CCS Technology Development & Transfer

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Outline

- Introduction
- What technologies for capture, transport and geological storage ?
- Two examples of European Projects
- Conclusions: European case history

Technology development is the key !

⇒ Three "pillars":

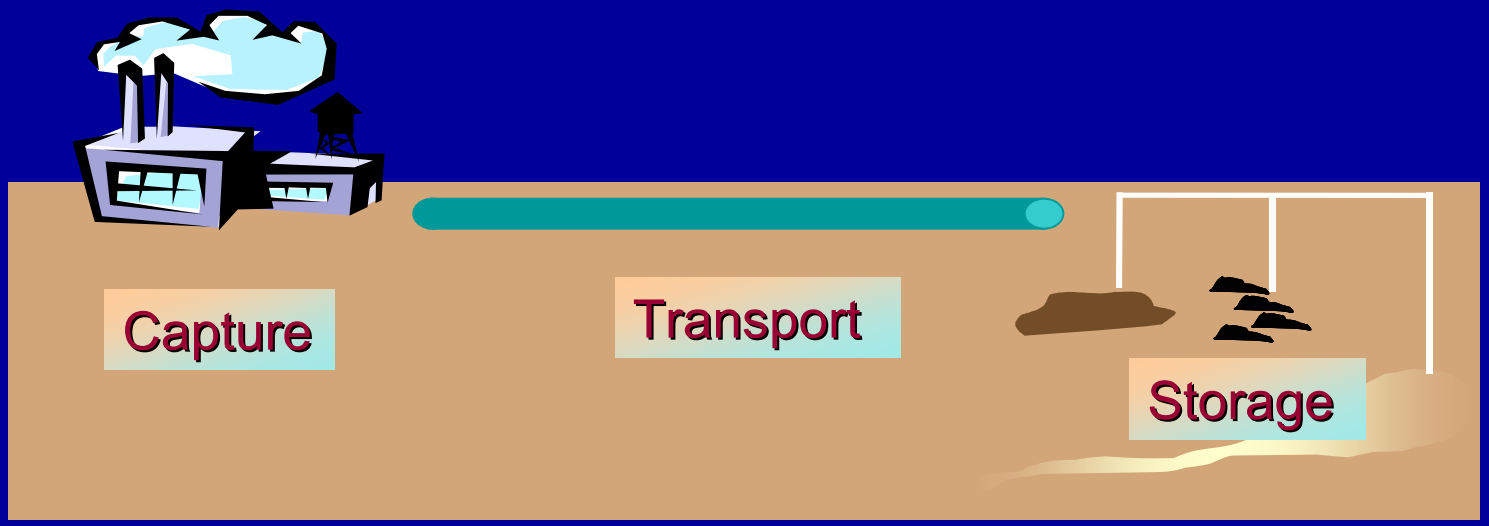
- Solve the technical issues and challenges involved at the different stages of CO_2 capture, transport and storage
- Define a realistic deployment roadmap, integrating industrial and financial constraints
- Provide an international forum for exchanging views and experience based on different initiatives world-wide

Focus for the work to reduce CO_2

- CO_2 emissions sources $\Rightarrow$ match with possible deposits
  - Mapping (IEA-GHG, Gestco, …) = WHERE to inject

    now … WHEN ? (Regulations, "qualification" of deep aquifers)

