



L'ENERGIA CHE TI ASCOLTA.

# **CO<sub>2</sub> Capture and Storage – An utility view**

**Pietro Barbucci**

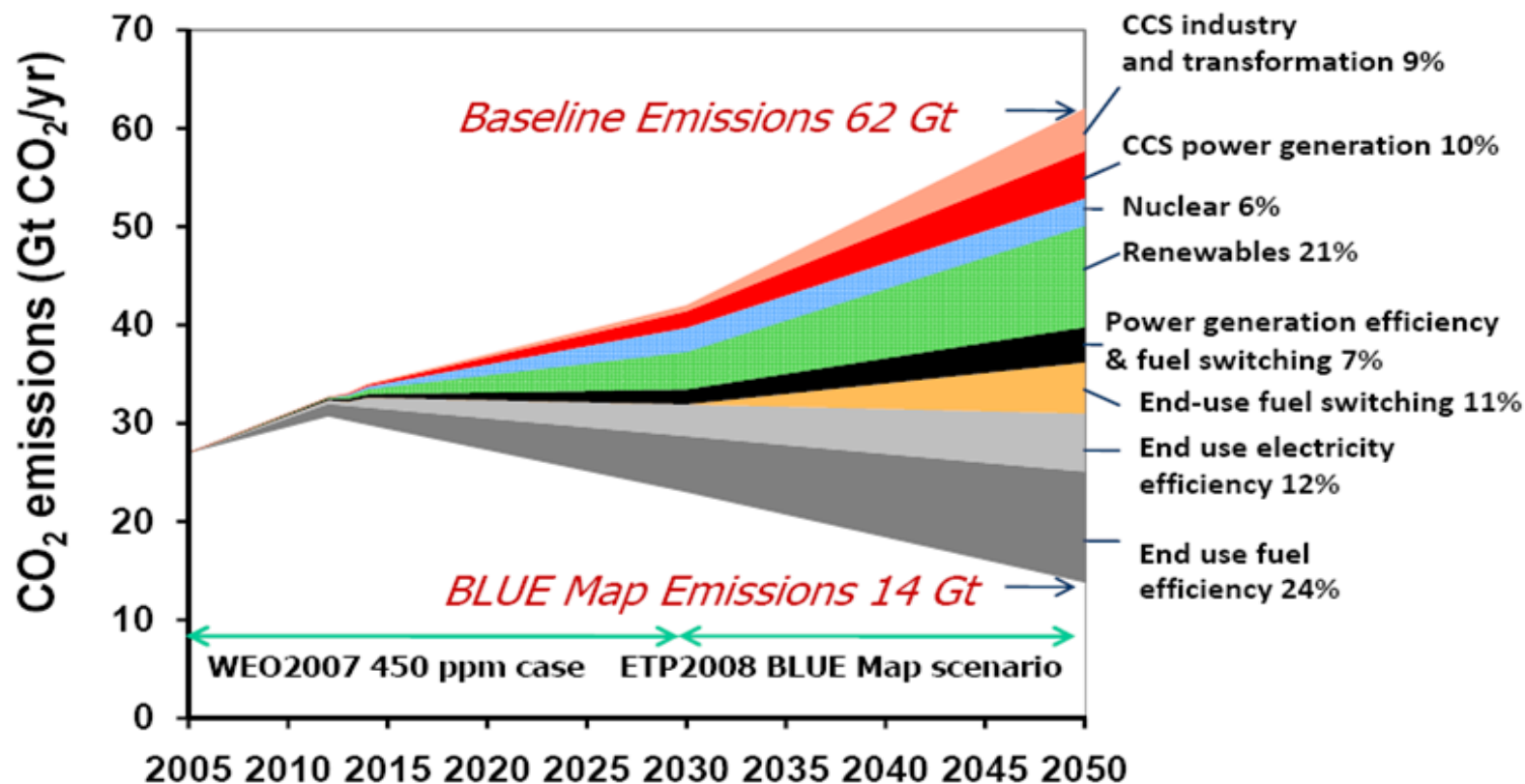
**Enel - Engineering & Innovation Division**

