



The European Network  
of excellence on the  
Geological Storage of CO<sub>2</sub>

# Assessment of storage options, potential and capacity in Europe

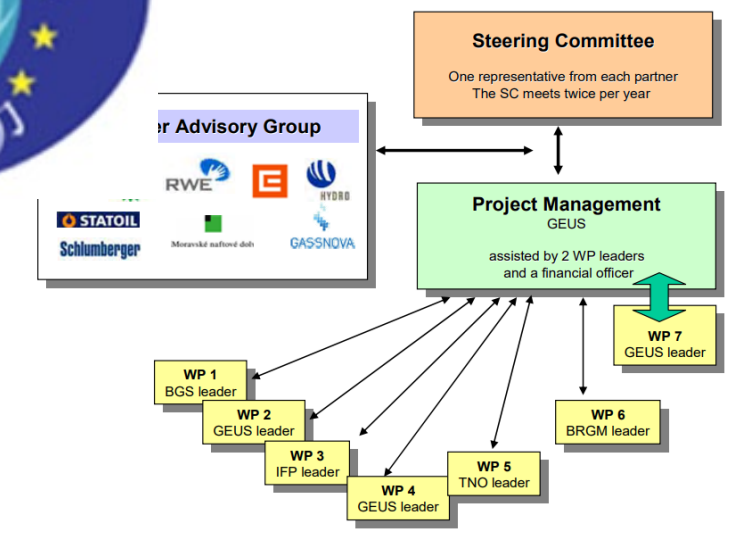
Vit Hladik (Czech Geological Survey)

CO<sub>2</sub>GeoNet Webinar State of Play of CO<sub>2</sub> geological storage  
21 February 2022



# History of European assessment of CO<sub>2</sub> storage potential

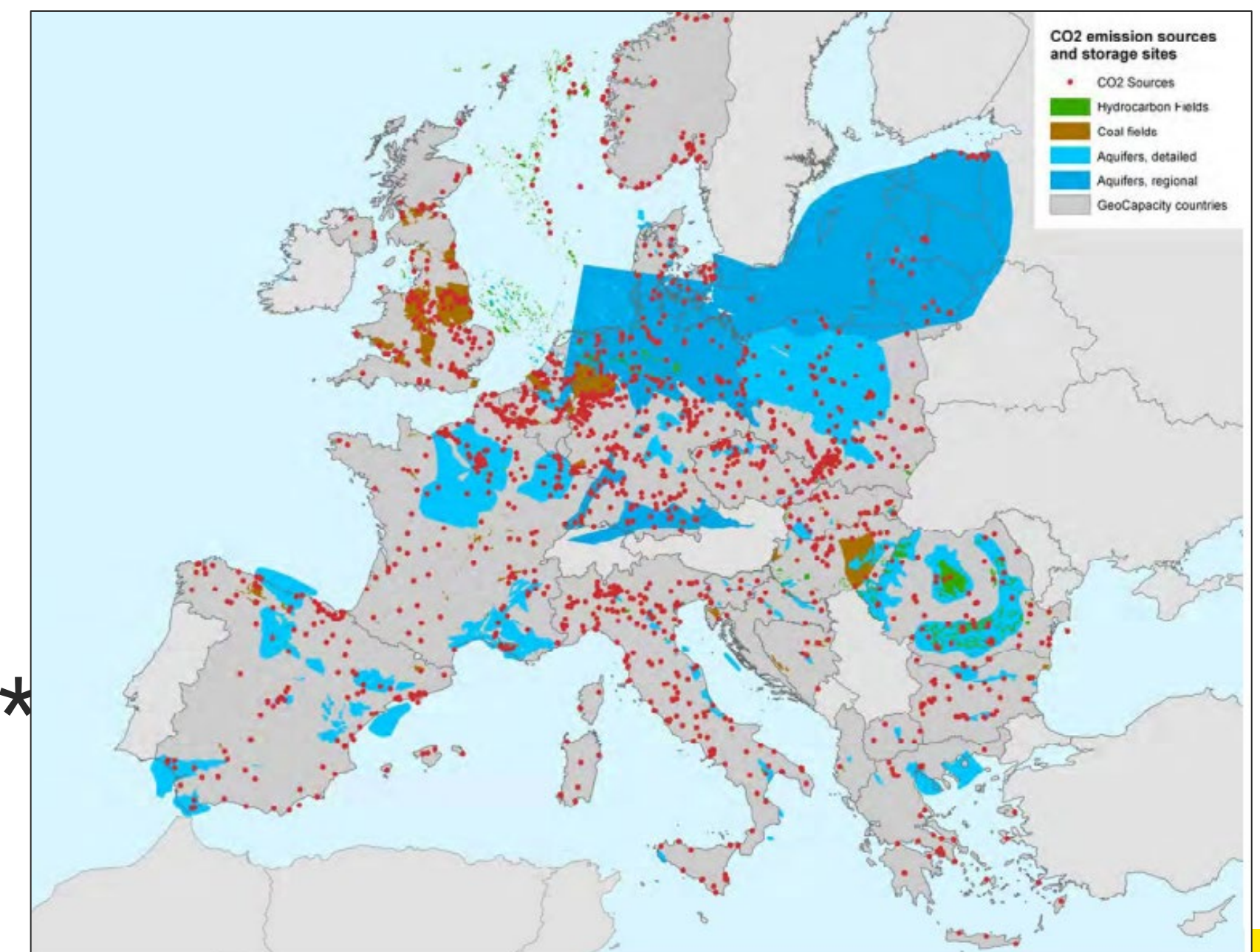
- JOULE2 (FP3, subactivity II.5 Energy) 1996
- GESTCO (Geological Storage of CO<sub>2</sub> from Combustion of Fossil Fuel; FP5) 2000-2003
- CASTOR (CO<sub>2</sub> from Capture to Storage; FP6) 2004-2008
- EU GeoCapacity (Assessing European Capacity for Geological Storage of Carbon Dioxide; FP6) 2006-2008
- CO<sub>2</sub>StoP (CO<sub>2</sub> Storage Potential in Europe; EC contract under FP7) 2012-2013