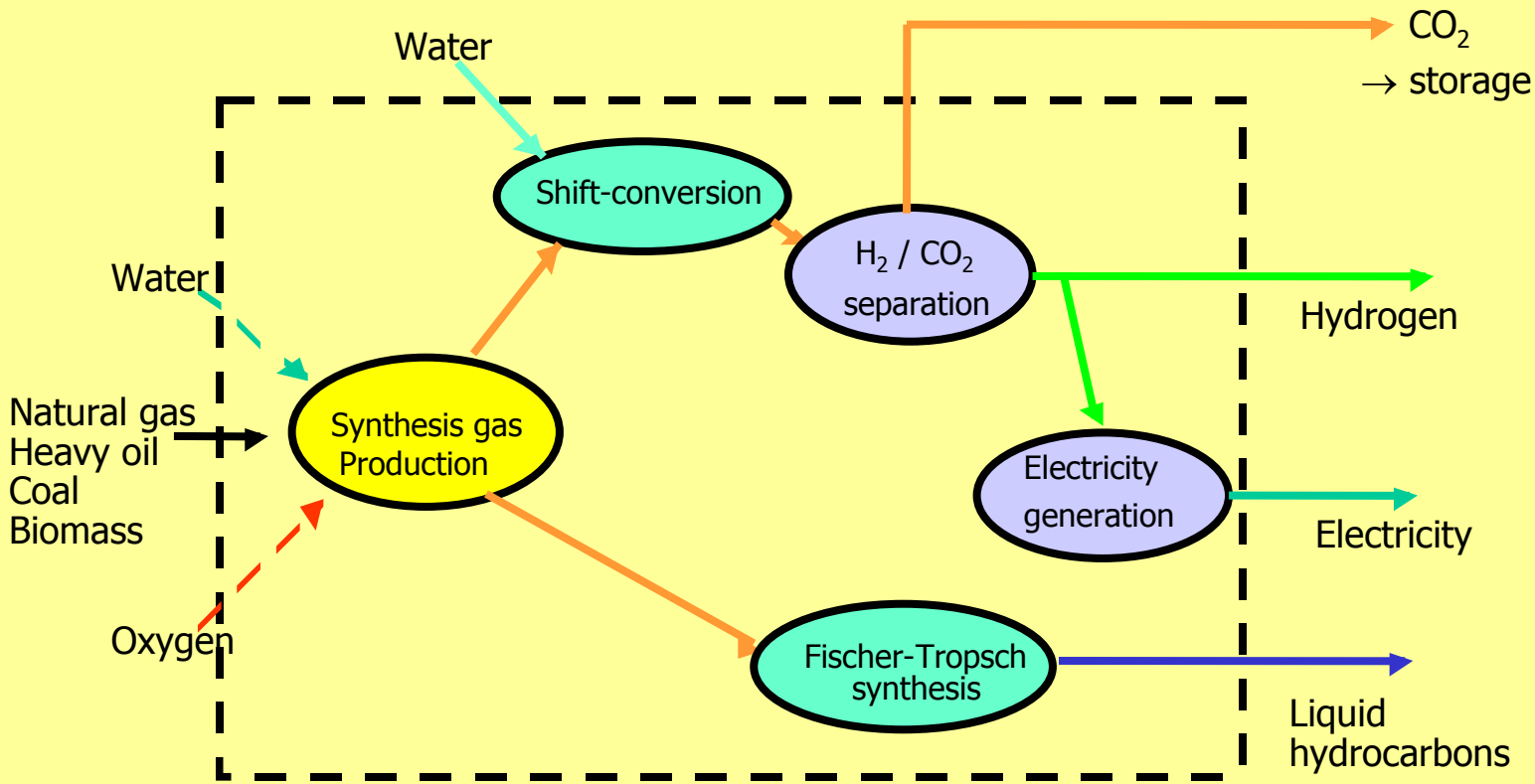
  - Identify pure CO_2 streams for early initiatives
  - Quality of CO_2, role of other components



Focus for the work to reduce CO_2

- CO_2 Capture
  - Develop and evaluate the different concepts / processes
  - Cost reduction
  - More cost reduction
  - Verification and validation $\Rightarrow$ from small scale demos underway to large scale operations
  - Strong link with hydrogen issues !

Hydrogen and power generation with CO_2 capture and storage



Focus for the work to reduce CO_2

- Transport
  - Most technology for pipelines and ship transport available now
  - How to develop an infrastructure ?

