



EUROPEAN STORAGE ATLAS MAPPING AND ENSURING EUROPEAN STORAGE POTENTIAL

NIELS POULSEN



"Increasing momentum for CO₂ storage"

11th CO₂GeoNet Open Forum, 9-11 May 2016



EUROPEAN CO₂ STORAGE ATLAS

- Thanks to partners
- The long way to a storage atlas
- Integrating the public available data from former EU and other projects
- CO₂StoP basic facts
- Ist European CO₂ Storage Atlas, challenges
 - Content of atlas,
 - New data, new countries
- The resources are limited, volunteer basis
- The information given and views expressed are those of mine though I'm doing my best to represent 26 CO₂StoP partners and EGS-GEEG





Thanks to partners

This is my thank you dance!

CO₂StoP

- → 26 partners and subcontracting partners
- Filip Neele
- -> Karen Kirk
- Nikki Smith
- Sam Holloway
- Niels Poulsen









32°E

The long way to 1st European CO₂ storage atlas







1993

2012

ENeRG Position Paper September 2012



The Need for a CO, Geological Storage European Atlas

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GeoNet

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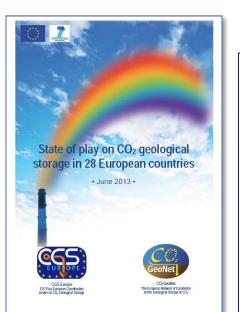
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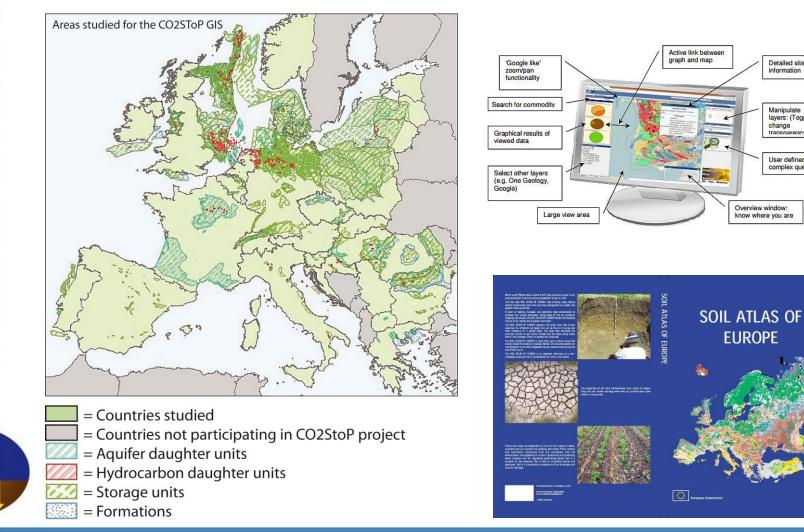
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	Isabelle Czemichowski-Lauriol ^{a,b} *, Rower	a Stead ^{s,b}
*CO;GeoNet - the Europea	n Network of Excellence on OO ₂ goological storage, 3 a sense Claude G Bonnes	ul Bennin, BP 36009, 45069 Orklans Cedex 2 -
¹ 885GM, French Gau	logical Survey, Direction of Research, 3 avenue Claude Guillemin, 80° 3	6009, 45060 Onláau Ceda: 2 - France
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The long way to 1st European CO₂ storage atlas

2014

GeoNet



CO2GeoNet Venice Open Forum 2016

Detailed site

information

Manipulate layers: (Toggle change transparency

User defined complex queries

Overview window:

EUROPE

know where you are

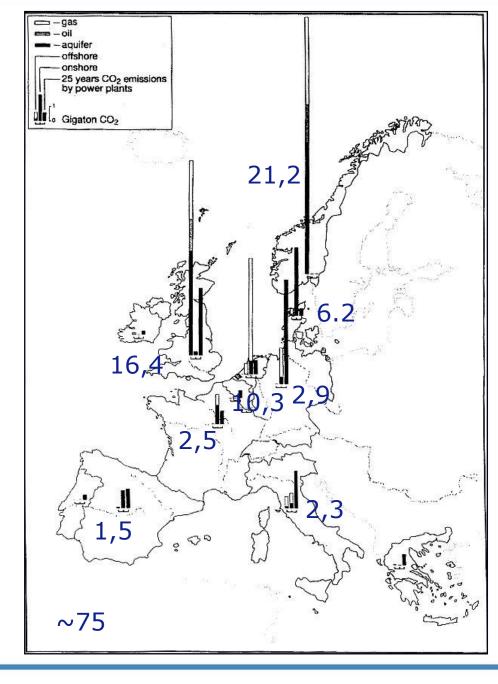


Joule II

CO₂ storage capacity in geological traps for the EU countries and Norway.

