Istituto Nazionale di Geofisica e Vulcanologia

Geological CO_2 Sequestration: Prognosis as a Clean Energy Strategy

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University Tor Vergata, Ingegneria, Course “CO2 transport and sequestration”

IEA Committee on Energy Research and Technology

EXPERTS’ GROUP ON R&D PRIORITY SETTING AND EVALUATION

Introductory items

- CCS costs in and of itself, is not a barrier. The foremost economic barrier is the price of carbon.

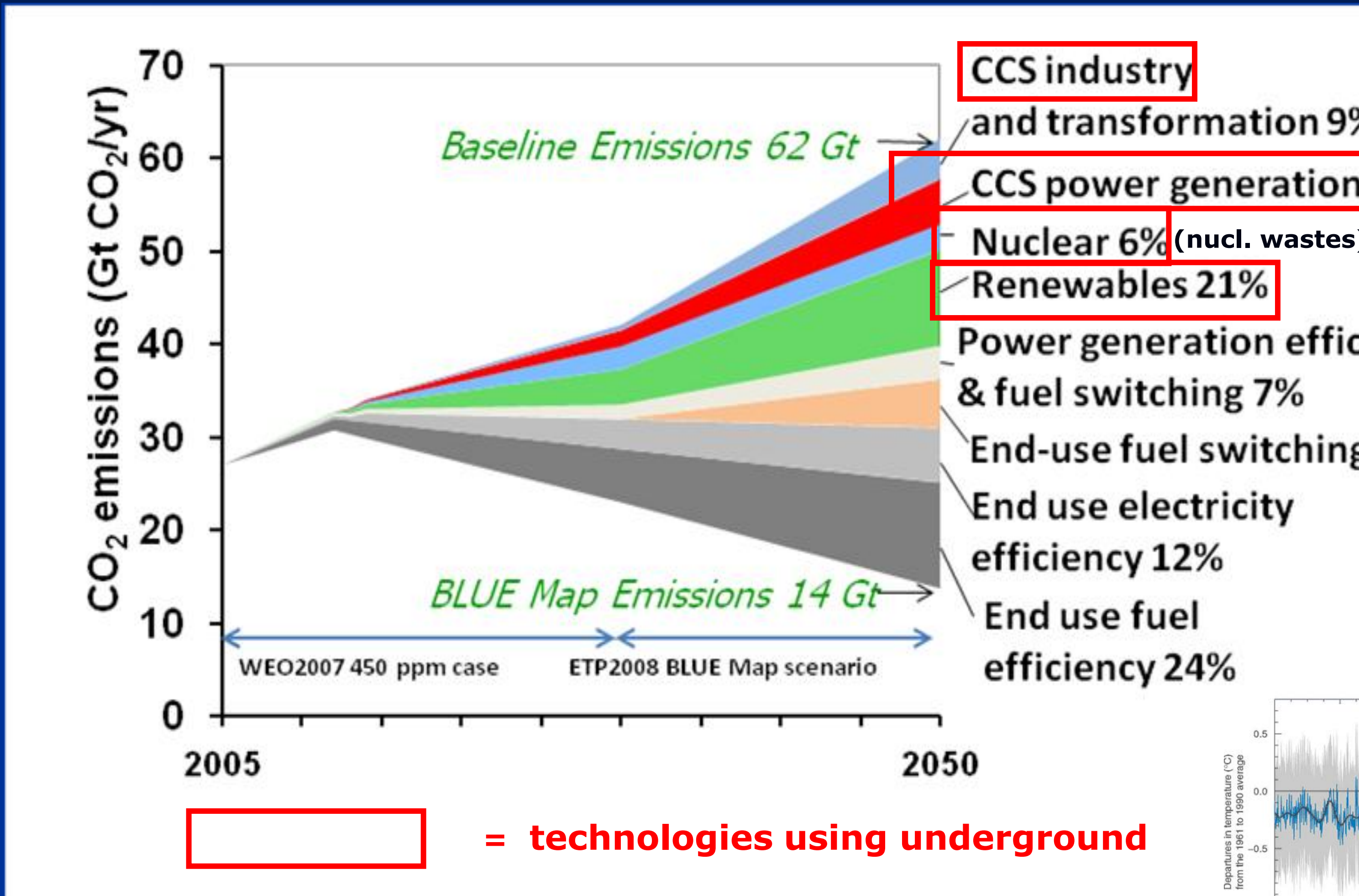
- CO_2 is a resource. At the present time an important limiting factor in new CO2-EOR project is a shortage of CO_2.

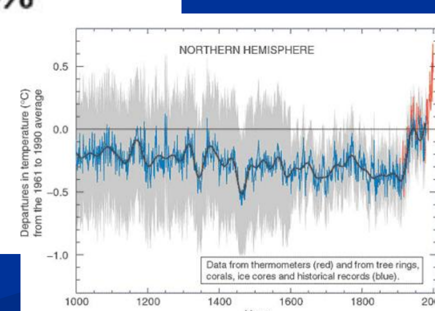
- CO_2 currently injected for CO2-EOR in USA comes both from natural and anthropogenic sources, which provide 79% and 21% respectively of CO_2 supply (NETL, 2008). Historically, CO_2 purchases comprise about 33 to 68 % of the cost of a CO_2 EOR project, as much CO_2 as possible is recovered and transported to other ER facilities to be used again. However, a certain incidental amount of CO2 remains underground.

- Currently 10 countries (China, US, India, Russia, Japan South Africa, Germany, Republic of Corea, Australia and Poland - ordered by annual emissions) account for 83 % of the Global CO_2 Emissions from coal use: these countries have to do the maximum CCS efforts.

- The recent established Global Carbon Capture and Storage Institute has catalogued and analysed potential CCS projects worldwide (Global CCS Institute, 2010). A total of 80 large-scale integrated projects in 17 countries: Algeria, Australia, Canada, China, Czech Republic, Finland, France, Germany, Republic of Korea, Netherlands, Norway, Poland, Spain, United Arab Emirates, United Kingdom and US)

IEA Road Map 2009 foreseen a multiple, synergyc use of underground: who decides ?



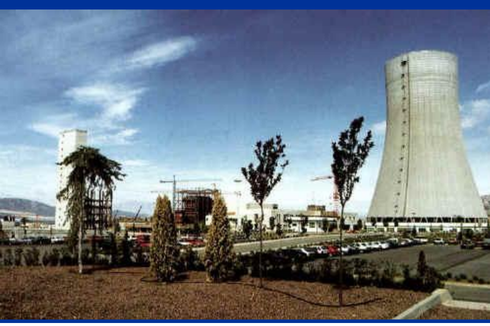


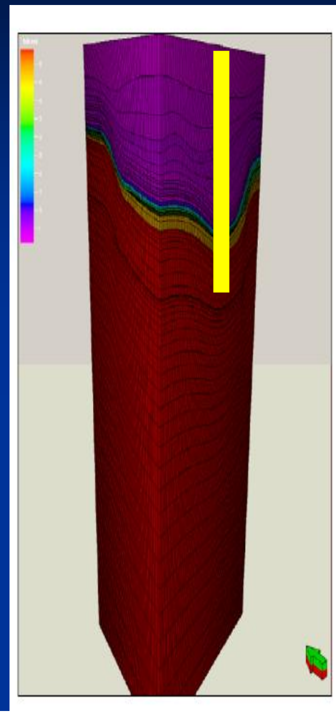
International School of Geophysics. 34° Co...
Erice, Centro Ettore Majorana, Septemb... 2010

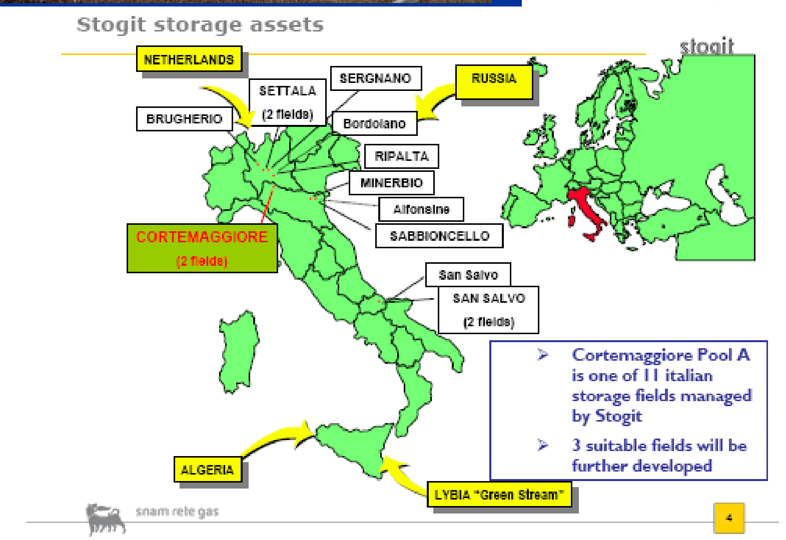
Director School: E. Boschi, Director 34° Co...

The different industrial lobbies interacting with the use of undeground, being a limited resource, have to plan its use in a synergical manner towards a sound energetic mixing

Does a sound energy mix need a planned use of the underground geological structures ?



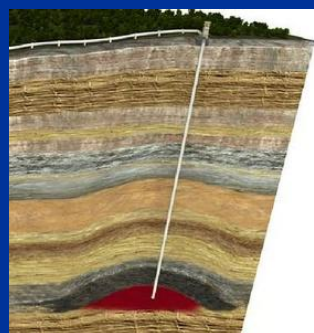




- **The Post-Kyoto energy revolution suggested by the IEA and IPCC urgently requires:**

- Clean Coal Technologies by adding CCS (CO_2 Capture & Storage);
- Last generation Nuclear Power (up to IV generation) & geological disposal
- Innovative renewables as deep geothermics (dry direct use) producing 365 day/year electric power;
- strategic storage of natural gas (mostly for "noble" uses, not electric power).

Low carbon energy production requires:

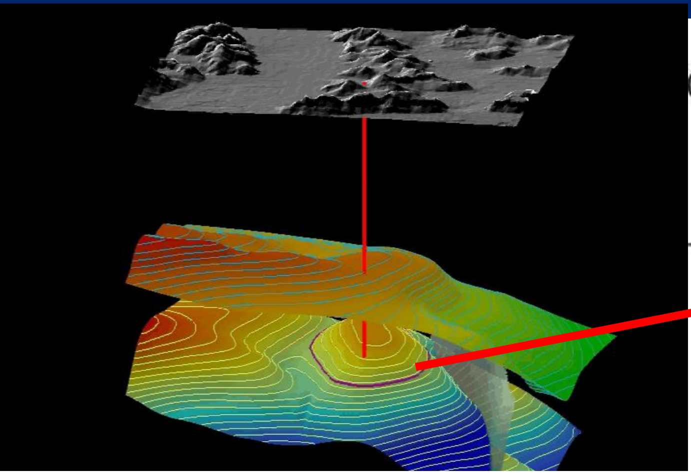


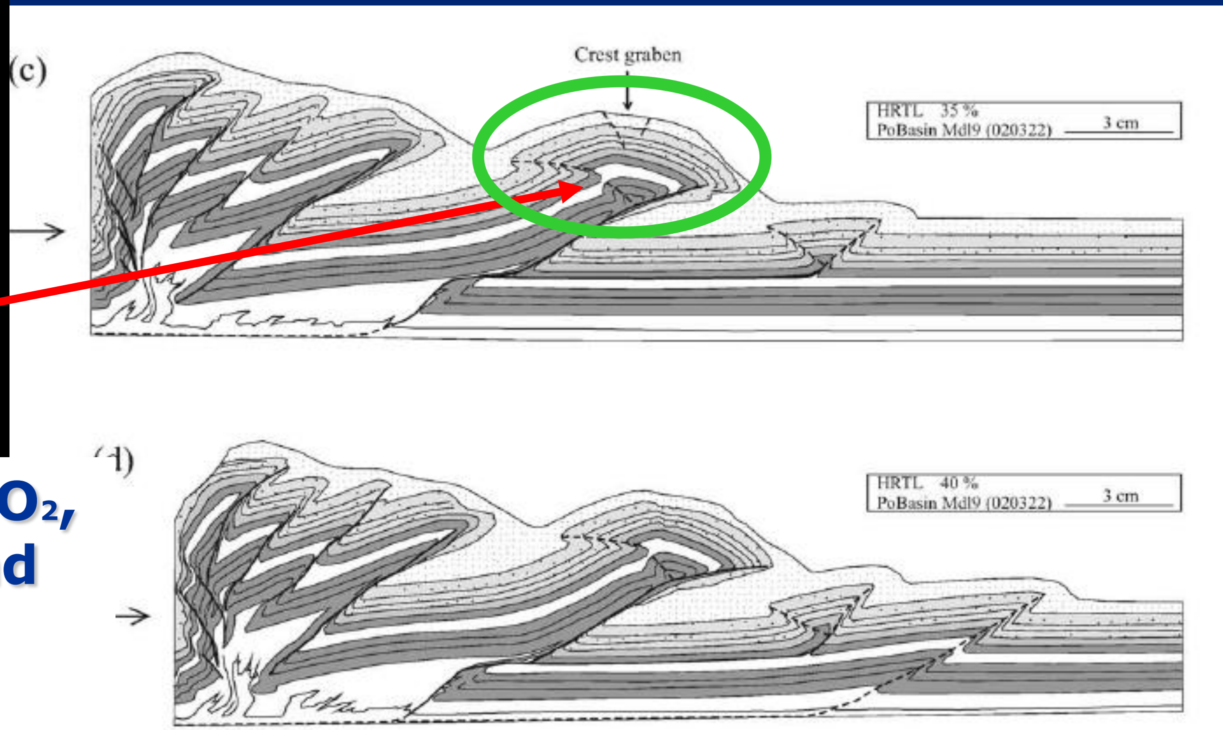
- space;
- water:
- underground storage/heat flow volume;
- dedicated scientists (full “staff”)
- public awareness about technologies against the “NUMBY SYNDROME”
- energy mix planning “BEFORE” both at nationally and regionally (Italy towards “federalism” ? …. But the underground structures are common among regions !!)

UNFORTUNATELY WE ARE LACKING OF ALL OF THAT REQUIREMENTS

Deep Geological Structures.

Can cohexist CO_2-CH_4 storage, nuclear wastes disposal and geothermics ?



