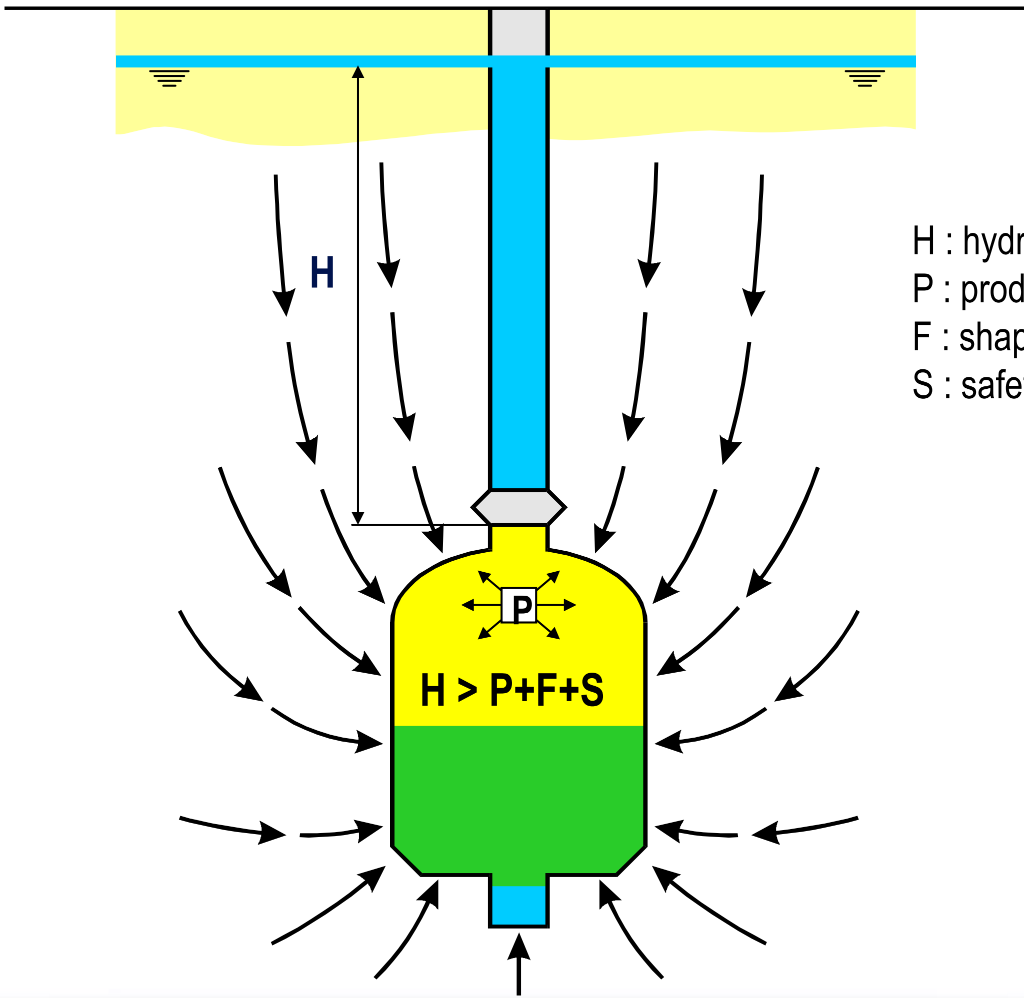


(CRYOGENIC) LINED ROCK CAVERNS

- Compressed Natural Gas (CNG)
- LNG (cryogenic)

