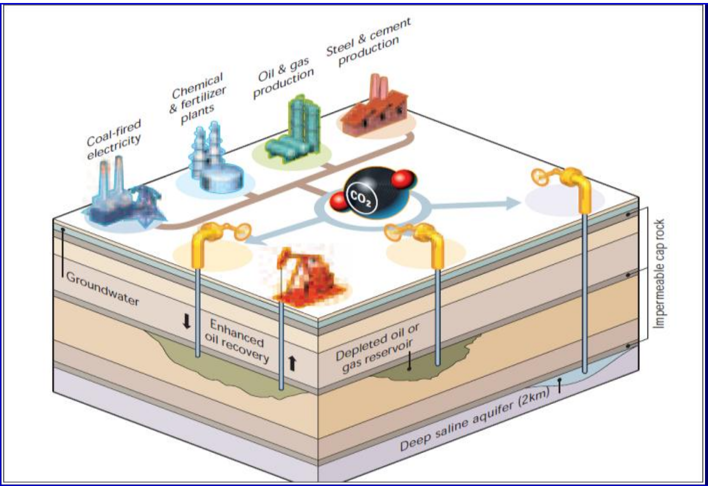

European Supply Security with Coal – High Uncertainties due to obstacles to Carbon Capture, Transport and Storage (CCTS)

Based on SECURE Meeting **(Brussels, September 29, 20010)**

Christian von Hirschhausen, Johannes Herold

Agenda

1. Introduction

2. (Steam) Coal: No Serious Supply Security Issues

3. The Real Issue: CCTS (Carbon Capture, Transport, and Storage)

4. Conclusions

Main Message

- **The real issue in European supply security regarding coal is not the resource availability, but the absence of an economically and politically sustainable use of the coal for electricity, liquefaction, gasification, industrial applications etc., due to obstacles in the implementation of a CCTS (carbon capture, transportation, and storage) value-added chain**

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Upstream: Threat Identification and Assessment

- Large share of imports in many European countries
- Climate policies may result in reduction / abolition of coal use in power generation in Europe

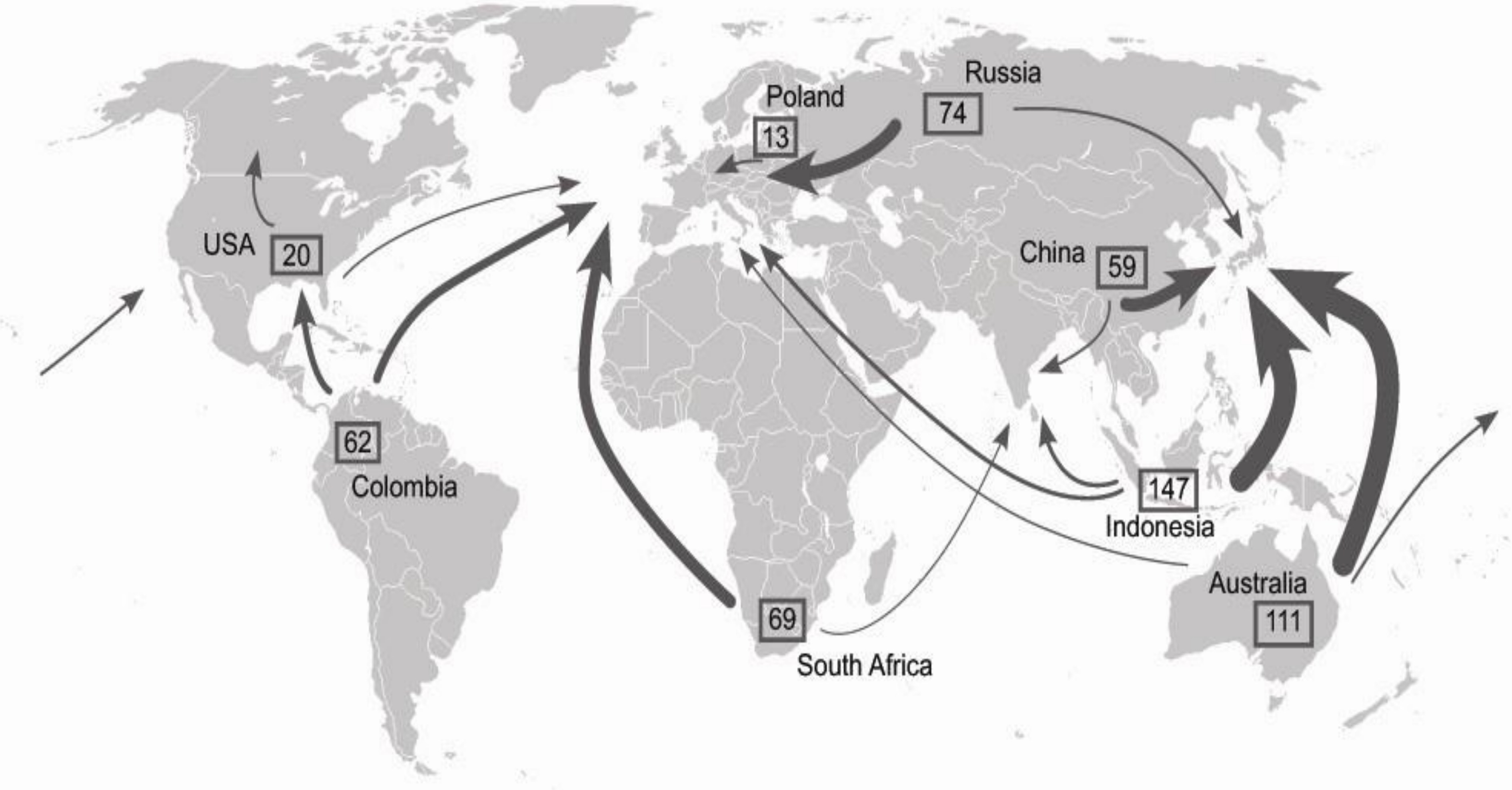
	Import dependency rate	Share of steam coal in electricity production
Germany	69.2%	20.6%
Italy	99.5%	14.4%
Spain	71%	23.5%
UK	63.4%	33.7%
USA	1.8%	47.9%
Japan	99.5%	24.5%
South Korea	95.4%	35.1%
Taiwan	100%	52.8%
China	11%	78.4%