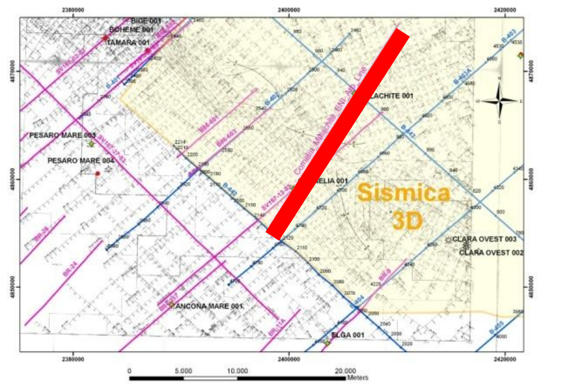


Storage capacity of CO_2, CH_4, geothermics and nuclear waste. What Priority ?

You have to PLAN the underground destination BEFORE storing geogas and nuclear waste (i.e. the IAEA criteria for nuclear waste disposal are not considering the CO_2 and CH_4 storing sites !!)

European Community Research plans (now FP7) has to take care of that…. for the FP 8 planning!! Public awareness is required!

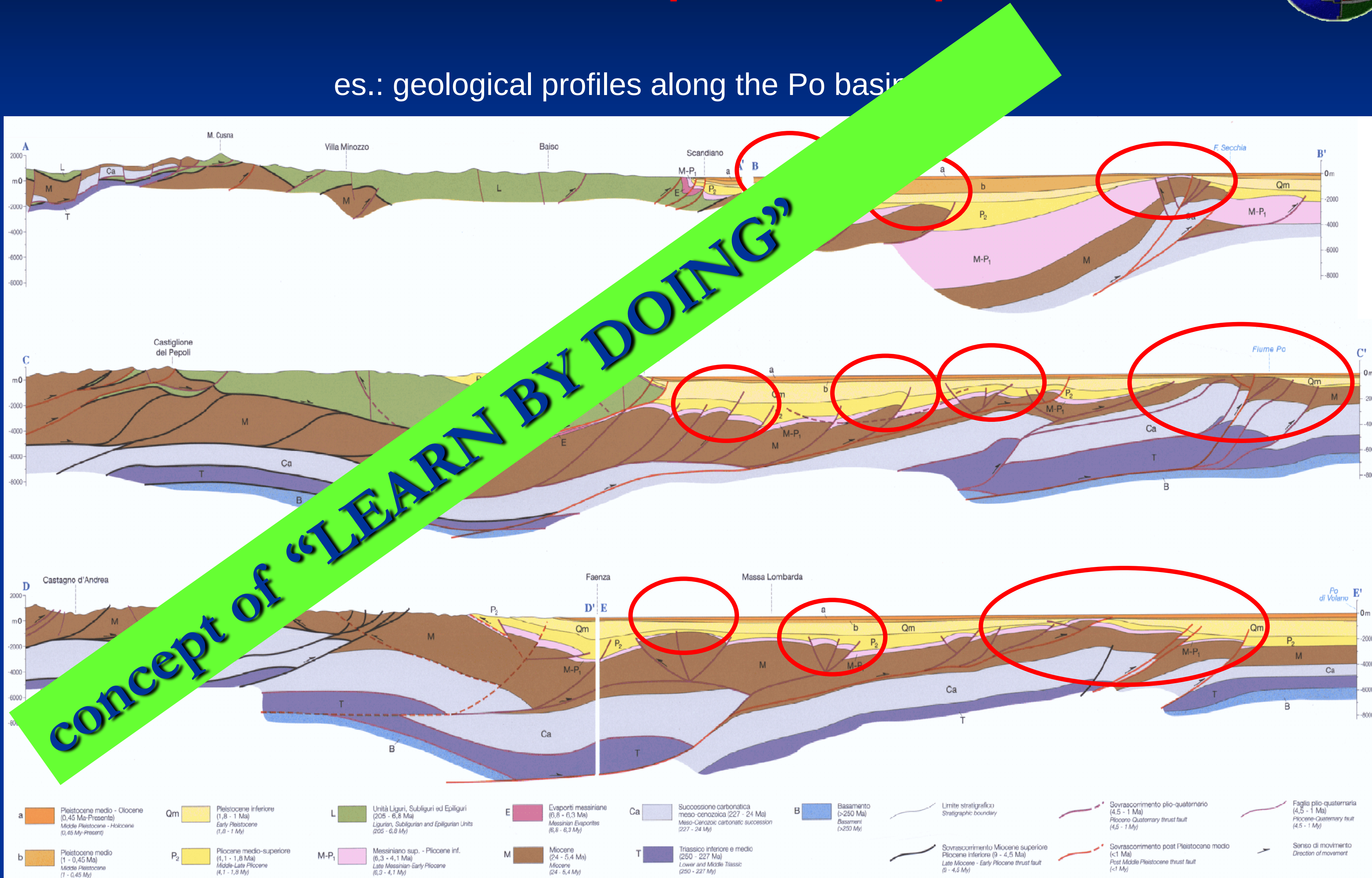
EXAMPLE: Why a so "perf…" structure should be desti… a CO_2 storage and not … one, irreversibly? (… CNR IGAG)



Who plan ?? Who decide ??

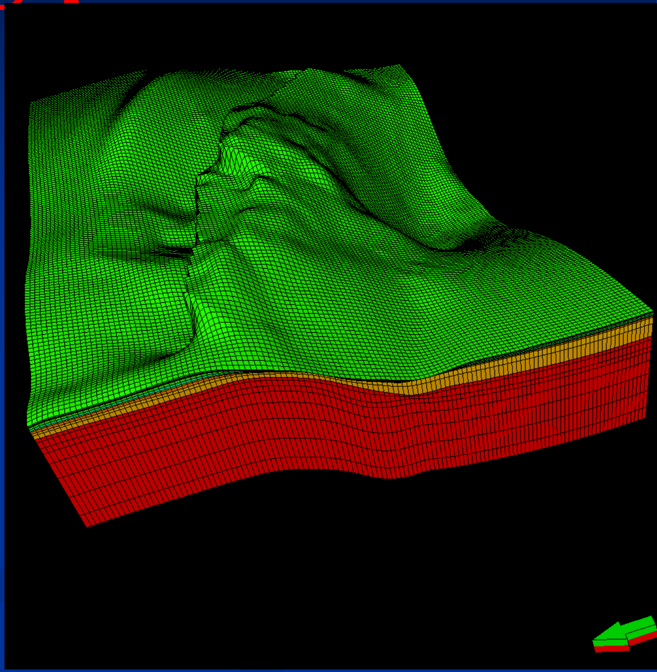
Planning before define the storage/use priority !!!!
Public research could do it …
Awareness positive for public !!

es.: geological profiles along the Po basin

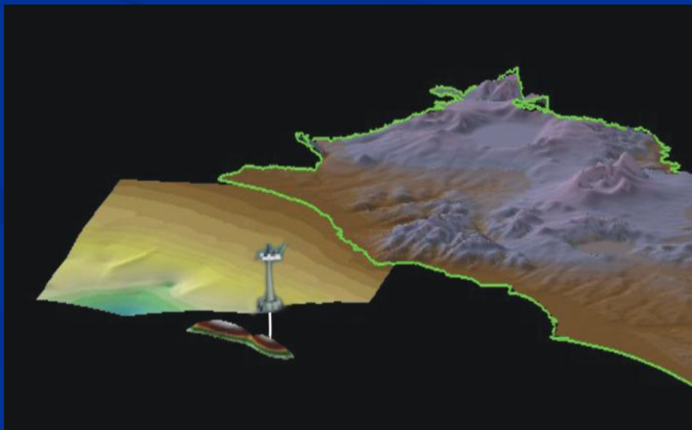


CO_2 storage/CH_4 storage SIMILARITIES ?

- Both CH_4 and CO_2 must be contained underground, i.e. they need cover rock
- Both CH_4 and CO_2 need permeability (for injection) and porosity (for storage), i.e. they need reservoir rock
- Both CH_4 and CO_2 need lateral containment, i.e. they need a structural trap
- UNI norms EN-1918-1 are fit for both
- Priority to CH_4 storage ? Strategic reserves !
- Both can co-exist with shallow low enthalpy and very deep (5-6 km) EGS geothermics

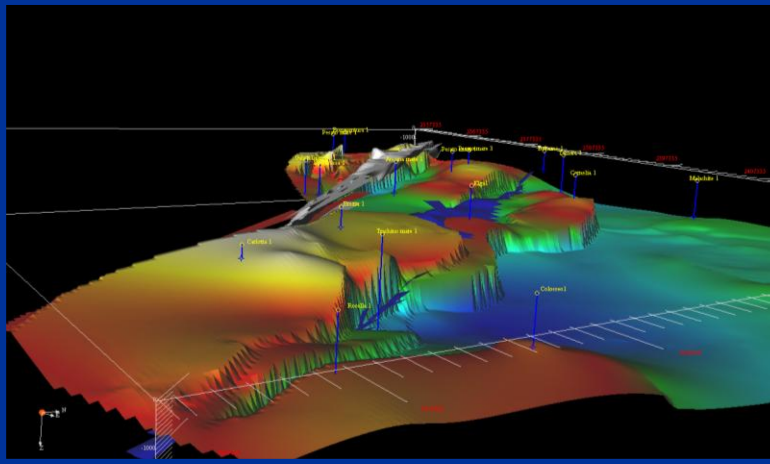


Produced by IR plc



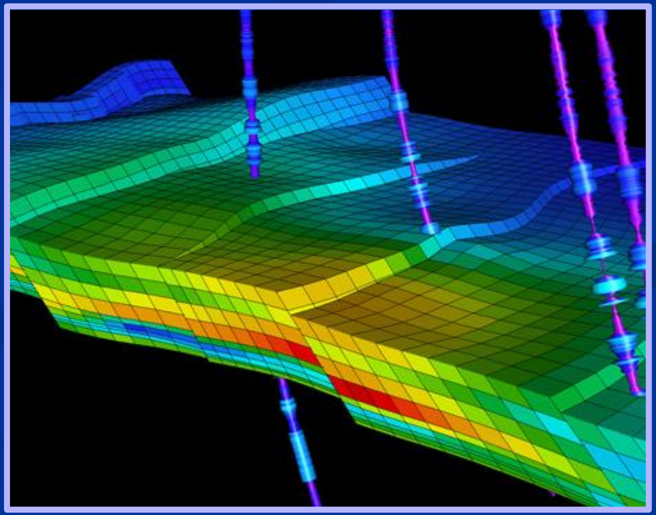
CO_2 storage/CH_4 storage DIFFERENCES ?

- **CH_4 is stored to be retrived** ***(two ways)***
- **CO_2 is stored forever** ***(one way)***



Produced by cooperation INGV-CNR

- **We need minimum trapping of CH_4 (minimum cushion gas)**
- **We need maximum permanent trapping of CO_2**



European Directivity on CO_2 storage: hints from public research

L 140/114 EN Official Journal of the European Union 5.6.2009

DIRECTIVE 2009/31/EC OF THE EUROPEAN PARLIAMENT ... OUNCIL

of 23 April 2009

on the geological storage of carbon dioxide and amendi... ...ve 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/... ..., 2006/12/EC, 2008/1/EC and Regulation (EC) ...

(Text wi...

Why this Directivity is not strictly linked to the Natural gas storage and deep geothermics (exploration phase at least)??

- the first 10-20 years the ... orage networking, monitoring and managing should ... blic hands;

- Planning of ... ace versus energy should be done in densely pop... ...untries (Europe): coexistence between CO_2 storage, ... gas (CH_4 strategic reserves storage, nuclear wastes ..., deep geothermics).

CCS Project in the world: storage under oil&gas

www.globalccsinstitute.com

- **around 350 project recorded;**
- **around 80 integrated projects (G8 critieria for 20 demonstration projects to be implemented for 2020);**

- **around projects with post combustion;**

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- **around projects with storage in saline aquifers.**

EEPR CCS Project in Europe

Costs associated to storage have been estimated in USA to be approximately **$0.4-20/tonne CO2**, depending on numerous factors, including type of reservoir, existing information/infrastructures for the site, onshore versus offshore storage, extent of monitoring, regional factors.

Active projects: $11-17 per tonne (Sleipner); $20 per tonne (Weyburn), $ 6 per tonne (In salah).