“3rd International Symposium on Capture and geological storage of CO<sub>2</sub>”

Paris , 5th November 2009

# The challenge of climate change

## A technology revolution required



Source: IEA – Energy Technology Perspectives 2008

# Enel Commitment to a Better World

- **Strongly oriented to sustainable future**
- **High Standards of environmental protection**
- **World class player in renewables**
- **Major performer into clean technologies**



**Enel aims to be the leader in innovation**

Source: F. Conti, CEO Enel – ZEP General Assembly, September 2006

# Towards CO2 free power

## Enel's strategy

### 1. Increasing growth in renewables

Enel Green Power and Endesa  
investment plans



### 2. Investing in new nuclear capacity

Mochovce 3 & 4  
Enel - EDF agreement on EPR



### 3. Developing and demonstrating new key technologies:

- ✓ CO2 Capture and Storage (CCS)
- ✓ Concentrated Solar Power (CSP)
- ✓ Smart Grids

# CCS – A key technology

## Why

- Enel shares the views expressed by the IEA, the European Institutions and the Zero Emission Fossil Fuel Power Plants Technology Platform (ZEP)
  - ✓ Fossil fuels will continue to have a primary role for electricity generation in the decades to come
  - ✓ Contribution of coal is essential for the security of supply
  - ✓ Only the implementation of CCS technologies will allow to make the continued use of fossil fuels compatible with the objectives to reduce the GHG emissions in the atmosphere

# CCS – A key technology

## Why

- In Italy Enel plans to built at least 4000 MWc clean coal capacity, substituting existing oil fired or NG fired steam cycles.
- Clean coal plant characteristics:
  - ✓ USC – PC,  $\eta = 45\%$
  - ✓ extremely low pollutant (NO<sub>x</sub>, SO<sub>x</sub>; particulate) emission levels
  - ✓ Completely closed coal management system

### Torrevaldaliga Nord Power Plant (3 units, 2000 MWe)



**First unit commercial operation: June 2009**

- These assets need to be preserved in the carbon constrained scenario



**CCS retrofit technologies required**

# CCS – A key technology

## Enel's role

Therefore Enel has decided to take the lead in the development of CCS technologies by:

- Promoting one demo project using the technology closest to the application for existing plants:
  - » **ZEPT - Zero Emission Porto Tolle** , a post-combustion capture and storage demo project
- Developing knowledge in the area of oxy-firing and pre-combustion technologies, that could provide better solutions for new power plants in the longer term:
  - » **Oxy-coal combustion project**
  - » **Power from Hydrogen**



# **ZEPT - Zero Emission Porto Tolle**

**Post-combustion capture  
and storage demo project**

# ZEPT- Zero Emission Porto Tolle

## Project goal

To retrofit one 660 MW<sub>e</sub> coal fired unit of Porto Tolle power station with CO<sub>2</sub> capture equipment and start CO<sub>2</sub> underground storage by 2015



