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CCS EXPERTISE AND ENGINEERING

Accelerating exploration for development of bankable CCS projects

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Based on IEAGHG report

Global Storage Resources Gap Analysis for Policy Makers

Framework

- **IEA goal for 2020**
  - 450ppm CO_2 in 2020, 100 up and running industrial scale CCS projects
  - Not using CCS as a CO_2 mitigation option would mean a 70% increase of total investment to meet the reduction target
- **Bottom-up analysis**
  - Are there a sufficient number of “bankable” storage projects to meet the storage needs implied by the current global commercial-scale CCS deployment goals?
  - Where do we identify storage development gaps exist?
- **Recommendations**
  - How to overcome identified gaps through appropriate work programs?

Bankability

A Storage site is bankable if it has been evaluated such that sufficient confidence exists in technical and cost elements to support final decisions for commercial-scale investment

Methodology / Bottom-Up Analysis

- **Technical bankability of pure storage project (DSF & DOGF)**
  - Suitability of geological areas (highly suitable, suitable, possible, unproven)
  - Storage Development Workflow: Steps needed for storage characterization: probabilistic approach to assess the costs and development times of the storage bankability assessment
  - Technical time (up to 12 years), cost and technical failure rate for storage bankability definition
- **Non technical bankability of pure storage project (DSF & DOGF)**
  - Other causes of project development failures (public acceptance, funding…)
- **CO_2 EOR contribution to the achievement of development goals**
  - CO_2-EOR (1-3 years) and DOGF (4-10 years) lead time are shorter than DSF
  - The contribution of CO_2-EOR is limited:
    - They are not distributed evenly between countries (oil and gas producing provinces).
    - Not all fields can be converted safely to CO_2 storage/ EOR.
    - There is a specific time window of opportunity for conversion of the field.

Key message for Storage development time and cost

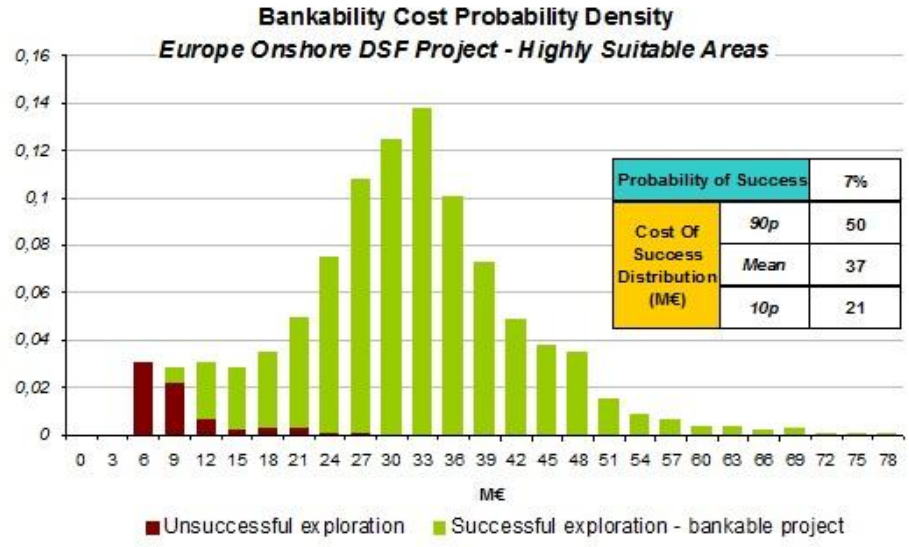
- **Storage bankability assessment is long**
  - 5 to 15 years are needed to achieve bankability for deep saline formations and some depleted fields: project starting date definition is driven by the storage implementation lead time.
  - Storage site bankability assessments take time because it is an iterative process.
  - Development time is very sensitive to geological knowledge, licensing and environmental issues**.** Those issues can count to more than half of the overall time needed to develop a storage site.
- **… is a limited investment as compared to the overall chain**
  - For onshore projects, storage bankability assessment costs represents in average less than 10% (up to 20% for some offshore projects) of capture plant costs.
- **… but is not always successful**
  - Technical success ratios are between 60 and 90 % for aquifers
  - Between 20 and 30% of depleted oil fields can be converted
  - Between 50 and 70% of depleted gas fields can be converted

