

# CO<sub>2</sub> STORAGE ASSESSMENT RECENT PROJECTS

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## CO<sub>2</sub> storage assessment

- › Europe
  - › Activities ongoing since about late 1990's
    - › Inventories of estimated storage capacities
    - › Inventories of emission points (capture potential)
  - › Methods to assess storage potential unified since a few years
    - › Applies mostly to (previously unused) saline formations
- › Europe, Member States
  - › Storage atlases (UK, Norway, Netherlands)
- › World
  - › Storage atlases developed in US, Australia, Mexico, *etc.*

Funded by EU,  
supported by  
Member States

E.g.: GESTCO,  
Geocapacity,  
CO2Stop

EU based  
projects; CSLF  
efforts;  
IEA working group

Aim atlases:  
provide data to  
stakeholders



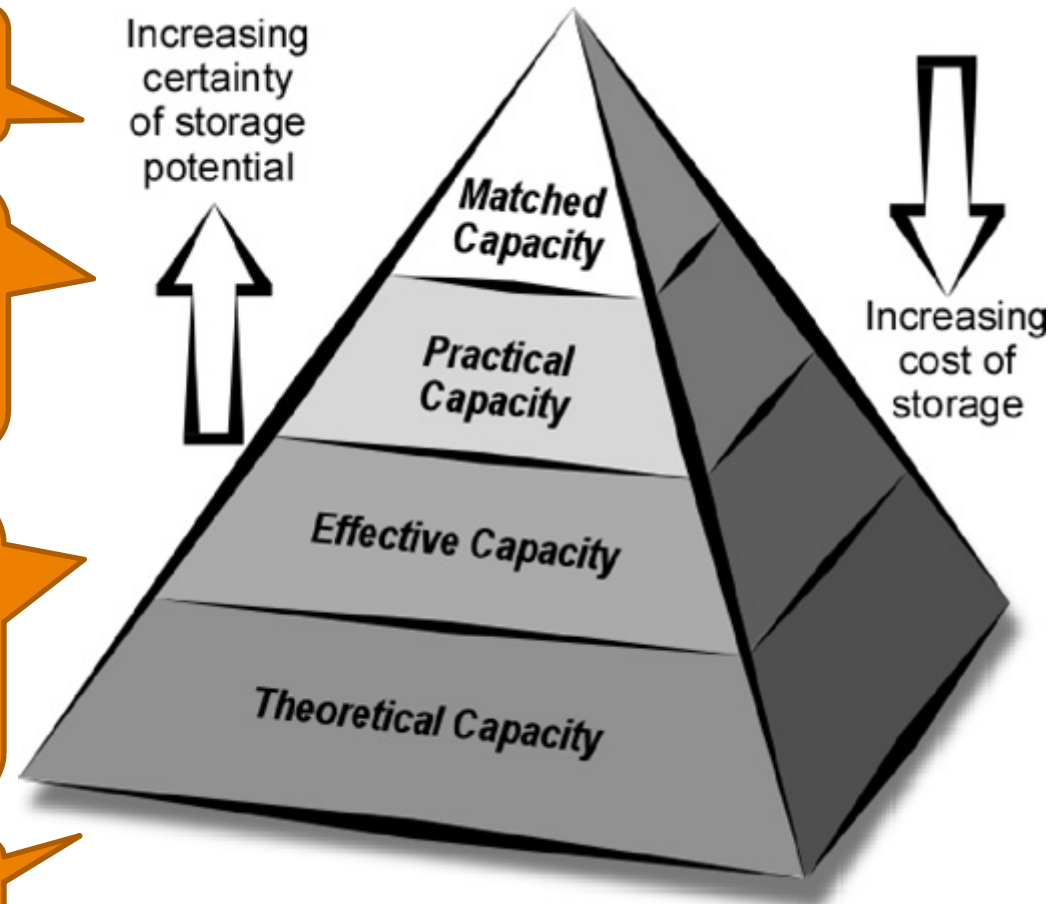
## CO<sub>2</sub> storage potential assessment

Detailed design  
Example: ROAD project

- Depleted field, detailed characterisation
- Saline formation, after extended injection test

- Saline formations after detailed study before injection test
- Depleted fields, before detailed study

After screening study



Source: CSLF



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## Storage assessment: Europe

# European storage prospectivity map

- Large CO<sub>2</sub> point sources
- Sedimentary basins

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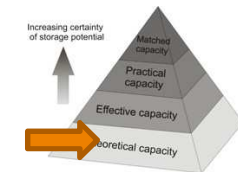
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[www.geocapacity.eu](http://www.geocapacity.eu)

