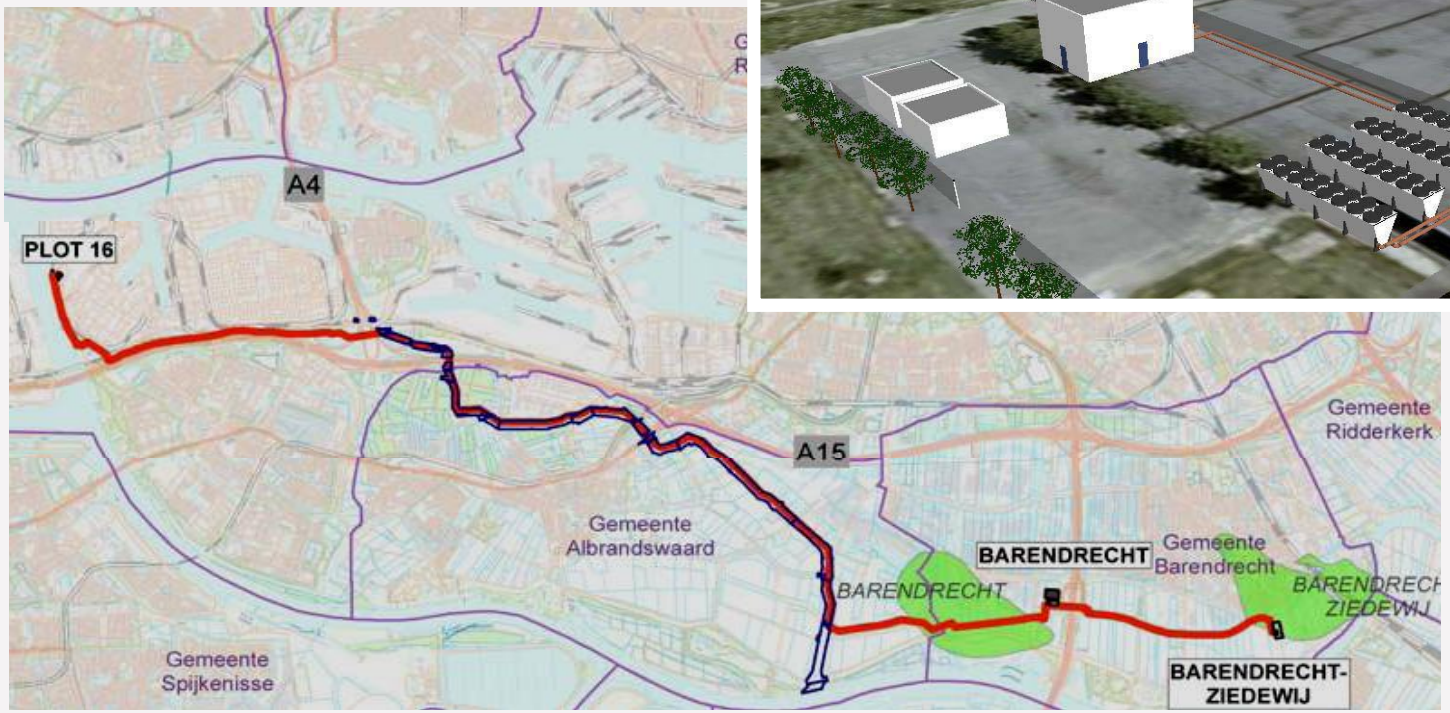
Heleen Groenenberg

ECN Policy Studies

Safety and liability of CO2 storage

CO_2 injection Barendrecht



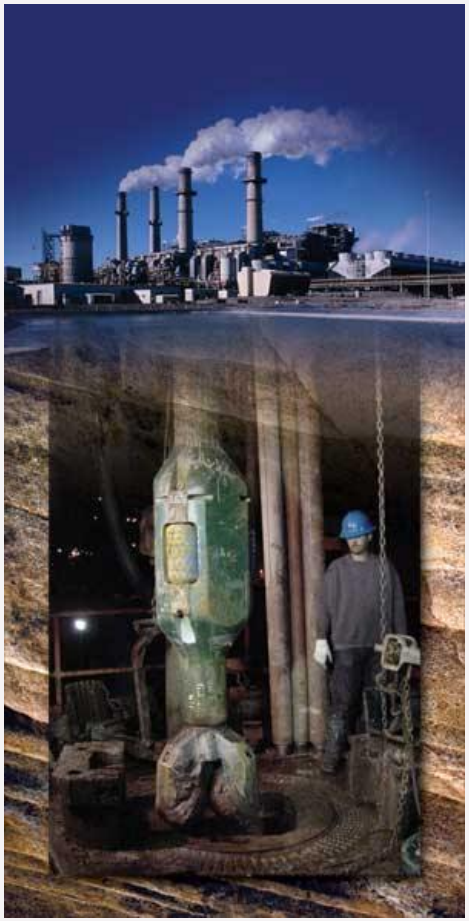
Why Barendrecht ?

