Technical Workshop on modalities and procedures
for carbon dioxide capture and storage in geological formations
as clean development mechanism project activities

Site selection:

Technical site selection criteria

and information needs

Outline

Brief introduction to criteria of *geological storage* site selection

- Commonly used site selection criteria
- Steps in a site selection process

- Information needs

- How site selection relates to other activities around geological storage of CO_2

- Timelines

Site selection criteria - Basis

Site selection is key for a CCS project.

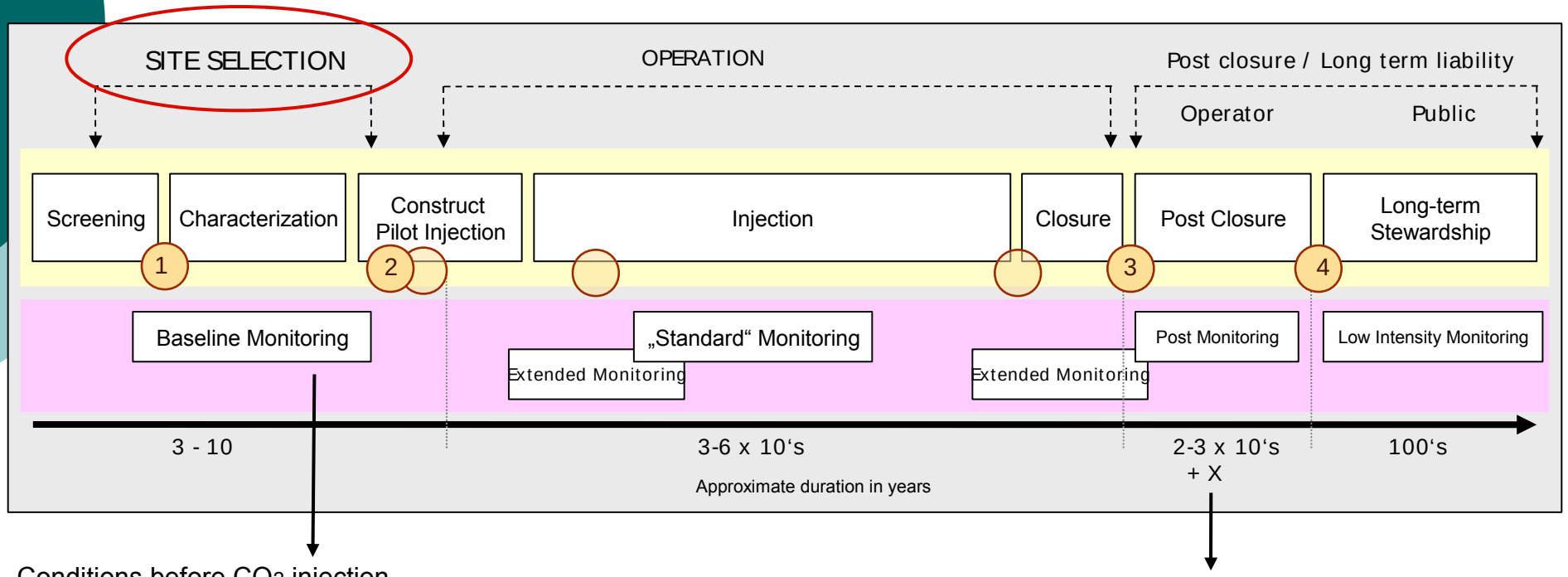
The poorer the selection was and the less is known the more uncertain (more risky – environmentally, economically) a project will be.

Goal of a site selection process is to find a suitable geological site for CO_2 storage.

Suitable: Permanent, safe retention of the foreseen amounts of CO_2 (and displaced brine) in deep geological formations - without impact on human, health, environment, and climate.

Process to be comparative: Use of internationally standardized methodologies, Approval schemes, Best Practice (esp. important in cases of trans-boundary projects).