# EU GeoCapacity (2006-2008)



- The most comprehensive activity on mapping pan-European CO<sub>2</sub> storage potential to date; 25 countries covered; comprehensive country reports and case studies produced
- Main result = a GIS-linked, pan-European database of CO<sub>2</sub> storage potential; includes both public and confidential data; therefore, not made freely available in the public domain
- Reports still available at [www.geocapacity.eu](http://www.geocapacity.eu)
- Estimations of European CO<sub>2</sub> storage potential:
  - 96 Gt in saline aquifers
  - 20 Gt in HC fields
  - 1 Gt in unmineable coal beds(compare with 587 Mt/yr of industrial emissions)\*

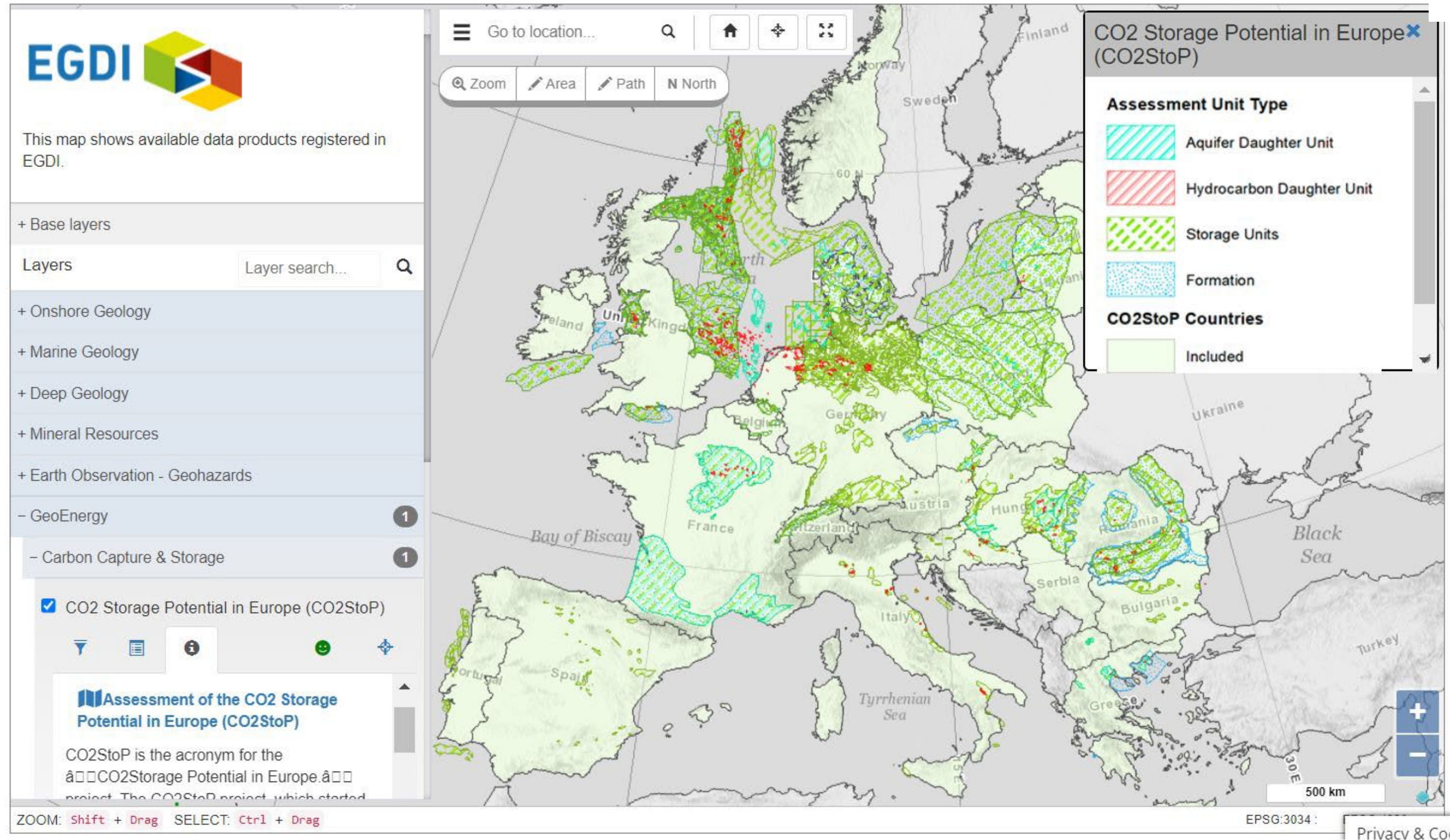


# CO<sub>2</sub>StoP (2012-2013)



- Main goal = establish a database of publicly available data on CO<sub>2</sub> storage potential in Europe; limited budget, only existing data used
- 27 countries covered; EU GeoCapacity data largely used, confidential data removed; updates provided by several countries, largely based on work funded at national level; improved methodology for storage potential assessment applied but no pan-European results published
- Project results – CO<sub>2</sub> storage database, GIS application (ESRI's ArcGIS 10), calculation engine capable of providing probabilistic estimates of CO<sub>2</sub> storage capacity, Data Analysis/Interrogation Tool able to perform calculations of storage capacity and injection rates with stochastic analyses
- Data first housed by the EC Joint Research Centre in Petten, made broadly available to the public only in 2020; publicly available online on the EGDl map portal of EuroGeoSurveys