→ All figures are in Gt CO_2

The underground disposal of carbon dioxide. *Sam Holloway (editor), 1996.* Final report of the Joule II project No CT92-0031.



Integrating the public available data from former projects into the CO₂StoP GIS database

→Since the early 1990s



→Joule II finalised 1996

The joule II project: The underground disposal of carbon dioxide "All Europe"

→GESTCO finalised 2003

Geological Storage of CO₂ from Combustion of Fossil Fuel

Belgium, Denmark, France, Germany, Greece, Netherlands, Norway, UK

→Castor finalised 2006

Bulgaria, Croatia, Czech Rep., Hungary, Poland, Romania, Slovakia, Slovenia



GeoNet

→EU GeoCapacity finalised 2008 (The project was co-funded by the EU within FP6)

Assessing European Capacity for Geological Storage of Carbon Dioxide

Bulgaria, Croatia, Czech Rep., Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, UK, Bosnia-Herzegovina, Albania, FYROM, Luxembourg, Belgium, Norway (25 countries)

→CO₂StoP finalised 2014

Building an aquifer and hydrocarbon field CO_2 storage capacity database for the EC (27 countries)





EU GeoCapacity:

Assess the European Capacity for Geological Storage of Carbon Dioxide.

Project duration: 3 years (Jan. 2006 – Dec. 2008)

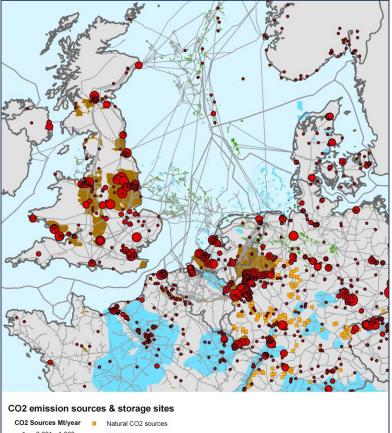
Budget: 10.5 M€ (FP6)

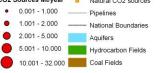
26 Partners from 21 countries

Coordinator: GEUS,

Outcome: provided the data required for the Europe wide adoption of CCS.

- Mapped potential sources and sinks
- GIS and Decision Support System
- Site selection criteria
- Estimated 117 Gt storage
 - ➔ 96 Gt in deep saline aquifers
 - 20 Gt in hydrocarbon fields
 - → 1 Gt in unmineable coal beds
- Emissions
 - → large point sources 1.9 Gt CO₂/year









CO₂StoP basic facts

Project

CO₂StoP is the acronym for the project "CO₂ Storage Potential in Europe."

Started on January 2012 and ended in March 2014

 $\rm CO_2 StoP$ was a project funded by the European Commission

- Total eligible costs: >EUR 238,581
- EU contribution: EUR 238,581

Countries

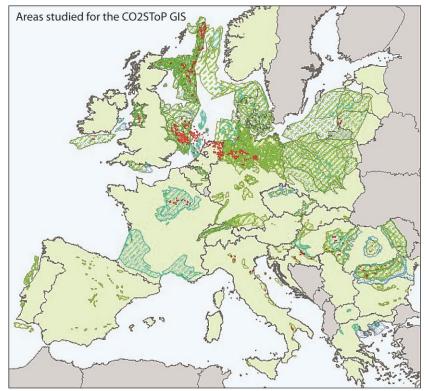
27 countries

Partnership

26 research institutes

Consortium

BGS, GEUS and TNO



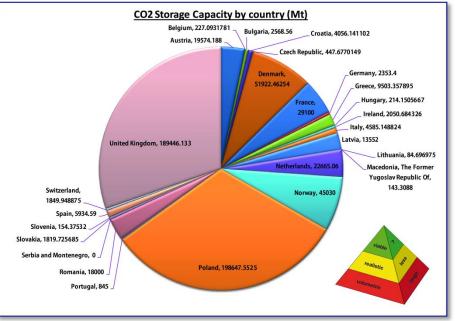
- = Countries studied
 - = Countries not participating in CO2StoP project
- Aquifer daughter units
- Hydrocarbon daughter units
- 📝 = Storage units
- Formations