- Large CO<sub>2</sub> point sources
- Sedimentary basins  
(~ saline formations)



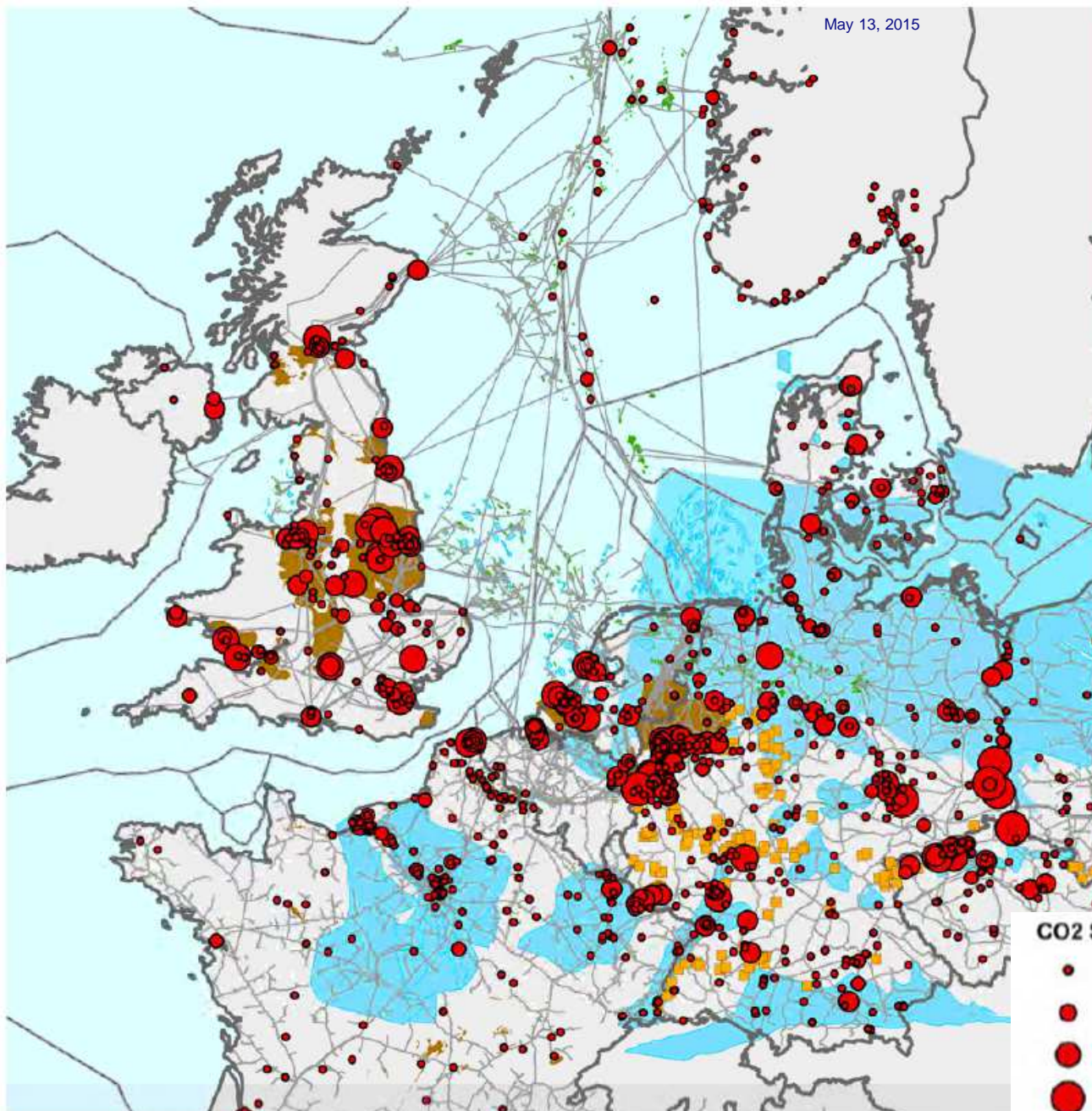
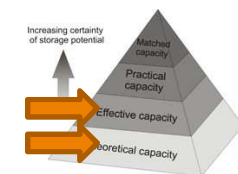


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[www.geocapacity.eu](http://www.geocapacity.eu)