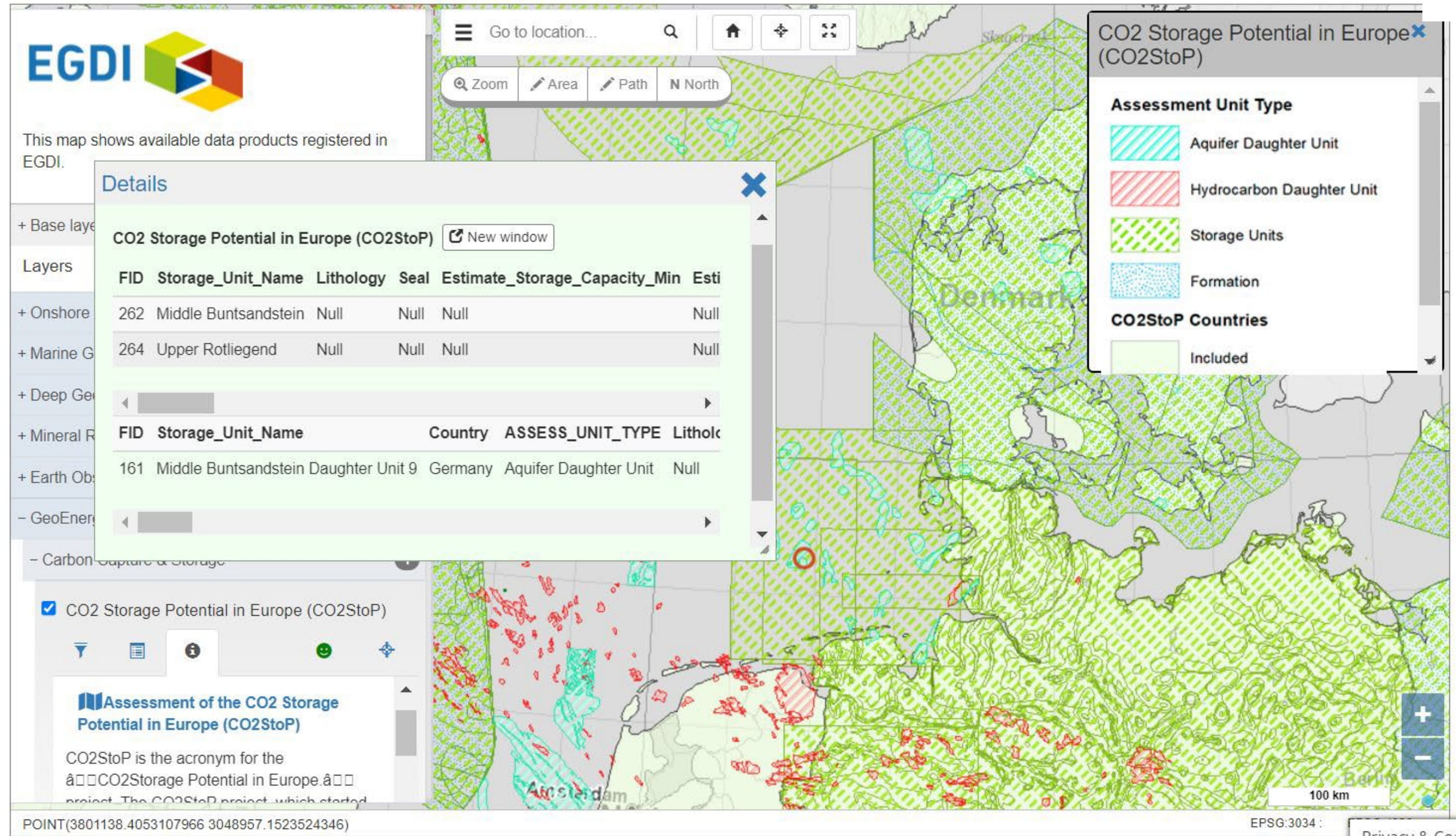
# CO<sub>2</sub>StoP results at EGD portal



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<https://www.europe-geology.eu/map-viewer>

