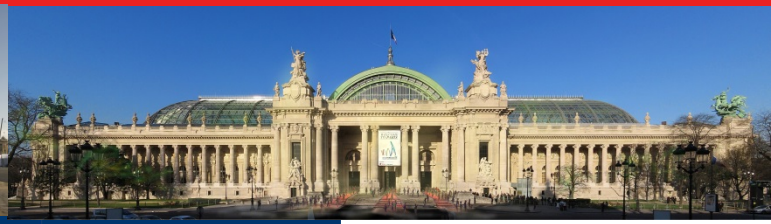
26th World Gas Conference

1 – 5 June 2015, Paris, France



WOC 2 - SG2.2 (TS)

Innovation and new technologies: can UGS take / do more?

Fabien Favret (EdF)
Jacques Grappe (Géostock)

IGU
WGCPARIS2015
WORLD GAS CONFERENCE

SG 2.2: Innovation and new technologies

- Leader: Fabien Favret
  - Goal: promote and share techniques “best practices” within storage community
  - Activities & Topics during Triennium:
    - Links development with other PGCs
    - Energy efficient operation gas storage leading to reduce environmental impact
      (Leader: Fabien Favret)
    - New opportunities - Energy storage
      (Leader: Jacques Grappe)
  - Reporting @ WGC June 2015
    (Leader: Fabien Favret & Jacques Grappe)
  - Specific focus on Energy storage
    (Leader: Jacques Grappe)

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- Established links & new potential topics for future
  - Coordination with PGC A (sustainability):
    - WOC2 CCS database presented by Ján Beňo in Helsinki 10-12 September 2014
    - As the development of CCS projects is still very initial stage, PGC A decided to pass this time to construct their original CCS database (existing GCCSI's database is the good alternative)
  - Link with PGC F (energy storage):
    - Distributed storage application for small quantities: hydrates, adsorption (C), CNG, … ➔ new business model! with UGS?
    - H2, CO2, acid gas storage impact to be addressed by UGS operators: especially ➔ porous reservoir
    - H2 dynamic vs CH4 may lead to heterogeneous gases in grids (maximum H2 content? ➔ not yet defined)
    - Pre-salt E&P (Gulf of Mexico) might capitalize from UGS salt caverns operators
    - UGS skills to be used (ex: monitoring) in other gas sectors (E&P for shale gas, geothermal, CBM, …)

      ➔ *New topics for future Triennium?*

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- Energy efficient operation gas storage leading to reduce environmental impact (Leader: F. Favret)
  - Goal:
    - Reduction of the environmental footprint within the UGS operation in synergy with increased efficiency of operations
  - Way:
    - Follow the injection/withdrawal/standby cycle and identify the points of energy consumption/ environmental impact.
    - Propose efficiency increase measures – mix of technologies, new Technologies – in-house vs market software
- Achievements:
    - IGU article published in April 2014
    - Topics of interest have been defined during April 2014 workshop
    - Related workshop: April 2014 (Pau – France)

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- Energy storage (Leader: Jacques Grappe)
  - Goal:
    - Identification of the synergy between UGS and energy storage ➔ new opportunities for the UGS
    - Recommendations/added value for the energy storage from the point of view of the UGS operators
    - Raise our voice for promoting UGS existing solution for energy storage: vision & contribution of the UGS to green energy deployment
  - Subjects of real and major interest identified:
    - Drawing on UGS Experience to Store Renewable Energy , views on energy storage, green transition of Energy system
    - Experiments (Sun Storage Lehen, GRHYD, …), business case for H2 storage, gas storage as energy storage in a renewable energy system
    - Overview of storage technologies and possible applications
- Achievements:
    - IGU article published in October 2014
    - Topics of interest have been defined during September 2014 workshop
    - Related workshop: September 2014 (Copenhagen - Denmark)

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- Reporting @ WGC2015: Final paper issued in January 2015 for WGC2015 addressing:
  - UGS techniques, new opportunities and best practices:
    - Operators of underground gas storage (UGS) facilities have to react quickly to changing market demands for gas while raising safety standards and reducing environmental impacts
    - In this context, latest developments and recent findings are presented such as:
      - Subsurface integrity management
      - Reduction of the environmental footprint of UGS operations and the enhancement of their energy efficiency
      - UGS operators to take advantage of sophisticated and advanced technologies mainly developed by/for O&G majors or engineering service companies
  - To which extent UGS technology may contribute to energy storage:
      - How to store excess electricity generated from intermittent renewable energy sources
      - Focus on the identification of solutions UGS applications might contribute, on the related technology gaps together with the R&D effort needed to overcome them