Timeline - life cycle of a CCS project



Conditions before CO_2 injection

End of Post Closure cannot be predicted in advance - depends on behaviour of the system, stable conditions, demonstrate long-term safety

Permits issued by Regulator / National Authority:
1 Exploration permit
2 Storage Permit
3 (Post) Closure Permit (Decommissioning, Reduced Monitoring)
4 Transfer of responsibility

Site selection: Starting point

Site selection actually starts with a need / a will to reduce climate-related emissions – CO_2

CO_2- intensive facility (e.g. steel, cement, refinery, natural gas processing, ammonia coal-fired power plant), look for

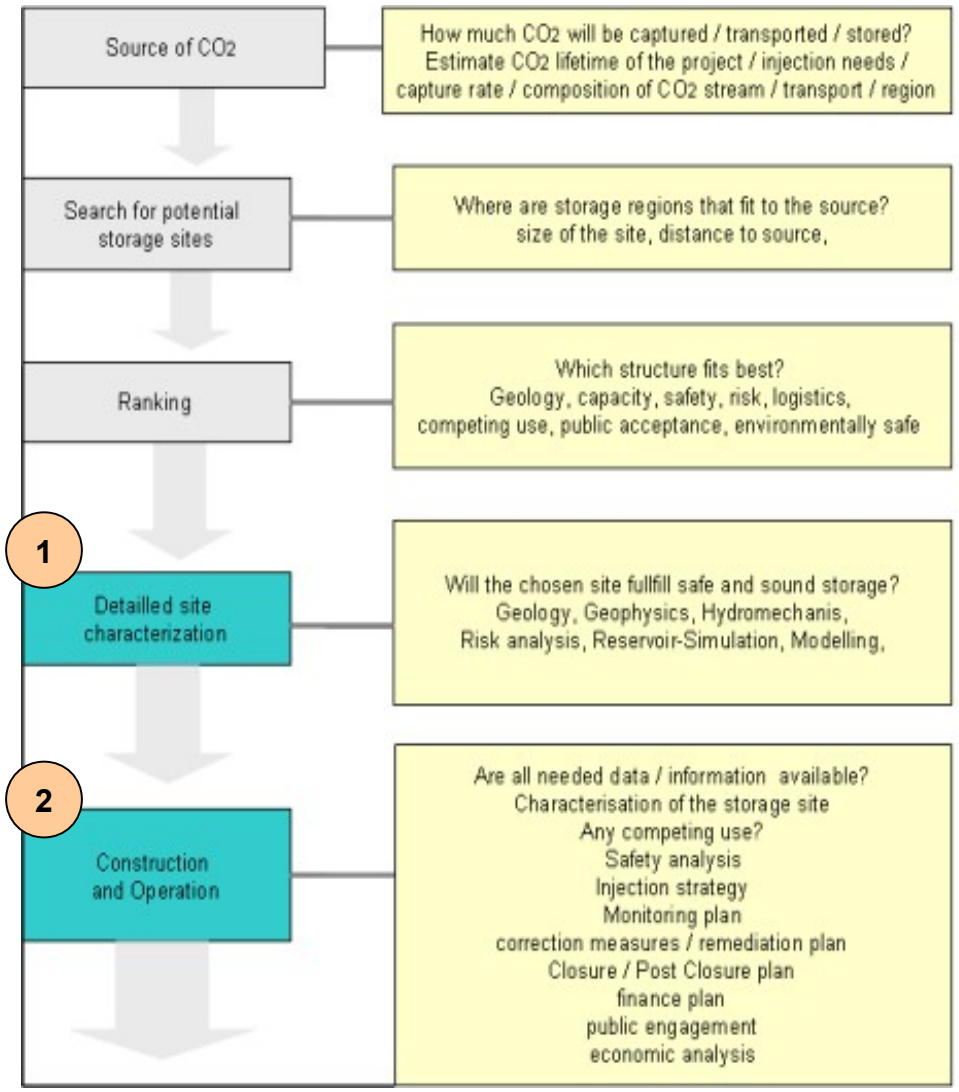
- Substitute
- Energy efficiency
- Renewable energy
- CCS

By assessing all options (alternatives, economics, environmental impact, climate benefit, feasibility) one may come to the conclusion that CCS is the option of choice – to capture – transport – and permanently store CO_2 in deep geological formations.

→ Amount of CO_2 that will need to be transported and stored „somewhere“ (from one or more sources, it might be of interest to watch for partner)

Site selection - Steps

- Statement of storage aims
- Geological site screening
- Ranking (short list)
- Site characterisation
- Site design and planning
- (Site construction)



Site selection: Screening

→ Assess opportunities for storage sites within a region and produce a short-list of sites that, based on a first evaluation of existing data, are promissing to serve as a safe storage site.