Steam Coal Import Dependency Rate (2006)

Source: Deliverable 5.3.1, based on IEA (2007) Coal Information; IEA (2007) Electricity information

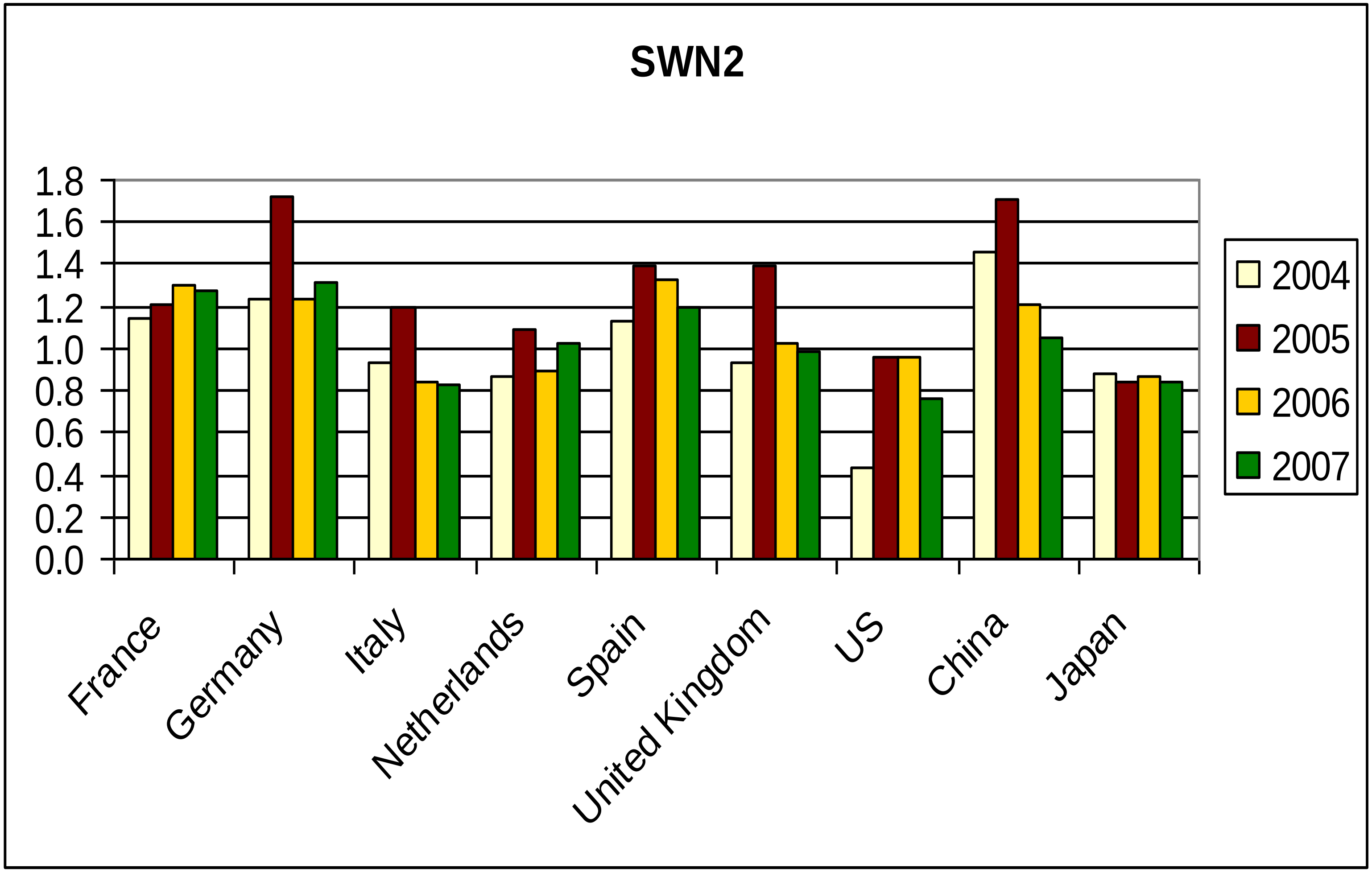
Seaborne Trade of Steam Coal: High Degree of Diversification of European Supplies

