**Z E P**
**Technology Platform**
**Zero Emission Fossil Fuel Power Plants**

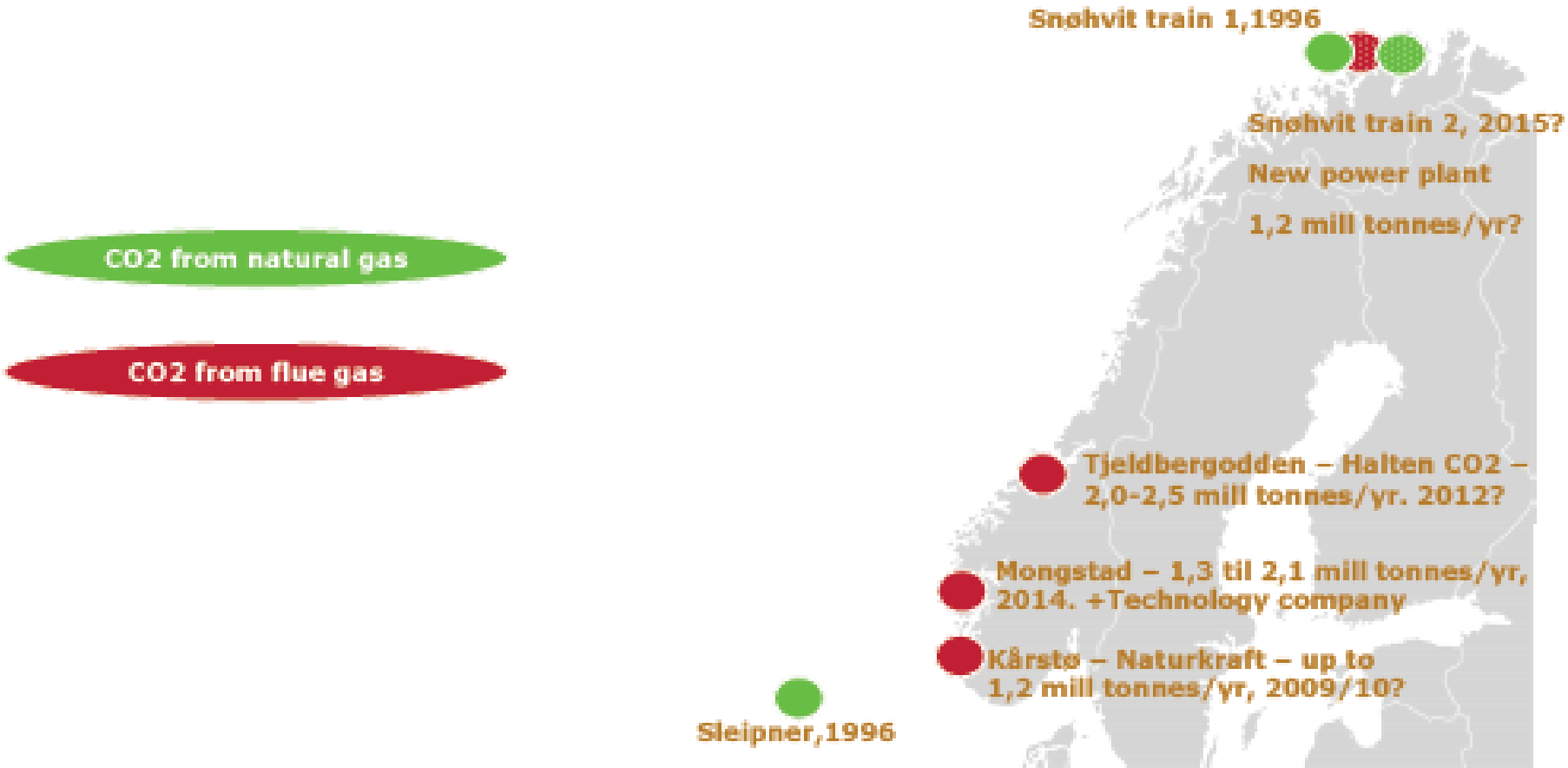
# ETP-ZEP
# SRA and SDD

## Expert workshop Dynamis
## “bridge the gap between platforms”
## Arve Thorvik

# Agenda

1. SRA
2. SDD
3. Examples of CCS

# An overview:
# Norway as a $CO_2$-laboratory



# The Sleipner field

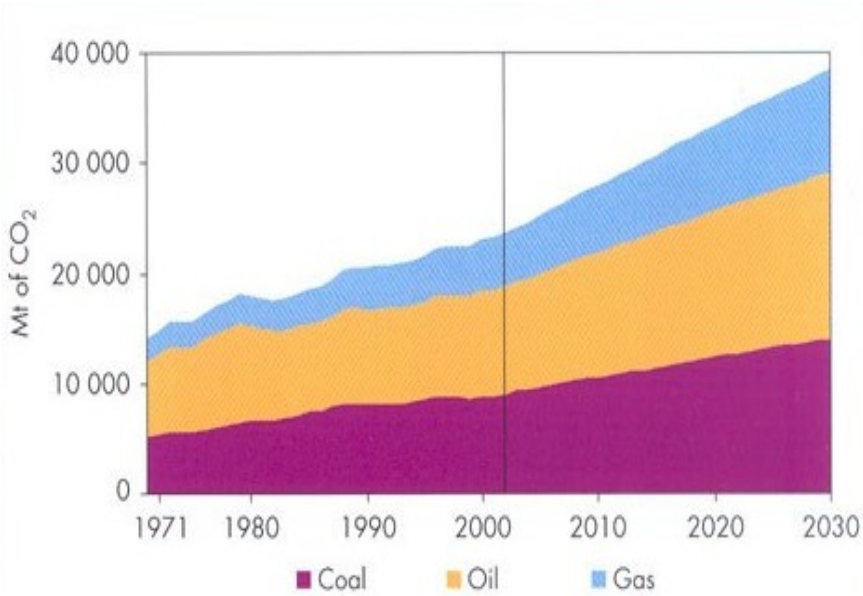
## $CO_2$ Treatment and Injection

# $CO_2$: The Global Challenge

Carbon Capture & Storage, together with improved energy conversion efficiency, is one solution to reducing $CO_2$ emissions on a massive scale. Its rapid deployment will help avoid the catastrophic consequences of climate change.