CO₂Stop: Assessment of the CO₂ storage potential in Europe

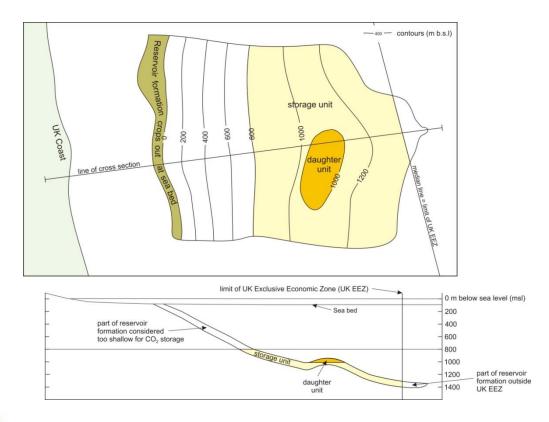
Outcome

- Database of CO₂ storage locations throughout Europe
- Public available data
- The CO₂StoP database paint a broad picture,
- but also identify the gaps in our knowledge
- It marks rather the beginning of atlases with resource estimation, and certainly not the end.
- The database is housed by the Joint Research Centre -European Commission, Petten





Storage formation contains structural reservoirs (traps)



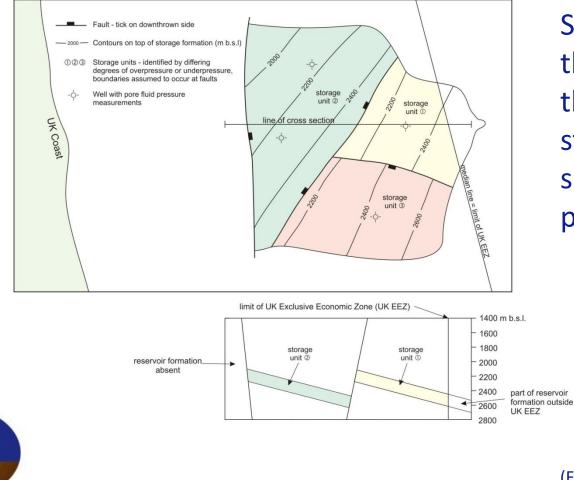
Method assumes different (higher) storage efficiency in trap than in rest of formation.

Calculation varies depending on whether parent unit has closed or open boundaries.

(Fig. after Gammer et al. 2011)