UK
3 Proposte presentate
Contributo da **180 M€**
Progetto vincente: **Hatfield (86/100)**
PowerfulPower
IGCC CCS Precombustione
Storage Offshore in a depleted gas field

Spagna
1 Proposta presentata
Contributo da **180 M€**
Progetto vincente: **Compostilla (81/100)**
Endesa
Ossicombustione in letto fluido
Storage Onshore in Acquifero Salino

Italia
1 Proposta presentata
Contributo da **100 M€**
Progetto vincente: **Porto Tolle (83/100)**
Enel
Cattura Post-Combustione
Storage Offshore in Acquifero Salino

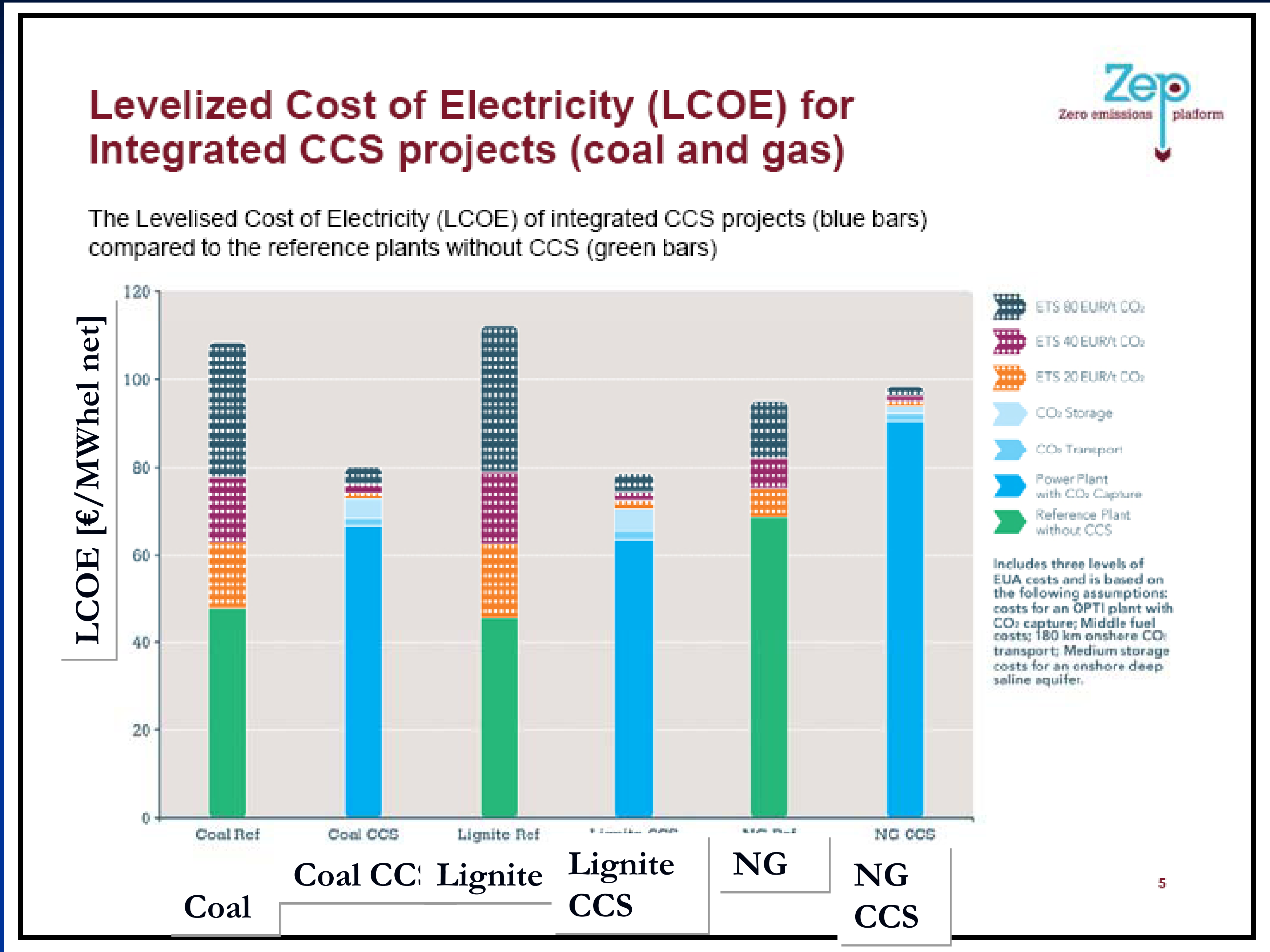
Olanda
3 Proposte presentate
Contributo da **180 M€**
Progetto vincente: **Rotterdam (87/100)**
E.on
Cattura Post Combustione
Storage Offshore in a depleted gas field

Polonia
1 Proposta presentata
Contributo da **180 M€**
Progetto vincente: **Belchatow (82/100)**
PGE
Cattura Post-Combustione
Storage Onshore in Acquifero Salino

Germania
2 Proposte presentate
Contributo da **180 M€**
Progetto vincente: **Jaenschwalde (89/100)**
Vattenfall
Ossicombustione
Storage Onshore in depleted gas field

Post combustione:	**3 progetti**
Oxycombustione:	**2 progetti**
IGCC:	**1 progetto**

EEPR projects based on costs of CCS by EU-ZEP data 2011



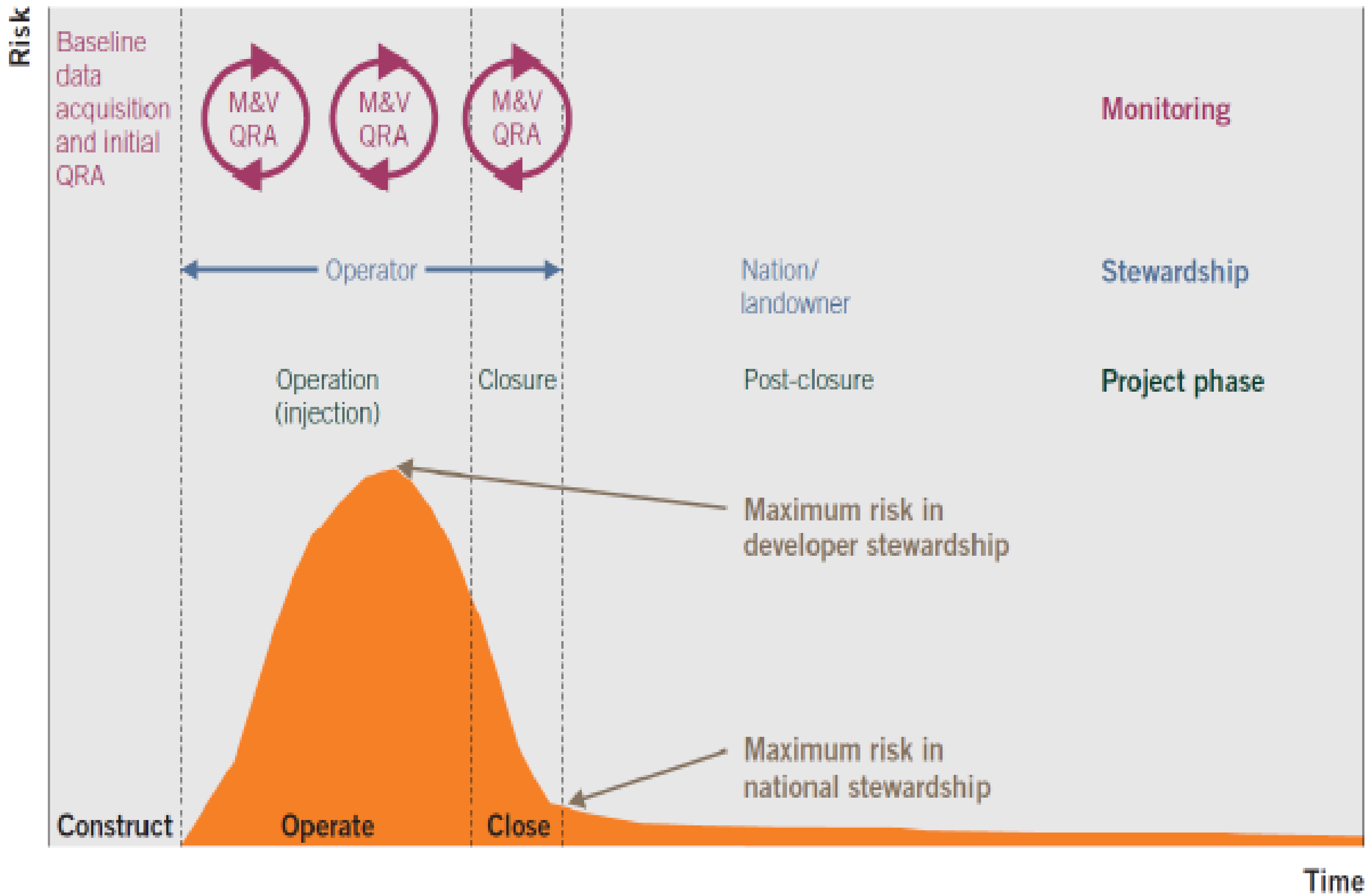
Transport of CO_2

CO_2 Transport Cost Estimates for Demo Projects

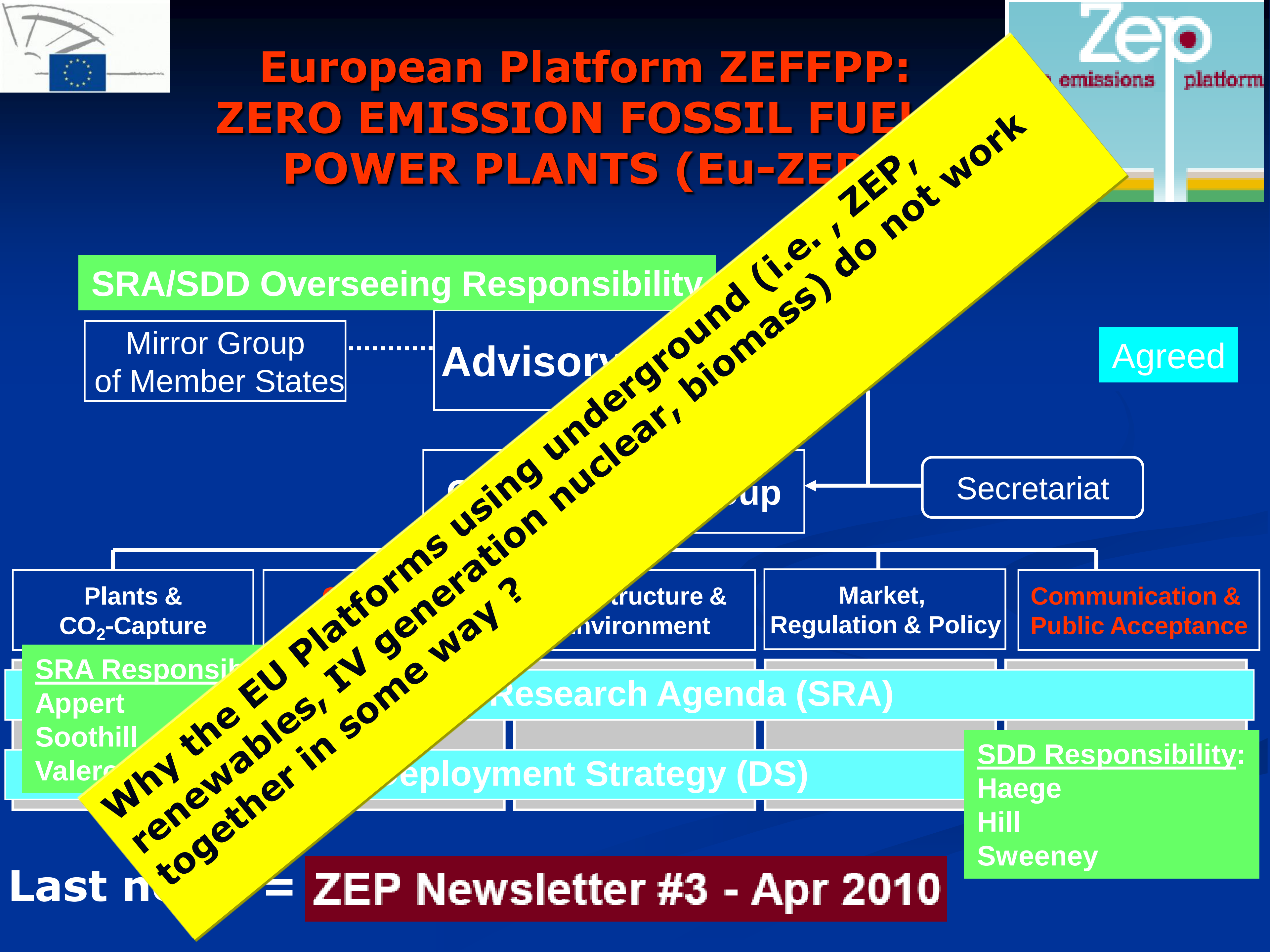
Table 1: Cost estimates (in €/t CO_2) for commercial natural gas-fired power plants with CCS or coal-based CCS demonstration projects with a transported volume of 2.5 Mtpa

Distance km	180	500	750	1500
Onshore pipeline	5.4	n. a.	n. a.	n. a.
Offshore pipeline	9.3	20.4	28.7	51.7
Ship	8.2	9.5	10.6	14.5
Liquefaction (for ship transport)	5.3	5.3	5.3	5.3

THE ISSUE OF LONG TERM LIABILITY



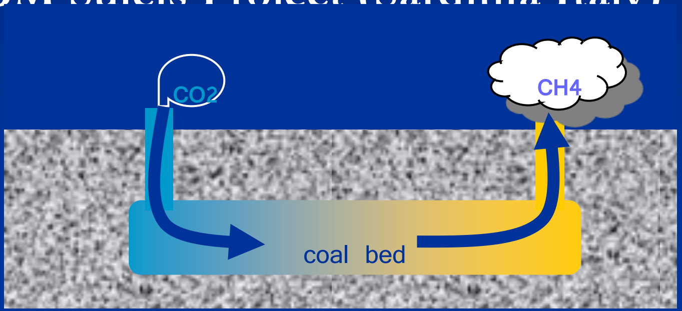
Note: Monitoring and verification (M&V) and quantified risk assessment (QRA)

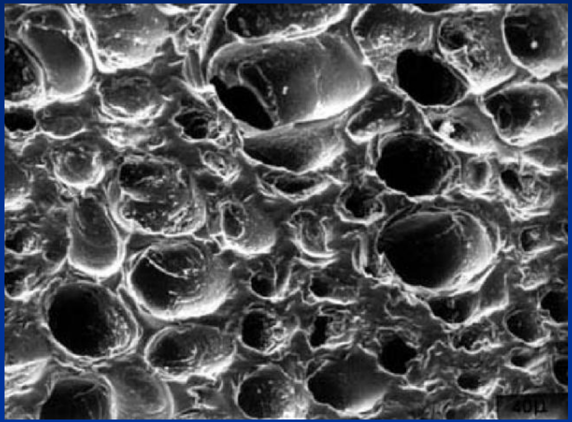


European Platform ZEFFPP:
ZERO EMISSION FOSSIL FUEL
POWER PLANTS (Eu-ZEP
SRA/SDD Overseeing Responsibility
Mirror Group of Member States
Advisory
Agreed
Secretariat
up
Plants & CO_2-Capture
ructure & nvironment
Market, Regulation & Policy
Communication & Public Acceptance
SRA Responsi
Appert
Soothill
Valero
Research Agenda (SRA)
eployment Strategy (DS)
SDD Responsibility:
Haege
Hill
Sweeney
Last n
= ZEP Newsletter #3 - Apr 2010
Why the EU Platforms using underground (i.e. , ZEP, renewables, IV generation nuclear, biomass) do not work together in some way ?

Cooptimization ECBM + saline aquifer + geothermics

ECBM Sulcis Project (Sardinia Italy)





Issues and Gaps I

- Non economic barriers could prevent projected CCS deployment, but public acceptance.