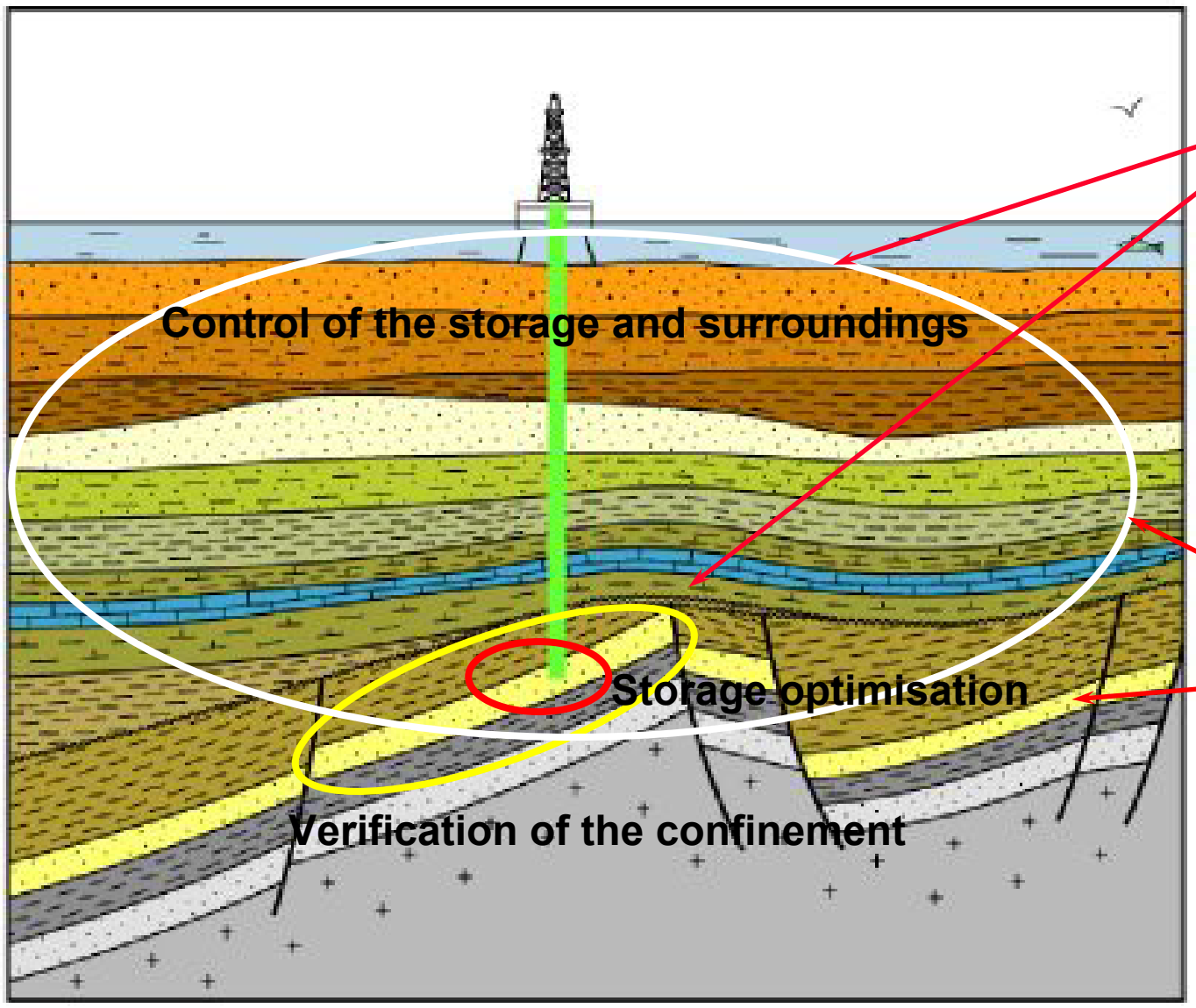
Focus for the work to reduce CO_2

- Geological storage
  - Potential of storage, actual availability
  - Evaluate risk, security and environmental consequences

    … and develop REMEDIATION technologies !

  - Develop capacity to predict, to control and to measure
  - Build confidence and acceptance

Underground storage: technical challenges



Monitoring
- storage
- wells
- overburden

Numerical modelling:

regional scale, long time (1000 years)

reservoir scale, short time (20-40 years)

CASTOR

CO_2, from Capture to Storage
an European Initiative

CASTOR objectives and targets

- Reduce the cost of CO_2 post-combustion capture
- Contribute to the feasibility & acceptance of the geological storage concept
- Validate the concept on real sites
  - Pilot testing for capture (25 t CO_2 / day)
  - Detailed studies of future storage projects in Europe

Consortium participants

R&D
IFP (FR)
TNO (NL)
SINTEF (NO)
NTNU (NO)
BGS (UK)
BGR (DE)
BRGM (FR)
GEUS (DK)
IMPERIAL (UK)
OGS (IT)
TWENTE U. (NL)
STUTTGARTT U. (DE)