Aquifer consists of compartments (units) with closed boundaries

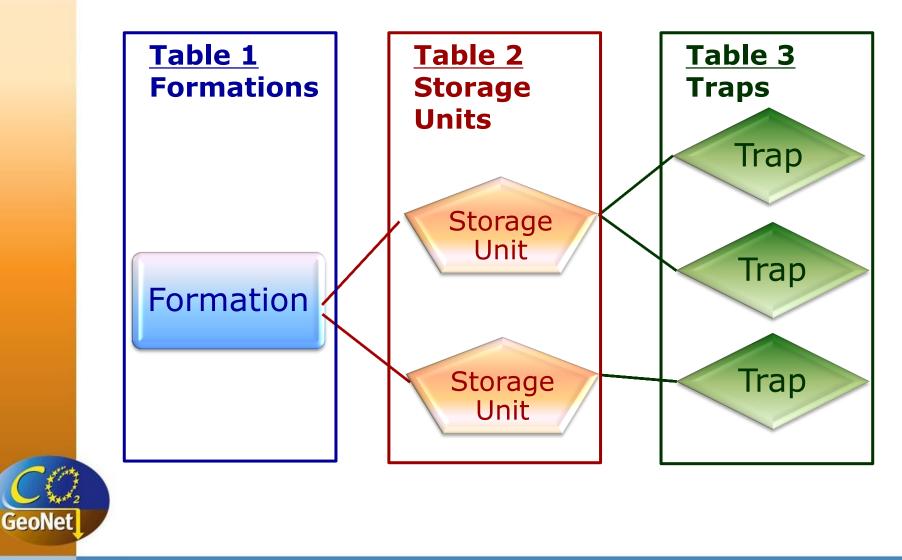


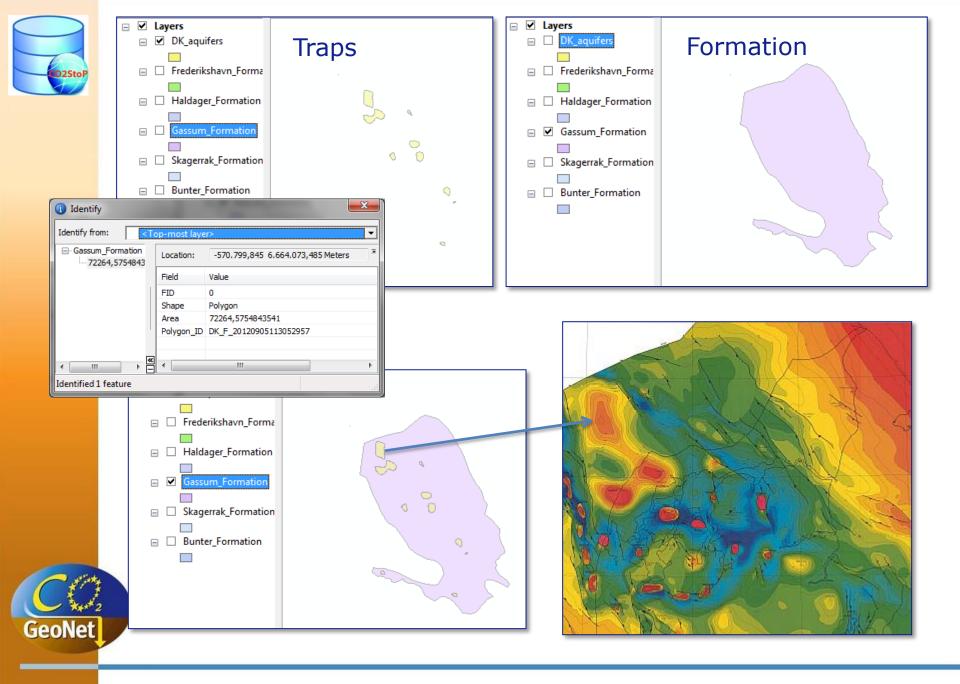
Storage capacity is the mass of CO₂ that could be stored in available space at limiting pressure

(Fig. after Gammer et al. 2011)