- Financial Incentives & carbon price. Lack of comprehensive climate change legislation is the key barrier to CCS deployment;
- Government intervention & means for overcoming or compensating for the market failure
- The private market has a limited incentive to invest in "shared learning" that would lead to an improved economic outcome for society as a whole
- Compensation of the parties for various types and forms of losses or damages that occur after the site closure & transfer of liability to the federal government after site closure
- Long term Liability and property rights (i.e., those arising after the closure of a CO_2 storage site);
- Site specific risk assessment and liability, "learning by doing" concept: portion of the gain from that knowledge cannot be captured by the firm making the investment.
- Need to conduct a periodic review of CCS and identify any additional research, risk management or regulatory needs;
- Though CCS technologies exist, "scaling up" these existing processes: a typical 550 MW net output coal-fired power plant capturing 90% of the CO_2 would capture about 5 million tonnes of CO_2 per year:
- Creation of regional partnerships promoting CCS

Need to assist the Administration in targeting any remaining technology gaps;

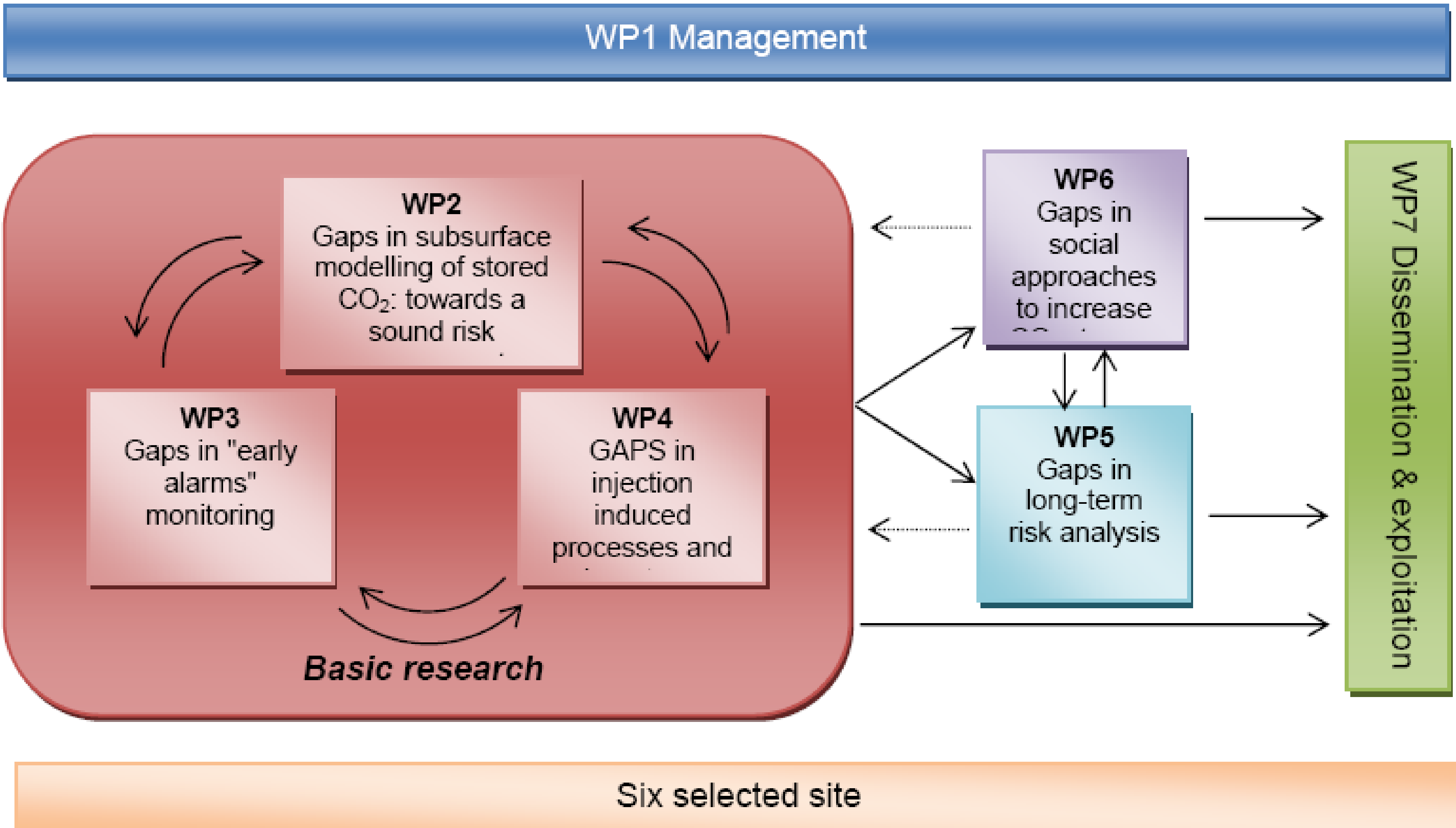
- Need to define eligibility criteria for projects to receive federal/state support (i.e., peer review of the results, modeling tools and methods as well as sharing the results);

Issues and Gaps II

- Need to assist the Administration in targeting any remaining technology gaps;
- Need to define eligibility criteria for projects to receive federal/state support (i.e., peer review of the results, modeling tools and methods as well as sharing the results);
- CO_2 sequestration may potentially conflict with other subsurface uses, including existing and future mines, oil and gas fields, coal resources, geothermal fields and drinking water sources.
- Further efforts to generate a comprehensive, catalogue of national sequestration potential using their recently finalized methodology - including risks assessment objects (i.e., seismogenic sources, degassing sites, sink-holes; Buttinelli et al., 2010 as done in Italy).
- Early projects: data sharing (site selection criteria and monitoring) must be totally spreaded and available also to NGOs.
- Access to monitoring wells mostly in the offshore framework and corrective action on pre-existing wells
- need to avoid lengthy delays in permitting

- Staff people: hiring, training and retaining a large workforce of highly skilled professionals (i.e., reservoir engineering).
- Access to world-class foreign researchers, who often look at the problems associated with taking a technology from the lab to the marketplace through different "lenses" : NO CLOSED LOBBIES (i.e., in Europe) YES NETWORK OF EXCELLENCE BASED ON PEER REVIEW SELECTION.
- Biomass co-firing with CCS towards "net negative"

CO2GAPS Vision proposed at EU FP7, by INGV and partners



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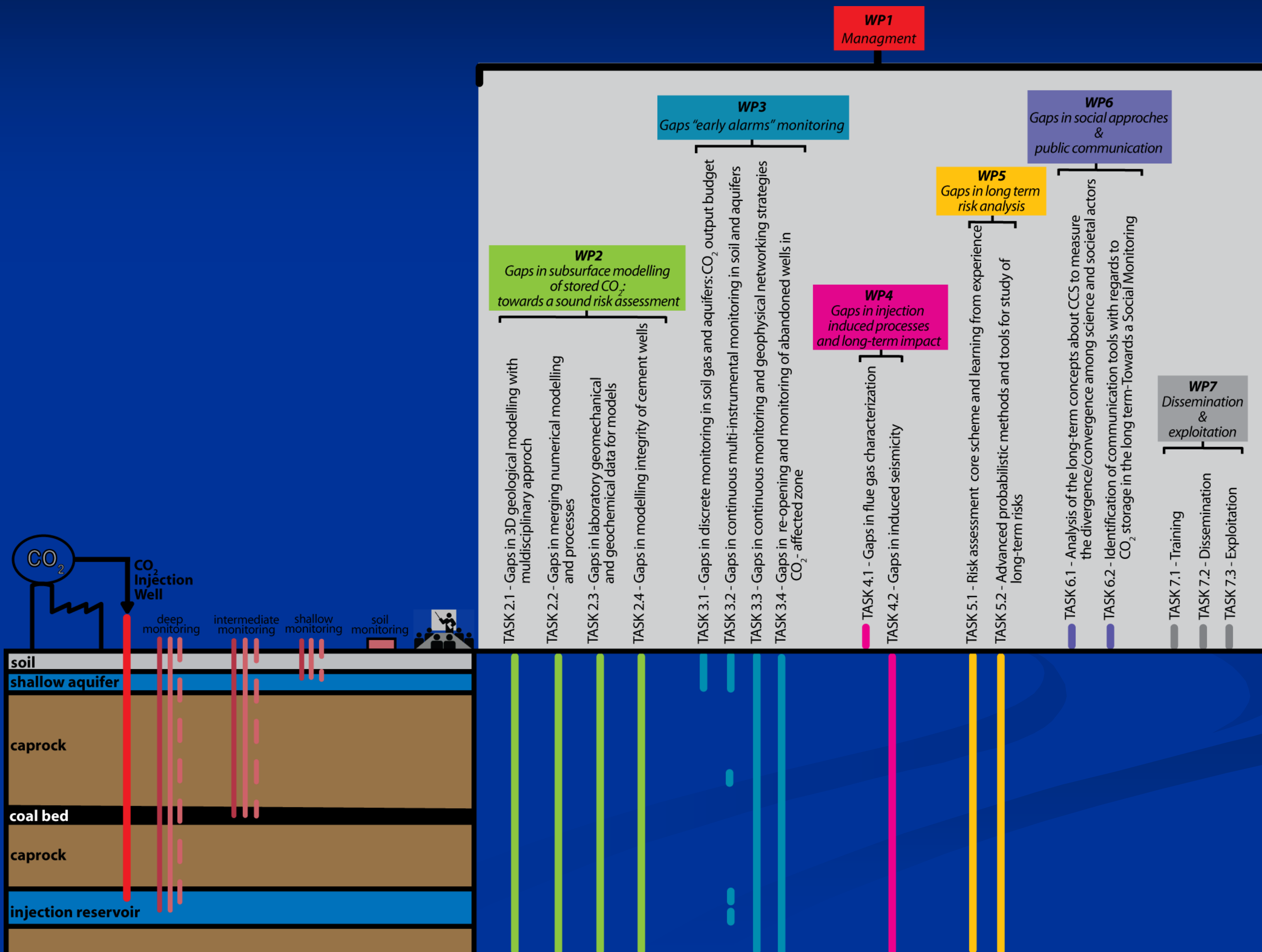


GAPS in selecting pilot and demonstration test-sites: inland (better monitoring/modeling comparison) or offshore (better public acceptance) ??

Workflow of a typical project of CO_2 storage

Storage of CO_2 is highly site specific

Aquistore – Deep Saline Aqui[…] Project

QUISTORE

Demonstrate CO_2 storage in deep saline formations is a safe solution for emissions reductions.

Develop a transportable, integrated suite of technologies

Create linkages among financial institutions developing trading mechanisms; policy makers; i[…] and public acceptance.

Current project runs f[…] Decem[…]

Capture 600 t/d[…] omplex

Tran[…] ection site.

CO_2 inj[…] e deep saline aquifer […]0m depth.

Implement […] prehensive Measurement, Monitorin[…] and Verification Program.

$3.5 billion being allocated in public funding from federal, Alberta and Saskatchewan governments for large demo projects

- Co[…] ve Refineries I[…]
  - […] grader complex
  - […]n expansion
  - […]sed capture process
  - […]ally 600 t/d; potentially up to 1600 t/d
  - > 99% purity CO2
- Delivery of CO_2 late 2012 or 2013
- SaskEnergy & Enbridge to build pipeline

Six sites have been selected in Europe in the frame of EEPR European Energy Programme for Recovery

Not only power plants couls have access to CCS but also refineries, cement and steel plants, biomasses: trace contaminants in flue gas could be different. Co-sequestration concept

Trace contaminats are really natural! Welcome underground!

CO_2 Flue Gas contaminants

• Different CO_2 streams will have different compositions, For example certain industrial processes (e.g., ammonia production and biofuels production) produce streams that are nearly pure CO_2.

• Natural gas combustion also produces a relative pure waste stream.

• Purity of the injected CO_2 stream is a consideration for storage because co-captures impurities could affect the storage processes.

• Excess O_2 (oxyfuel) in the CO_2 sequestration stream.

• Arsenic, lead, selenium, cadmium, mercury organic compounds.

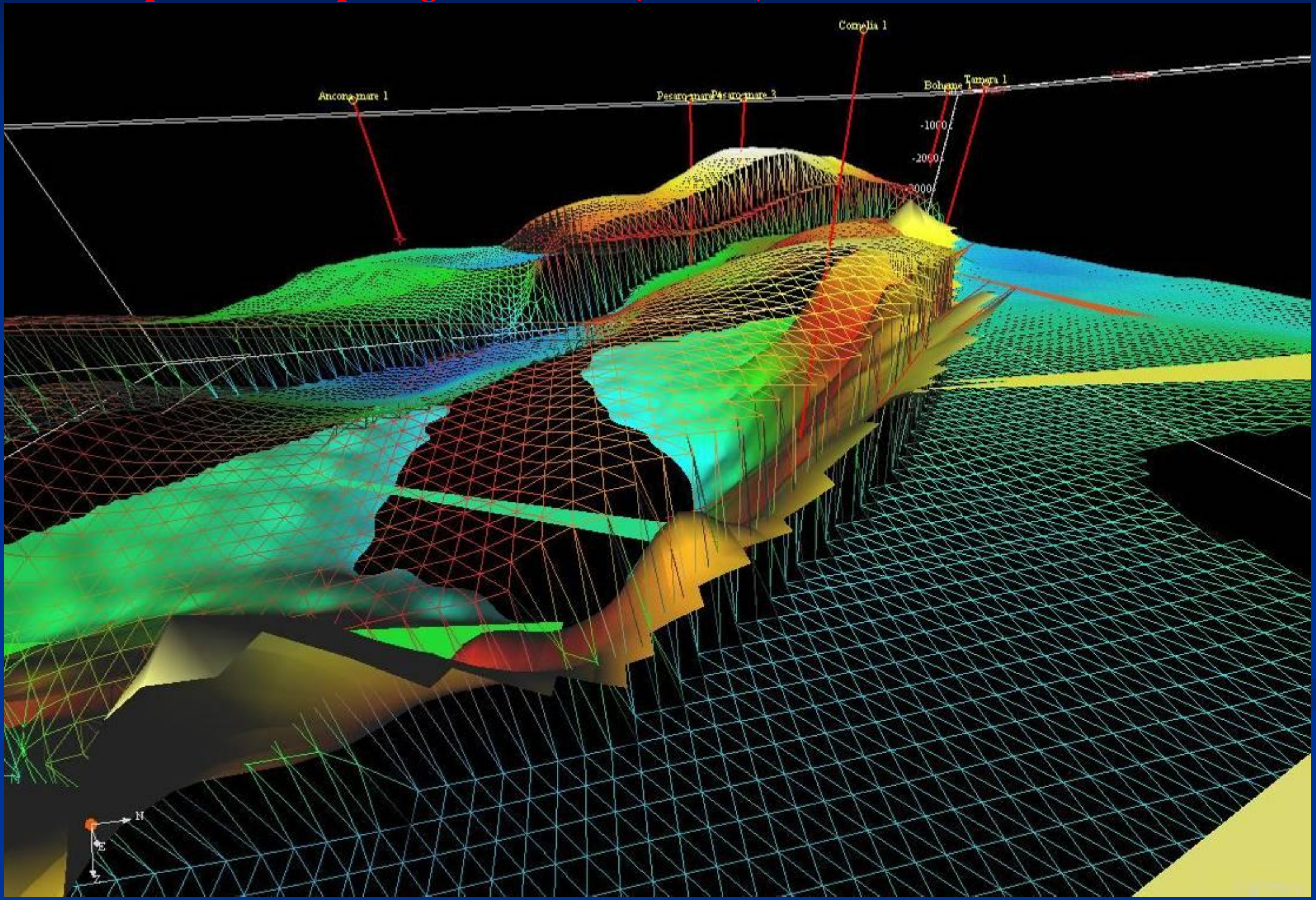
• H_2S, SO_2, NOx, NH_3, organic matter. H_2S is known to promote steel corrosion.