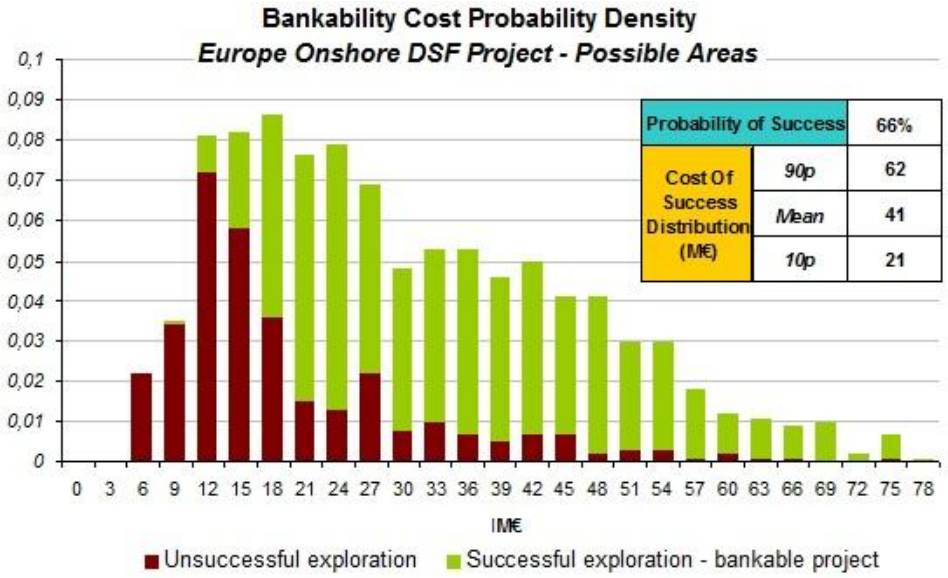
Key message on Required Funding - 2020 Gap Analysis

- **In the current financing framework,**
  - Presently promised 21 billion Euros for large scale CCS projects concern only developed countries. There are no current major public funding announcements from developing countries
  - It will allow only between 14 and 21 projects worldwide to be financially balanced
  - CO_2-EOR has the potential to increase by 70 to 80% the number of projects that can reach bankability
    - Assuming CO_2-EOR projects succeed technically, there could be **18 CO_2-EOR projects worldwide by 2015-2018**.
    - This window of opportunity depends on each field producing costs versus oil and gas prices and also upon technical constraints (among others , water invasion of the reservoir, surface facilities compliance with CO_2 rich streams).
    - With current funding, it means that **32 to 39 projects will have reached bankability by 2025**.

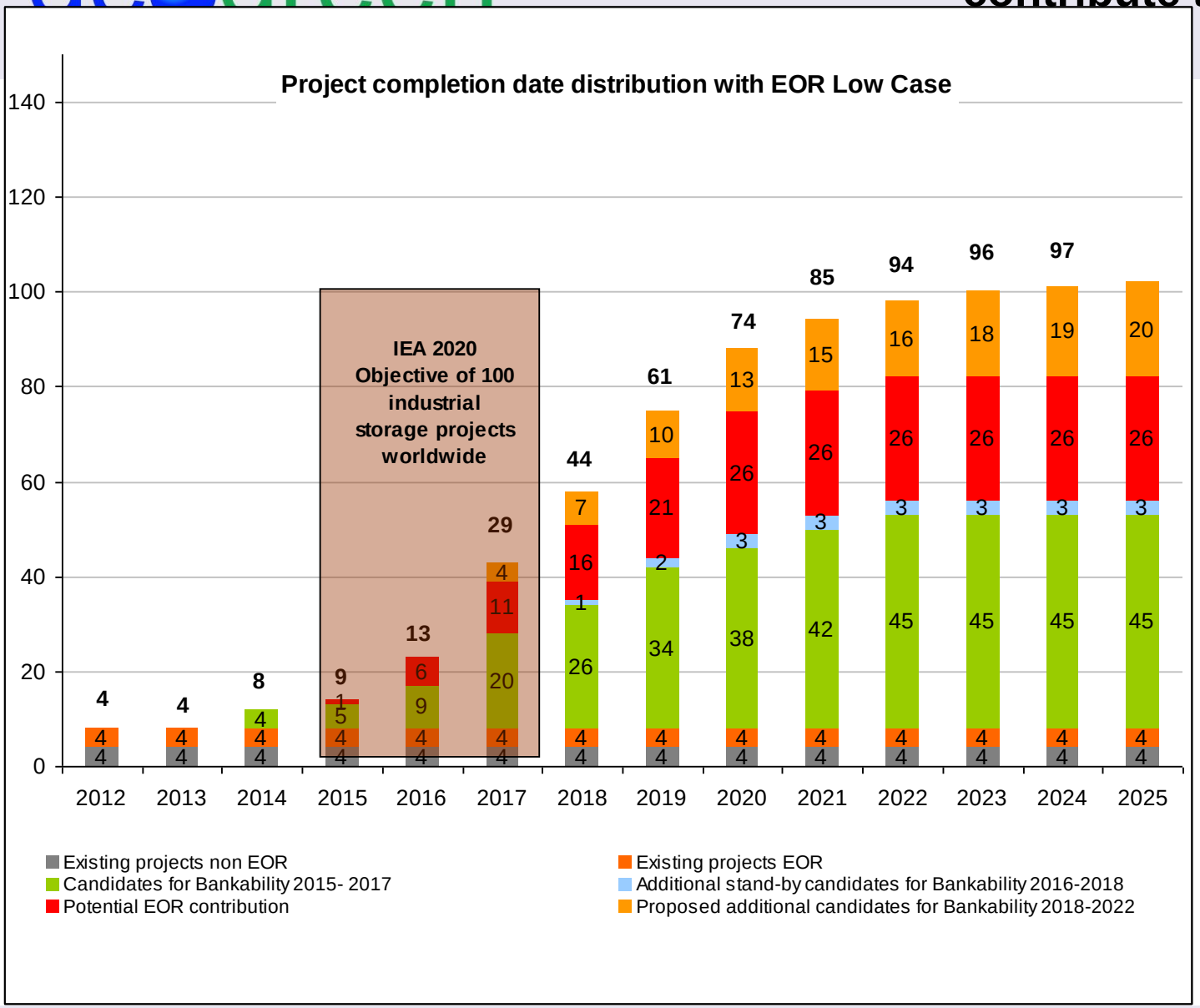
Key message on Required Funding - 2020 Gap Analysis