GeoCapacity maps of Sources & Sinks

CO2 Sources Mt/year

- 0.001 - 1.000
- 1.001 - 2.000
- 2.001 - 5.000
- 5.001 - 10.000
- 10.001 - 32.000

- Natural CO2 Sources
- Pipelines
- National Boundaries
- Aquifers
- Hydrocarbon Fields
- Coal Fields



# CO<sub>2</sub> emissions in Europe

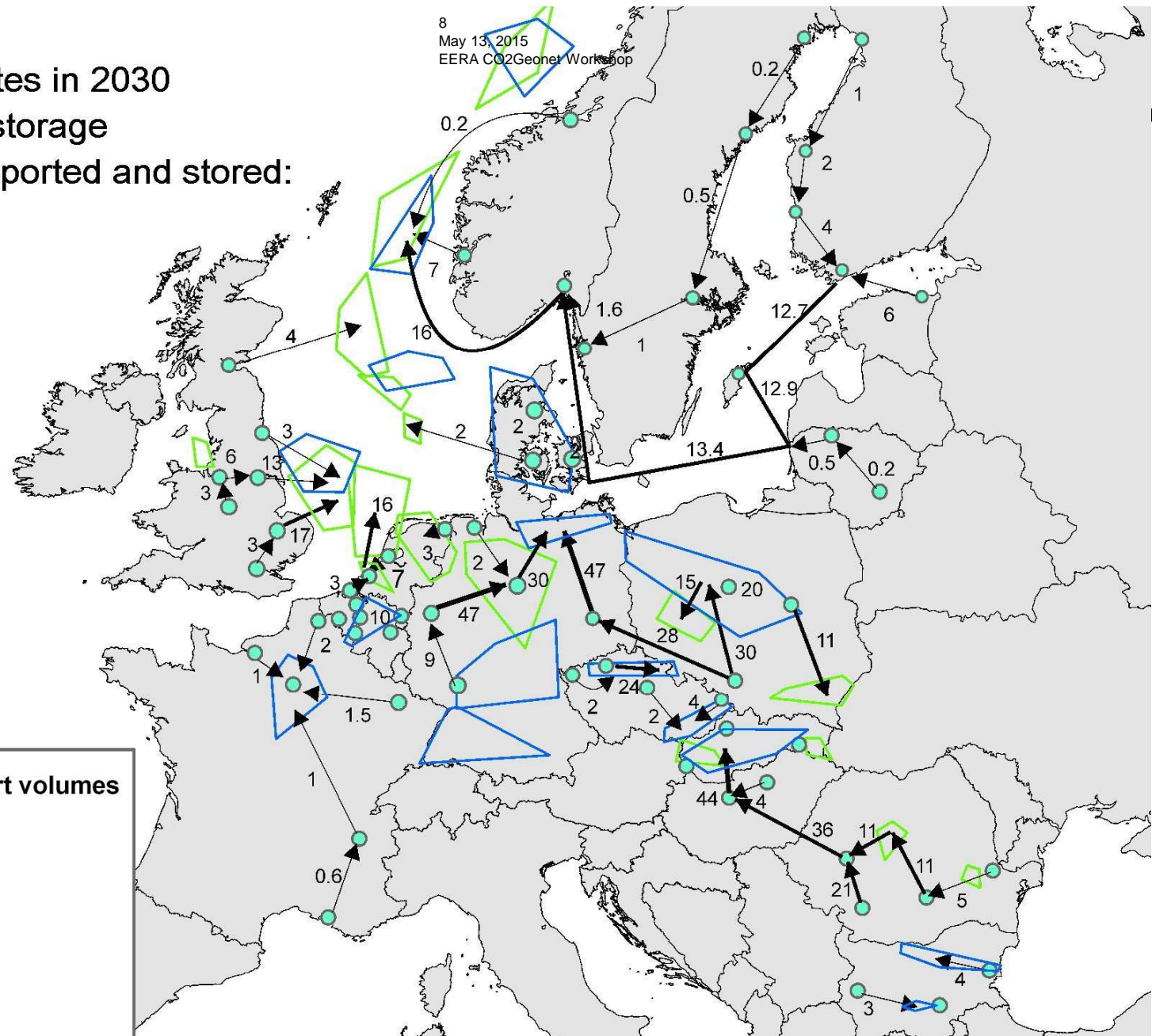
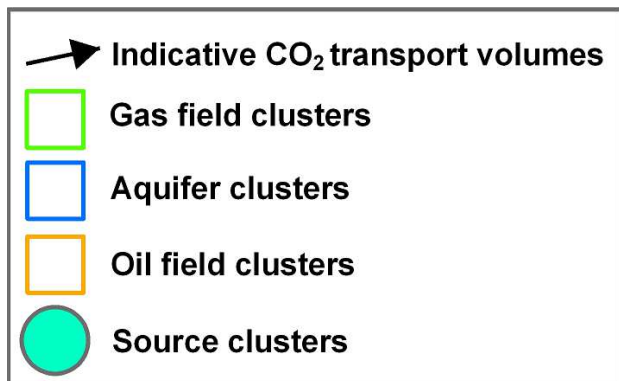
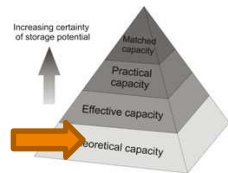