• Note that "*a solid waste is a hazardous waste if it is a listed hazardous waste or exhibits any of four characteristics (ignitability, corrosivity, reactivity or toxicity)*"

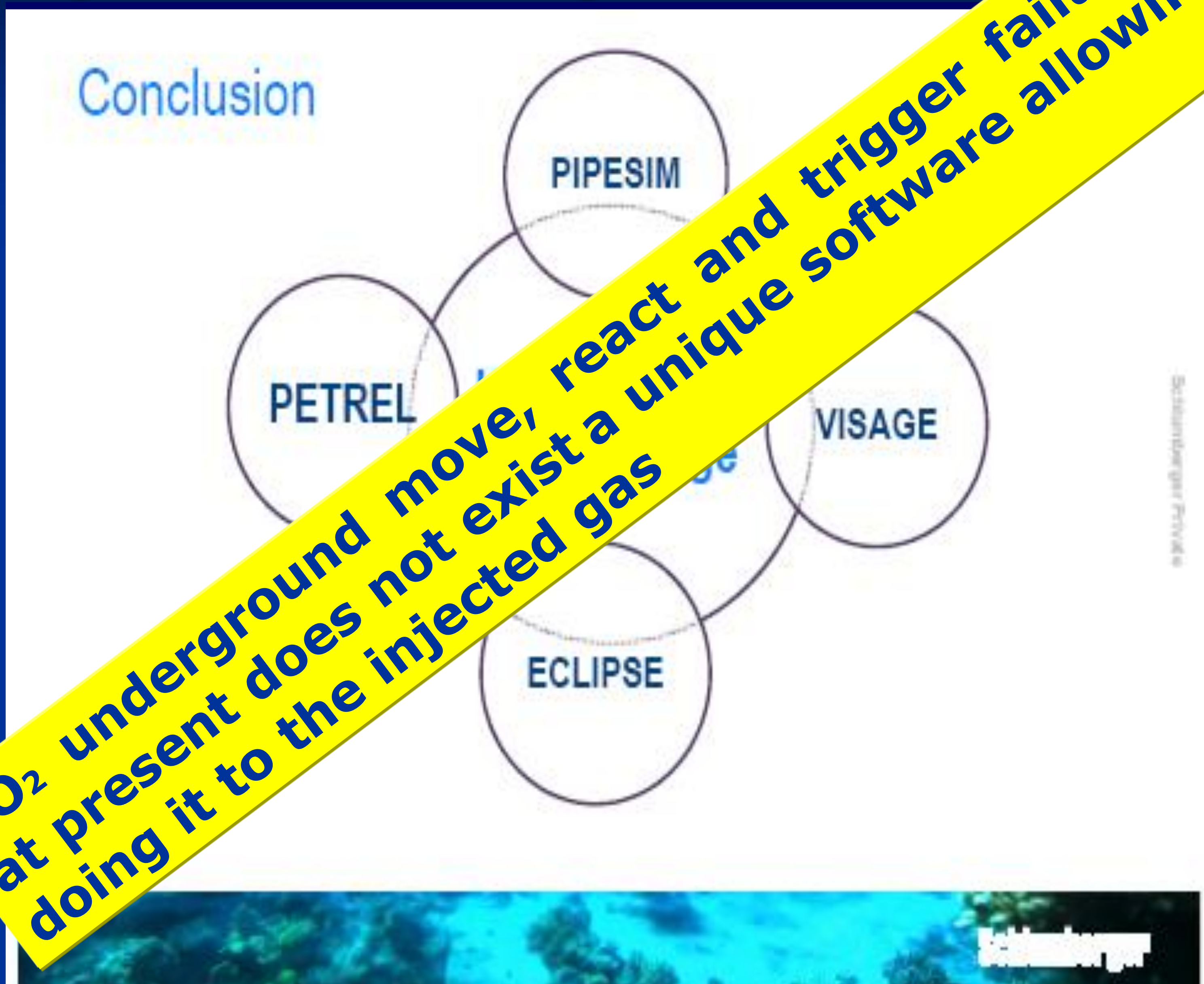
GAPS in merging modeling: mass transport, geochemical and geomechanical

3D modeling must consider very carefully the fault peculiarities (porosity, permeability, mechanics)

3D Depth View Top Scaglia Calcarea (Eocene) con Sovrascorrimento



Merging modeling software: mass-transport, geochemical and geomechanical

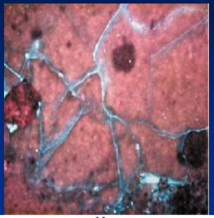


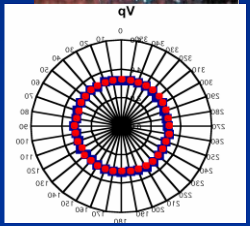
CO_2 underground move, react and trigger failures: at present does not exist a unique software allowing doing it to the injected gas

Rock Physics and Geomechanics applied to thermo-hydro-mechanical processes

Characterisation of rock samples

- Microstructural state of rocks (e.g porosity; density; voids space; mineralogy)

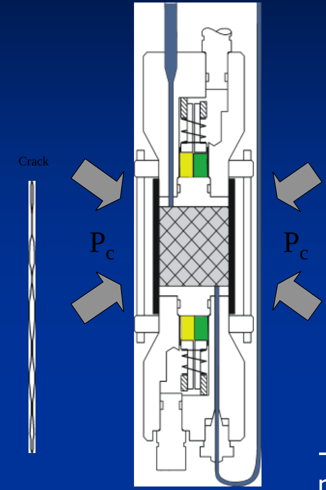




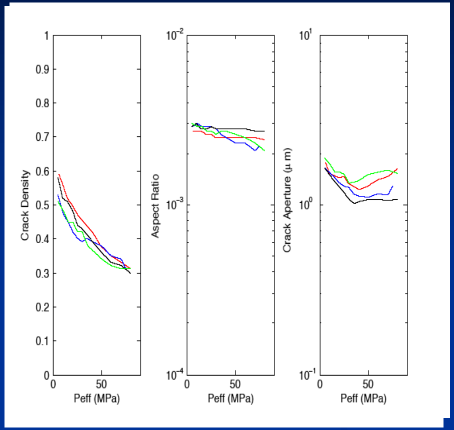
Vinciguerra et al., IJRM, 2005

- Dynamic elastic moduli
- Seismic inner structure

Permeability/velocity under increasing effective pressure



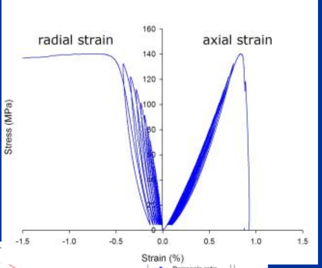
Permeameter

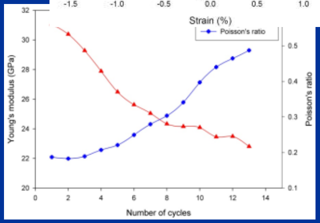


- Full inversion (elastic wave velocities, Porosity and permeability)

Benson et al, JGR 2006,
Vinciguerra et al., Pageoph, 2005

Mechanical parameters





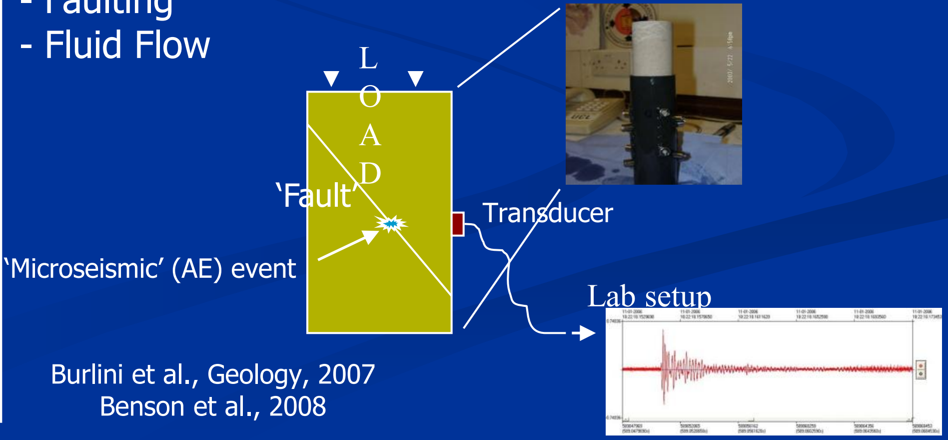
- UCS
- Static elastic moduli
- Thermo-chemical reaction and mechanical parameters

Heap et al., Tectonophysics, 2008
Benson et al., GRL, 2007

-Degradation of elastic moduli under cyclic stress

Seismic signals and thermo-hydro-mechanical coupling

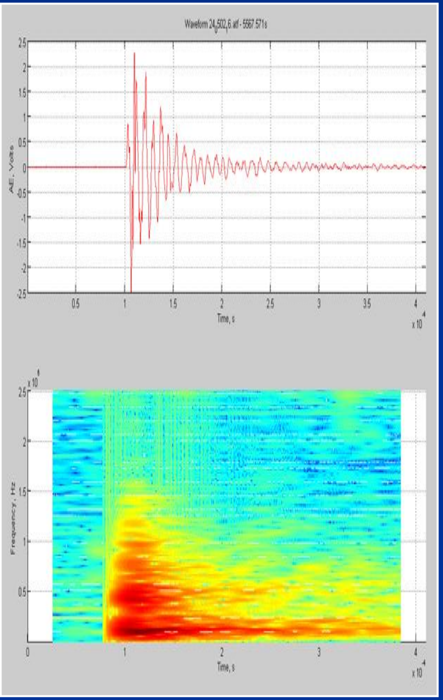
Monitoring microearthquakes during:
- Faulting
- Fluid Flow

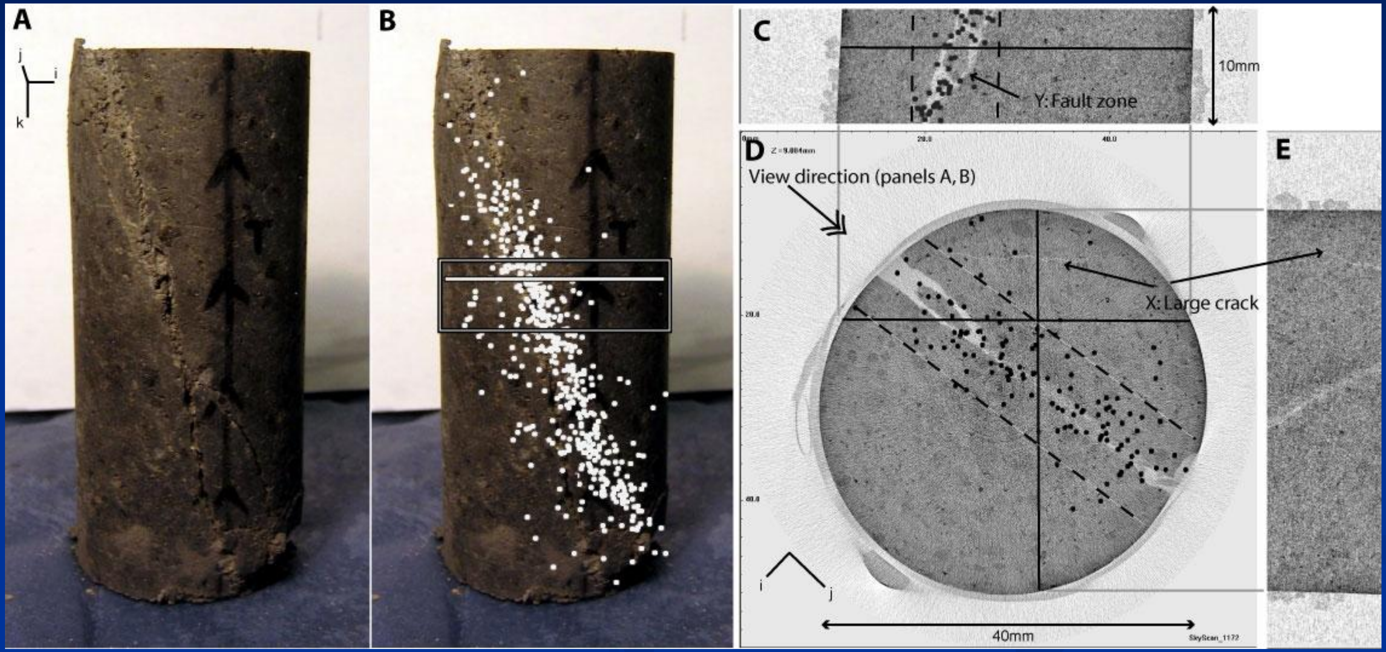


Burlini et al., Geology, 2007
Benson et al., 2008

Micro-earthquakes in the laboratory

High Frequency





(A) Photo shows broad, complex fault zone from linking of many microcracks.