Database Structure

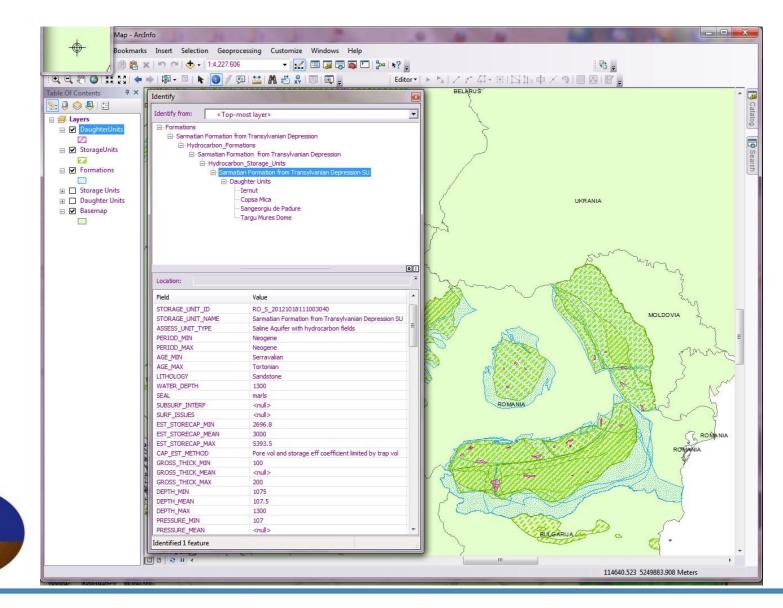




Data linked to polygons in the GIS

D2Sto

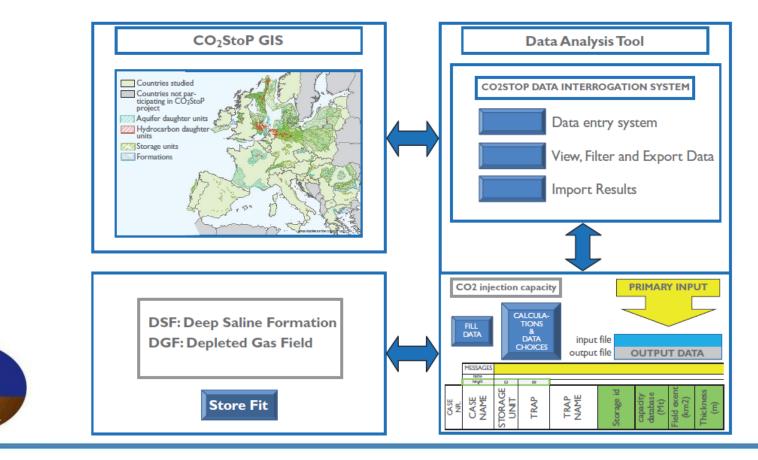
GeoNet





Database interrogation tool

The CO₂StoP tools established probabilistic estimates of the CO₂ storage resource in Europe and calculation of injection rates



1st European CO2 Storage Atlas

- Develop a first CO₂ Storage Atlas for EU, to be built on the foundations of the CO₂STOP database (owned by JRC)
- JRC believes it is now or it will not be possible before a good number of years.
- Publishing the atlas now is needed as a follow up on the outcomes from the COP21

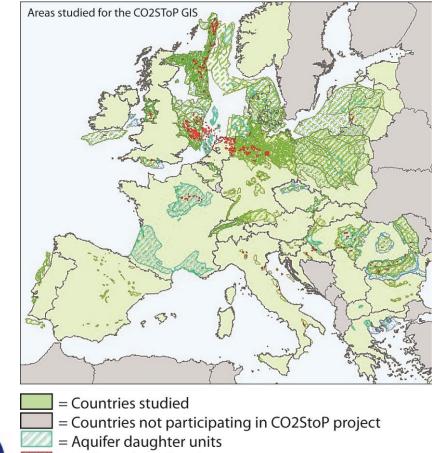


The Geological Surveys of Europe

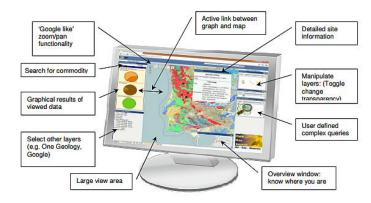
GeoNet

Next steps 1st European CO₂ storage atlas

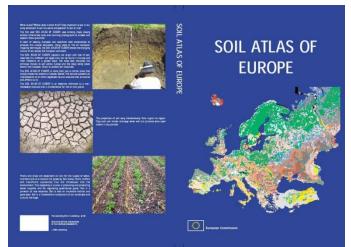
2014



November 2016



2017



- = Hydrocarbon daughter units
- 🕗 = Storage units
- Formations

GeoNet



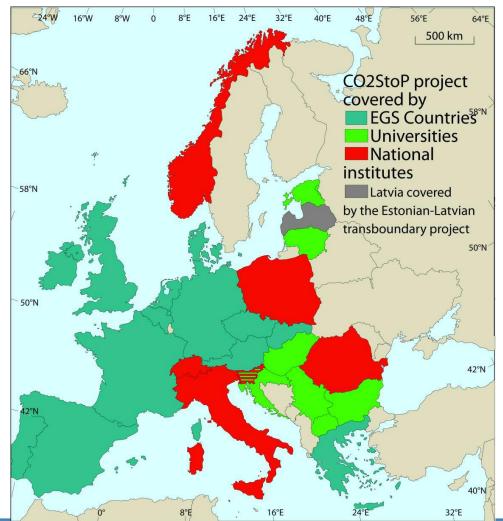
Text for online and publishes atlases

The resources are limited.

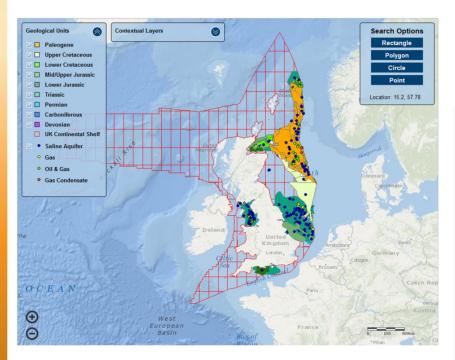
Mainly volunteer basis Text needed and good to have.