Seaborne traded steam coal 2007: 607 Mio. t



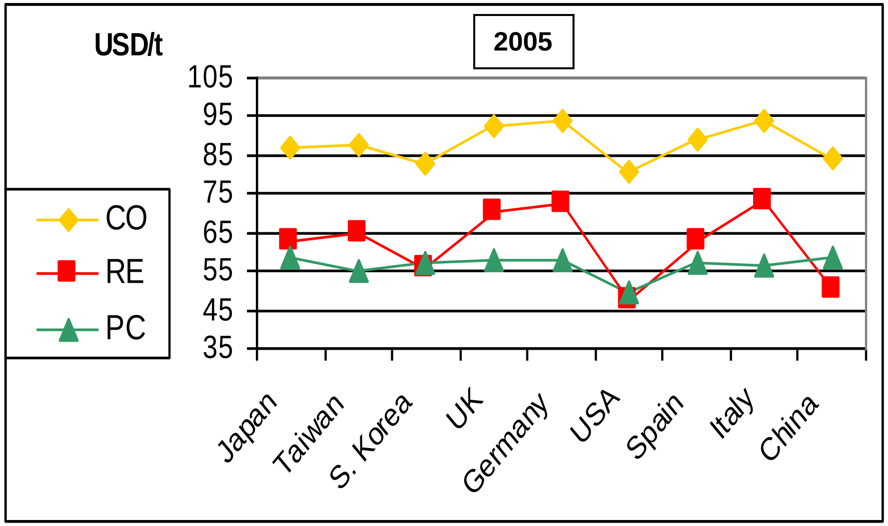
Source: IEA (2008) Coal Information

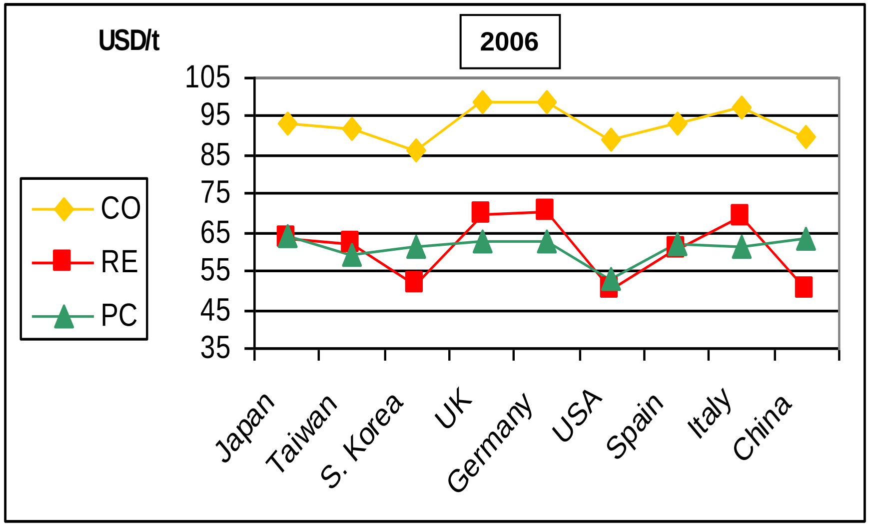
Diversification of Coal Supplies over Time
Taking into Account Political Risk and Domestic Production