**BUT** we must demonstrate:

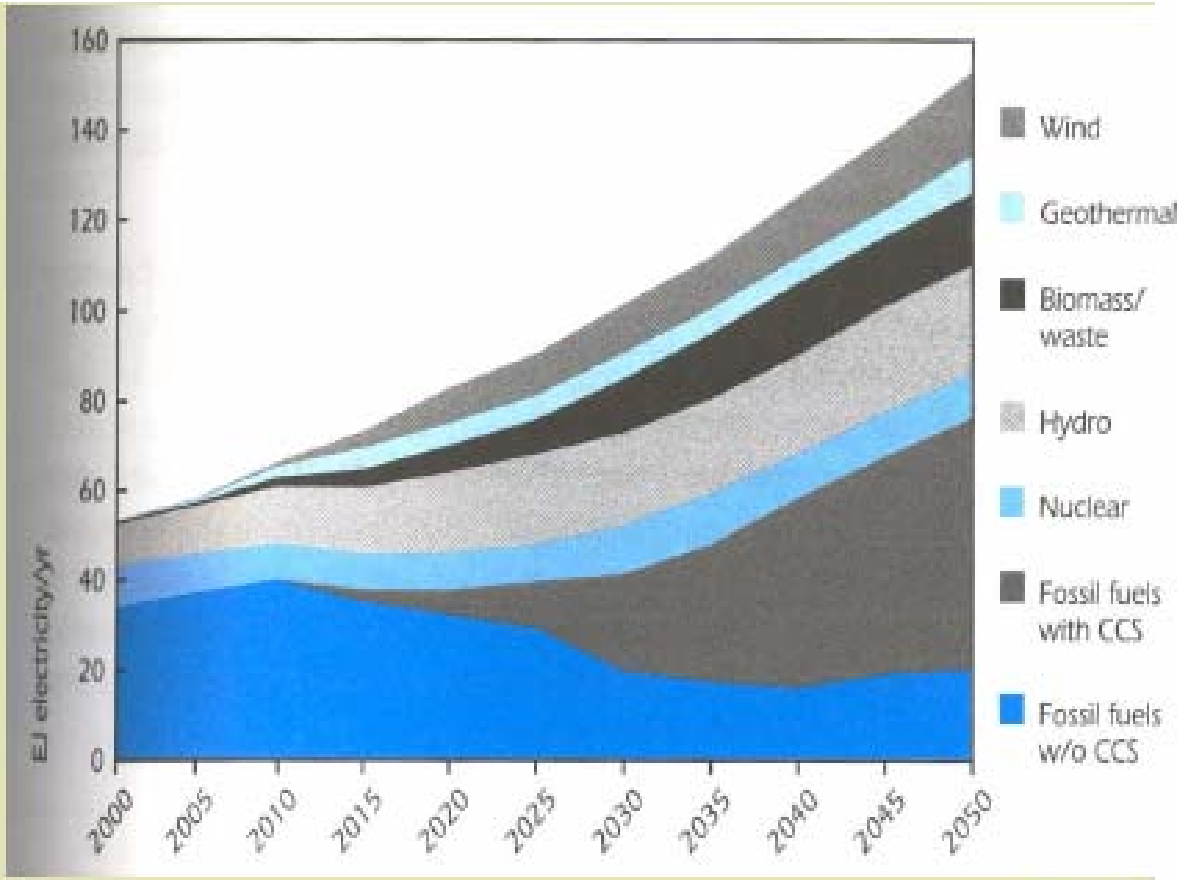
- Reduced $CO_2$ capture and plant costs
- The safety of $CO_2$ geological storage




ETP-ZEP, SRA&SDD, 18-

# CCS role in a future energy market

- **Number of studies on future GHG abatement e.g:**
  - Princeton "wedges"
  - WBCSD "pathways"
- **<u>All show CCS with major role</u>**




***CCS deployment under a $50/tCO$_2$ scenario***

Source: IEA Prospects for CO2 capture and storage

# The Key Research Questions

1. Can $CO_2$ be captured effectively?
2. How can captured $CO_2$ be transported safely?
3. Can CCS be achieved at reasonable cost?
4. Is $CO_2$ storage safe?