- → What is CCS
- \rightarrow CO₂GeoNet
- Geological description of geological basins and formations
- CO₂StoP partners & EuroGeoSurveys GeoEnergy Expert Group
- Methodology
- is already available in the CO₂StoP report
- Give reference for new, more and better information like the CO₂Stored or NORDICCS.
 - Relevant partnerships, countries





CO₂Stored Interactive Map and database



CO₂Stored	project	partners



Unit Designate	Select One	-
Group	Select One	-
Formation	Select One	-
Member	Select One	-
Area	Select One	-
Storage Unit Type	Select One	

Age	Select One	
Unit ID		
Maximum Water Depth [m]		
Permeability [mD]	to	
Porosity [fraction]	to	
CO ₂ Theoretical Capacity [10 ⁶ t]	to	

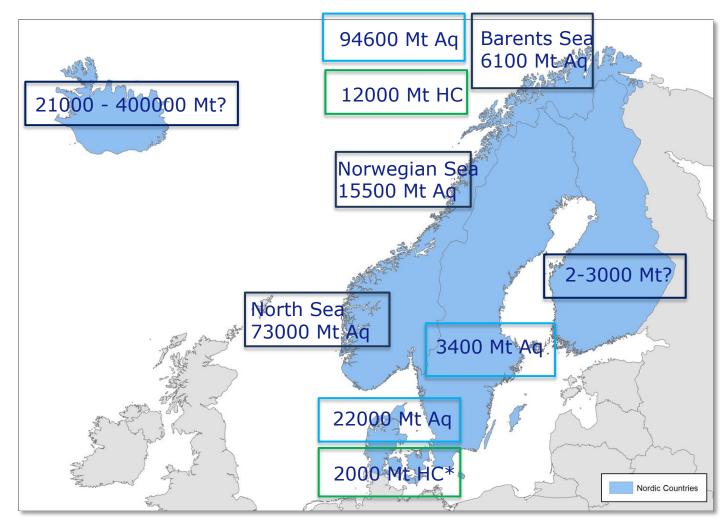
Capacity Data Results

Description	Units	Measurements
Total Number of Storage Units		574
Number of Storage Units With Results		505
Preliminary Overall Theoretical Capacity (P90)	[10 ⁶ Tonnes]	62845
Preliminary Overall Theoretical Capacity (P50)	[10 ⁶ Tonnes]	69172
Preliminary Overall Theoretical Capacity (P10)	[10 ⁶ Tonnes]	75499

Storage Unit Results (574)

		1 2 3	4 5 6		
Unit ID	Description	Area	Unit Designate	Lat	Lon
1.000	Cormorant_009_14	Northern North Sea	Saline Aquifer	59.55	1.78
2.000	Cormorant_009_09	Northern North Sea	Saline Aquifer	59.24	0.26

NORDICCS: Total Nordic CO₂ storage capacity mapped until 2015





Providing digital data to the Nordic CO₂ Storage Atlas



CELANDIC INSTITUTE OF NATURAL HISTORY



NORDICCS project partners

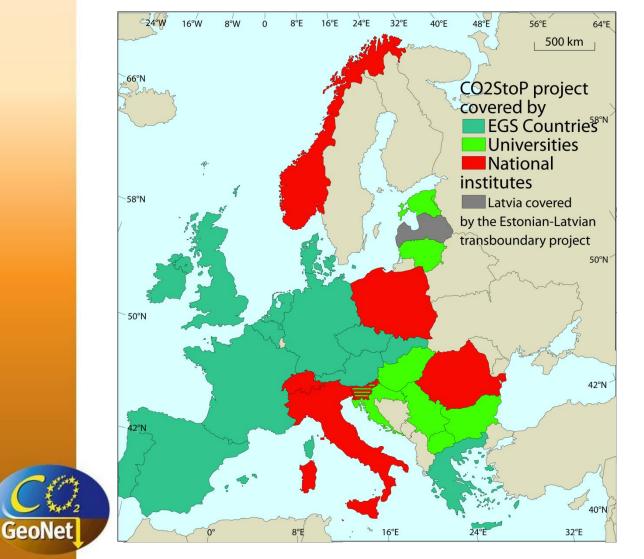




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Atlas: growing variety of partners



- EU GeoCapacity
- ENeRG
- CGS Europe
- CO₂GeoNet Association
 - Universities
 - Research Institutes
 - National Agencies
 - EuroGeoSurveys