# CO<sub>2</sub>StoP results at EGDl portal



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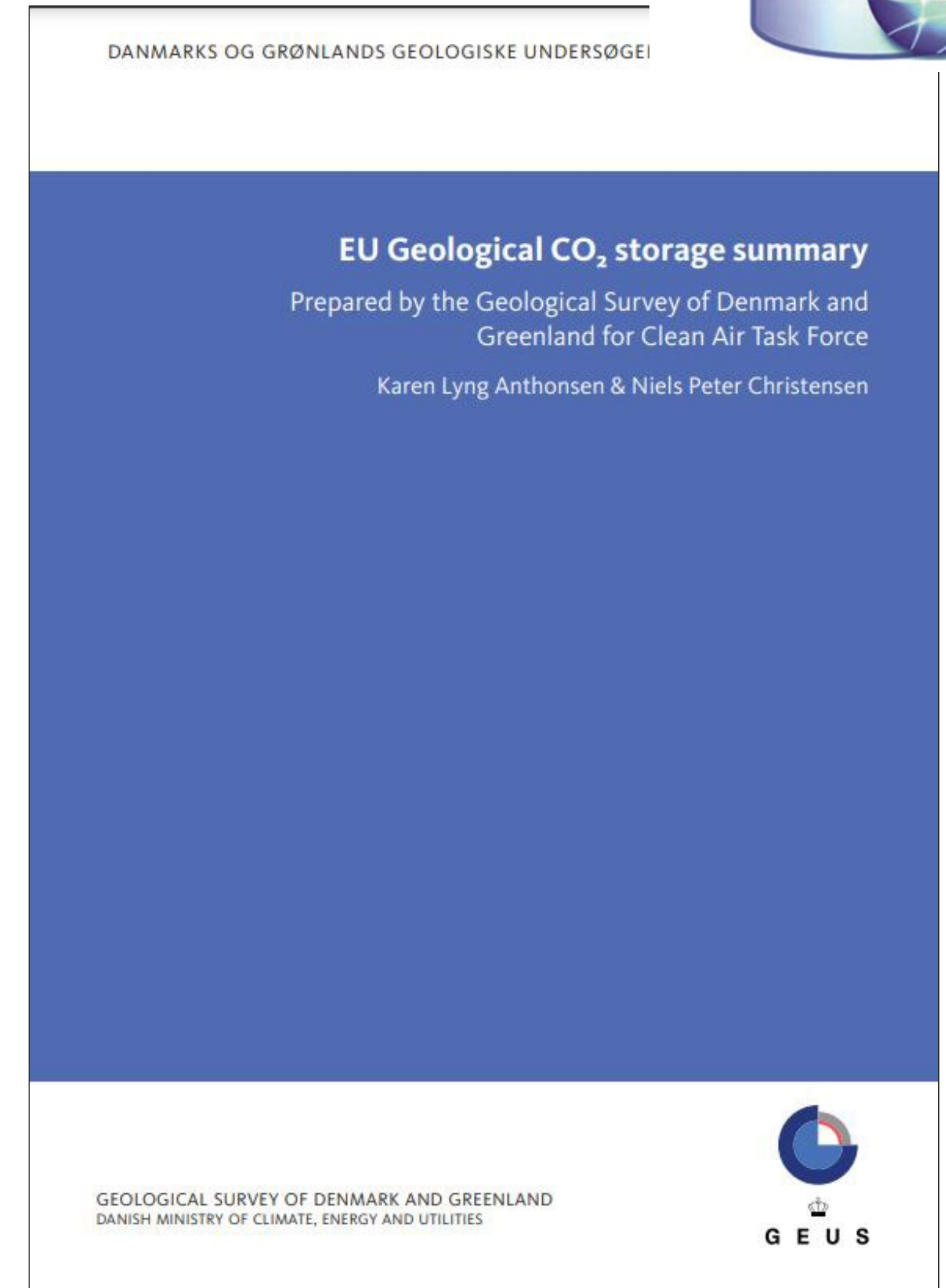
<https://www.europe-geology.eu/map-viewer>

# CO<sub>2</sub>StoP results publication



- EU Geological CO<sub>2</sub> storage summary; prepared by GEUS for Clean Air Task Force
- Published in October 2021
- Estimations of European CO<sub>2</sub> storage capacity (based on CO<sub>2</sub>StoP data and methodology):
  - 482 Gt in saline aquifers (= storage units)
  - 31-54 Gt in storage reservoirs (= aquifer daughter units)
  - 25 Gt in hydrocarbon fields (= hydrocarbon fields daughter units)