Source: Deliverable 5.3.2

Prices and Market Structure Conclusions



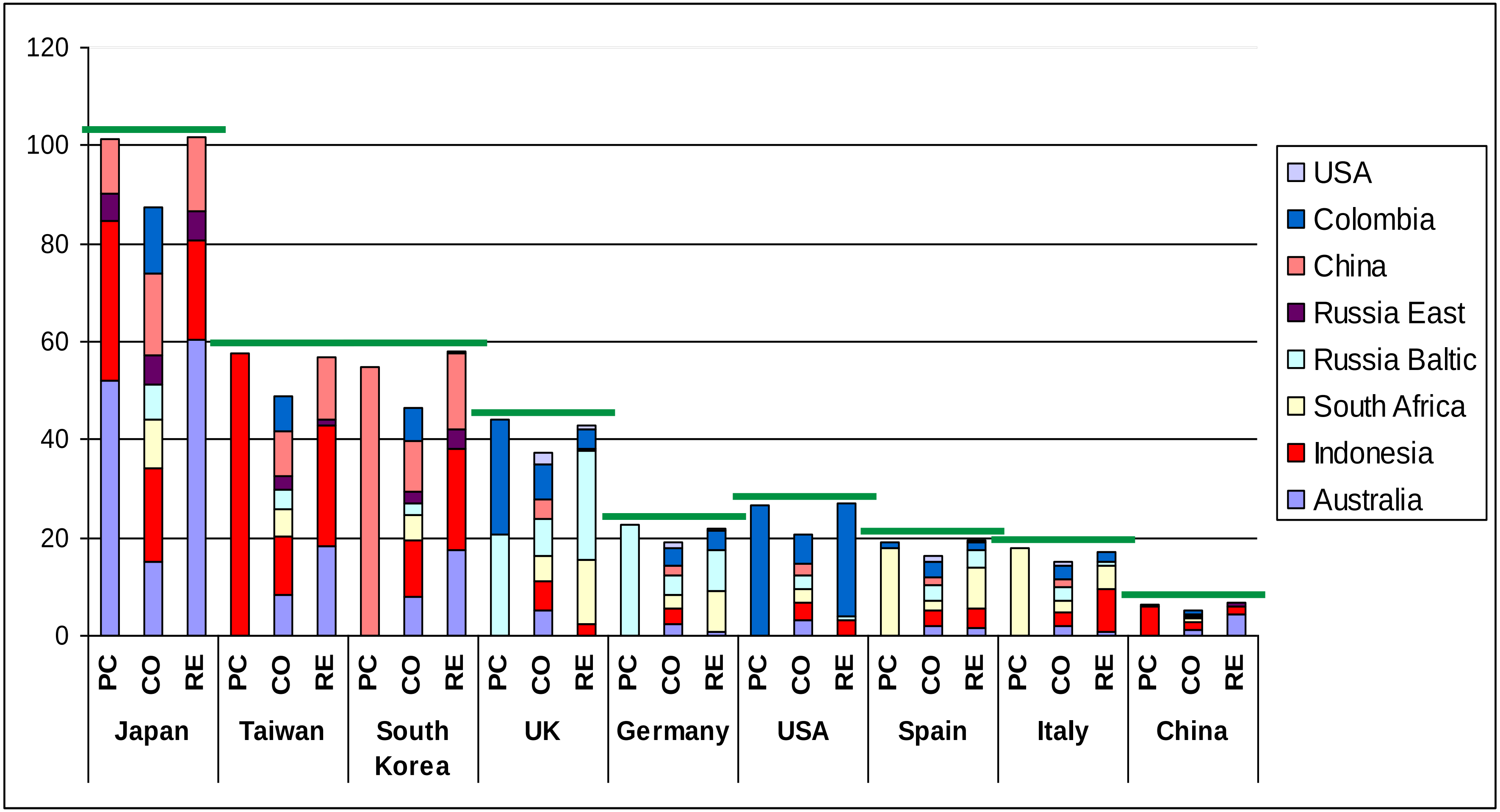


- **The real prices are between the modeled price but in 2006 clearly closer to the perfect competition case.**
- **The results tend to indicate that the international steam coal market is competitive.**

Other (than geo-political) risks in the long-term:

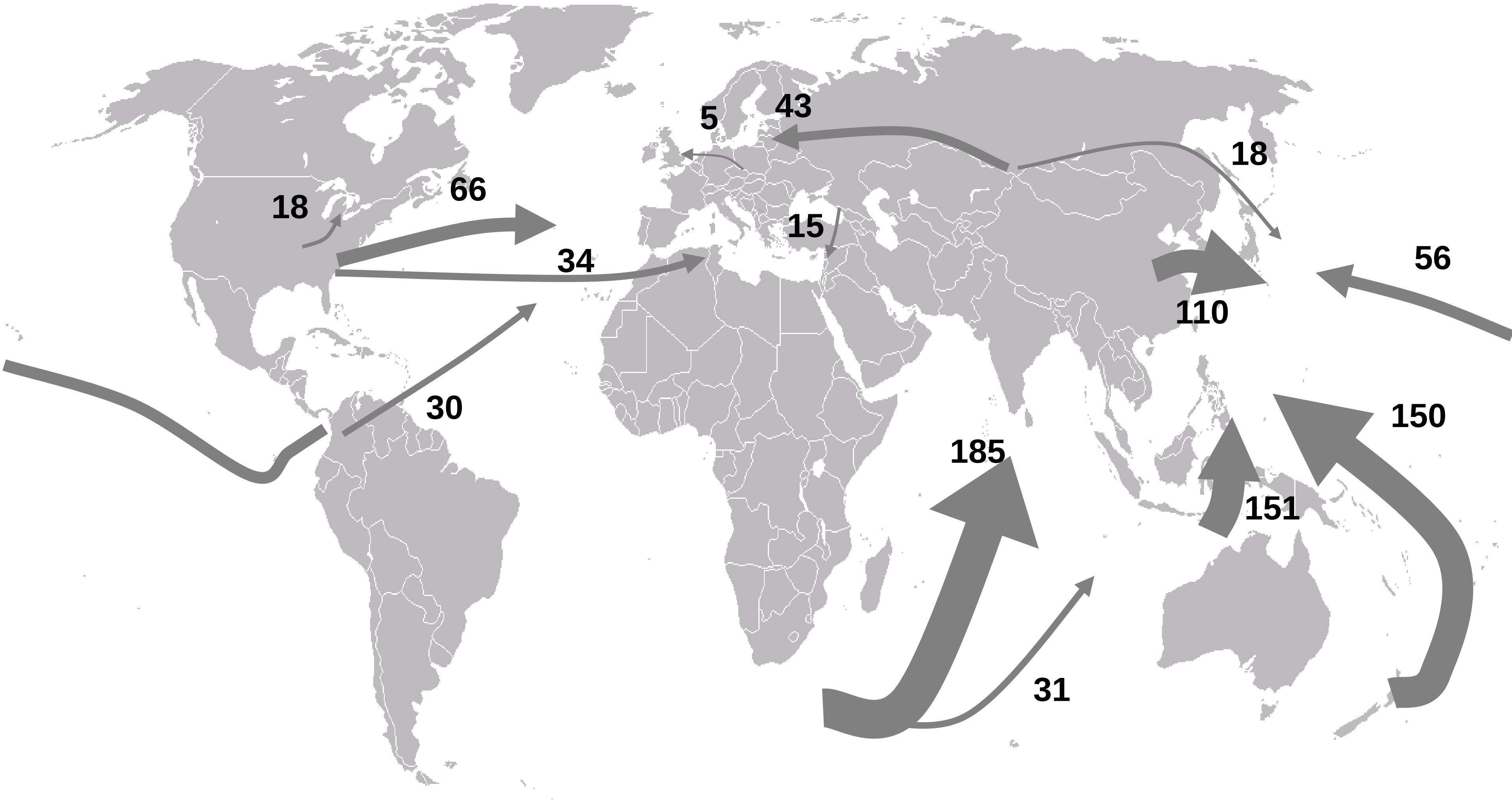
- **under-investment, especially in transport infrastructure (railways, export terminals), in large exporting countries, e.g. South Africa → scenario analysis**
- **No reserve risk foreseeable**