Oil & Gas
STATOIL (NO)
GDF (FR)
REPSOLYPF (SP)
ENITecnologie (IT)
ROHOEL (AT)

Power Companies
VATTENFALL (SE)
ELSAM (DK)
ENERGI E2 (DK)
RWE (DE)
PPC (GR)
POWERGEN (UK)

Manufacturers
ALSTOM POWER (FR)
MITSUI BABCOCK (UK)
SIEMENS (DE)
BASF (DE)
GVS (IT)

Co-ordinator: IFP
Chair of the Executive Board: Statoil

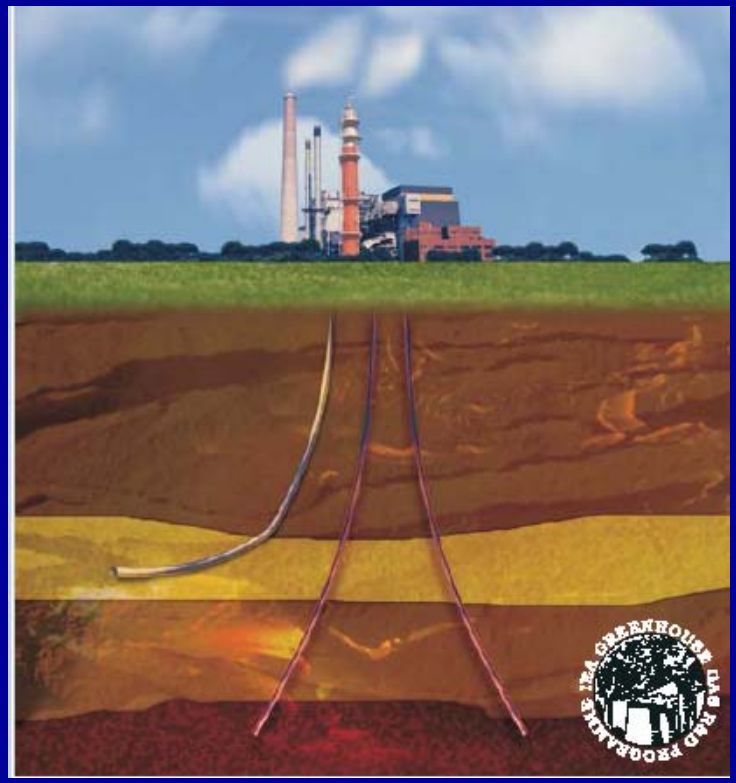
4 years
Total budget: 15,8 M€
EU funding: 8,5 M€
Industrial funding: 2,2 M€

CASTOR - Post-combustion Capture

- Overall Objectives
  - Development of absorption liquids, with a thermal energy consumption of 2.0 GJ/tonne CO_2 at 90% recovery rates
  - Resulting costs per tonne CO_2 avoided not higher than 20 to 30 €/tonne CO_2, depending on the type of fuel
  - Pilot plant tests showing the reliability and efficiency of the post-combustion capture process

CASTOR - Geological Storage

- Overall Objectives
  - Develop and apply a methodology for the selection and the secure management of storage sites
  - Improve the "Best Practice Manual" by adding 4 more real-site cases