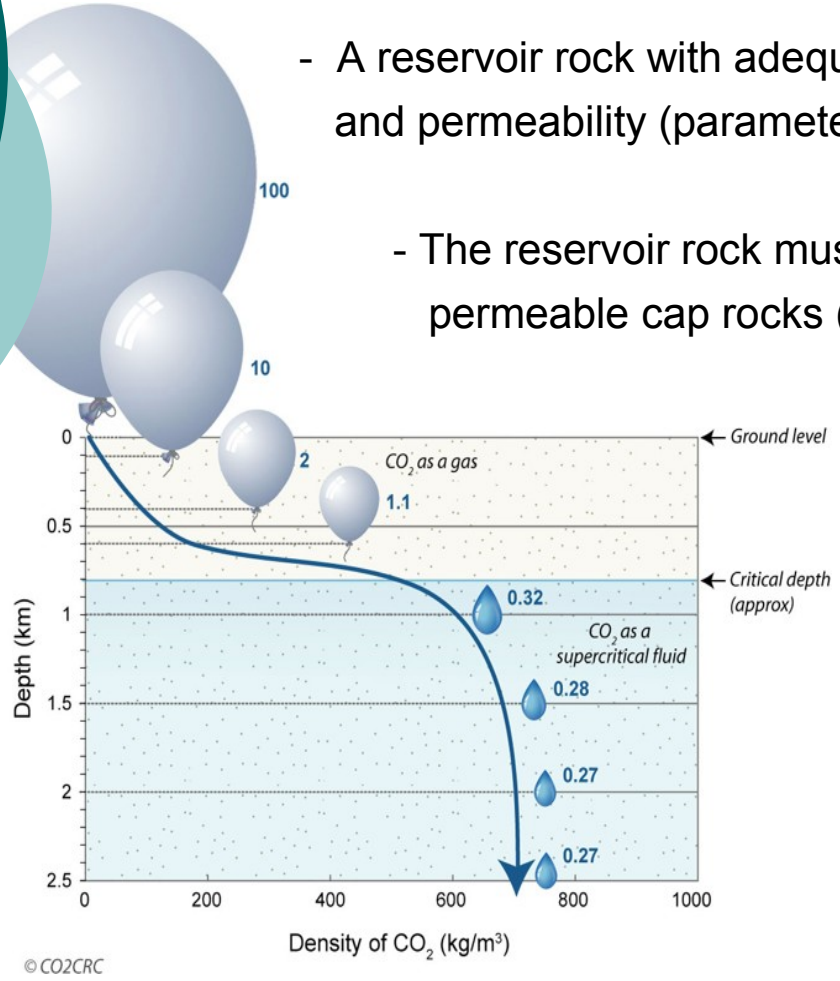
Geological evaluation on progressively more and more detailed scales (top-down approach)
Country and state-scale screening – Basin scale – Site assessment

Initial acquisition of data:

- National Geological Surveys
- National Mining Authority (and/or others – Water, Nature Conservation Authorities, Ministries)
- Suppliers such as oil / gas companies

Exchange / communication between project developer / operator and authorities.
Inclusion of regional / local communities / stakeholders as early as possible – CCS is also a national task.

Geological criteria include



- A reservoir rock with adequate porosity, thickness (for storage capacity) and permeability (parameter for injectivity) at sufficient depth (> 800 m)

- The reservoir rock must be capped by one, better more tight, low permeable cap rocks (multibarrier system)

- A geological structure with no natural or man-made leakage pathway, no hydraulic contact to drinking water horizons, and sufficiently stable to avoid compromising the storage integrity.