(B) AE locations superimposed on fault showing good spatial agreement

[Grey box and white line indicate volume investigated in CT scan and plane of projection in (D)]

High resolution X-ray CT scans of the deformed sample, with AE (black dots):

(D) Fault zone and large crack (X) appear as lighter colour due to lower local density

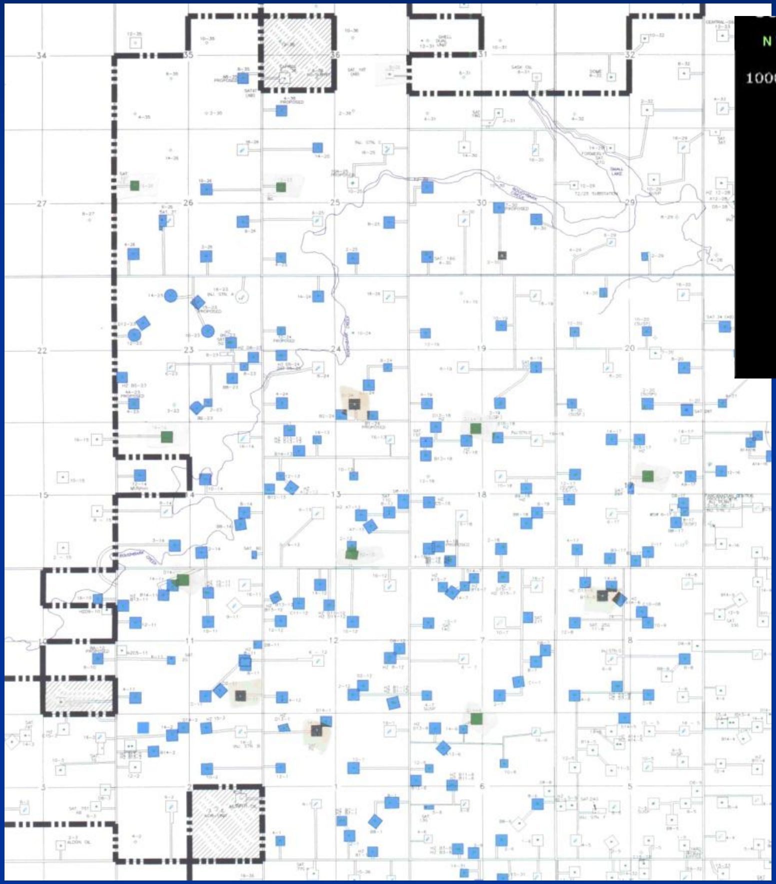
(C + E) Orthogonal elevation views of the fault zone and large crack

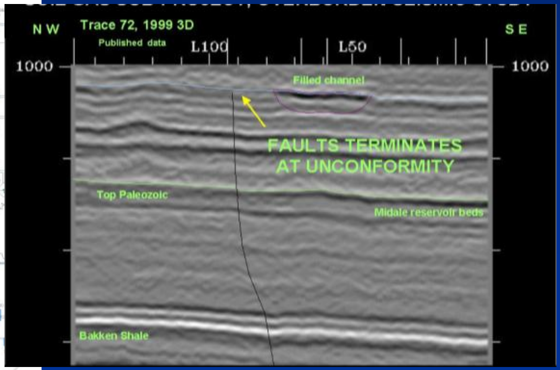
Key mechanisms in thermo-hydro-mechanical coupling of rocks to be investigated in the laboratory

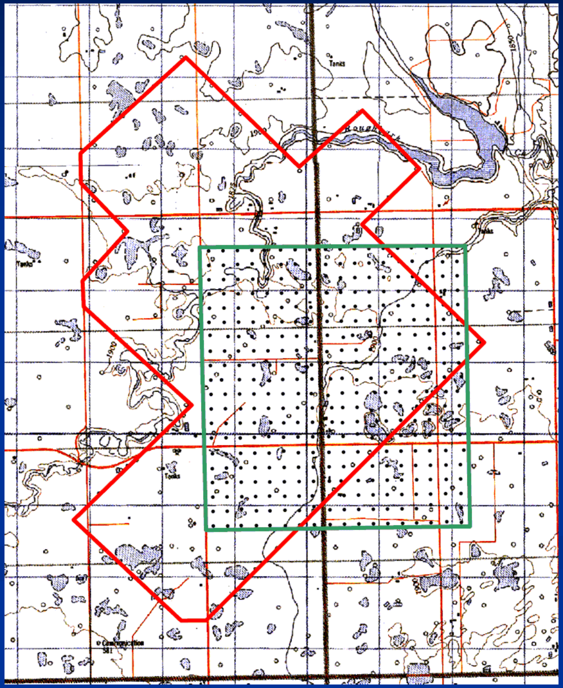
- Compaction, dilatancy and failure modes
- Localized and distributed deformation
- Coupling of mechanical response with fluid flow
- Fracture growth, interaction and network development
- Thermo-chemical reactions, high temperature fluids and rock deformation
- Geophysical/geochemical signatures and deformation processes

GAPS in monitoring strategies and choice of a sound “leakage and induced seismicity early alarm” system

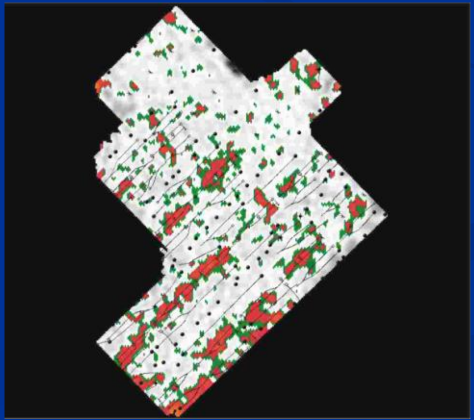
“Public Acceptance”: INGV monitoring in Weyburn deep reservoir and soil gases to discriminate CO_2 leakage







“Soil gas”

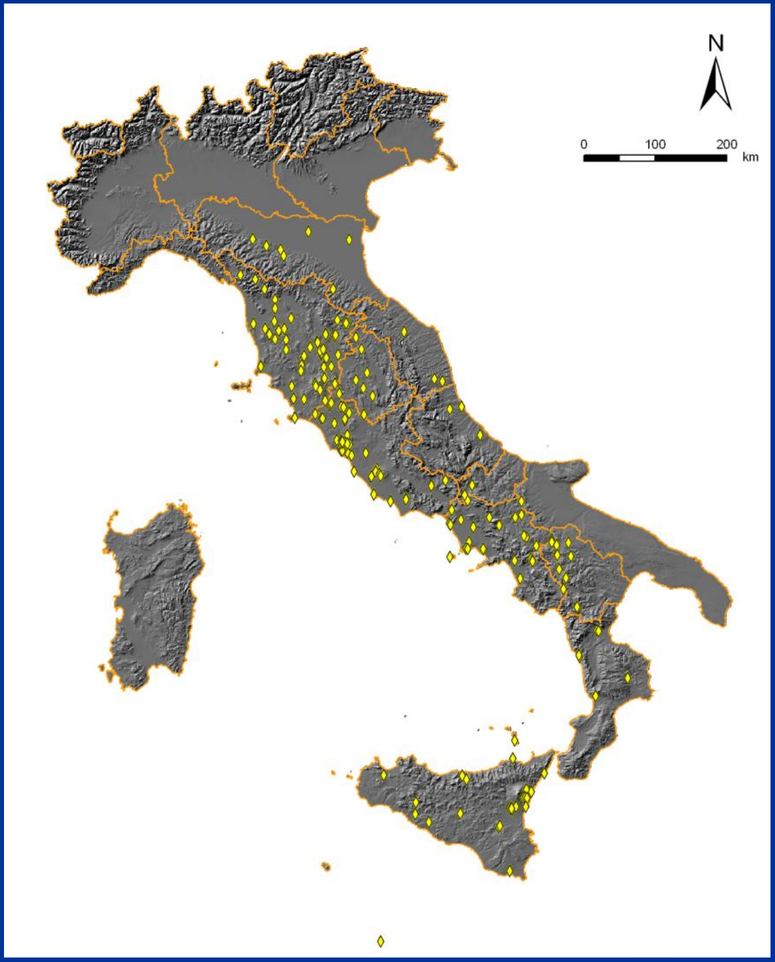


“Oil waters”

“Reservoir” profondo tramite sismica 4D and microseismicity

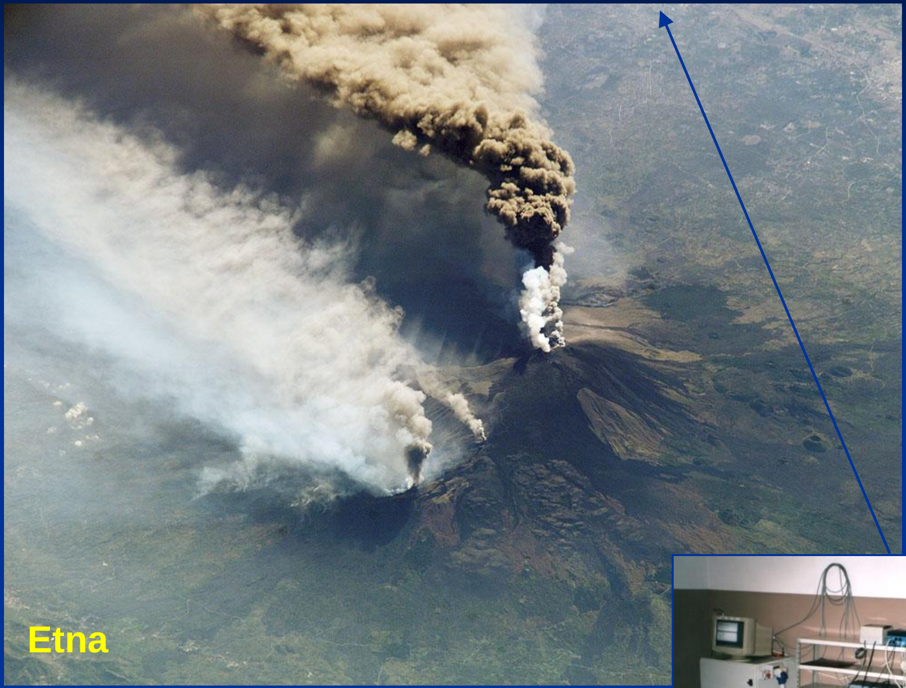
The 300 talian Diffuse Degassing Structures could be considered as 300 "failure" in selecting CO_2 storage sites in the past: risk managed in Italy since decades

Public awareness could start from the natural flux of CO_2



Monitoring tools already exist: maximum expertise in Italy being full of CO_2 underground (faults, volcanoes)