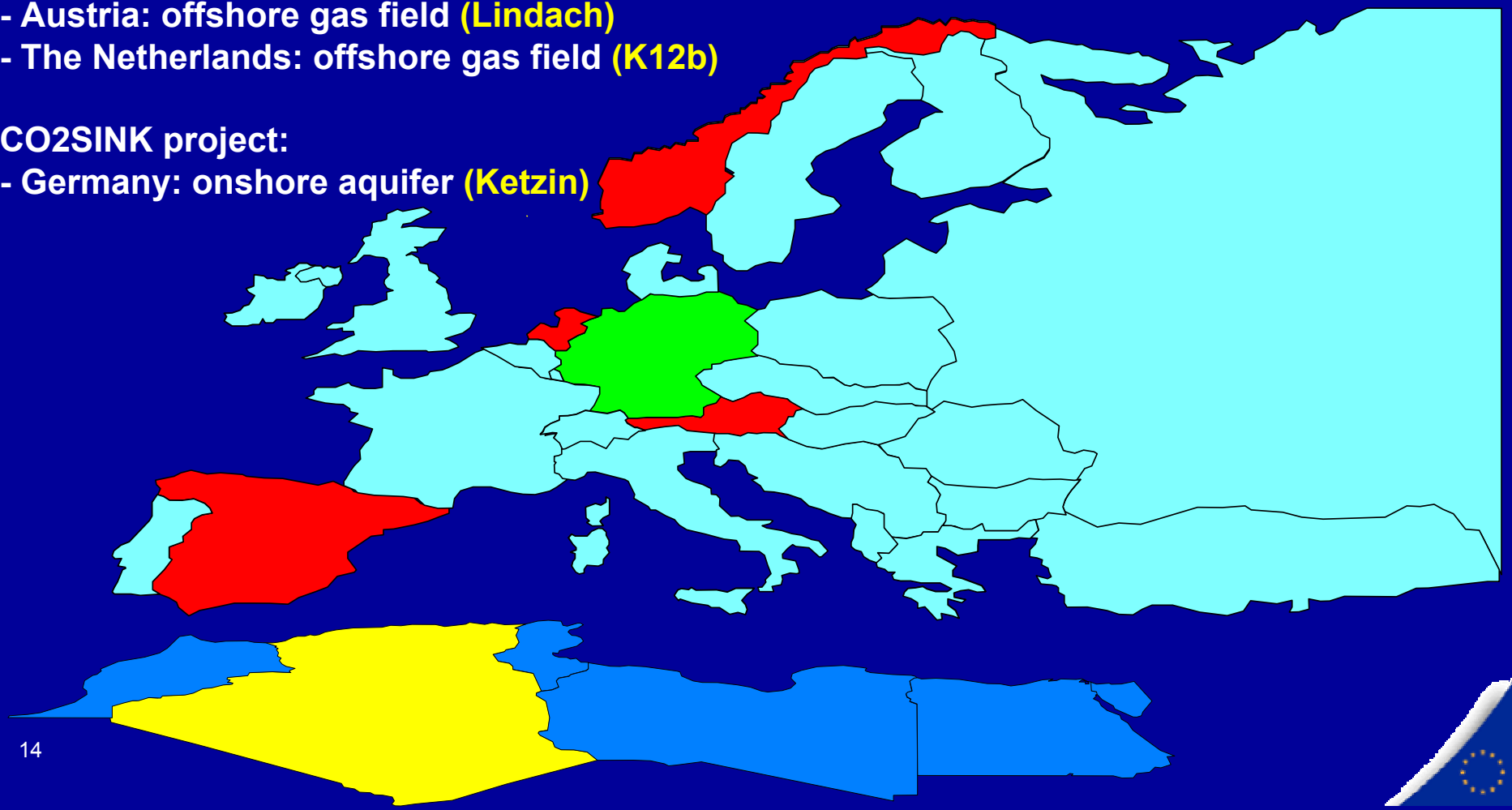


Some new CO_2 storage initiatives in Europe

CASTOR project:
- **Spain: offshore oil reservoir (Casablanca)**
- **Norway: offshore aquifer (Snohvit)**
- **Austria: offshore gas field (Lindach)**
- **The Netherlands: offshore gas field (K12b)**

CO2SINK project:
- **Germany: onshore aquifer (Ketzin)**

In-Salah project:
Injection started



Specific Support Action: InCa-CO2

"International Co-ordination Action on CO_2 Capture and Storage"

- Providing to European stakeholders support for the international forums such as CSLF
- Establishing international relations with international projects & programs (US, Canada, Australia, Japan, ...) for exchanging information on projects, and identifying opportunities for future co-operation and technology transfer
- Analyzing new information on CCS and providing a coherent view on international activities for input in policy