Other criteria include

- Natural resources (e.g. drinking water, geothermal heat)?
  (sites where other natural resources are present with current or potential future value may be ruled out – this is not a developers decision)
- Competing underground use or synergies possible?
- Public acceptance?
- Area remote or densely populated?
- Co-benefits (EOR)?
- Geological structure onshore – offshore?
- Existing infrastructure (depleted oil/gas fields)?
  (advantages – disadvantage (abandoned, old wells)

Site selection –Ranking and selection

1. Ranking of sites

   Ranking factors (example, not comprehensive)

   - Storage Capacity (will meet the requirements of the source(s)
   - Injectivity potential (will influence an injection strategy, number of wells etc.)
   - Site logistics (source-sink not too far, possible pipeline route viable)
   - Reservoir depth, water column (in case of offshore geological storage)
   - Containment (seal and trap good, no fractures, faults – no leakage to be expected)
   - Existing natural resources (no resources that could be compromised)
   - Existing data basis, quality

2. Selection of highest ranked storage sites (documentation)
   Communication between developer, regulator, local communities / public

3. Apply for an Exploration Permit to undertake a detailled site characterisation of the selected site (scale depends on characterisation status / existing data basis)
   Documentation, analysis and results of existing data, Exploration Plan – what work will be done? (will normally be granted for a limited period of time by the regulator / authority)

Site selection – site characterisation

Aim: Detailled analysis (e.g. seismic surveys, groundwater analysis, drilling, sample analysis, acquire baseline data) to decide about suitability / non-suitability of the site

Characterisation steps

1: Data Collection (incl. Baseline monitoring)
   - Geology, geophysics, geochemistry, hydrology, geomechanics -
2: Building a three-dimensional static geological earth model
3: Characterisation of the storage dynamic behaviour
4. Sensitivity characterisation, uncertainties, risk assessment (RA), environmental impact assessment (EIA)

Questions to be answered:

Are there potential leakage pathways?

How large will the influenced area be? (CO_2 plume, pressure built-up)

Could CO_2 and/or displaced brine move upward into drinking water horizons? Impact

How will the system behave in the future (injection / post injection)?

Site selection – Final Step

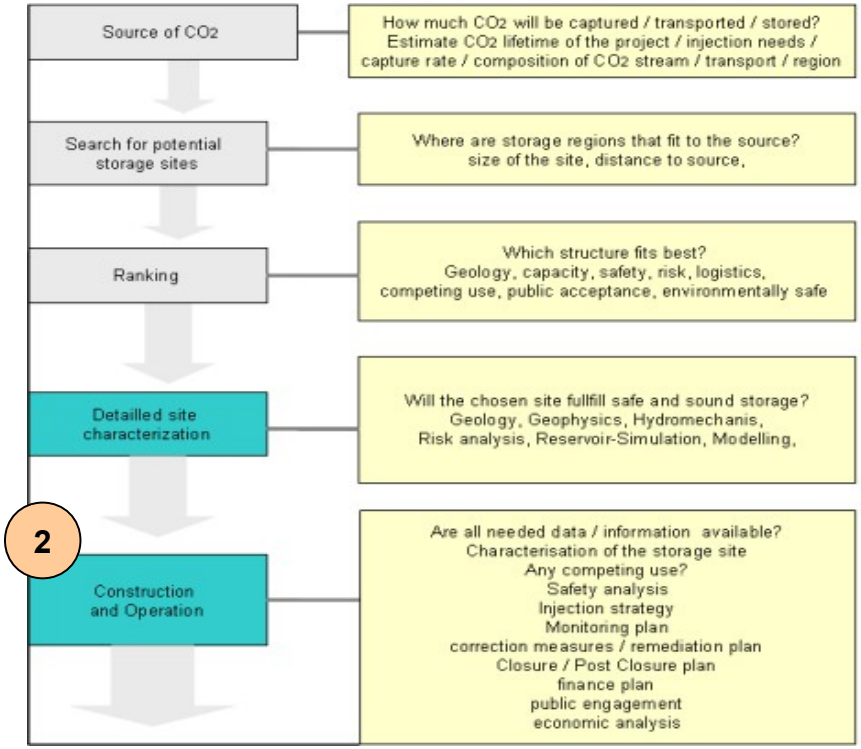
High confidence that the site will behave as expected

- storage capacity, injectivity
- no leakage of CO_2, no upward movement of CO_2 / brine
- no environmental impacts