Results 2006: Imported Quantities in Mt
Evidence of Competitive Market



PC: Perfect competition simulation **RE: Reference quantities 2006**
CO: Cournot competition simulation

Base Case Results 2030: Diversification Remains (in Mt)



in Million tons

Policy Conclusions (1): Upstream

- **The real issue in European supply security regarding coal is not the resource availability, neither potential curtailments due to national export limitations**

- **Upstream, there are little worries about the supply security of (steam) coal**
  - Market monitoring should be continued, in particular on developments and prices in specific regions (e.g. China)
  - Competition authorities should continue to monitor international coal markets, with a special focus on mergers& acquisitions of “Big Coal”

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1. Wishful thinking …
2. … Reality
3. Modeling exercise
4. Focus on industrial emissions

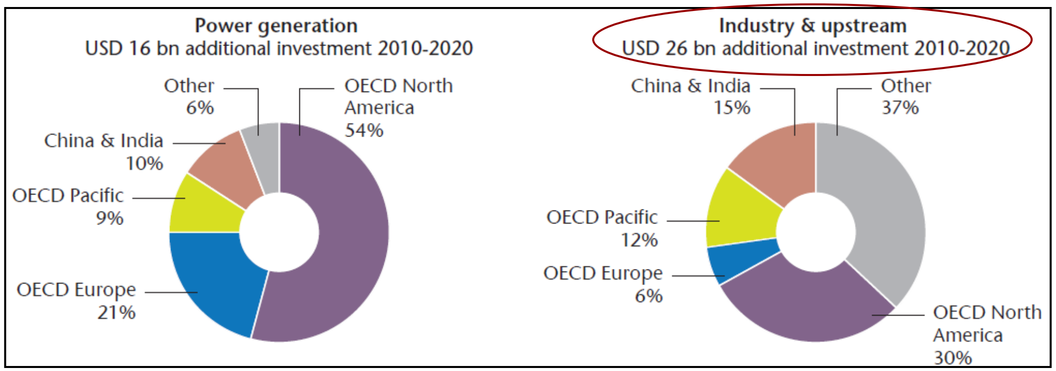
4. Conclusions

3.1 "Wishful Thinking" (1)
PRIMES Energy System Forecast (Sep. 2010)

- **Baseline scenario:**
- **"For CCS, the scenarios assume that the infrastructure and the regulations will deploy and become operational after 2020. " (p. 23)**
- **5.4 GW installed by 2020**
- **35 GW installed by 2030; ~ 8.7% of total generation (23.6% CO_2 captured)**

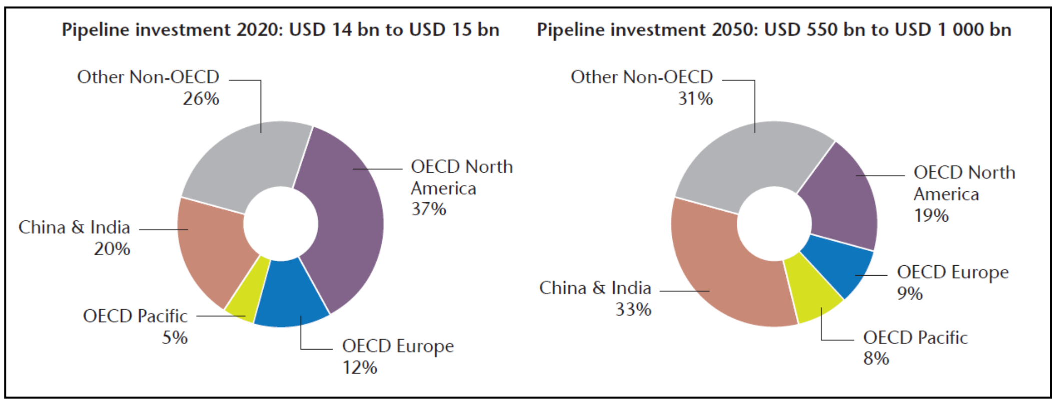
3.1 “Wishful Thinking” (2): Investment Needs for CCTS