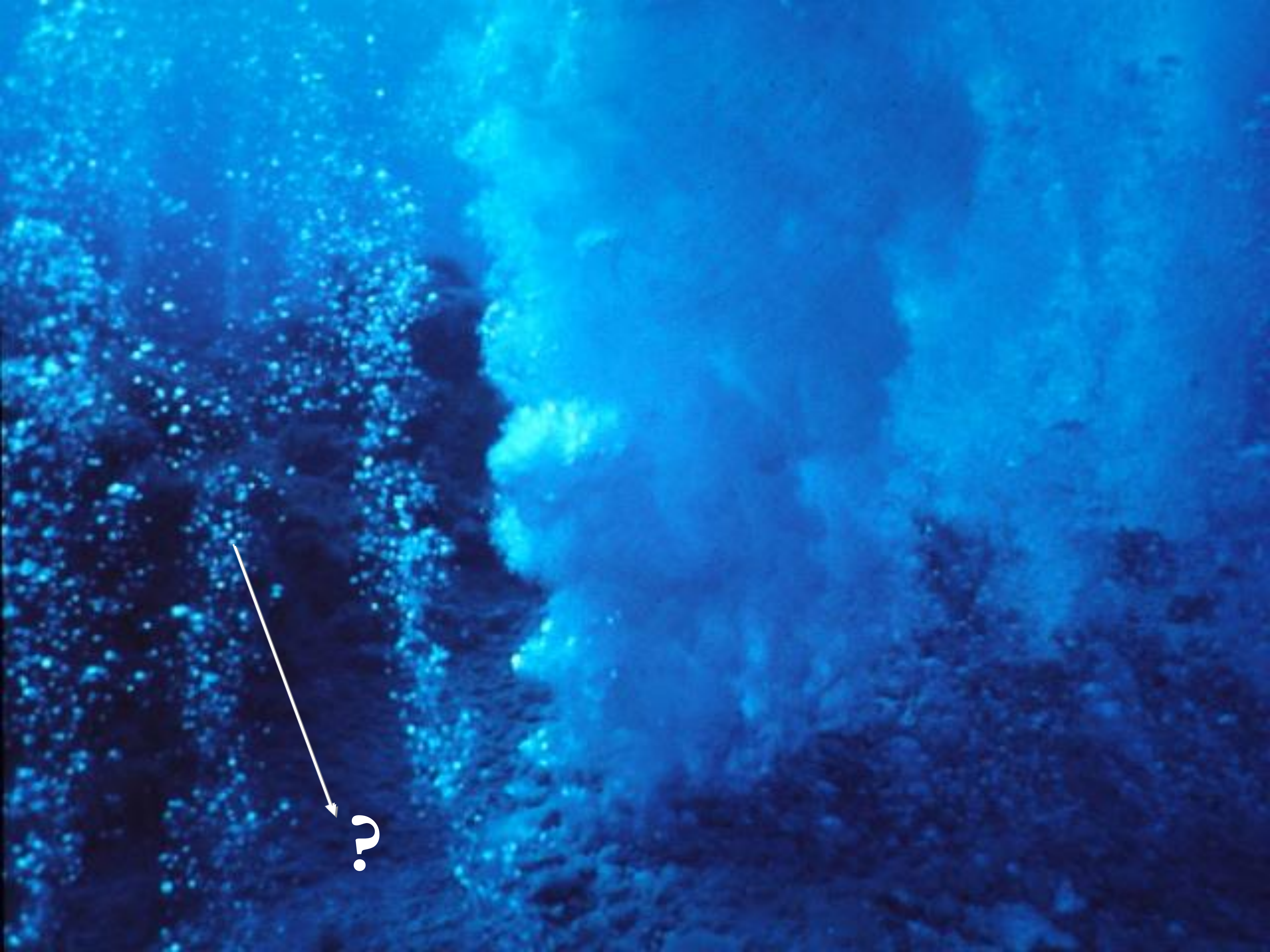
INGV



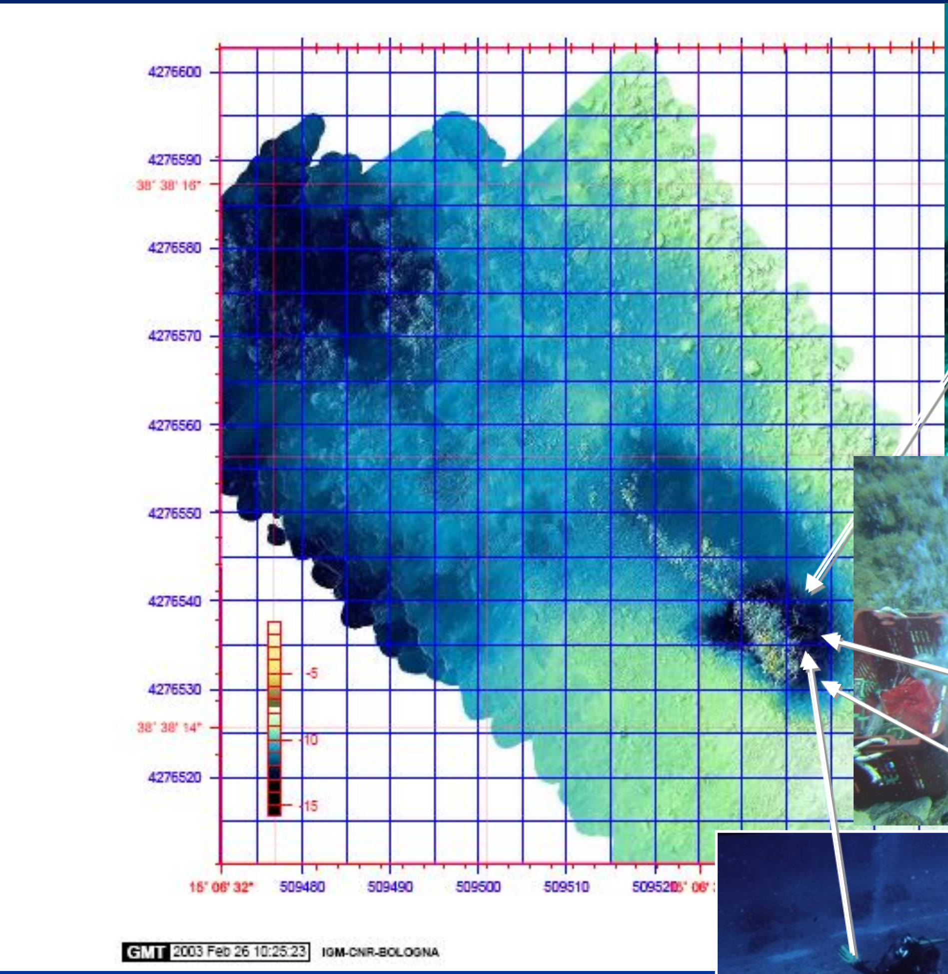
INGV station on Etna

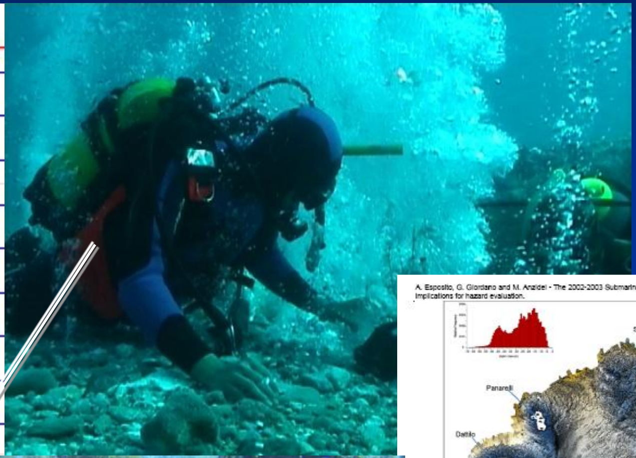
INGV installed more than 200 monitoring station over the italian territory (CO_2 related parameters under monitoring h24 on line)

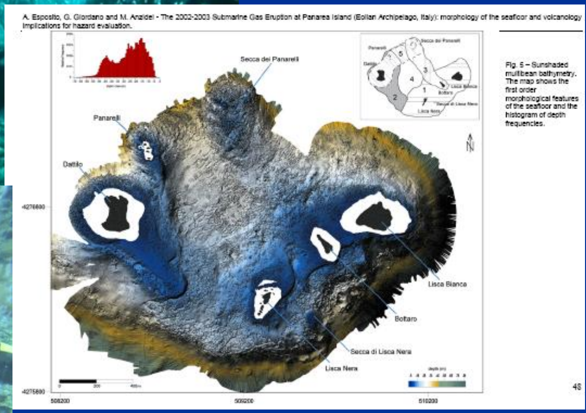
INGV sub at work

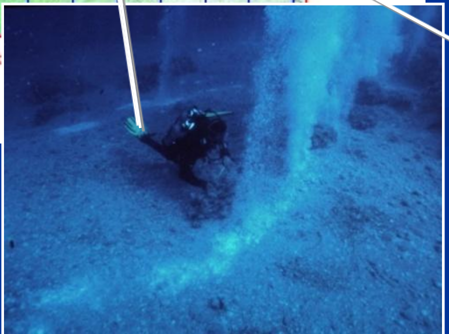


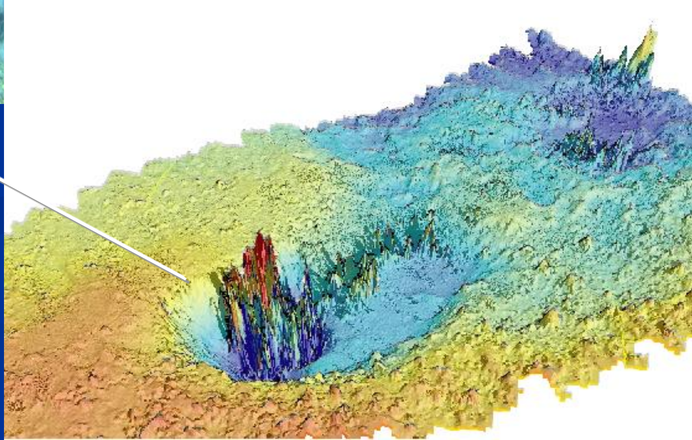
Offshore strategies could be cheap (INGV have different criteria agains some commercial european lobbies)



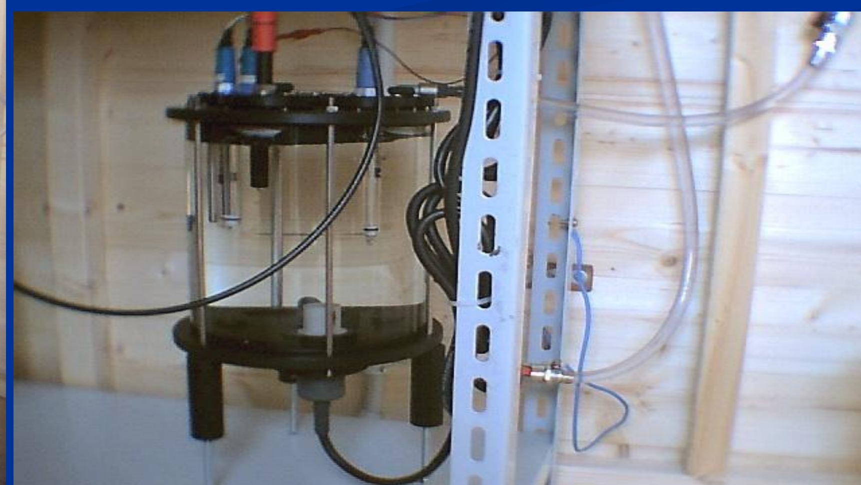




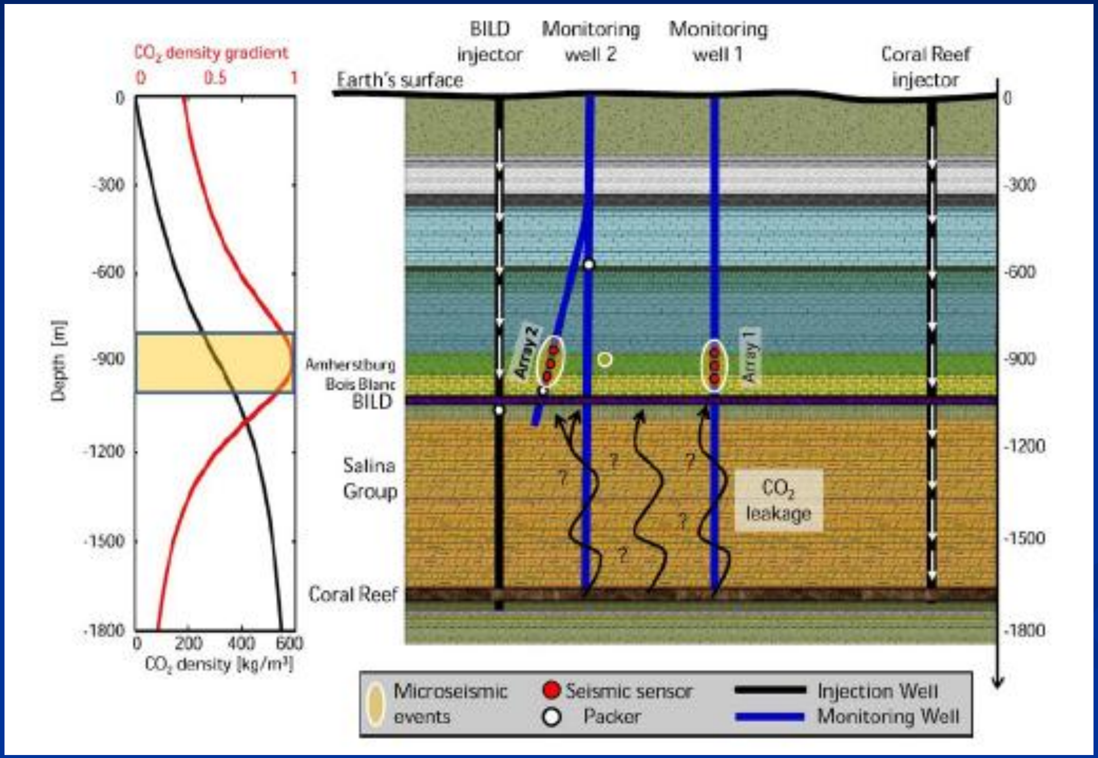




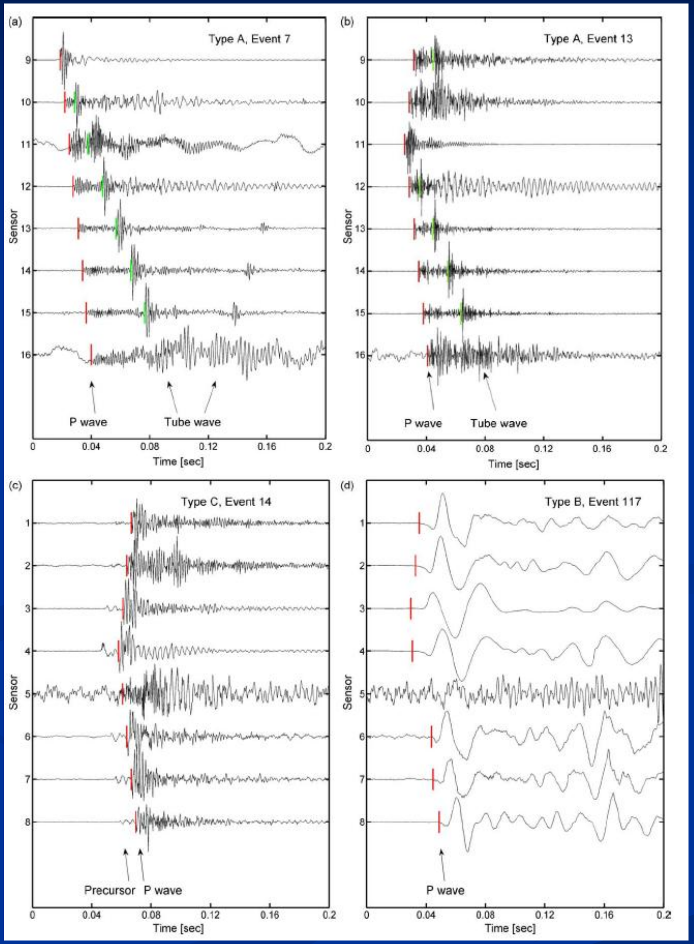
Prototipi Geochemical Monitoring System (GMS 2-GMS3)



Seismic detection of CO_2 leakage along monitoring wellbores



Bohnoff et al., 2010



Detection of non shearing events (no S) can be used as a precursor of leakage

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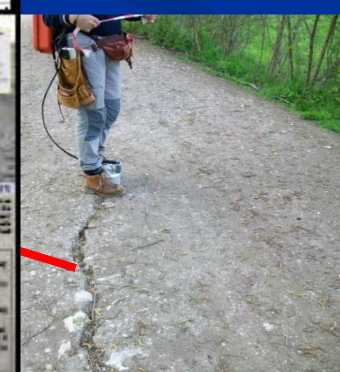
Very slightly anomalou ... in
activated faults of the st ... ly).
Implications for risk as ... of
CO_2

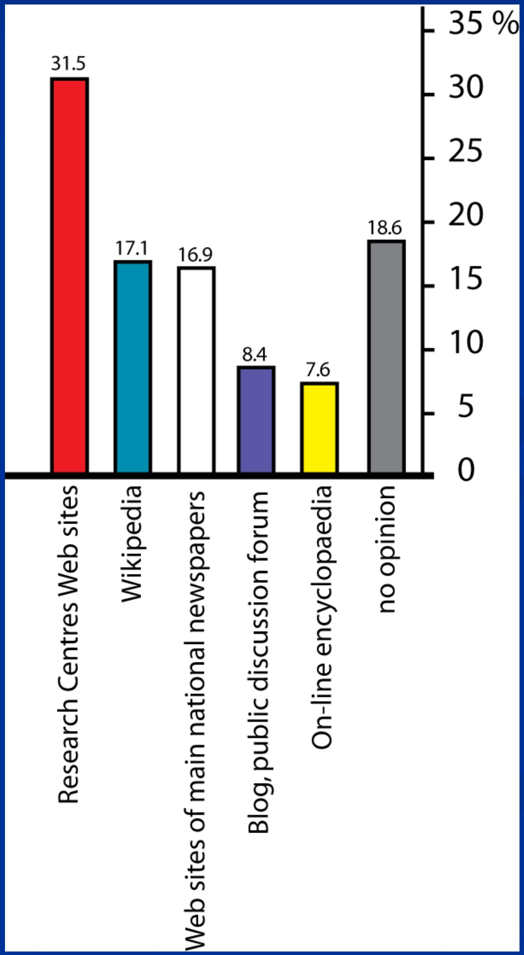
Quattrocchi F[a], Galli G[a], G ... N [a]

[a] Istituto Nazionale di Ge ... cal
Storage, Geothermics", Section Seis ... aly.