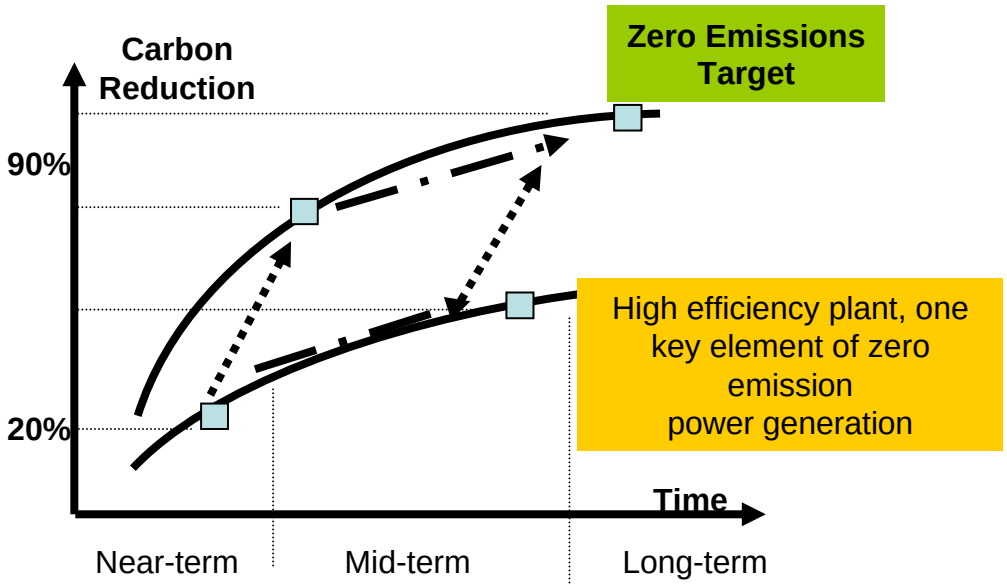
The SRA proposes Research Development & Deployment Priorities and a technology roadmap to address these issues

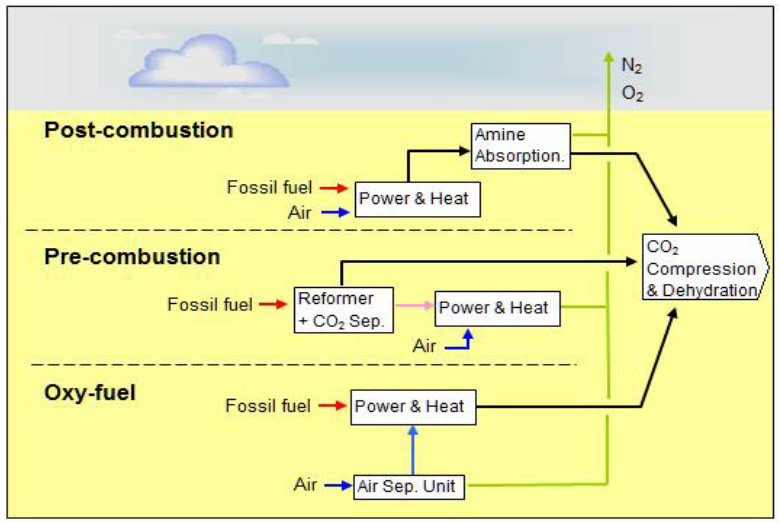
# SRA key points: Capture Technology options