Additional investment needs for CCTS over the next ten years. IEA, 2009



IEA., 2009

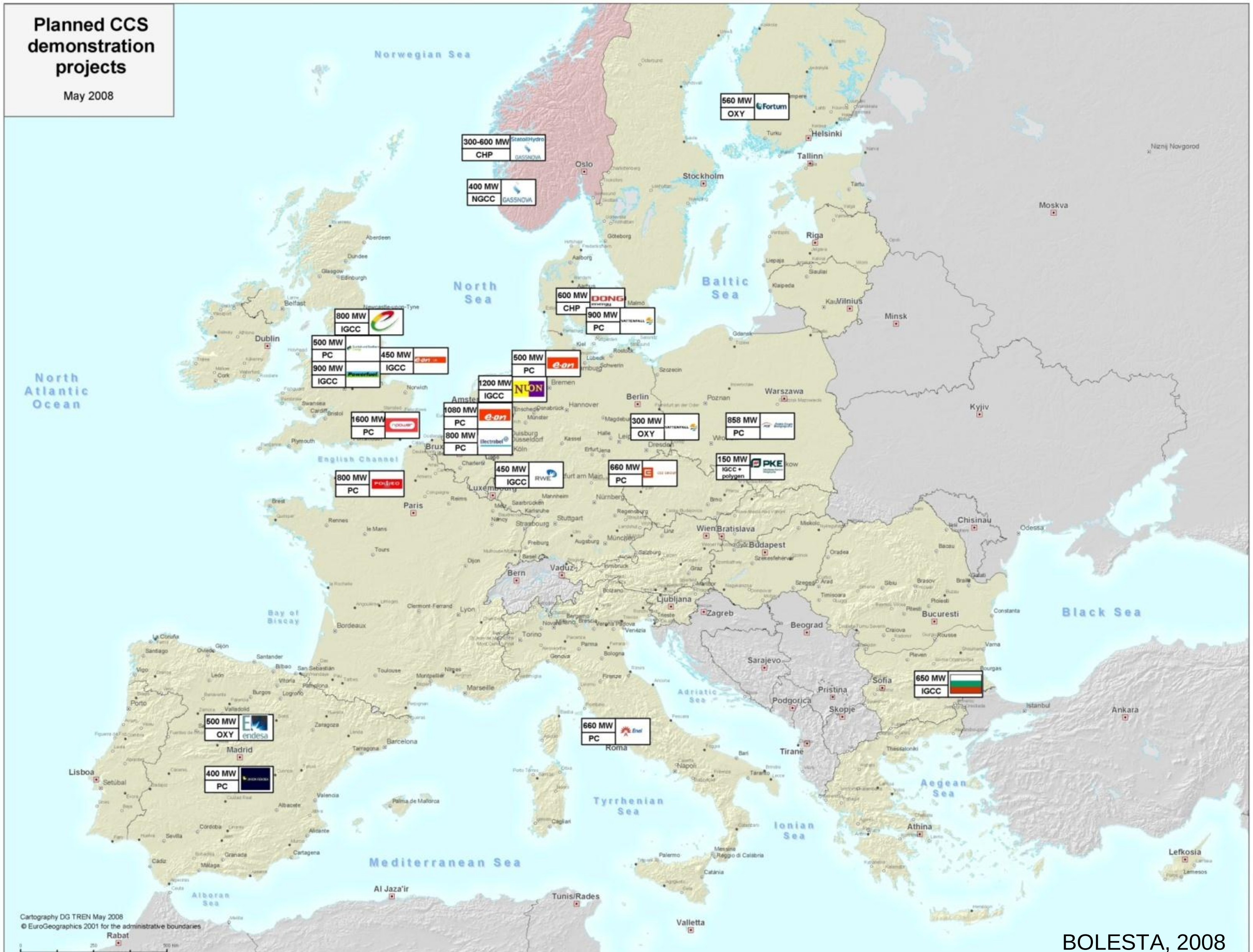
Global CO_2 pipeline development 2010-50. IEA, 2009