<https://www.catf.us/resource/eu-geological-co2-storage-report/>



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# Developments after 2013

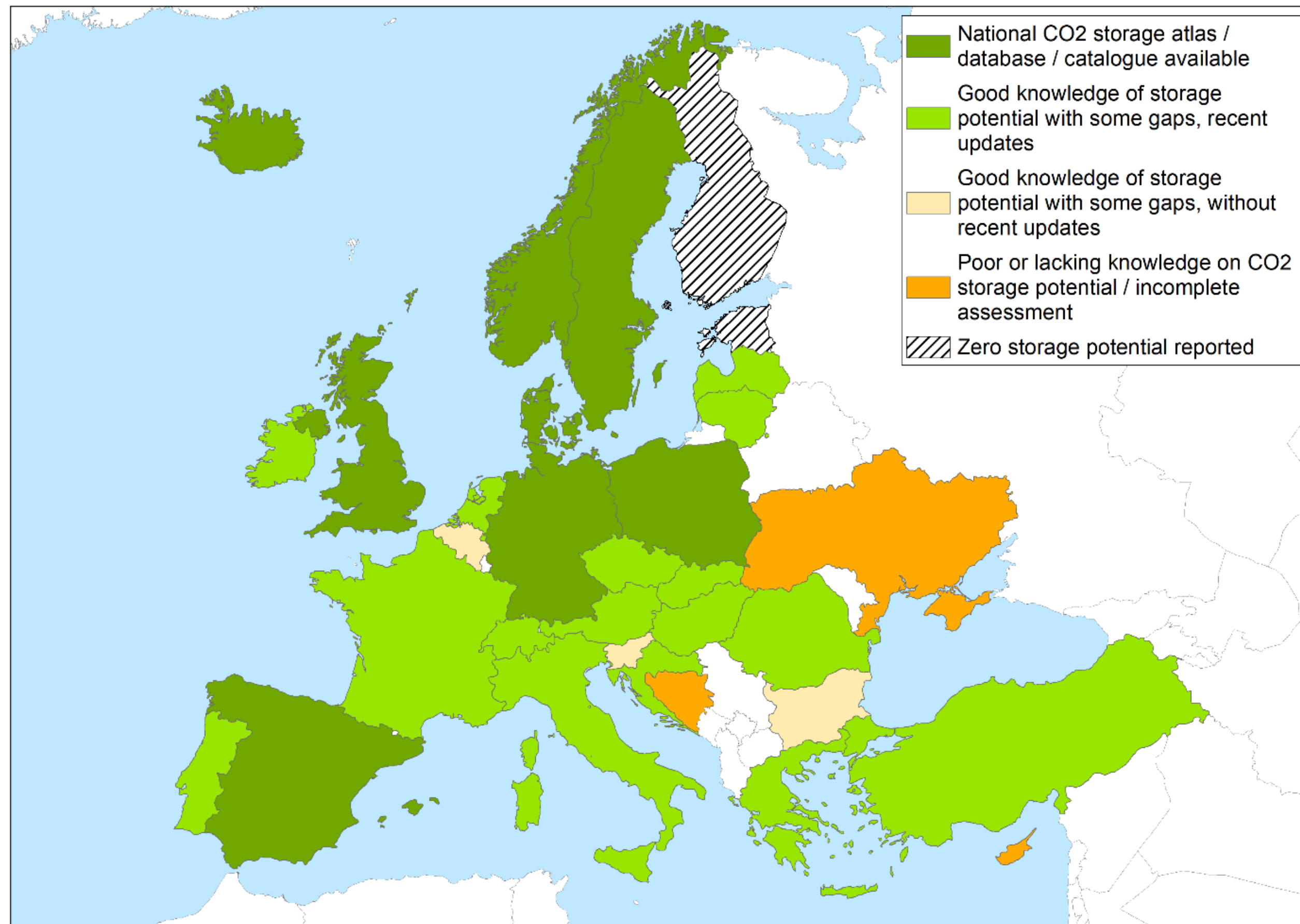
- Storage capacity evaluation updates reported by **25 countries** - strong argument for the value of a new pan-European CO<sub>2</sub> storage atlas
- Updates ranging from thorough storage capacity assessments or re-assessments on country or even transnational levels, to updates focusing on selected regions or clusters of potential storage sites.
- **Notable examples of new developments** – Nordic CO<sub>2</sub> Storage Atlas, UK storage database CO<sub>2</sub> Stored, CO<sub>2</sub> Storage Atlas of the Norwegian Continental Shelf, Spanish Atlas of Subsoil Structures Susceptible to CO<sub>2</sub> Storage (AlgeCO<sub>2</sub>).
- **Significant developments** of storage capacity assessment or re-assessment at a national level achieved in Hungary, Ireland, Italy and the Netherlands