**Key issue: lower the cost**

## Pathway to zero emission:

- Carbon capture
- Improved efficiency
- 3 main routes

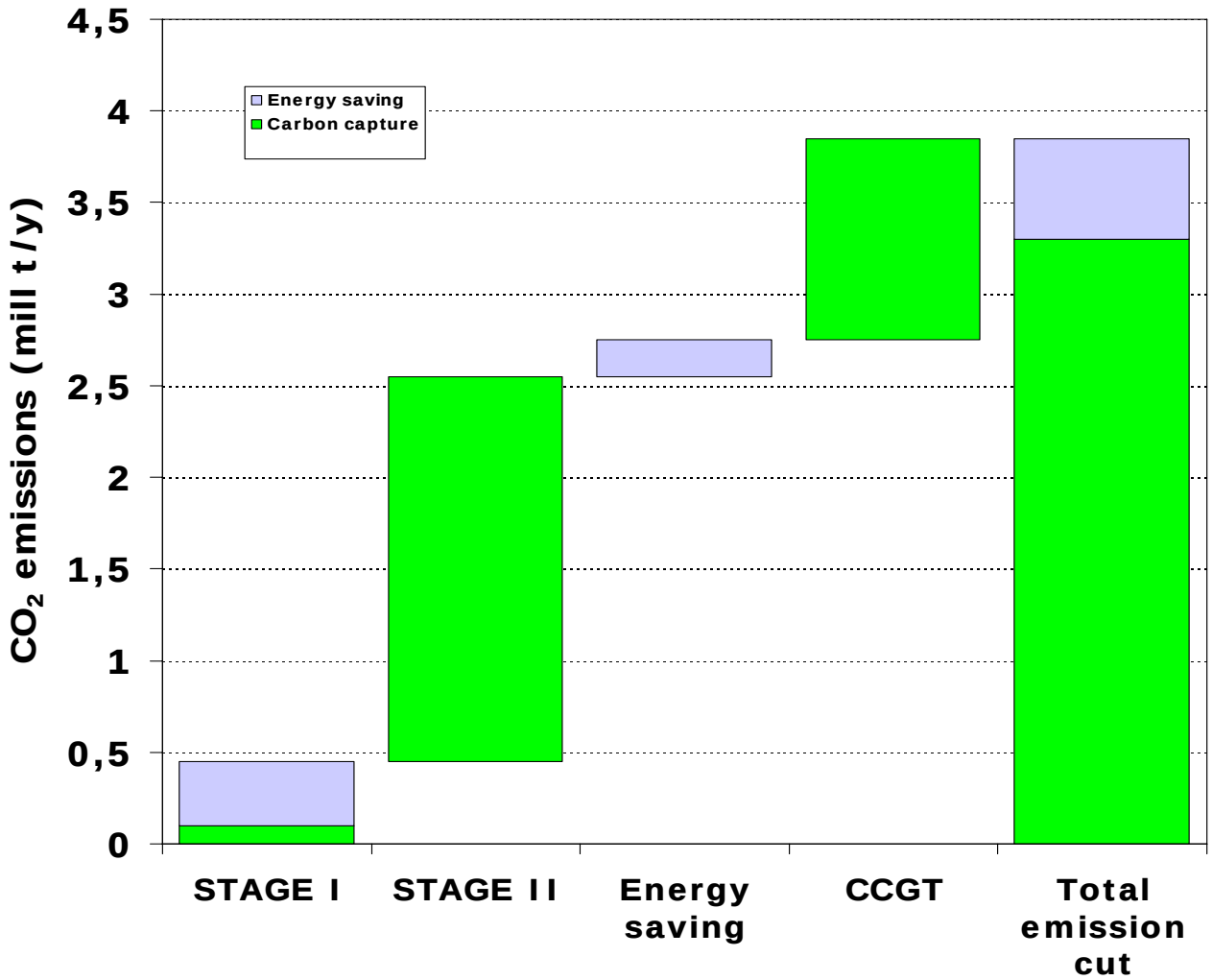



ETP-ZEP, main points
SRA&SDD, 18-01-2006, Thorvik

# Mongstad CHP station

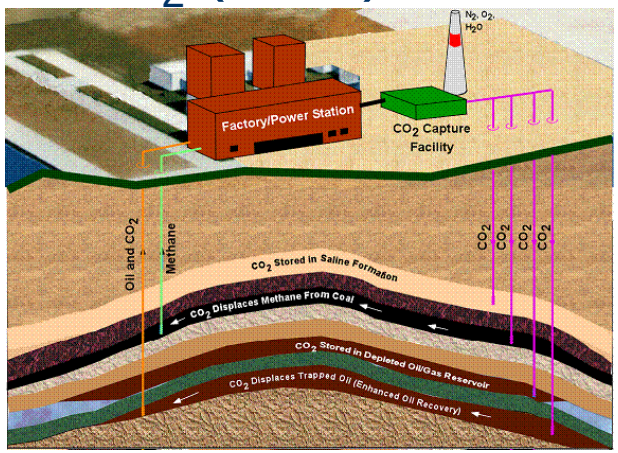
## Long-term opportunity for substantial $CO_2$ capture and emission cut