IEA., 2009

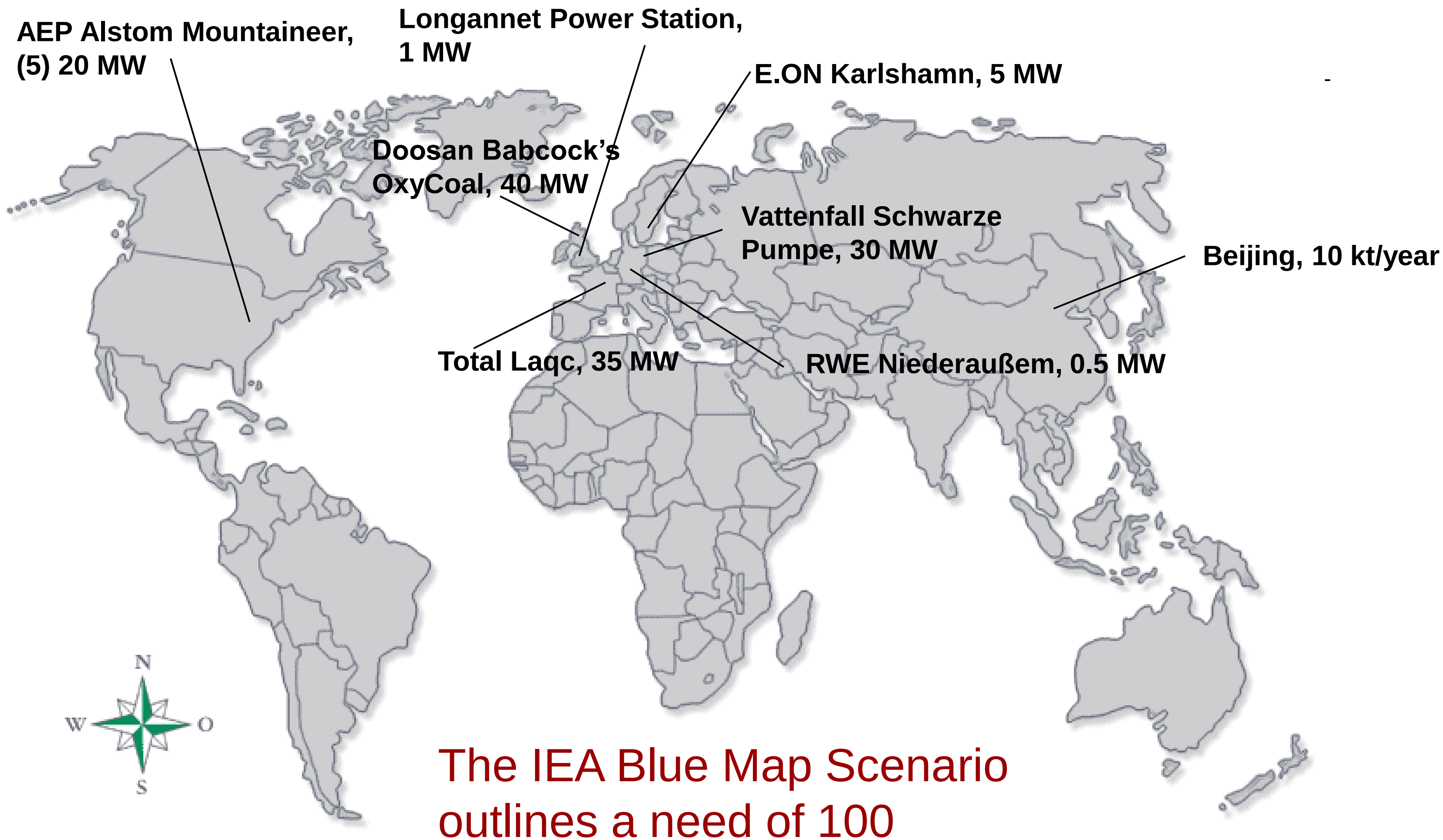
- **The next 10 years are a critical period for CCTS (IEA, 2009).**
- **Among the 62 announced CO_2 capture projects, only 7 pilot projects are operating on the pilot scale.**
- **Assuming that all of the announced projects are realized by 2050 there still remains a gap of 40 projects to reach the IAE blue map scenario.**
- **This gap is higher with respect to regional projections. Only Europe could reach the IEA forecast by 2020 given 37 announced CCTS projects.**

3.1 “Wishful Thinking” (3): Announced EU Demonstration Projects (2008)