# CO<sub>2</sub>Europeipe

## Map of transport routes in 2030

- Onshore + offshore storage
- Total captured, transported and stored:  
400 Mt/yr





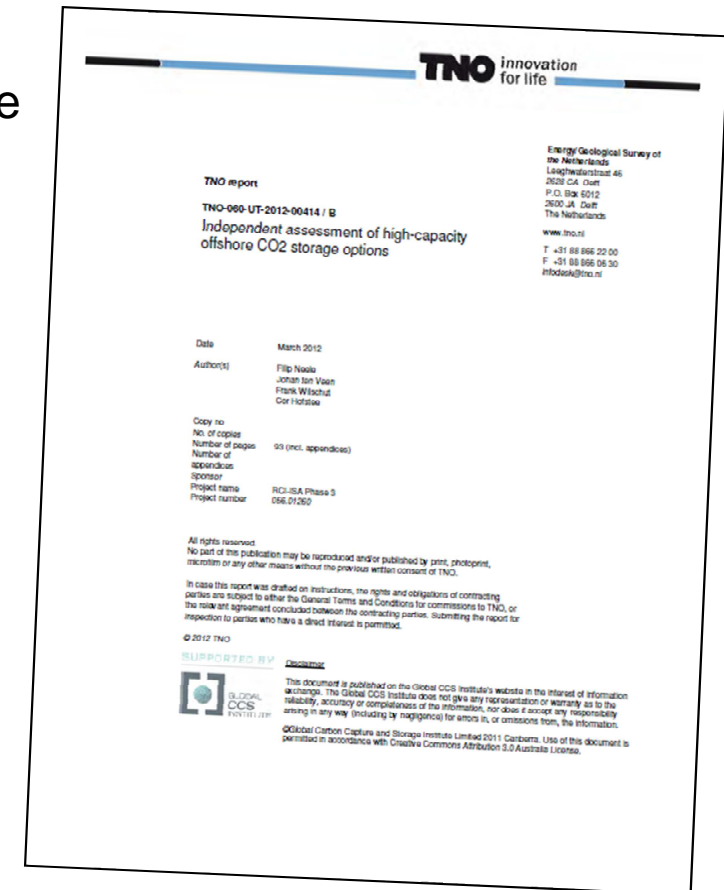
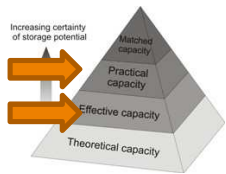


## Storage assessment: country level



## Screening in The Netherlands

- › Inventory of offshore, large-scale storage options
  - › Published 2012
  - › (Depleted) gas fields
  - › Gas field clusters
  - › Saline formations
- › Ranking of options
- › Cost estimates (re-use vs. new build)
- › Timeline and approach site development



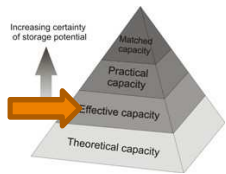
<http://www.globalccsinstitute.com/sites/www.globalccsinstitute.com/files/publications/35621/independent-assessment-high-capacity-offshore-co2-storage-options-opt.pdf>