- Close to source with pure CO_2
- Geologically very suitable
- Injection through existing wells
- Phased approach

What is an acceptable risk?

What is a good site?

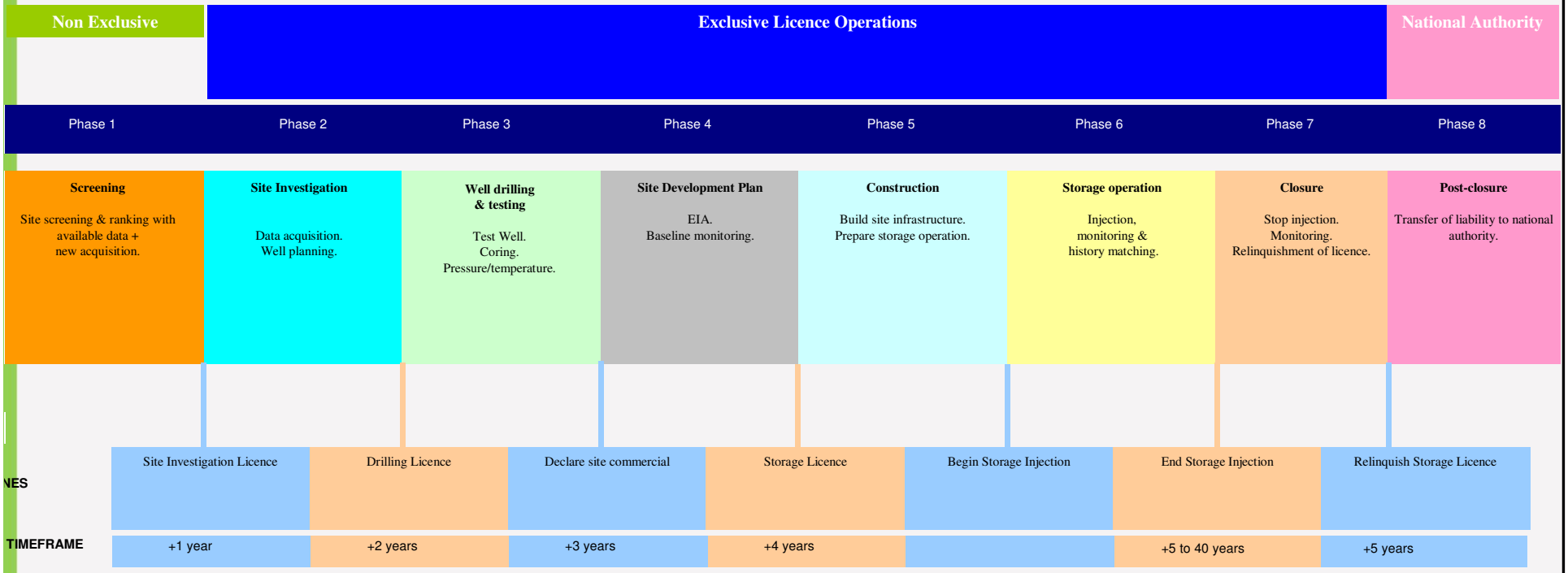
What is good monitoring?



Regulations

- EU Directive Geological Storage of CO_2
- US EPA proposal: Requirements CO_2 sequestration
- Australia (MCMPR): Regulatory guiding principles for CO_2 capture and geological storage
- Best practices

CO_2ReMoVe Draft Guidelines



Site selection

procedural checks *(CO_2ReMoVe)*

1. Screening	2. Site investigation	3. Drilling + testing
CO_2 sources + sinks	leakage pathways	core extraction
infrastructure	trapping mechanisms	down hole logging
volumes, composition CO_2	2+3^{ary} containments	faults, fractures
storage capacity	caprocks	pressure
conflicts of use	flow, chemical modelling	refinement models
select candidates	assess risks	resolve on area extent
site investigation licence	**drilling licence**	**site commercial**