Elsevier us



GAPS in the CCS communication and “public awareness”



CO_2 is not a waste !

It is a climate-alterant gas

GAPS in the CCS communication and “public awareness”

Non-economic barriers could prevent projected CCS deployment.: two main fears: induced seismicity and escaping/leakage of CO_2

- CCS project cancelled (case histories: Spremburg, Germany, Greenville, Ohio, Barendrecht, Netherlands, etc…)
- Whether the public will support or oppose commercial-scale CCS projects is largely unknow (Malone et al., 2010) and the public reaction may be project-specific.
-public is less likely to trust information coming from a single source, particularly coming solely from industry or government;
- the public feels that several factors serve to widen the gap between the social and private returns to CCS technology development.

Elements of a successful outreach strategy

-integrating public engagement and education into core project management systems from the earliest possible point in time. *"Best practices guide for public outreach and education for carbon storage Projects"* (DOE 2009, INGV, 2010, 2011);

GAPS in the CCS communication and "public awareness"

- provide easily accessible information about CCS projects;
- engage the community during the planning stage and maintain engagement throughout the project lifetime;
- communicate the potential benefits of future CCS projects as job creation and stimulus to the local economy, and decrease in local air pollution;
- provide local communities with several opportunities to raise concerns, and address those concerns in a timely manner;
- focus on creating an open dialogue with the public, as opposed to a one-sides conversation;
- create mechanisms and systems to monitor and gauge public reactions and opinions;
- discuss why CCS is important (climate risks, need for sufficient and reliable energy)
-misinterpretation above this new technology: the monitoring case history… information about monitoring influence negatively, in a first stage, not local, the laypeople's perception of CCS (Quattrocchi, 2009; Selma L'Orange Seigo, 2011)
- there can be interaction effects between the content and the sender of communication (Euristic affect). Future research should investigate the possibility that the effect of monitoring information depends on the communicator.
- Match communication strategies to the mental models of the people (gender differences in CCS have been highlighted): i.e., higher risk perception induced from more information…
-More information does not always lead to views that are more balanced and might even

The better communication of the CCS technologies, and in particular of the storage part of CCS, passes through the faith to who is communicating the technology: public research accredited people

G Model
IJGGC-464; No. of Pages 6

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Short communication

Communication of CCS monitoring activities may not have a reassuring effect on the public

Selma L'Orange Seigo *, Lasse Wallquist, Simone Dohle, Michael Siegrist

ETH Zurich, Institute for Environmental Decisions (IED), Consumer Behavior, Universitätstrasse 22, 8092 Zurich, Switzerland

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GHGT-9

Communication Strategy for a public information campaign on CO_2 geological storage and on CCS as a whole: the case history in Italy from 2003 to 2008

Quattrocchi F.[a]

Istituto Nazionale di Geofisica e Vulcanologia (INGV), Section Rome 1, UF "Fluid Geochemistry, Geologica Storage and Geothermics", Via di Vigna Murata, 605, 00143, Rome, Italy, quattrocchi@ingv.it

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3.0.2.2)

se Degassing Structures
DS) INGV catalogue

r identification the real
l storage capacity of CO_2

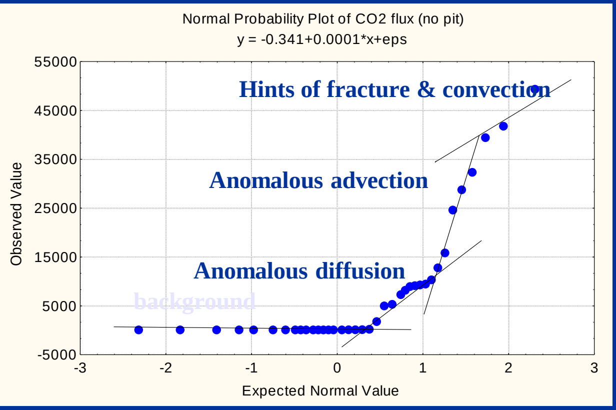
Concept to "digest" by the people in our communication events: a natural flux of CO_2 exists

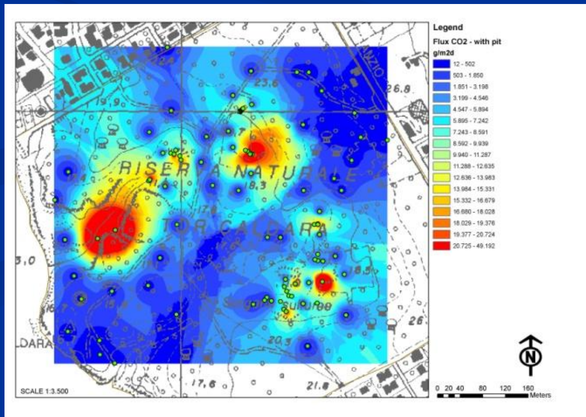
- I processi base riconosciuti da noi geologi essere importanti nel muovere verso la superficie del suoli dei geogas naturalmente o industrialmente conservati nel sottosuolo (processi noti come: leakage e seepage) attraverso gli strati di roccia del sottosuolo ed I sedimenti sono: la *diffusione,* la *advezione*, oltre alla *convezione*.
- Se il trasporto attraverso il mezzo (roccia e acquiferi) avviene per diffusione, il flusso stazionario, diffusivo, Φ_d è proporzionale al gradiente di concentrazione, $dC/d\lambda$, come espresso dalla Legge di Fick:

$$\Phi_d = -\nu D(dC/d\lambda) \qquad (1)$$

- Dove ν e D rappresentano la porosità del mezzo (i.e., la frazione di volume di poro rispetto al totale del volume del suolo o della roccia e il coefficiente di diffusione rispettivamente, il segno meno indica che le molecole di gas (CO2) si muovono verso l'alto cioè dal punto a maggiore concentrazione al punto a minore concentrazione. Al contrario, l'advezione implica movimento di massa conseguente ad un gradiente di pressione $dP/d\lambda$. Il flusso advettivo Φ_a è descritto dalla Legge di Darcy:

$$\Phi_a = (k/\mu)(dP/d\lambda) \qquad (2)$$





Start to communicate the CCS maximum risk as very near to the natural one: human beings coexist with this kind of low risk from millennia

Picture of the ENEL Torrevaldaliga coal-fired power plant, which was object of a CO_2 storage feasibility study: the little hill, highlighted by the red arrow is an ancient travertine deposit, accumulated in thousans years, due to a CO_2 leakage pathway located in the caprock of the deep saline aquifer, enriched by natural thermometamorlphic CO_2 (TRAVERTINE = $CaCO_3$): this is a typical example of CO_2 sequestration at surface when a deep CO_2 reach the surface together with the hot saline water coming from the deep reservoir, as natural leakage point in a geometric form in a "new rock hill" .

People of the Torrevaldaliga surroundings ! It is dangerous a little hill of a precious travertine arisen from CO_2 ? NO. We use travertine for building luxurious tables in our houses.

WE HAVE TO START FROM THIS "EURISTHIC AFFECT" MESSAGE FOR THE STORAGE ACCEPTANCE

QUOTIDIANO ENERGIA
www.quotidianoenergia.it

Anno 7 numero 170 - chiuso alle ore 18:35 di martedì 20 settembre 2011

Greggi ($/b)

	19/09	Var. % 16/09	Var. % 2010
WTI (Future)	85,70	-2,57	+15,88
Brent (Future)	109,14	-2,74	+38,87
Paniere Opec	108,68	-1,82	+43,97
Paniere QE Italia	110,58	-2,28	+40,88

Fonte: QE su dati mercato

Costo termoelettrico (€/MWh)

	Set-11	Ott-11
ITEC	88,26	88,85
ITECcqt	88,16	88,21

Fonte: Ref-Morgan Stanley

Cambio €/$

20/09 1 € = 1,3710 US $ (Var. +0,0069)
19/09 1 € = 1,3641 US $

Fonte: QE su dati Bce

Principali titoli energia (€)

	20/09		19/09
Eni	12,970	▲	12,880
Enel	3,124	▲	3,050
Snam Rete Gas	3,448	▲	3,404
Terna	2,628	▲	2,540
Edison	0,896	▲	0,867
A2A	0,888	▲	0,876
Acea	5,515	▼	5,535
Saras	1,123	▼	1,137
Hera	1,048	▼	1,085
Iren	0,825	▲	0,817
Erg	8,505	▲	8,415

Fonte: QE su dati Borsa Italiana

Borsa elettrica Italia

Prezzi Ipex (€/MWh)			
	F1	F2	F3
20/09	92,82	97,21	64,14
var % sett.	-3,80	-2,89	-10,64
	Media	Picco	Vuoto
20/09	85,91	94,91	66,42
var % sett.	-4,91	-3,44	-8,87
Domanda Sistema Italia			
Media oraria (MW)			38.358
Massima (MW)			44.653
Prezzo ora max (€/MWh)			98,52
Ora max			10-11

AUTORITÀ ENERGIA

Audizioni, la sfilata

Con la Robin Tax al centro

I.P. a pag. 8

Prezzi gas Italia: "Non c'è solo il caropetrolio"

Meno capacità dall'Europa, l'effetto Libia, le strategie dell'Eni nei commenti degli operatori. Ipotesi capacity release

articolo a pag. 5

"SERVONO ACCUMULI"

Le batterie dell'Enea

Ma c'è il nodo costo

C.M. a pag. 2

RIORGANIZZAZIONE

Idro Enel post Egp

Da 500 a 176 MW

C.M. a pag. 6

CONSIGLIO ENERGIA

La Ue dopo Fukushima

Saglia: "Ora più coesione"

articolo a pag. 9

L'INTERVENTO

"Economic geology"

di Enzo Boschi* e Fedora Quattrocchi**

Dopo il sisma del Giappone, accanto ad una ovvia revisione ma anche una obbligata continuazione della ricerca nel campo nucleare, fosse solo per lo smaltimento dei rifiuti ancora sparsi sul nostro territorio ed il know how da e verso l'estero, con imprese italiane attive, in primis Enel, nuove parole si impongono più di "nucleare", nello scenario energetico italiano.

segue a pag. 6

FER: RAPPORTO GSE 2010 (PAG. 7)

IGNORATI FMI-SSP

Wti-Brent in volata

Check-Up Prezzi QE

articolo a pag. 3

Edison, Brescia punta sull'intesa di marzo

Paroli: "Posizione condivisa con Pisapia". I dettagli dell'asta se salta l'accordo. Giovedì i Consigli di A2A

articolo a pag. 9

CONCLUSIONS I

- The complexity and novelty of CCS may present a formidable challenge to agencies in dealing with uncertainty in science and risk assessment, missing information, and consideration of new risks to human welfare or to the environment from the deployment of CCS. This last item is partially true in countries very well dealing since centuries with high CO2 content underground (volcanic and geodynamically younger countries).

- The integration of CO_2 Capture, transportation and permanent sequestration at commercial-scale, coal-fired power generating facilities has not yet been demonstrated but very close (2015);

- Ultimately an honest assessment of a project's risks and uncertainties is very necessary for CCS.

- The main question for the future legal controversial will be: the harm is or not in fact caused by the storage site, but would have occurred without the storage activity. A full baseline monitoring is the main sound pre-requisite.

- RD&D and learning by doing could transform CCS from a technology only affordable to industrialized nations to a cost-effective GHG mitigation option with a global impact.

CONCLUSIONS II

- The role of public research is strategic: efforts early in the process are necessary working with trustworthy messenger is an important first step since the credibility of the person or organization delivering the information can make a significant difference how the public reacts.

- No market is expected to develop for reuse (mineral carbonation, conversion of CO_2 in biofuels as methanol, urea production, ceramics, fertilizers, polyurethane and polycarbonate production) of CO_2 on a scale that would significantly affect the strategy to roll out CCS on a national basis by 2016.

- By 2016 in USA, Europe, Australia, China, etc…. complete small-scale field testing of 2nd generation CO_2 capture technologies and components that demonstrate significant reduction in CO_2 capture cost and energy penalties compared with current technologies. The field testing will be between 0.5 to 5 MWe scale from pilot plant facilities and/or slipstream at operating coal-based power plants.

FINAL CONCLUSIONS

- importance of the deep geological structures. UNDERGROUND VALUE

- CCS must be implemented widely and quickly AS « BRIDGE » tech: ONLY BY SYNERGIES WITH OTHER ENERGY LOBBIES

- The mentioned technologies can cohexist underground. PLANNING BEFORE

- « Risk objects » in the potential sites catalog WHY SO LOW PUBLIC MONEY ON IT ? ….

- We have 20 YEARS and we are in delay

CONCLUSIONS FROM A POLICY MAN

Coal with Carbon Capture and Storage: The Low-Cost, Low-Carbon Solution

"Clean coal technology is something that can make America energy independent. This is America. We figured out how to put a man on the moon in 10 years. You can't tell me we can't figure out how to burn coal that we find right here in the United States of America and make it work." **– President Barack Obama**

Thank you

Enzo Boschi
INGV President | Bologna University, ITALY
Fedora Quattrocchi | INGV, ITALY
Davide Scrocca | CNR-IGAG, ITALY
Aldo Brondi | ex-ENEA | Tuscia University, ITALY
Pete McGrail | U.S. PNNL, USA
Stuart Haszeldine | University of Edinburgh, UK
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34th Course of the International School of Geophysics
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