## Depleted gas fields

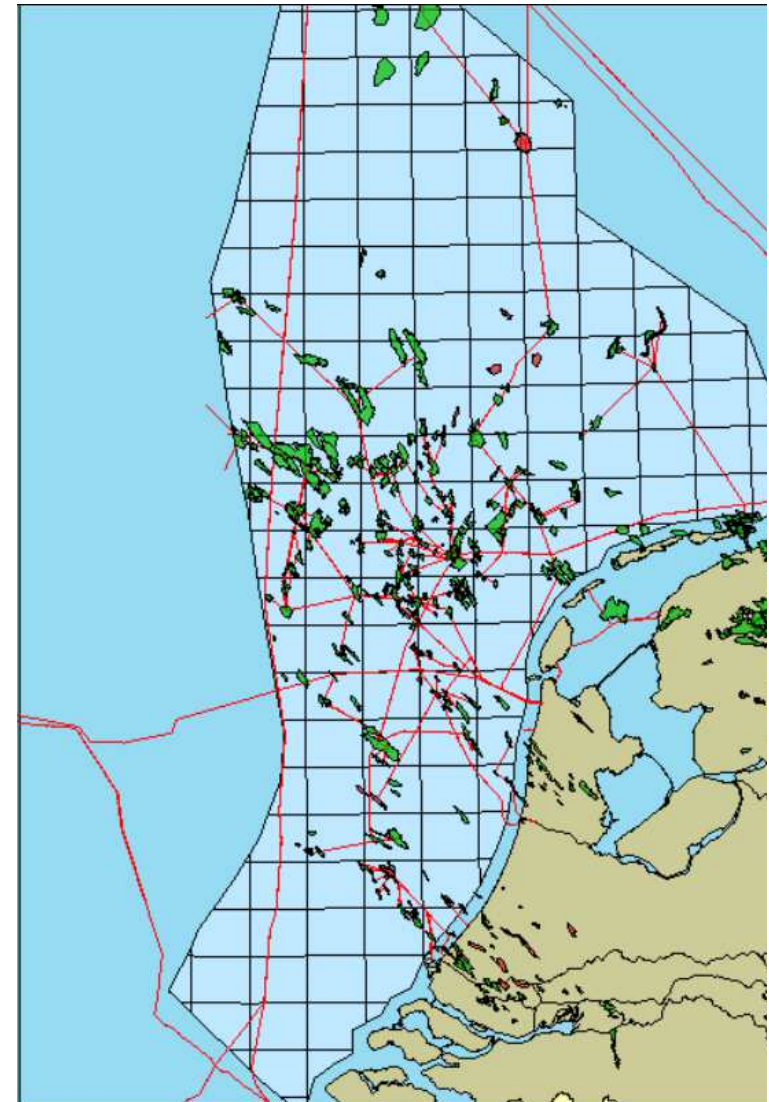
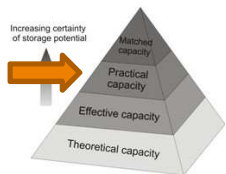
### Data

- › Field data provided by operators
- › Existing installations
  - › Age platform, # of wells, # of abandoned wells
- › Public parts of O&G fields production plans: [www.nlog.nl](http://www.nlog.nl)



### Results

- › Identification of issues
  - › Wells, platforms, availability (end of production)
- › Storage capacity, injection rates
- › Cost estimates
- › Several fields: detailed analysis

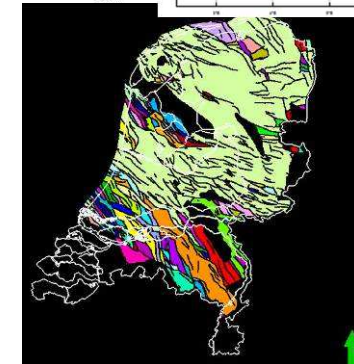
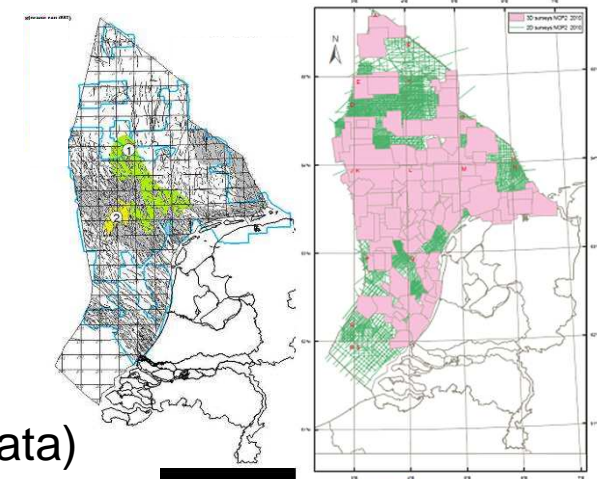
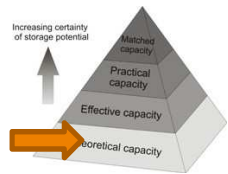