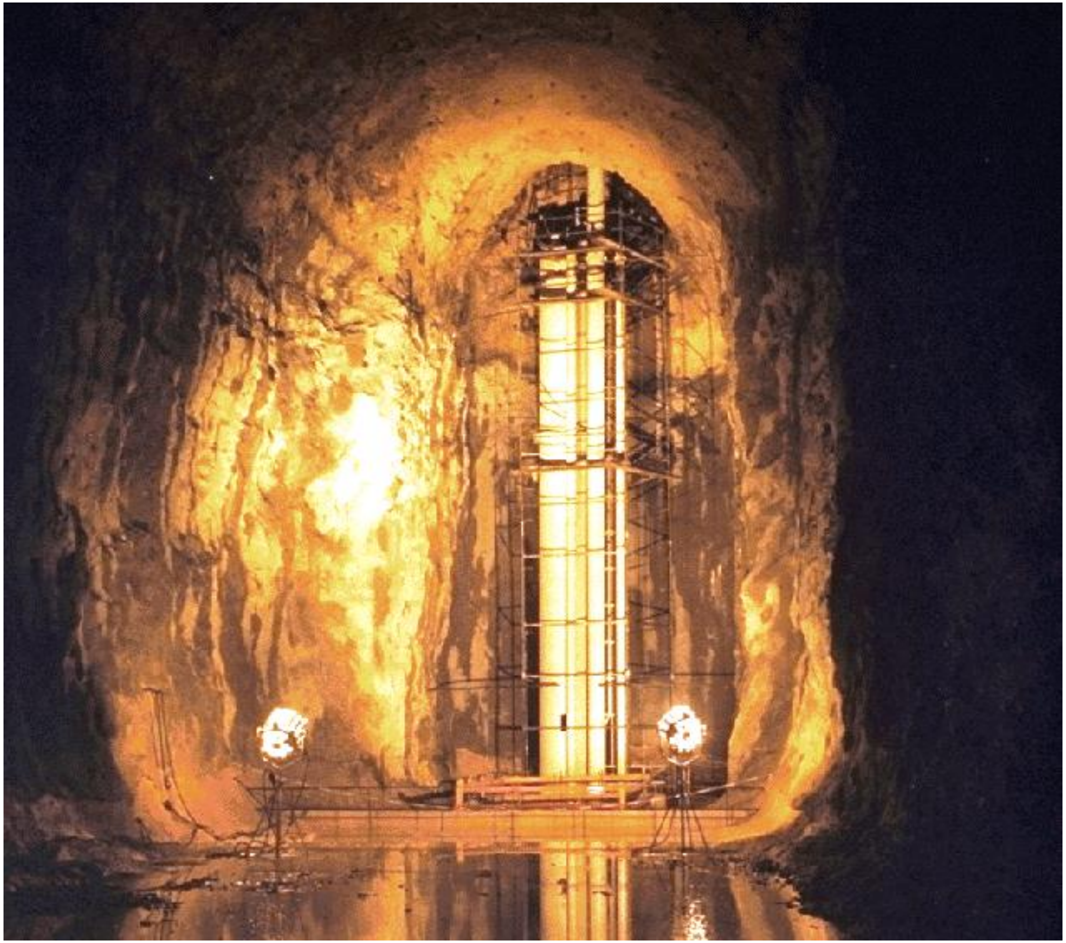


Mined caverns: tightness criteria



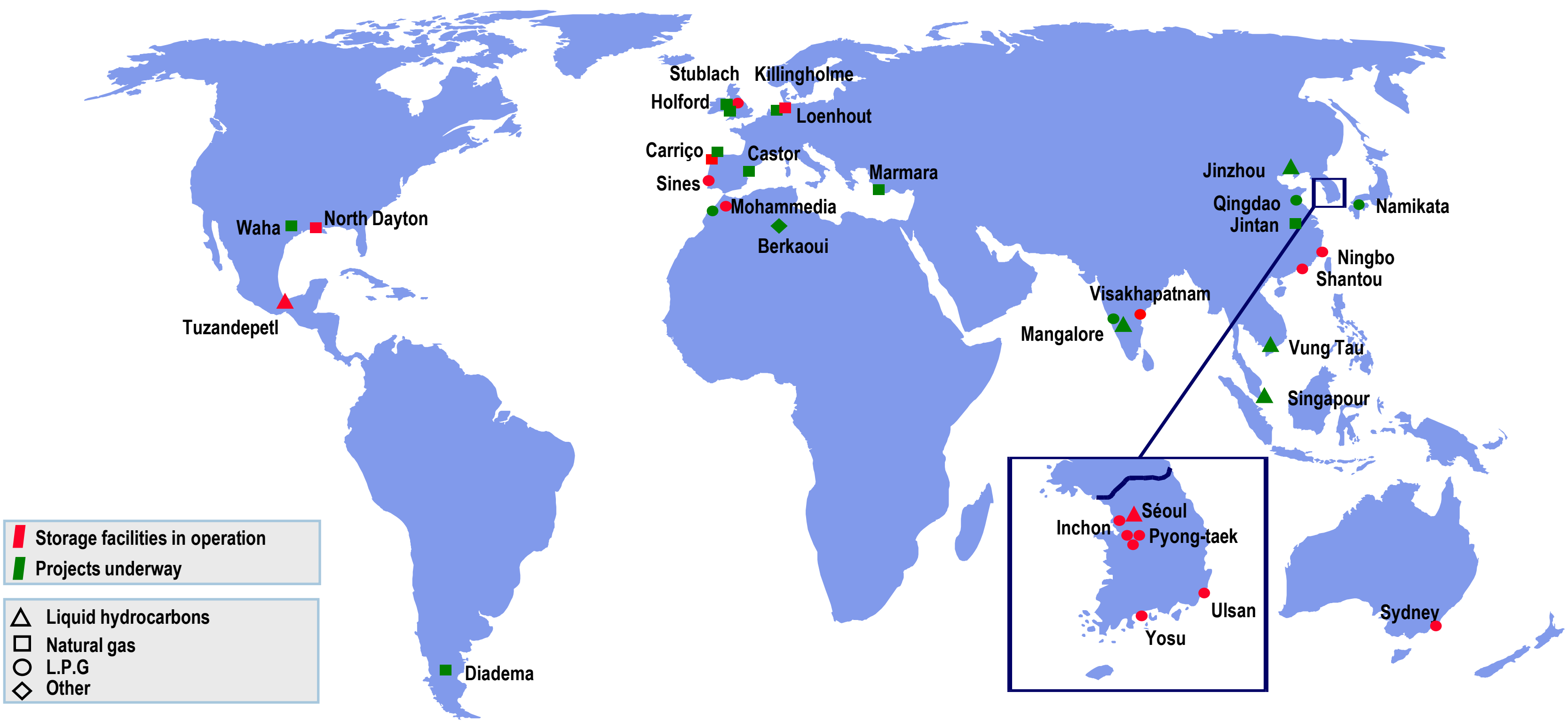
H : hydrostatic head
P : product vapour pressure
F : shape factor
S : safety factor

Lavéra (France)



GEOSTOCK Experience

- **France: GEOSTOCK references (Engineering, Operation): 5 storage sites (salt caverns and mined caverns)**
- **Germany: UGS subsidiary references (Engineering, Operation): 16 storage sites (porous media, salt caverns)**
- **Main GEOSTOCK projects outside France and Germany:**



Gas Markets

Current trends : uncertainty

- Strong impact of unconventional gas in the US & consequently on the LNG market.
- Low gas prices in the US, high prices in the EU & Asia.
- The sovereign debt & financial crisis in the EU have impacted the UGS market.
- Still good perspectives in Asia due to the expected boom in the natural gas consumption.

Gas Markets

Geostock activity : “return to earth, smooth landing”

- Projects already sanctioned or initiated continue. Investment decisions for new projects (in particular grass root projects) are postponed.
- Mainly focused on large projects in Europe and particularly:
  - UK : Cheshire (EON, Storengy, EDF)
  - France : EDF, Geomethane
  - Belgium : Loenhout (Fluxys)
  - Spain : CASTOR (offshore), Yela (ENAGAS)
  - Italy
- Most of the recent projects are in Salt Caverns driven by demand for high flexibility and modularity. New development in Reservoir storage are less booming (timeframe for development and cushion gas are of essence and penalize in particular aquifer storage).
- The perspectives of natural gas storage in Asia (mainly in China) are promising (ex.: 20 bcm of additionnal capacity advertised in the coming 20 years).