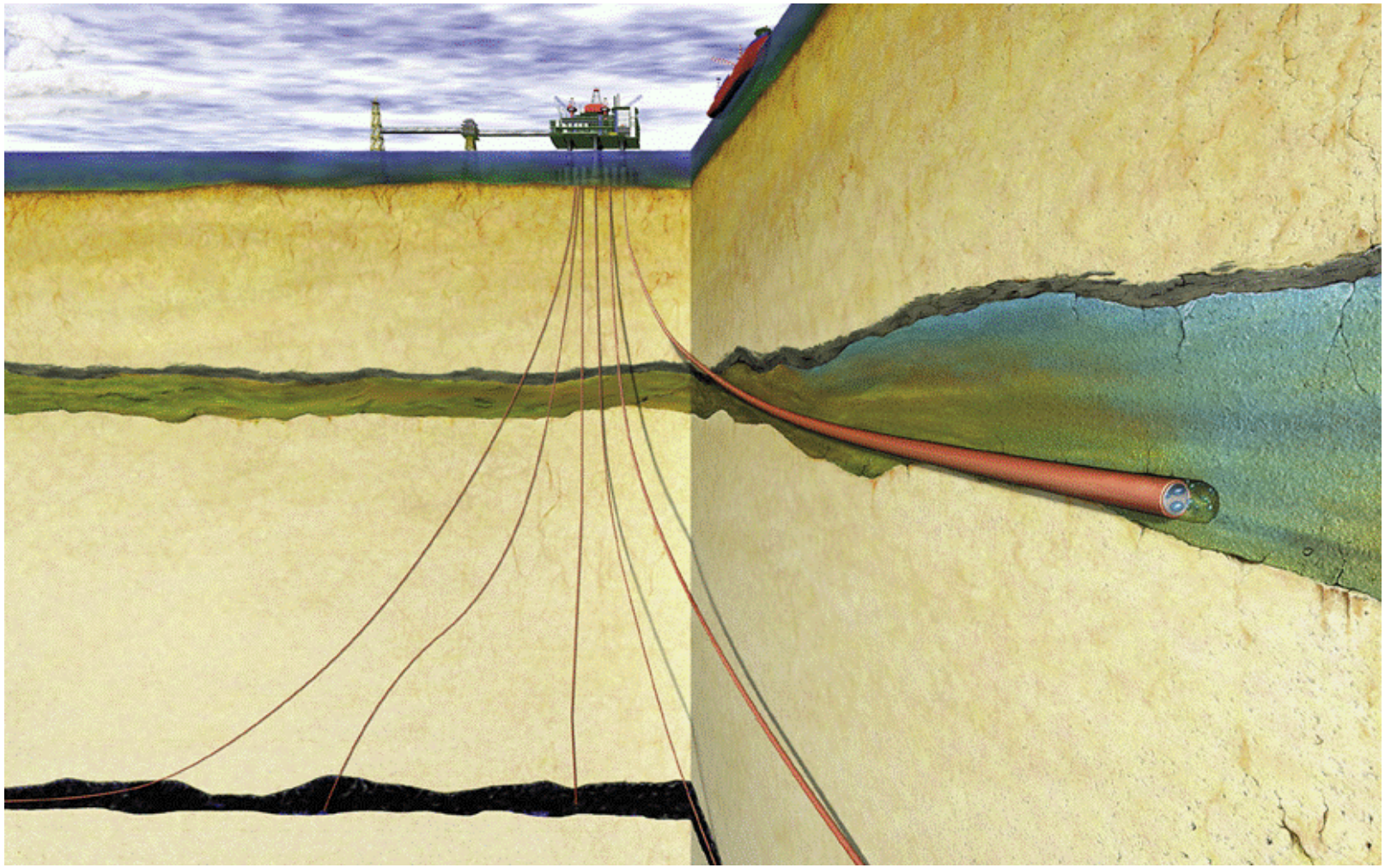
# SRA key points: Storage & Transport

**Key issue: Prove the value chain**

1. Demonstration of long term safety and monitoring is vital for $CO_2$ storage
2. Numerous storage options exist but room for more innovation and better mapping of capacity in EU
3. Optimise the benefits from use of $CO_2$ (EOR)
4. Transport options are well understood, but safe,efficient & cost effective routes must be identified



# The offshore storage principle: Sleipner



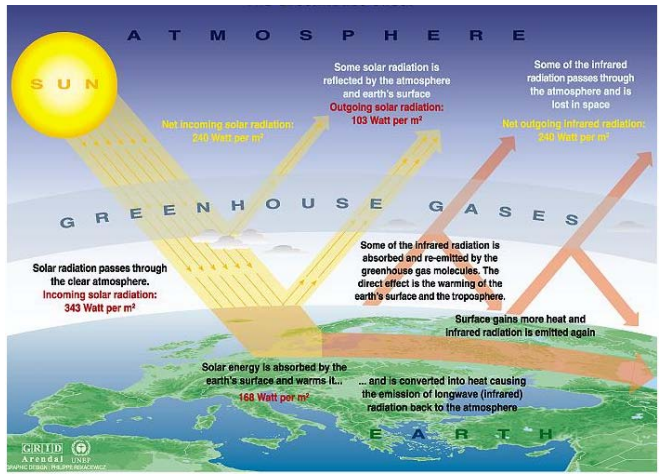
# Transportation of $CO_2$

$CO_2$ pipeline to Snøhvit

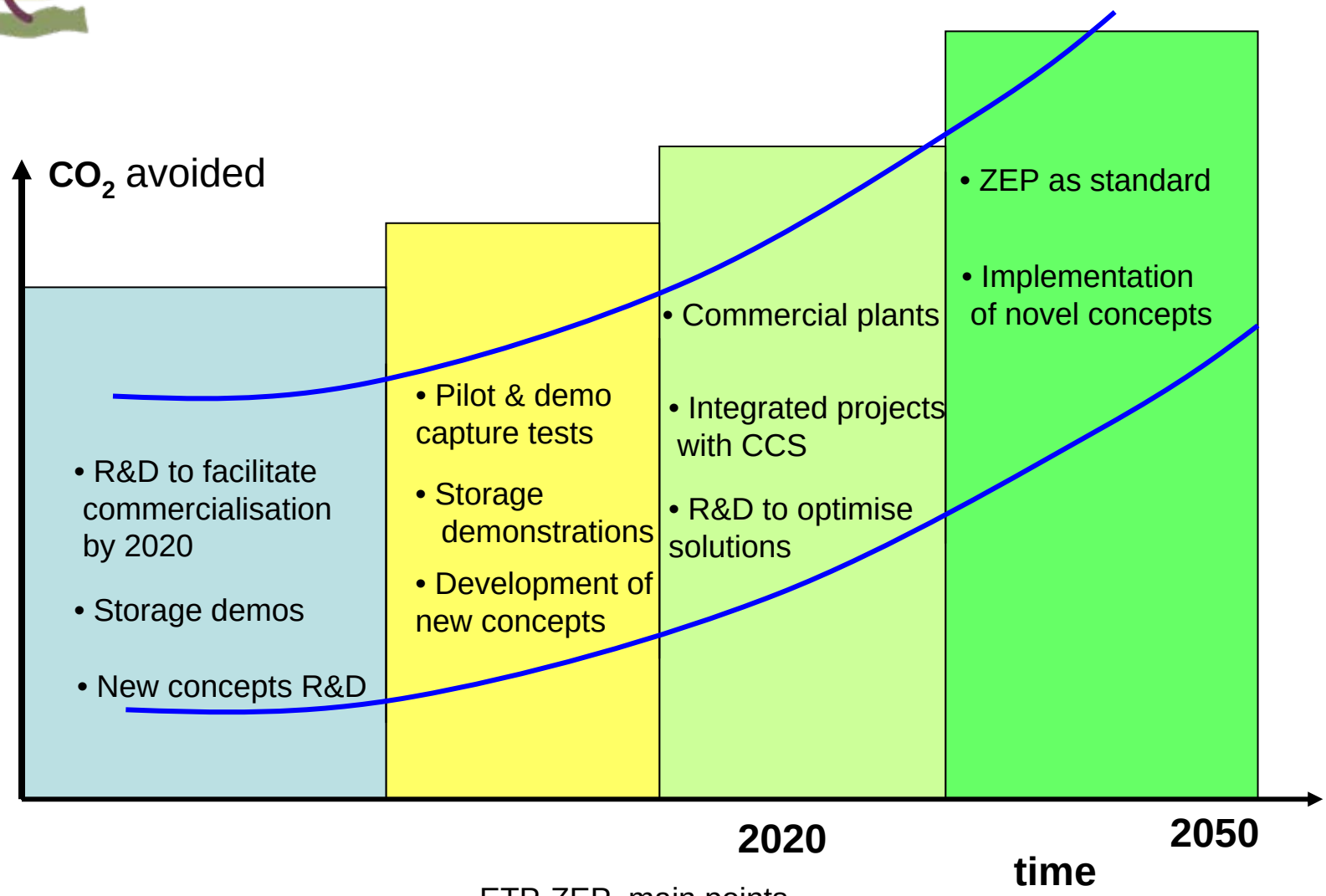
# SRA key points
# Environment & Public Perception