## Saline formations

- › Combined:
  - › Regional extension of formations
  - › Fault maps (faults identified from seismic data)
    - › 3D data (best quality), 2D data (lower quality)
  - › Thickness maps
  - › Porosity maps
  - › Gas field production data
- › Major offshore reservoir formations considered



- › Result
  - › Maps of compartmentalisation
  - › Estimates of compartment size (in MtCO<sub>2</sub>), using 2% storage efficiency
  - › Likelihood of presence of compartments

Lower Slochteren Formation  
Upper Slochteren Formation  
Triassic Fms (combination)  
Lower Cretaceous



## Saline formations

### › Classification

› Class A: poor option, high certainty

› Good data, no appropriate structures

› Class B: poor option, low certainty

› Missing or low-quality data, no appropriate structures

› **Class C: good option, low certainty**

› Reasonable data, appropriate structures

› **Class D: good option, high certainty**

› Good data, appropriate structures

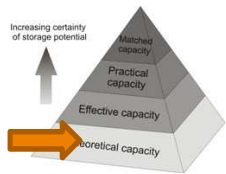
Examples of classification:

← Good fault data (3D seismic),  
compartments small

← 2D seismic, no good  
definition of compartments

← 2D seismic, but  
additional information  
from gas field properties

← 3D seismic +  
geological knowledge

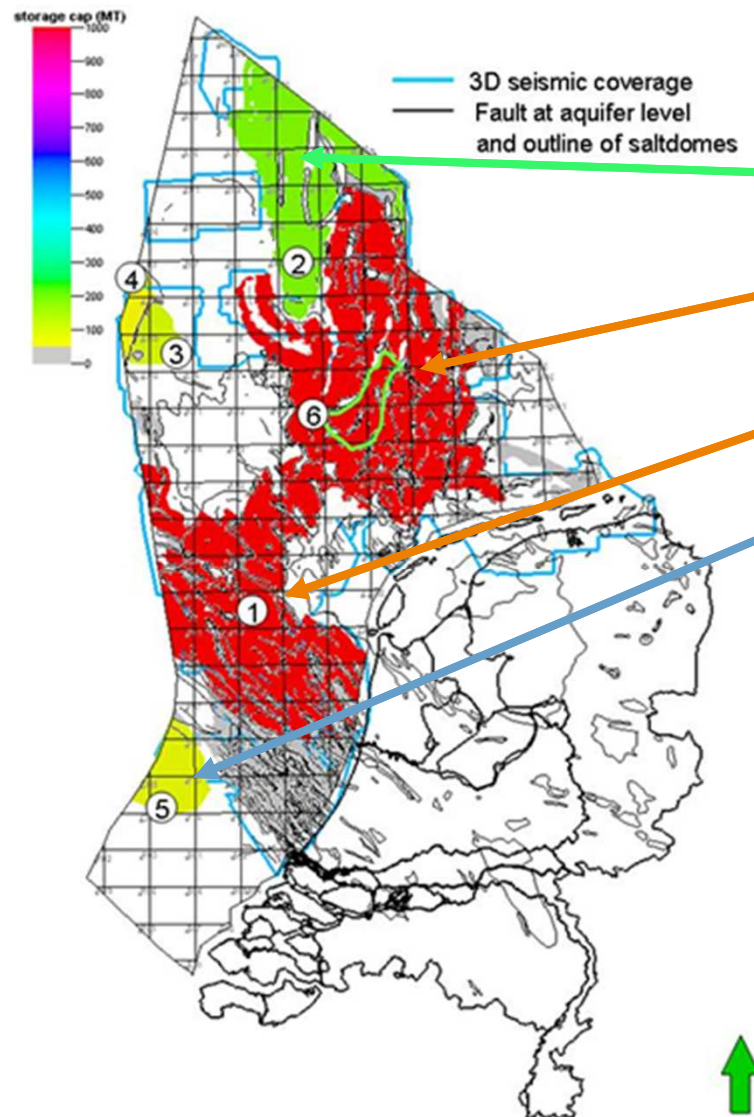
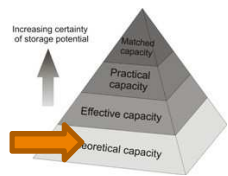




## Triassic (stacked reservoirs) - capacity

Conclusion after data analysis:

- Step Graben: absence of faults may not be real; formation continues into GE, DK
- Potential compartments in northern salt province have capacity ~ **75 Mt**
- Southern half of Triassic: connected volumes unlikely to be large enough
- Large compartments in south due to absence of fault information (**not realistic**)

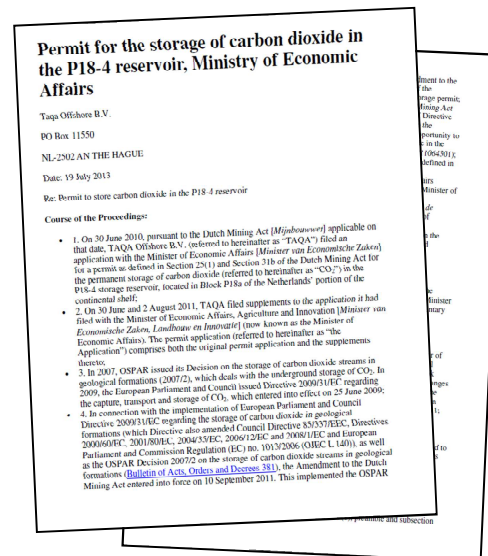
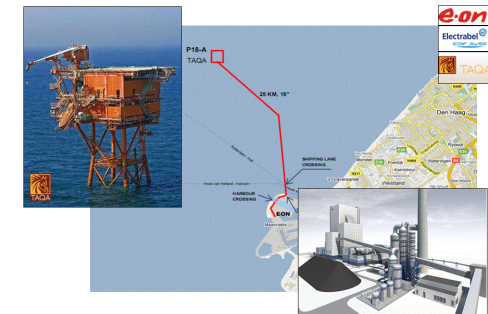
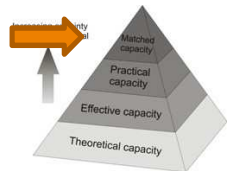






## ROAD project – first storage permit under EU Directive

- ▶ Storage permit successfully reviewed by the Commission, which has given its first Opinion (a second is to follow prior to injection) <sup>(1)</sup>
- ▶ **Storage permits published July 2013, now irrevocable** <sup>(2)</sup>
- ▶ Project currently negotiating with EU and Member States to close financial gap (due to low ETS price)
- ▶ Project ready to start – upon FID



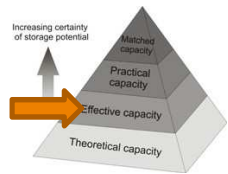
(1) [https://www.rvo.nl/sites/default/files/2014/02/B06\\_1 Commission Opinion.pdf](https://www.rvo.nl/sites/default/files/2014/02/B06_1_Commission%20Opinion.pdf)

(2) [https://www.rvo.nl/sites/default/files/2014/02/B06 Storage permit TAQA English.pdf](https://www.rvo.nl/sites/default/files/2014/02/B06%20Storage%20permit%20TAQA%20English.pdf)

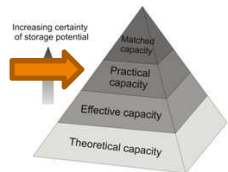


## Site characterisation methodology

- › Workflow for screening and characterising potential CO<sub>2</sub> storage sites
- › Risk based
- › Condensed experience and expertise of SiteChar partners, tested and published in the EU FP7 SiteChar project