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- Reporting @ WGC2015: TS & IS sessions
  - SG2.2 Technical Session (this one!)
    - Wednesday 3rd June, 17:15 -18:45
  - SG2.2a interactive session (previously in afternoon)
    - Wednesday 3rd June, 13:50 -14:35
  - SG2.2b interactive session (tomorrow)
    - Thursday 4th June, 10:30 – 11:15

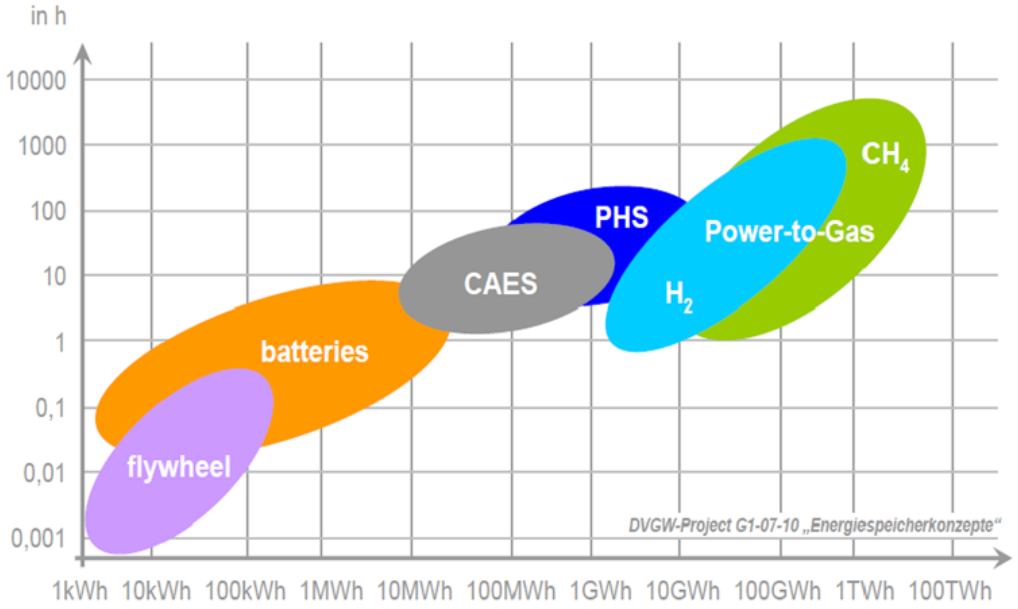
- Each session is a mix of:
  - UGS innovation and new technologies topics
  - Energy storage topics

Drawing on UGS experience to store Renewable Energy

- Setting the scene
  - Emergence of energy transition policies worldwide
  - Renewable Energy (REN): a growing share in the energy mix
  - Currently mostly developed REN are wind and solar:
    - Intermittent and weather dependent
    - How to convert intermittent electricity generation to a stable stream?
    - Storing massive electricity production requires conversion into another energy vector. Needs are evaluated in the order of tens to hundreds of TWh
  - Natural gas UGS:
    - From 10 MMm3 up to 10 bcm+ (110 GWh ➔ 110 TWh)
    - Global working gas capacity 393 bcm (4325 TWh) with 6,8 bcm (3100 GWh/h) max. daily deliverability

UGS CAN PLAY A ROLE AND CONTRIBUTE SOLUTIONS

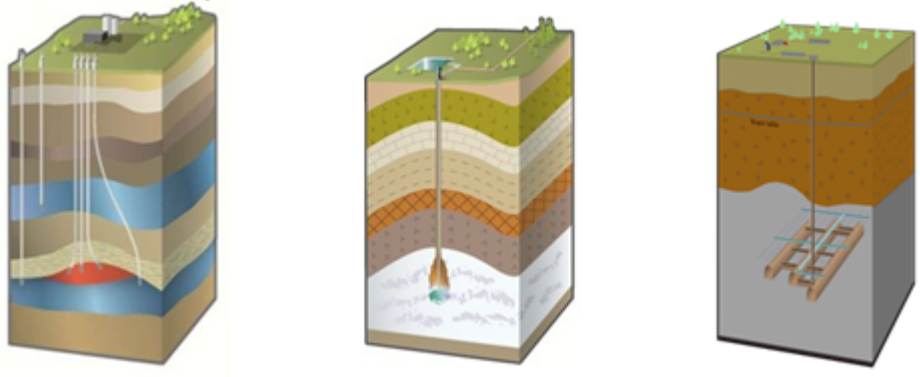
Electricity storage options



UGS solutions applicable for 10 MWh and above to be released over at least a few hours!!!!