Géométhane – Manosque (France)

GEOMETHANE Manosque (France)

Leaching platform (UK)

Snubbing operation (removal of de-brining string) at a UK salt cavern

CASTOR (Spain)
Client: Escal UGS

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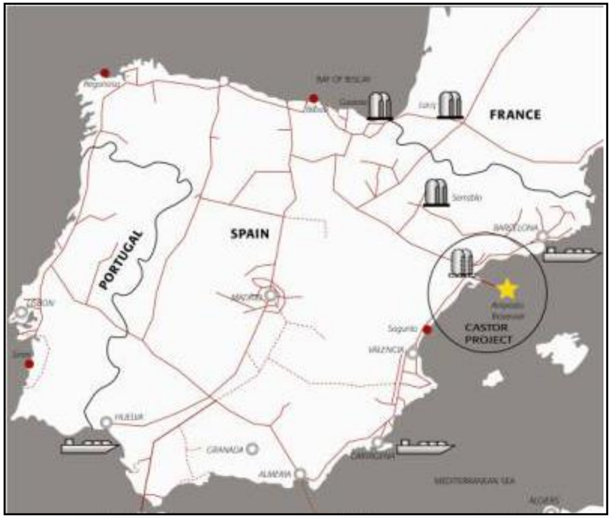
General information:

- **Location: 21km Offshore Mediterranean sea (Vinaroz – Province of Castellon)**
- **Water depth 60m**
- **Depleted oil field (produced by Shell 1972-1988)**
- **Project status: Development drilling completed in March 2012 (12 wells drilled)**



CASTOR (Spain)
Client: Escal UGS

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Aquifer Storage LOENHOUT (Belgium)
Client: Fluxys

DIADEMA (Argentina)
Client: YPF

General information:

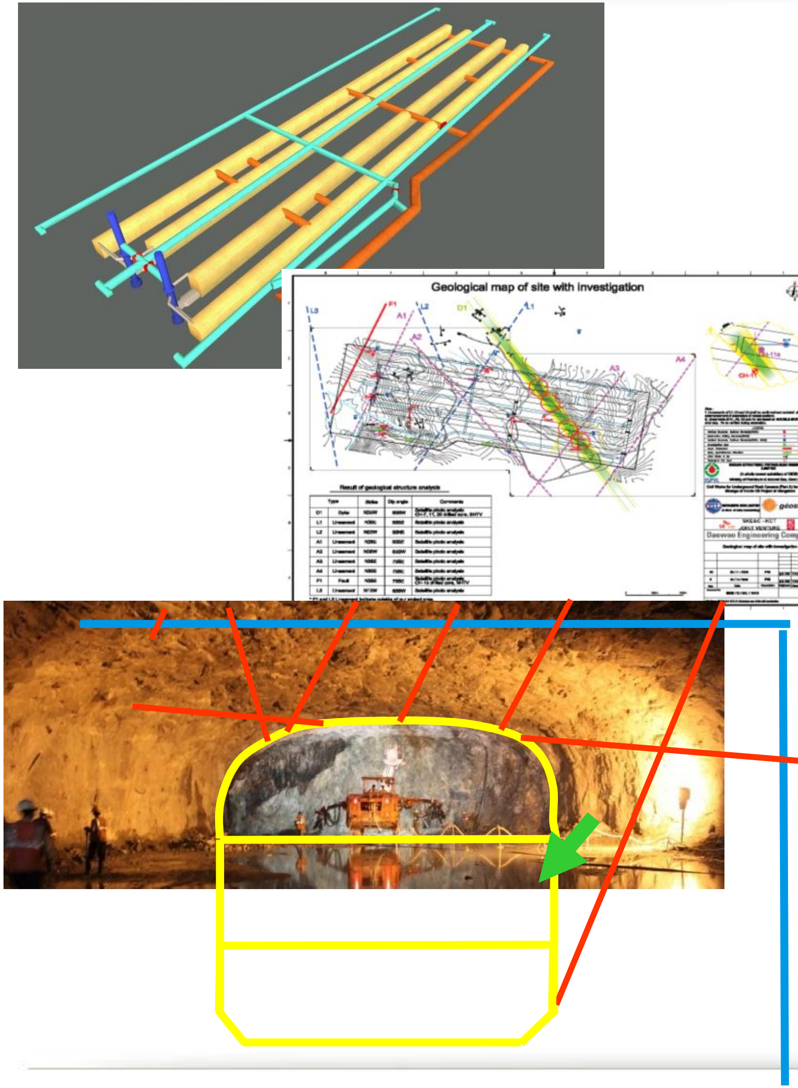
- **Location: Onshore, South East coast of Arger**
- **Depleted gas field**
- **Project status: Gas storage operation since 2**