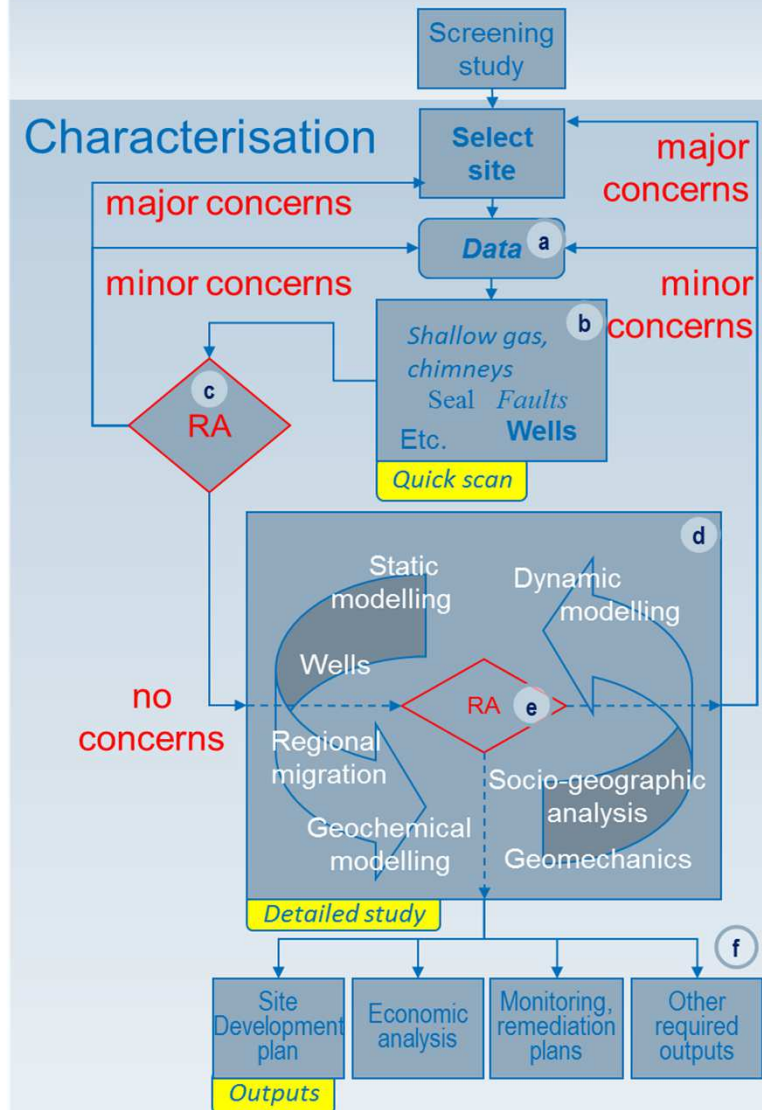
or



<http://www.sitechar-co2.eu/FileDownload.aspx?IdFile=812&From=Publications>

### Screening

### Characterisation

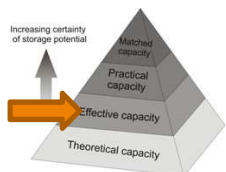
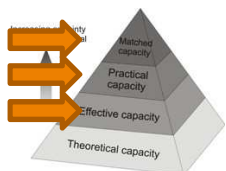
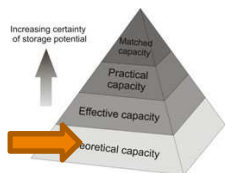


After: SiteChar project



## High-capacity CO<sub>2</sub> storage options in Netherlands

	High-capacity options?	Timing	Comments
Saline formations	Yes <b>1.5 Gt</b>	2015 – 2020 (225 Mt) Post 2020 (rest)	Theoretical capacity High risk - high reward Re-use?
Gas fields, Gas field clusters	Yes <b>350 Mt</b> (fields) <b>650 Mt</b> (clusters)	Starting ~2020	Re-use options Risk aspects: wells, existing installations, timing of individual fields
Oil fields	No	Varies	Feasibility CO <sub>2</sub> -EOR depends on <i>many</i> factors; mutual benefits with CCS possible







## Storage capacity assessment: what is needed?

- › Storage assessment on critical path of CCS project development
  - › Long lead time (7-10 yr from idea to injection)
- › Availability of proven storage capacity is major hurdle to CCS development
- › Storage at 'Matched capacity' level helps!
  - › Storage: certainty about storage
  - › Transport: end points of pipelines and / or ship routes
  - › CCS stakeholders: long-term planning possible
- › Recommendation: provide a certain amount of certified storage capacity
  - › 'Practical' or 'Matched'?
  - › Fully or 'almost' permitted?



## References

### Independent Storage Assessment studies

- › ISA 1: Methodology report
- › <http://cdn.globalccsinstitute.com/sites/default/files/publications/15421/co2-storage-capacity-assessment-methodology.pdf>
- › ISA 2: Summary report of detailed field characterisation for CO<sub>2</sub> storage
- › <http://cdn.globalccsinstitute.com/sites/default/files/publications/15416/independent-storage-assessment-offshore-co2-storage-options-rotterdam-summary-report.pdf>
- › ISA 3: high-capacity storage options for CO<sub>2</sub> in Netherlands offshore
- › <http://cdn.globalccsinstitute.com/sites/default/files/publications/35621/independent-assessment-high-capacity-offshore-co2-storage-options-opt.pdf>
- › ISA 4: economic assessment of CCS networks in The Netherlands
- › <http://www.globalccsinstitute.com/sites/www.globalccsinstitute.com/files/publications/101121/transport-storage-economics-ccs-networks-netherlands.pdf>



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