**Key issue: Gain Acceptance**

1. Adopt zero tolerance to any significant level of $CO_2$ leak and establish mitigation plans
2. Determine impact on the full ecosystem
3. Develop advanced studies & models for $CO_2$ infrastructure
4. Public acceptance of CCS is prerequisite and will be addressed



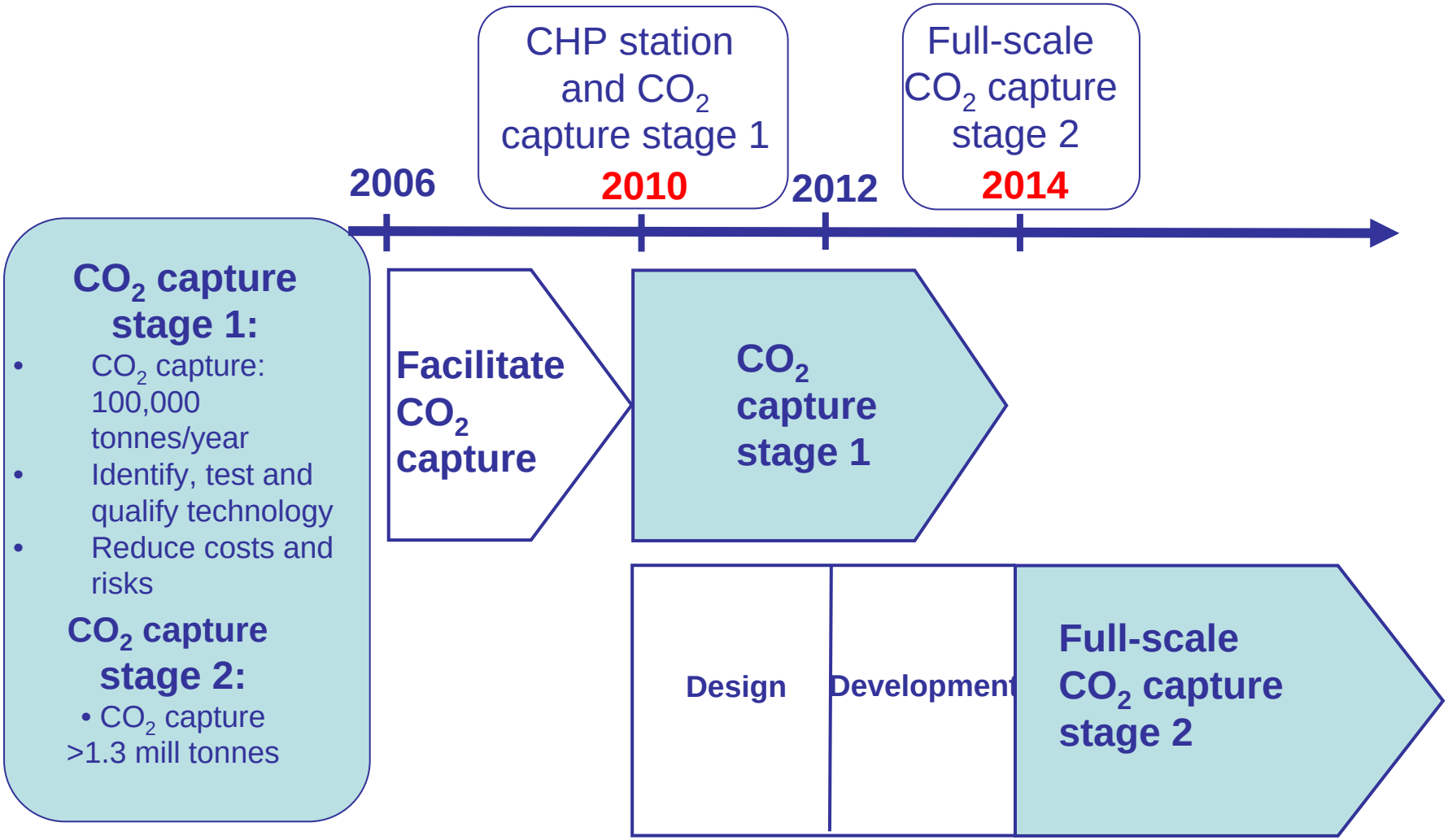
# The R&D roadmap
# Building the Road to Success



# Mongstad CHP station

Source: www.oed.dep.no

## Parallel schedule – full-scale $CO_2$ management



# The Key Recommendations

1. Implement 10 -12 integrated, large-scale CCS demonstration projects throughout Europe
2. Develop novel underpinning concepts for demonstration by 2010 - 2015 and implementation beyond 2020
3. Support long-term exploratory R&D in advanced, innovative concepts for implementation of next-generation technology by 2050
4. Maximising co-operation at National, European and International level
5. Strengthen and accelerate R&D priorities to support the Strategic Deployment

# Commission supports money in FP7:

Commission Energy Review , 10 January 2007

*Commission action: The Commission will substantially increase the funding for R&D in the energy area, making the demonstration of Sustainable Fossil Fuels technologies one of the priorities for 2007-2013. The Commission calls on Member States to show an equal commitment to R&D and demonstration in this area. The Commission will also seek to ensure that action at both EU and Member State level complement the efforts by industry in the framework of the ZEP TP. A European Strategic Energy Technology Plan will provide a suitable instrument for the overall coordination of such R&D and demonstration efforts and for the maximisation of synergies at both EU and national level.*