- **Public funding of storage bankability assessment could efficiently remove the storage development time roadblock to achieve quick CCS commercial build up**
  - Even G8 objective of 20 large scale commercial CCS projects seems not achievable
  - Currently no specific incentive for private stakeholders for bankability assessment.
  - Between 0.5 and 1.5bn€ extra public funding dedicated to storage bankability support would allow to have 100 storage sites ready by 2025 (today, only 40% of it)





Key Messages: All types of storage must contribute to the global effort

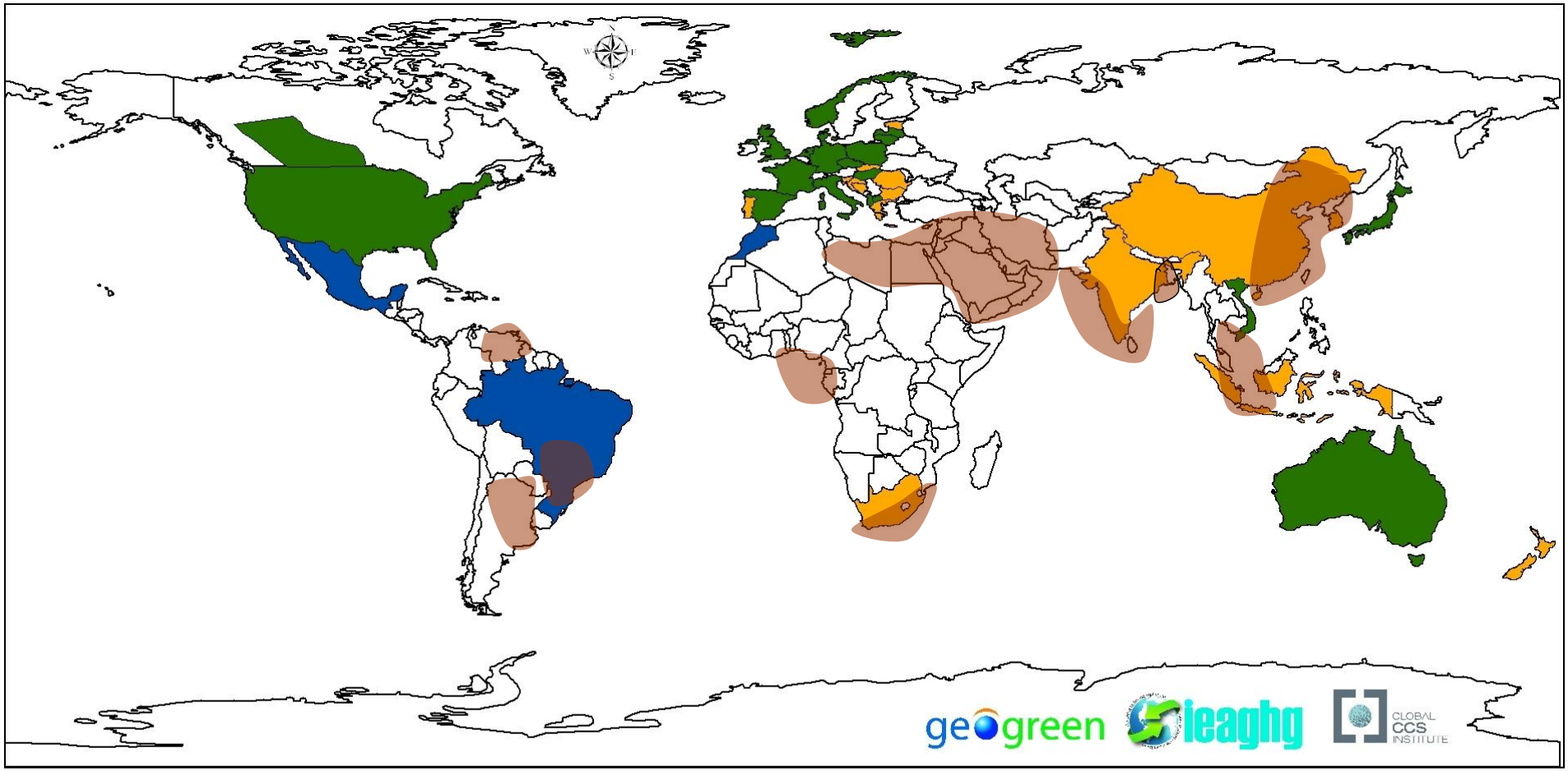


Depleted Oil and Gas fields and CO_2-EOR although being attractive options suffer from some limiting factors such as their location limited to oil and gas producing provinces, the impossibility to convert safely all the fields and the time window issue.

Deep Saline Formations present a huge potential but are not well known and need more time and money to be developed

Filling the gap to 2020 Recommendations

- **Improve the knowledge of subsurface in areas where large volumes of CO_2 might be captured in order to save development time and increase success rate**



Filling the gap to 2020 Recommendations

- **Ensure regulatory framework is suitable for CO_2 storage and support project developers towards public acceptance to reduce non technical failure causes**
  - Key regulatory aspects: medium to long term liabilities, failure cost state insurance
  - Public acceptance is another key issue for onshore storage projects. Active government support and proper local communities up-front involvement are mandatory to make public understand the key reasons and outcomes of CCS deployment.

Filling the gap to 2020 Recommendations

- **Increase or create incentives to provide a business case to CCS**
  - Inclusion of CCS under CDM mechanism in Cancun is a first good step to provide a revenue stream to projects in developing countries.
  - However, the perspectives over CCS-CDM methodology acceptance timeline are still uncertain.