# Notable examples of new development



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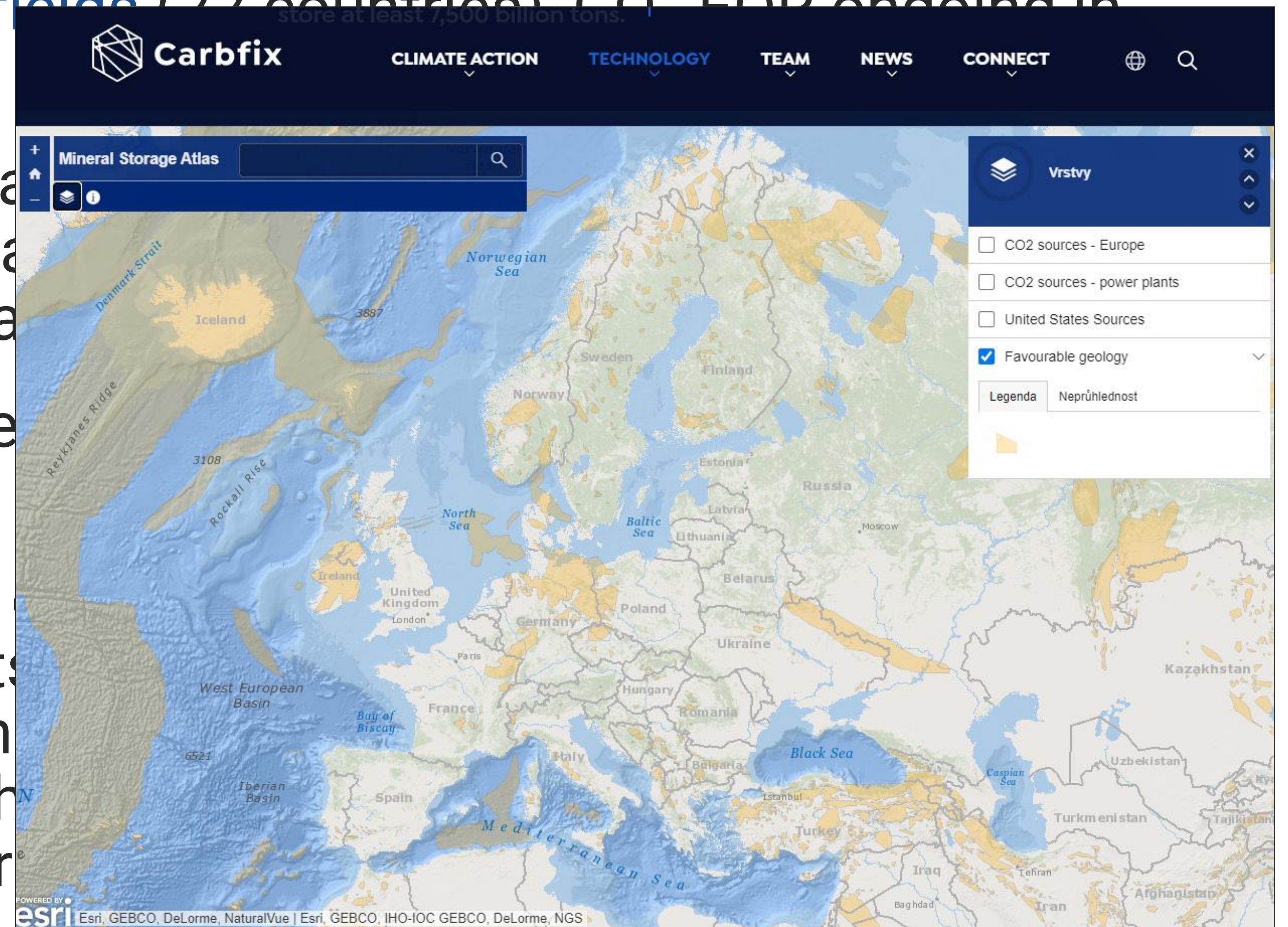
# Status of CO<sub>2</sub> storage potential assessment in European countries



- national CO<sub>2</sub> storage atlas / database / catalogue available for 8 countries – DNM, GER, ICL, NOR, POL, SPA, SWE, UK
- good knowledge, recent updates – 16 countries
- good knowledge without recent updates – 3 countries – BEL, BUL, SLO
- ongoing / incomplete assessments, poor or lacking knowledge in 3 countries – CYP, BIH, UKR
- no storage potential – EST, FIN

# Storage options

- Prevailing types of structures considered = saline aquifers (25 countries), depleted/depleting hydrocarbon fields (22 countries), CO<sub>2</sub>-EOR ongoing in 3 countries (CRO, HUN, TUR)
- Offshore sites = the preferred location with a focus on the North Sea as a potential has been identified so far
- Storage capacity in coal seams redevelopments
- Iceland - pioneer and an advocate of ultramafic rocks, especially basalts, has injected water before or during its injection and has launched “Mineral Storage Atlas” for mineral storage in Europe and world