Site selection & risk assessment

procedural checks (*Storage Directive*)

1 Data collection

2 Static 3D model

3 CO_2 flow modelling

Sensitivity characterization

Risk assessment - hazard characterization – *what may happen*

- exposure assessment – *to whom/what*
- effects assessment – *by how much*
- risk characterization - *integration*

à Scientific committee

Site development and operation
procedural checks *(CO_2ReMoVe)*

4. Site development	**5. Construction**	**6. Operation**
EIA	baseline monitoring	CO_2 injection
risk assessment	tender construction work	monitoring (~ plan)
'Safety case long term storage containment'	operational planning	history matching against models
monitoring plan	training personel	performance assessments
contingency plans		risk assessments
well abandonment plan		
Storage licence	**Begin injection**	**End injection**

Monitoring

procedural checks *(Storage Directive, suggested MRGs)*

Monitoring plan with

- temporal, spatial sampling + rationales
- parameters
- technology + justification
- best practice at time of design

- accuracy requirement in MRGs
- MRGs not prescriptive wrt sampling, technologies

Post injection

Procedural checks *(CO_2ReMoVe)*

7. Closure	**8. Post closure**
continued monitoring	no monitoring
conintued history matching	avoid subsurface activity
safety case long term CO_2 containment	responsiblity with authority
removal infrastructure	
well abandonment	
RA, PA reporting	
Relinguishment licence	**Infinite**

Post-closure *(Storage Directive)*

Legal obligations transferred to authority if:

- evidence that CO_2 completely and permanently contained;
- after at least 20 yrs (…)
- financial obligations fulfilled;
- site sealed, injection facilities removed

Then:

- cease inspection
- reduce monitoring (intensify)
- financial security

Conclusions

- Ample material for legal frameworks worldwide (EU, US, Australia, best practice)
- Regulation involves considerable expertise in administrations
- Experience with demos will improve understanding of good sites, acceptable risks, good monitoring
- Procedural checks to be complemented with well-considered public participation strategies

CO2ReMoVe Guidelines available at www.co2remove.eu

contact:

Heleen Groenenberg

ECN Policy Studies

groenenberg@ecn.nl

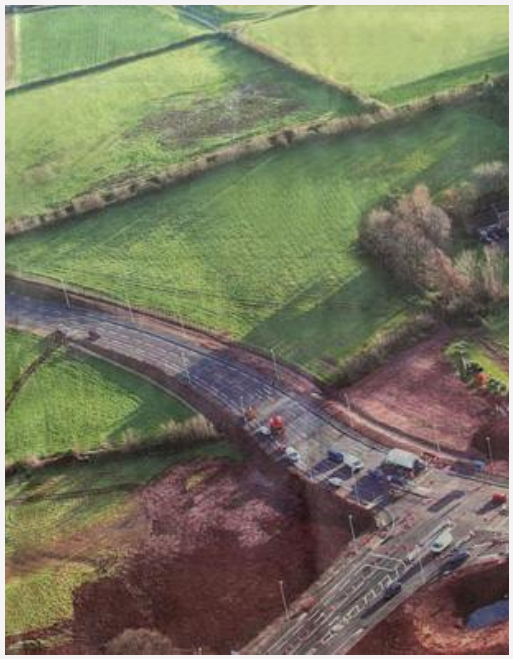
Checklists operators and regulators

Stages licensing procedure
1 Screening
2 Site investigation
3 Drilling and well testing
4 Site development
5 Construction
6 Storage operation
7 Closure
8 Post closure

Milestones
Site investigation licence
Drilling licence
Declare site commercial
Storage licence
Begin injection
End injection
Relinguish licence

EIA criteria affect site selection

soil	*movement, disturbance, quality*
water	*groundwater, surface water*
ecology	*flora, fauna, valued areas*
landscape	*visibility, impact*
archeology	*disturbance*
noise	*neighbours, nature*
emissions	*air, smell, light*
traffic	*# movements, local + group risk*
waste	*waste processing*
energy	*use, supply, CO_2 leakage*
subsoil	*reservoir, surroundings, monitoring, other functions*



Post-closure *(Storage Directive)*

After transfer of responsibility, routine inspections .. shall cease and monitoring may be reduced ...

If .. leakages .. are identified, monitoring shall be intensified ...

(Art 18.6)

Financial security or similar:

- required to comply with permit obligations (post-closure, ETS)
- proof in permit application
- valid/effective after closure

(Art 19)