⇒ A panel of European stakeholders representative of industry and R&D

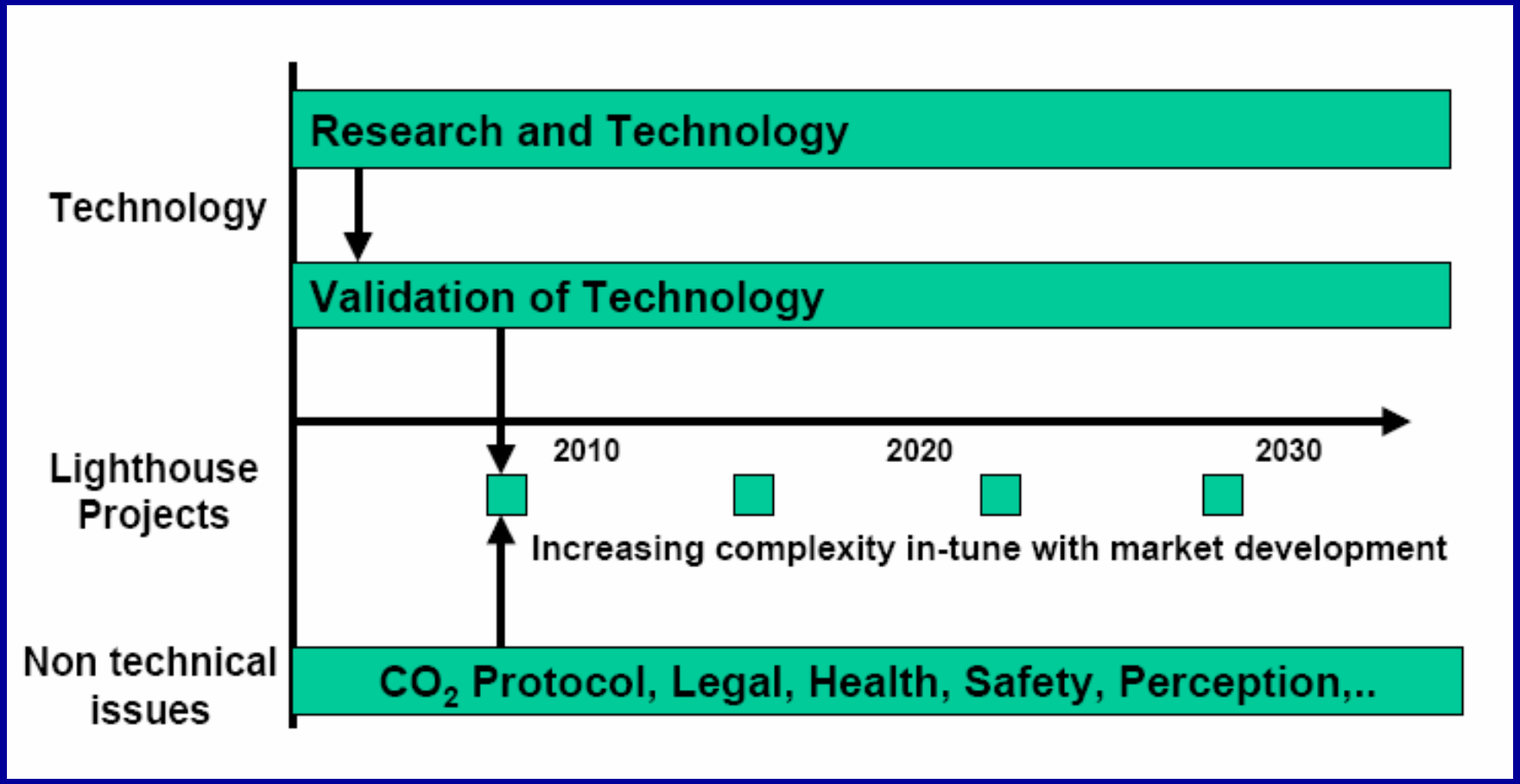
- Research institutes
  - IFP (France, co-ordinator)
  - TNO (The Netherlands)
  - GEUS (Denmark)
  - SINTEF (Norway)
  - BGS (UK)
  - OGS (Italy)
  - BRGM (France)
- Industries
  - Statoil (Norway)
  - Vattenfall (Sweden)
  - Alstom Power (UK)
  - BP (UK)

European case history

- Successful R&D EU funded programmes called FP4 & FP5
- Europe is in the lead: Sleipner (1 Mt of CO_2 / year since 1996)
- Present FP6 larger projects enabling demonstrations: ENCAP, CO2SINK, CASTOR, CO2GeoNet

  … and more to come!
- European Lighthouse Projects $\Rightarrow$ Zero Emission Power Plant, other industries: steel industry (Ultra Low CO_2 initiative)

Elements of a strategy



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