  - Lack of revenue stream to these projects could jeopardize the achievements of storage development ambition.
- **But CDM is not adapted to funding bankability assessment**
  - CDM stream of revenue is available only when the projects have started and storage bankability has already been assessed.
  - Moreover, the CO_2 price perspectives are not sufficient to convince private investors of developing storage projects at the needed scale.

Filling the gap to 2020 Recommendations

- **Finance, Increase or create incentives for private stakeholders to launch bankability assessment as soon as possible to avoid further time delays**
  - With CO_2-EOR, at least **42 large scale new storage bankability assessments (30 DSF/DOGF and 12 EOR**) should be launched to obtain 100 storage sites by 2025.
  - Extra public funding requirements of between 0.5bn€ and 1.5n€ worldwide if we consider that CO_2-EOR bankability assessment costs are met by field operator and if private investors step in storage characterization when 50 to 75% of the costs are subsidised.
  - Finance storage characterization programs next to important CO_2 emission hubs in order to have storage site ready when emission mitigation incentives will be sufficient to sustain private investment in CCS (expected between 2020 and 2030).
  - To launch necessary storage development in emerging economies, an international mechanism should be developed to allow fund transfer from the North to the South.

Filling the gap to 2020 Recommendations

- **Capitalize on low cost industrial early opportunities and BECCS**
  - CCS is not only applicable to the power sector. Almost half of global CCS deployment should concern emissions from other industrial sectors.
  - Opportunities of low cost “easy to capture” projects exist for industrial sources with high CO_2 purity. Storage bankability assessment efforts should be focussed in consistency with their locations.
  - Among them: bio ethanol production associated with CCS (carbon negative emissions), natural gas processing, ammonia and fertilizer production, and refining activities under development (Africa, ME, SE Asia, China and India)