Liquid Storage Market

- **Market Trends :**
  - Crude Oil & refined products demand is decreasing in OECD countries, but increasing in Asia

- **Geostock Activity :**
  - Current construction projects to develop strategic storages ensure a good level of activity :
    - France – SAGESS - Salt Cavern - Manosque
    - Singapore - JTC – Mined Caverns – Jurong Island
    - India – ISPRL/EIL – Mined Caverns - Mangalore
    - China – Mined Caverns

MANGALORE C/O (India)



- **Main features:**

4 Parallel galleries + 1 lateral access tunnel
Depth: 50 to 100 m / GL (crown level)
Length: 900 ml each
Section: 20 m x 28 m to 20 m x 32 m (> 550 m²)
Capacity : 1.900.000 m^3 (2 separate units)
2 operation shafts
Box-type water curtain system
Construction: Under progress

- **Main Geotechnical features:**

A dynamic predictive 3D geological model (structural & hydrogeological) is utilised.
Search for potential Key Wedges detrimental for cavern stability.
Short distance between independent storage units.
Surface constraints topographical variations.

LPG Market

- **Market trends :**
  - A surprising market "boosted" by the increase of LPG consumption for the Petrochemical Industry.

- **Geostock Activity :**
  - The Activity in Asia remains sustained with good perspectives
    - China – Mined Caverns : Qingdao (2009 – 2011)
    - China – Mined Caverns : Yantai - Construction in progress of a $1Mm^3$ storage
    - Japan – JOGMEC – Mined Caverns : Namikata & Kurashiki
  - Activity in Morocco for the creation of Sidi Larbi 3rd salt cavern for SOMAS (leaching in progress).

Mohammedia (SOMAS) Morocco

Mohammedia (SOMAS) Morocco

Qindao (China)

Qindao (China)

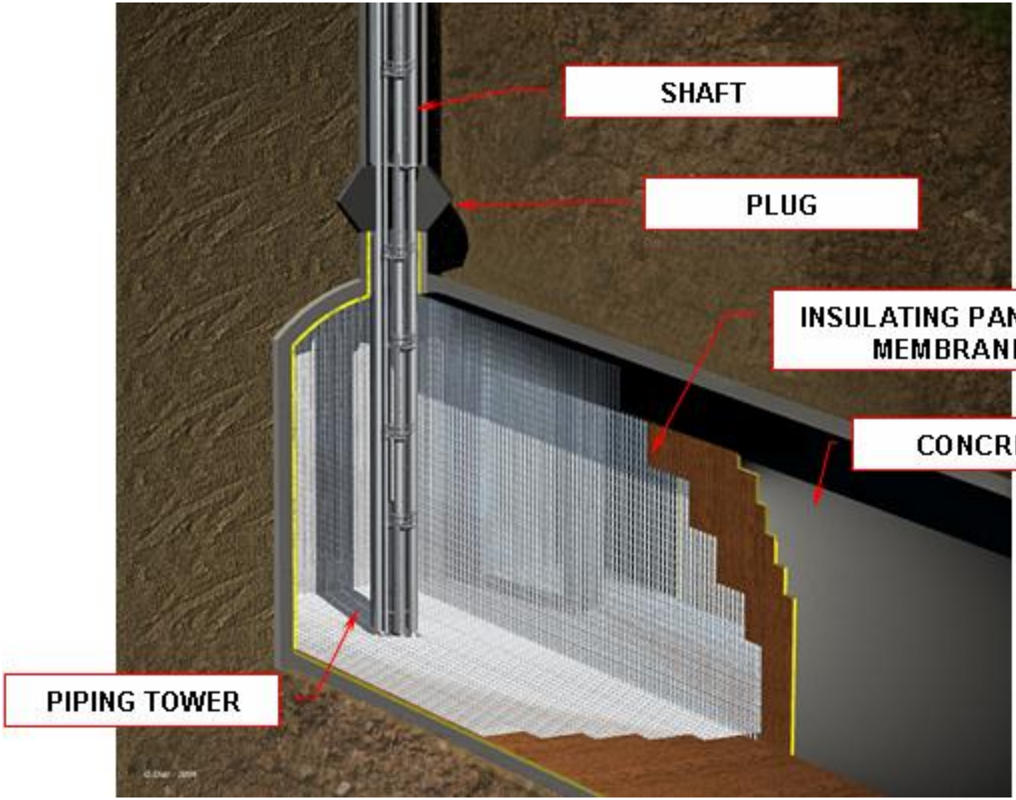
Qindao (China)