# Commission supports 12 demo projects:

*Commission action: The Commission will examine (inter alia by way of an in-depth impact assessment study to be undertaken in 2007) possible measures for achieving the demonstration of Sustainable Fossil Fuels, and particularly Sustainable Coal, technologies. On this basis, the Commission will determine the most suitable way to support the design, construction and operation by 2015 of up to 12 large-scale demonstrations of Sustainable Fossil Fuels technologies in commercial power generation.*

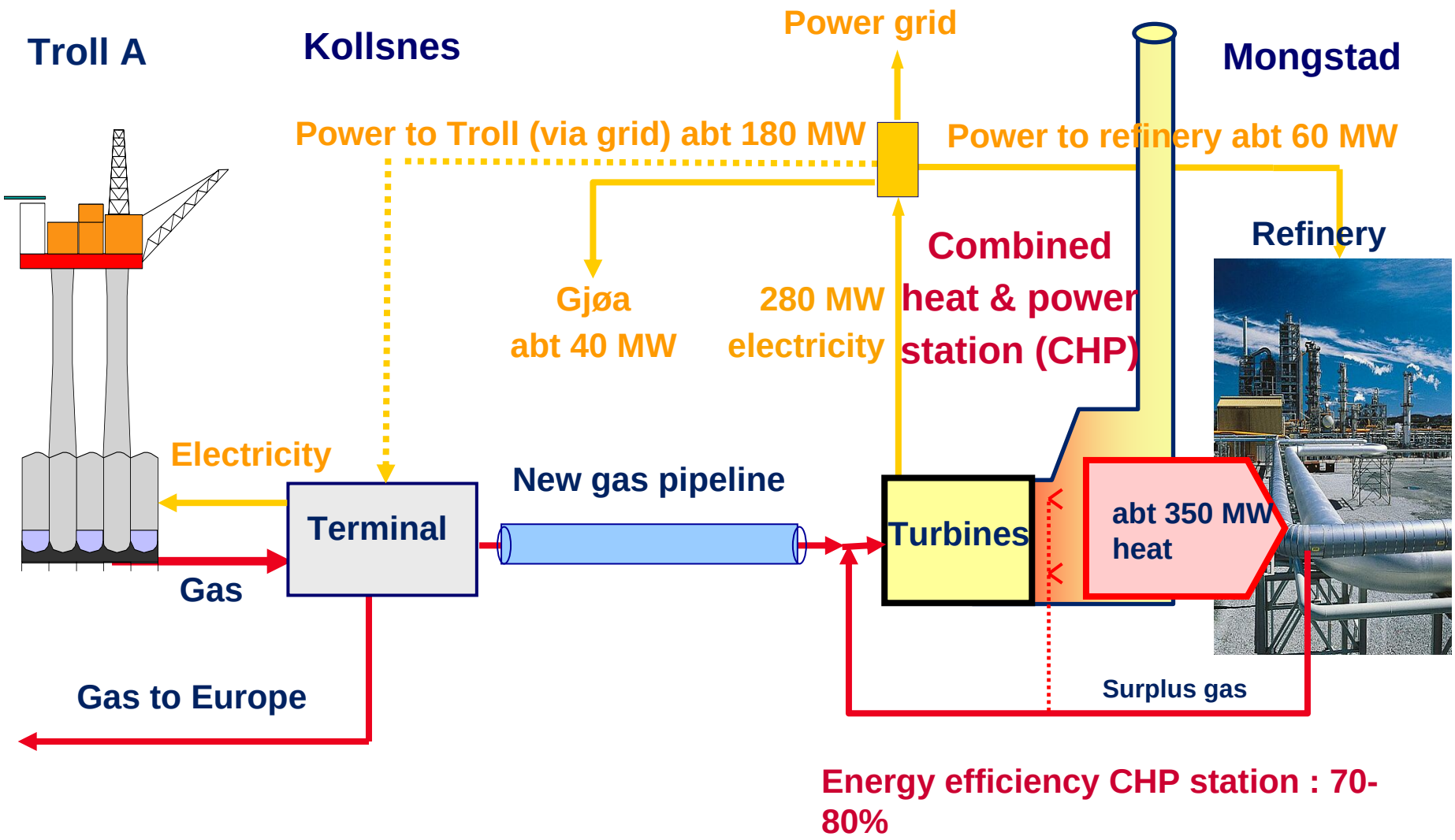
# The Way Forward: 1

Through this SRA we will:

- Cost effectively improve the efficiency of the fossil fuel to electricity conversion process
- Evaluate, optimise and implement technologies for $CO_2$ capture
- Deal with issues relating to $CO_2$ transportation and infrastructure
- Resolve remaining issues (technical,political, public acceptance,health & safety) relating to $CO_2$ storage

# Mongstad CHP station

## Technical concept




**Energy efficiency CHP station : 70-80%**

# Mongstad CHP

## Agreement – principles, costs and risks

- Develop master plan for $CO_2$ capture plant and tie-ins, covered by Statoil
- STAGE 1, technology company
  - Costs shared in proportion to participation
    - Statoil 20%, government 80% less involvement by other companies
  - All participants except the government carry the risk of cost overruns
- STAGE 2, Statoil and the government
  - ”Constructing a future $CO_2$ capture plant must not weaken the refinery’s international competitive position”

# The Way Forward: 2

We will achieve this by:

1. Establishing a robust portfolio of RD&D programmes
2. Optimising links with other key ETPs & promoting R&D of underpinning technologies (materials, combustion, modelling etc)
3. Maximising EU & international collaboration and funding opportunities
4. Establishing a Joint Technology Initiative

# ZEP Strategic Deployment
# Structure of this presentation

- The key issue
- Objectives
- Key Recommendations
- Road map to achieving the Vision
- Conclusions

# SDD: Key issue

CCS is still not deployed for two key reasons:

1. The costs and risks still outweigh the commercial benefits
2. The regulatory framework for $CO_2$ storage is not sufficiently defined

The **S**trategic **D**eployment **D**ocument outlines how we can accelerate the market to achieve **zero emission power production by 2020**.