Compressed Air Energy Storage

- CAES: an attractive technical solution for peak shaving (10 MW to 1 GW over a few hours)
  - The UGS industry can contribute experience & knowledge from existing facilities
    - **Salt caverns:** technology is there; some adaptations needed. The preferred option… where salt, leaching water and brine disposal are available. Extension of existing caverns field rather than Greenfield, stand-alone projects
    - **Mined caverns** (unlined and lined)
    - **Reservoir storage:** depleted fields are excluded; aquifers: maybe, …



- Developments are underway to increase efficiency (Adiabatic and Isothermal CAES)

Main limitations: location and ECONOMICS…

The P2G (Power to Gas) option

- Surplus electricity can be converted to hydrogen (hydrolysis). A further step consists in combining hydrogen and CO2 to produce synthetic methane (low energy efficiency)
  - H2 can be used as a fuel or blended into the gas grid (limited %)
  - Synthetic methane can be injected into the existing gas system
- Storage options for hydrogen include:
  - For small size, distributed storage: conventional pressure vessels, novel solid storage solutions (metallic hydride e.g.).
  - For massive storage (above 100 GWh i.e. approx. 3000 tons or 35 Mm3 (n) hydrogen): UGS solutions
- What we know:
  - Feedback from operating hydrogen storage in Salt Caverns
  - Coal gas storage experience in the 70's (salt caverns, reservoir)
  - Helium R&D storage projects (Russia, Gazprom)

Underground Storage for Hydrogen

- Available UGS options:
  - Feasibility of Hydrogen storage in salt caverns considered proven for pure salt. Site specific evaluation needed for bedded salt
  - A few challenges for reservoir storage (showstoppers?). Might impact feasibility of large % of H2 blending into the natural gas stream
  - Other options: lined rock caverns, tubes (pressure vessels)

- Some remaining obstacles to overcome (R&D):
  - Studies: InSpEE (Germany); HyUnder
  - Pilot Projects: Falkenhagen, Mainova (Thüga, Germany), HYCHICO (Argentina), Sun (RAG AG, Austria)

- Limitations:
  - Large size storage volume: applicable for concentrated rather than for dispersed electricity production
  - Suitable geology

The current situation

- **In the current energy transition period, Natural Gas is the bridging fuel of choice**, and could allow balancing intermittent electricity production and demand (using in part the existing infrastructure)

- **The Gas industry can provide storage solutions (mainly CAES and Hydrogen UGS) for surplus electricity, provided quantities are large enough**

- **As of today, the P2G option cannot make it on its own. There is no market incentive for stabilizing intermittent electricity through storage, hence no driver for investment.**

KEY ISSUE: WHAT WILL BE THE FUTURE NEEDS OF THE ENERGY MARKET?

What about tomorrow?

- **A few factors likely to impact the deployment of UGS applications for energy storage:**
  - Will intermittent electricity production be concentrated or dispersed?
  - Demand side management and demand volatility?
  - Emergence of smart grids
  - New rules of the game and related business models
- **Besides providing UGS solutions for intermittent electricity storage, UGS industry could take advantage of its know-how (subsurface, well & completion, reservoir, environmental impact monitoring, surface and process operation, permitting) to extend it to other energy storage solutions:**
  - Geothermal heat storage in aquifers or dry rocks
  - Subsurface monitoring
  - CO2 storage in the wider perspective of a de-carbonated energy society

HOWEVER THE FUTURE EVOLVES WE ARE READY TO FACE THE CHANGE AND TO RESPOND TO THE CHALLENGES AHEAD, WITH A COMBINATION OF EXPERIENCE FEEDBACK AND TECHNOLOGY DRIVEN INNOVATION

SG 2.2: Innovation and new technologies

Thank you for your active support

☺

YES WE CAN