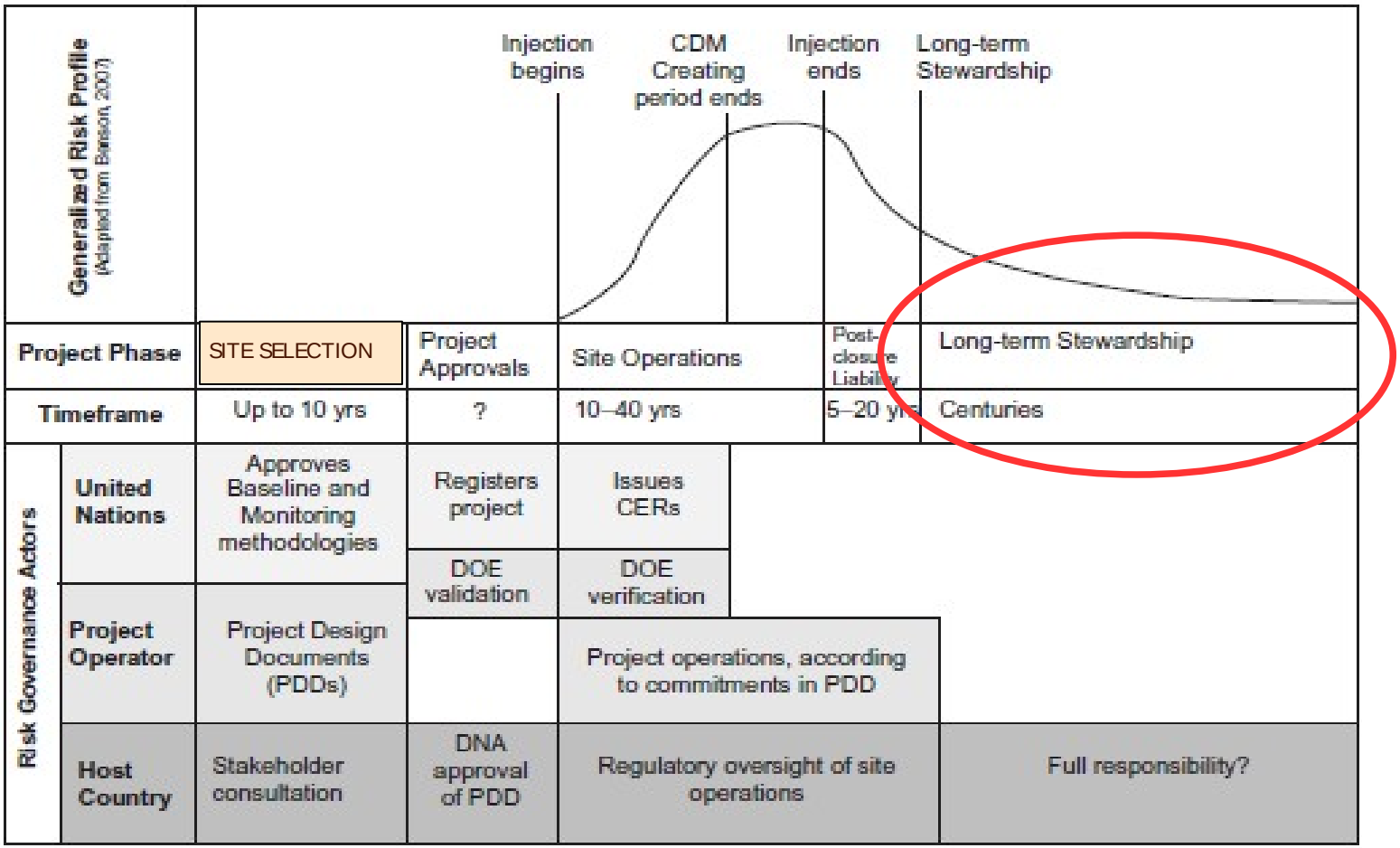
Apply for a Storage Permit (2)

Stakeholder / public consultation has been undertaken / documented
Injection strategy, site management
Monitoring Plan
Remediation Plan
RA, EIA
Financial Plan, Reporting ...

It is not just the operator,
the State is also in responsibility ...



Timeline (CDM)



Source: Pollak, M., Wilson, E. (2009): Risk governance for geological storage of CO2 under the clean development mechanism. Climate Policy, 9, 71-87)

Concluding remarks

- A comprehensive site selection process is key (so not a guarantee) for permanent and safe storage of CO_2
- It requires extensive knowledge / expertise on a developers as well as a regulators / permitting authorities site

 - independent experts (an international working group?) evaluating all applications / reports during the site selection process (and over the whole project) migt assist the process

- Site selection based on risk-based approach including Environmental Impact Assessment
- Standardized criteria and procedures are needed