# Way forward

- Progress in storage capacity evaluation expected in many countries
- New European CO<sub>2</sub> storage atlas necessary, taking the recent progress and expected development of CCS into account
- The need reflected by the EU SET-Plan Action No 9 CCS and CCU and its Implementation Plan - R&I Activity 4: 'Establish a European CO<sub>2</sub> Storage Atlas' included in 2017 with the intention of this work being completed by 2020 – not achieved(?)
- SET-Plan update - target No 5 for CCS/CCU: 'An up-to-date and detailed inventory of the most suitable and cost-effective geological storage capacity (based on agreed methodology), identified and accepted by various national authorities in Europe'
- CCUS Roadmap to 2030

*Action: Priority regions for appraisal should be identified, using the proposed online open-access European Storage Atlas as a foundation and establishing recommendations and responsibilities for development.*



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## The Need for a CO<sub>2</sub> Geological Storage European Atlas

**What is CO<sub>2</sub> Geological Storage?** Capturing carbon dioxide (CO<sub>2</sub>) emissions from various point sources and storing it underground is a crucial technology to reduce the global warming impact of fossil fuels such as coal and hydrocarbons, on which the world will continue to depend for decades. This method of restricting the release of CO<sub>2</sub> into the atmosphere is termed carbon capture and storage (CCS), or CO<sub>2</sub> geological storage, when referring only to the downstream part of CCS.

CCS usually involves a series of steps:

- Separating the CO<sub>2</sub> from the gases produced by large power plants or other point sources.
- Compressing the CO<sub>2</sub> into dense (supercritical) form.
- Transporting it to a given location.
- Injecting it into deep underground geological formations.

The science and technology behind CCS is already manifested and has been in use for enhanced oil recovery (EOR) since the 1950's and for CO<sub>2</sub> geological storage since 1996. Further development of CCS is needed, however, if it is to be implemented on a large scale. A number of CCS demonstration projects are now at various stages of development in Europe and other parts of the world.

The EU aims to promote the construction and operation of a number of CCS demonstration projects by 2015 in order to stimulate the role that CCS can play in a portfolio of greenhouse gas mitigation options. ENeRG is aware that we require coherent information about effective CO<sub>2</sub> storage capacity, where this storage capacity is and when it will be available.

**Storage Atlas:** Most of the EU member states and associated countries participated in the EU GeoCapacity project and even more countries are now involved in the CO<sub>2</sub>StoP project. The European Commission initiated the project CO<sub>2</sub>StoP to establish a database on publicly available data on CO<sub>2</sub> storage potential in Europe. The CO<sub>2</sub>StoP project is building upon the basic work and results generated by the previous projects, the EU GeoCapacity FFS R&D project (2006-2008) which again was based upon the results of the Jule II project (finalised 1995), the GESTCO project (finalised 2003), and the CASTOR project (finalised 2007). ENeRG considers the CO<sub>2</sub>StoP project as a very important step and that this area needs to be further developed.

# Way forward

- Horizon Europe call: Sustainable, secure and competitive energy supply (HORIZON-CL5-2021-D3-02), TOPIC ID: HORIZON-CL5-2021-D3-02-14 Support to the activities of the European Geological Services (closed 05/01/2022)



**Topic description**

ExpectedOutcome:

Project results are expected to contribute to all of the following expected outcomes:

- An improved evidence-based decision-making and long-term sustainable management of Europe's subsurface, including offshore, needed to build a climate neutral continent.
- Comprehensive inventory of harmonised data on primary raw materials in Europe, with a focus on applications of critical raw materials<sup>[1]</sup> for energy storage and power generation, resulting in a higher level of independence for Europe.
- **Comprehensive inventory of information on geothermal energy resources and subsurface storage capacities for sustainable energy carriers (hydrogen, heat and cold) and sequestration of CO<sub>2</sub>, based on common and national scale assessment criteria and standardised reporting.**
- Improved appraisal, protection and sustainable use – including appraisal of capacities for temporary storage - of Europe's groundwater resources, which are under increasing pressure because of climate change and competing uses of the subsurface. Improved adaptation of coastal zones to the effects of climate change and sea level rise.
- A strong and sustainable network of national Geological Survey organisations in order to provide geological knowledge and services on a Pan-European level.

- Deploying and maintaining a European storage atlas for CO<sub>2</sub> and sustainable energy carriers = one of 12 key issues to be addressed



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# Thank you for your attention

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