Looking ahead

<u>Technical :</u> Innovation is critical to prepare the future

- Maintenance, revamping of ageing facilities, WIM, improving technical efficiency, etc..
- H2 storage, CAES, Energy storage

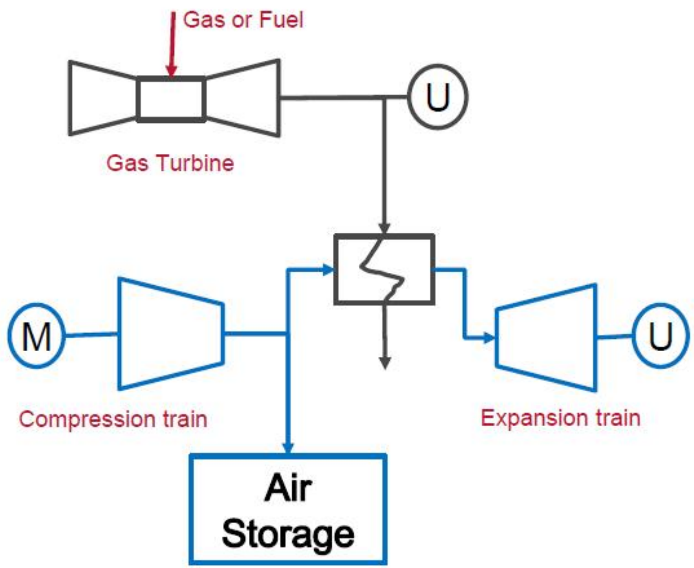
Lined rock caverns for LNG storage



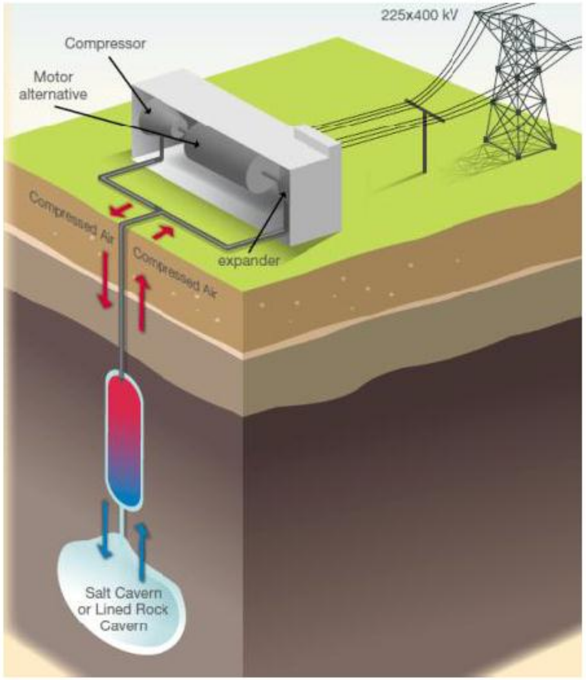