BOLESTA, 2008

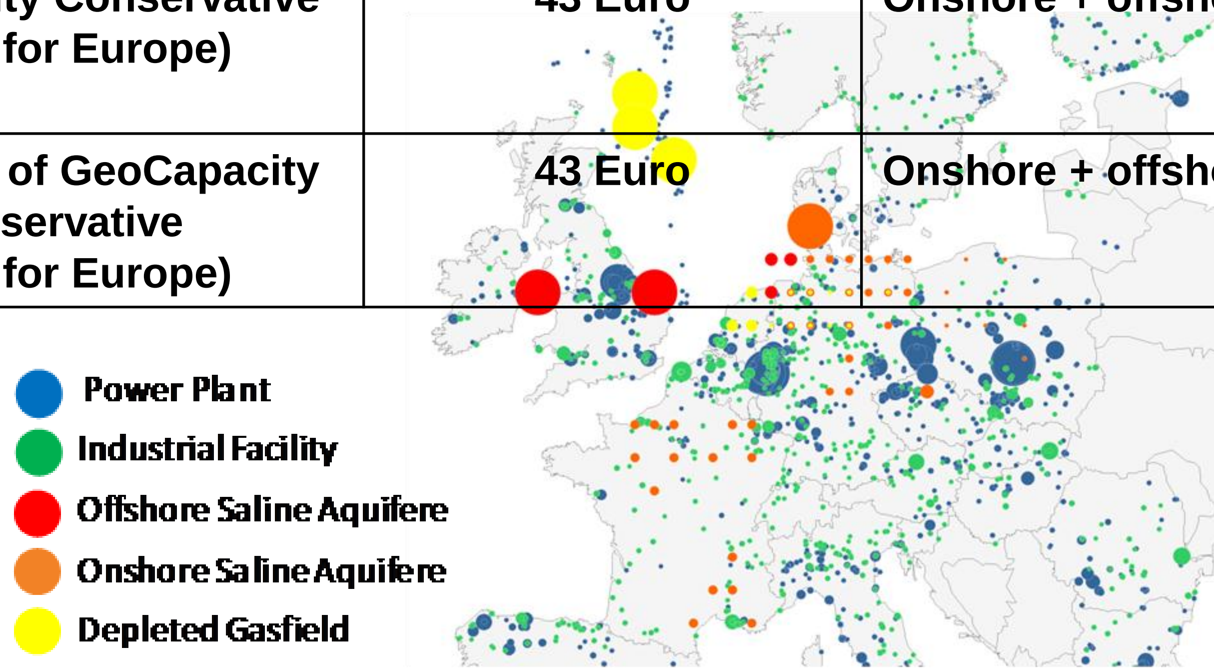
3.2 Reality Check (1)
CCTS Power Projects Operating, 09/2010



The IEA Blue Map Scenario outlines a need of 100 serious CCTS demonstration projects until 2020!

3.3 Modeling a European CCTS Infrastructure: Scenario Key Assumptions

Scenario	Geological storage potential	CO_2 certificate price in 2050	Public acceptance
BAU	GeoCapacity (100 Gt for Europe)	43 Euro	Onshore + offshore
Off 120	GeoCapacity (100 Gt for Europe)	120 Euro	Offshore storage only
Conservative storage potential	GeoCapacity Conservative (50 Gt for Europe)	43 Euro	Onshore + offshore
Low storage potential	50 percent of GeoCapacity Conservative (25 Gt for Europe)	43 Euro	Onshore + offshore



Source: Own illustration based on input data from EEA (2007) and GeoCapacity (2009a, b)

Modeling a European CCTS Infrastructure: Scenario Results

Scenario	CO_2 price in 2050 [€]	CO_2 stored via CCTS in 2050 [%]	Infrastructure length in 2050 [km]	Share of CO_2 from industry [%]
BAU	43	19.4	2897	54.0
Off 120	120	24,7	15889	47,2
Conservative Storage Potential	43	13.5	1333	60.6
Low Storage Potential	43	5.6	-	66.8

- **Under certain assumptions, CCTS may theoretically contribute significantly to the decarbonization of Europe's electricity and industry sector**
- **Results reveal that the development of the CCTS infrastructure is highly sensitive to the availability of storage sites.**
- **An early integration of Europe's industry and electricity sectors in the CO_2 infrastructure planning increases network efficiency.**
- **In all scenarios, industry plays an important role as a first mover to induce deployment of CCTS.**

Alternatives to CCTS in Industrial Applications

- **Cement: responsible for more than 5% of global anthropogenic CO_2 emissions.**
  - Production of 1 ton Portland cement results in 0.65 – 0.92 tons of carbon
  - Alternative production processes under development,
- **Iron/Steel: the iron and steel industry accounts for about 19% of final energy use and about a quarter of direct CO_2 emissions from the industry sector.**
  - CO_2 neutral iron production in combination with biomass gasification (CO),
- **Pulp/paper: responsible for ~ 6% of industrial final energy use**
  - Already high share of biomass co-firing (~50%) and CHP
- **Hydrogen: due to much lower costs and technical maturity, H_2 production primarily based on the steam reformation of natural gas.**
  - Electrolysis with renewable based electricity could lower carbon emissions significantly
- **Ammonia: CO_2 emissions**
  - Use of "green" hydrogen possible, but uneconomical (q.v. hydrogen)
- **Refineries: the use of hydrogen will increase with the use of heavy oils, oils sands and oil shale**
  - Use of "green" hydrogen possible, but uneconomical (q.v. hydrogen)

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Conclusions (Downstream)

- **The technical, financial, and institutional structures of the entire chain pose significant challenges**
- **The real bottleneck towards CCTS is the transport and storage infrastructure:**
- **The focus should be extended to industrial applications, which can be highly vulnerable to an abandonment of coal.**
  - Due to a larger number of small emissions sources, this will pose higher challenges to network development.
  - Technical alternatives to CCTS are available
- **Early planning of transport routes is of paramount importance should large-scale CCTS deployment ever become reality**
- **Future regulation should specify the allocation and financing principles as well as access for third parties**

➔The potential contribution of CCTS to a decarbonised European electricity sector should be reconsidered given new data available on CCTS costs

➔ The idea that CCTS could constitute an “energy bridge” into a new, largely renewable-based energy system, should be discontinued.