# Mongstad CHP and $CO_2$ capture and storage

## Cost/income division – **approximate** estimates

| Estimated investment and operating costs are based on today's technology status | Investment million EUR | Annual operating costs million EUR | Paid by/credited to |
|---|---|---|---|
| Mongstad CHP station | Over 500 | - | Statoil, Troll and Dong Energy |
| Tie-ins future $CO_2$ capture | 5 | | Statoil Mongstad (MRDA) |
| Develop master plan for $CO_2$ capture Mongstad | 6 | | Statoil Mongstad (MRDA) |
| $CO_2$ pipeline, or other transport/storage solution | 130 - 250 | - | Norwegian Government |
| STAGE 1, capture/pilot plant 100,000 tonnes/year | 90 | 15 | Technology company |
| STAGE 2<br>Alt a: Capture plant for CHP station, 1.3 mill tonnes $CO_2$/year**<br>Alt b: Capture plant for CHP station and cracker, 2.1 mill tonnes $CO_2$/year** | 400 - 500<br><br>600 | 50 - 60*<br><br>75 - 90* | MRDA meets expenses equal to alternative $CO_2$ costs. Government meets investment and operating costs in excess of Statoil's contribution, less allowance income and possible positive value in the $CO_2$ value chain |

* At a gas price of EUR 0.2/scm and an electricity price of EUR 0.042/kWh

** Total capture costs are about EUR 60/tonne $CO_2$ captured at these gas/electricity prices

# SDD: Objective

***Objective of SDD: To enable European fossil fuel power plants to have zero $CO_2$ emissions by 2020.***

**Main consideration: support of all stakeholders**

Success can only be achieved through a collaborative effort between all relevant industry sectors, national governments, the EC, academics and the environmental NGO community.

The SDD therefore aims to secure the support of all stakeholders

**SDD in short:**

Establish a clear, stable fiscal and regulatory framework.

Unless investors are convinced that CCS technology has a secure, long-term future, it will simply not get off the ground.

# SDD: Key Recommendations

## 1. *Kick-starting the $CO_2$ value chain with urgent short- and long-term commercial incentives:*

- By 2007, clarify the conditions under which the geological storage of $CO_2$ qualifies for the EU Emissions Trading Scheme and other incentive mechanisms
- By 2007, clarify CCS status under European Union guidelines for State Aid
- By 2007, create early mover funding mechanisms to support the development of 10-12 large-scale CCS projects which demonstrate a diverse range of infrastructure, technologies, fuels and storage locations.
- Establish long-term, sustainable mechanisms to supplement EU ETS, informed by experience gained in demonstration projects.

# SDD: Key Recommendations

## 2. *Establishing a regulatory framework for the geological storage of $CO_2$:*

- By 2007, amend existing EU legislation (concerning waste and water) in order to clarify the conditions under which $CO_2$ is stored underground
- By 2008, implement new EU guidelines for Member States permitting geological storage projects (including risk management, site selection, operation, monitoring, reporting, verification, closure and post-closure).

# SDD: Key Recommendations

3. ***Gaining public support via a comprehensive public information campaign:***
   - Generic EU-wide outreach via multi-media (TV, internet, print)
   - Local, focused outreach in support of early mover CCS projects.
4. ***Establishing robust RD&D funding under the FP7 and national programmes (Ref SRA):***
   - Improve energy conversion efficiency, reduce cost and reduce scale-up risk of $CO_2$ capture technology
   - Undertake EU-wide mapping of large $CO_2$ sources and geological storage
   - By 2008, establish a Joint Technology Initiative as part of a portfolio of mechanisms for maximising European co-operation.

# SDD Conclusions

1. **Establish a legal and long-term regulatory framework by 2007/8, including accreditation of CCS under EU ETS, CDM and JI.**
2. **Establish an Early Mover funding mechanism by 2008.**
3. **Implement R&D to improve the efficiency of power plants with CCS as soon as possible.**
4. **Establish potential storage locations for 10-12 large-scale demonstration projects during 2007.**
5. **Engage with regulators and the public in 2007 and carry out an information campaign as soon as possible.**
6. **Undertake a study on the re-use of existing infrastructure in the North Sea versus new build requirements in 2008.**

# SDD Conclusions

7. **Undertake 10-12 CO2 capture demonstrations and build 4-6 onshore storage sites by 2015 (with a minimum capacity of 2 million tonnes CO2).**
8. **Identify CO2 point-sources and possible locations for new power plants and other industrial plants with large CO2 emissions by 2007.**
9. **Define optimum model for the European CO2 infrastructure linking capture and storage locations by 2009, and start planning for building pipelines that will become part of a European CO2 transport infrastructure in 2010.**
10. **Establish an EU storage programme to develop knowledge, skills and capability for large-scale saline aquifer storage by 2010.**

# ZEP 2007 - Next steps:

Focus areas:

- Technology & FP7 priorities
- Promote the 12 Demo´s and secure implementation of projects
- Ensure early adoption of Policy and regulations
- Public acceptance