New Opportunities

CAES & ACAES plants

Technology concepts



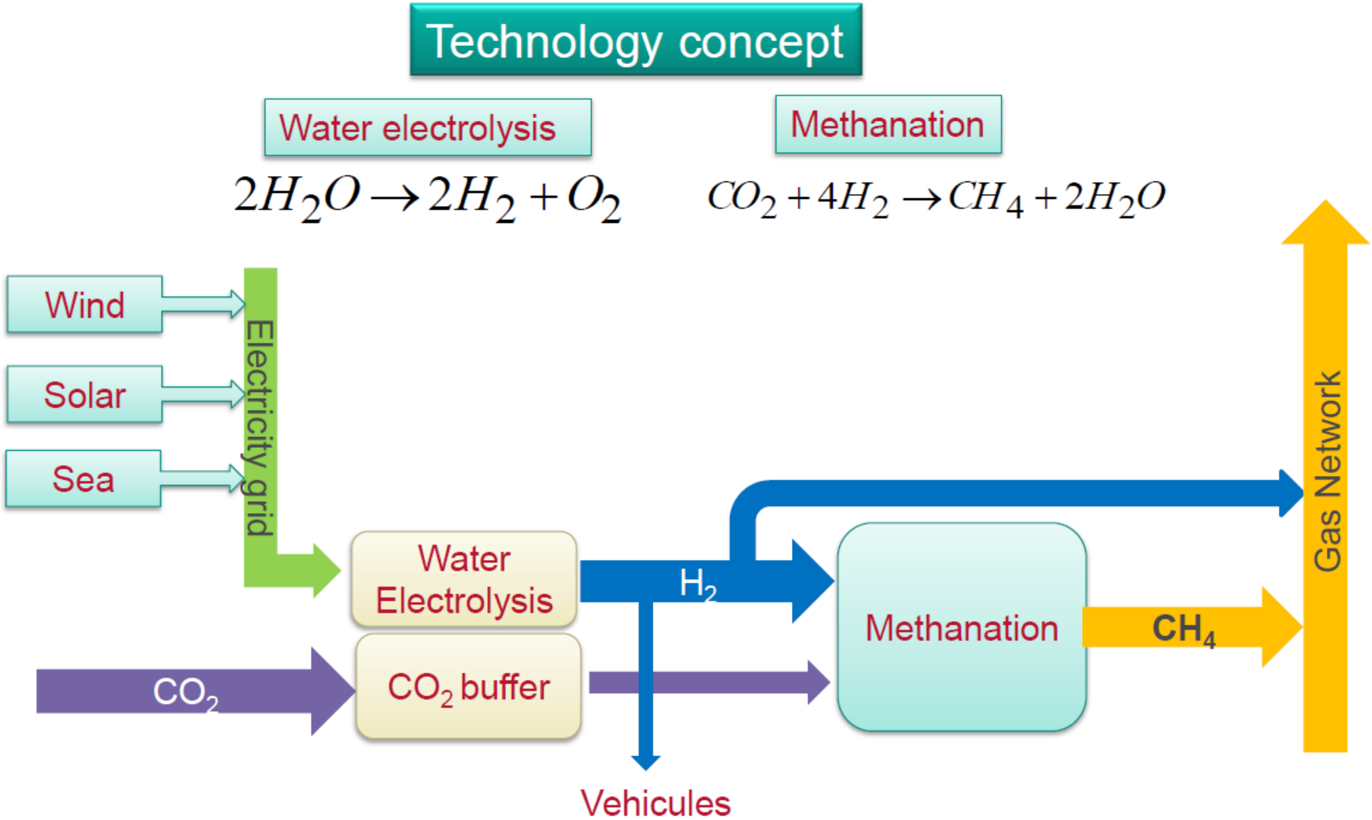
Compressed Air Energy Storage 2G plant



Adiabatic Compressed Air Energy Storage plant

New Opportunities

Methanation



New Opportunities

Methanation

Where Storage might be required ?