# ZEPT- Zero Emission Porto Tolle

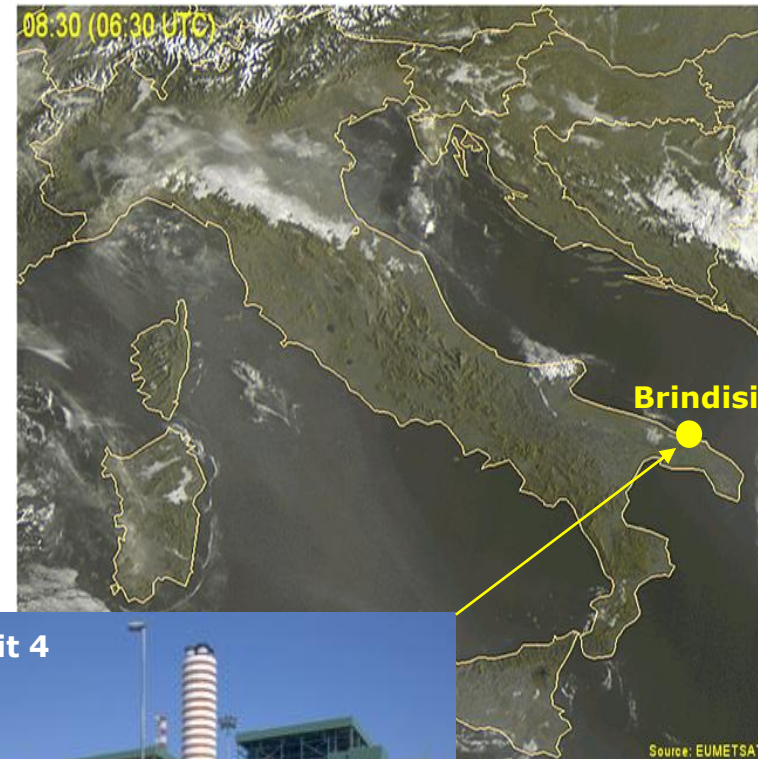
## Time schedule

Year \ Phase	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1. Lab	Capture process tests at lab scale			Technology follow-up						
2. Pilot		Design and construction of a 10.000 Nm <sup>3</sup> /h pilot plant			Operation of the capture pilot plant and pilot tests on transport & injection					
3. Storage		Geological studies for site selection		Geological storage site characterization and preparation						
4. Demo			Feasibility study, design and construction of a CCS demo plant							

# ZEPT - Zero Emission Porto Tolle

## Phase 2 – CO<sub>2</sub> capture pilot plant

- At the site of Brindisi coal fired power station a pilot plant for CO<sub>2</sub> separation via ammine scrubbing is under construction. The plant is installed on the Unit 4.
- The plant is composed by a flue gas pre-treatment section (able to remove completely the particulate and the SO<sub>3</sub> and to reduce SO<sub>2</sub> level below 20 mg/Nm<sup>3</sup>) and by a CO<sub>2</sub> separation unit
- The plant size is **10.000 Nm<sup>3</sup>/h**, capturing about **2,5 t/h of CO<sub>2</sub>**
- Target: gain experience in CCU designing and operation, and assess the environmental impact of the process

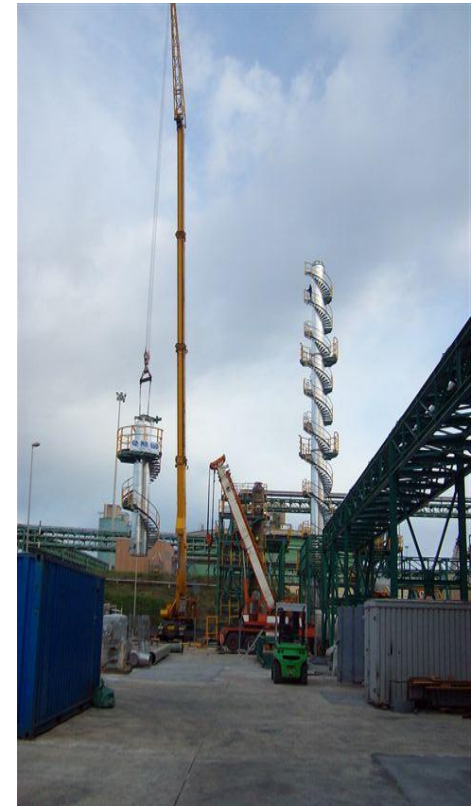


# ZEPT - Zero Emission Porto Tolle

## Phase 2 - CO<sub>2</sub> capture pilot plant



Work in progress at site - October 2009



The adsorber column  
under erection

**Plant completion expected by Feb 2010**

# ZEPT - Zero Emission Porto Tolle

## The technological network

- **ENI**

In October 2008, Eni and Enel signed a Strategic Cooperation Agreement to develop technologies for CO<sub>2</sub> capture, transport and geological sequestration and to accelerate the deployment of CCS. Specific goals of the cooperation program are:

- ✓ To build the first integrated pilot project in Italy
- ✓ To carry out a detailed feasibility study for the Porto Tolle CCS demo plant
- ✓ To jointly evaluate the CO<sub>2</sub> storage potential in Italy



- **IFP**

In January 2009 IFP and Enel have signed a MoU to test an IFP proprietary technology for flue gas scrubbing using chemical solvents, in Enel's Brindisi pilot plant.



# ZEPT - Zero Emission Porto Tolle

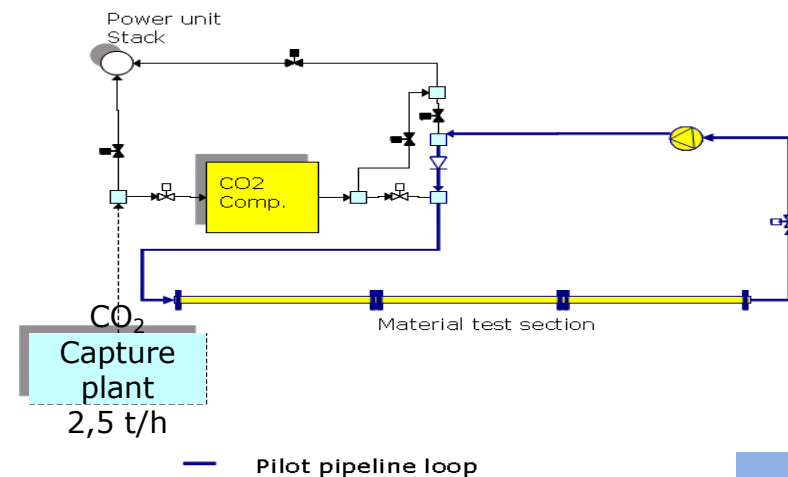
## The Eni - Enel pilot CCS project



A pilot covering the entire CO<sub>2</sub> chain:

- ✓ **An integrated capture-injection project** where the Enel's CO<sub>2</sub> capture pilot plant in Brindisi will provide CO<sub>2</sub> for the Eni's pilot injection project in an exhausted gas field at Cortemaggiore (Piacenza). The start of the CO<sub>2</sub> injection (8.000 t/y) is scheduled for the end of 2010.

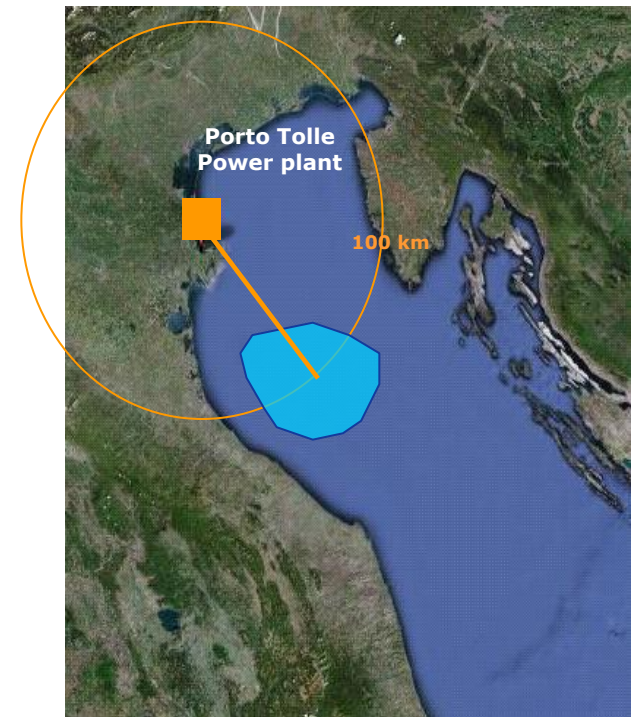
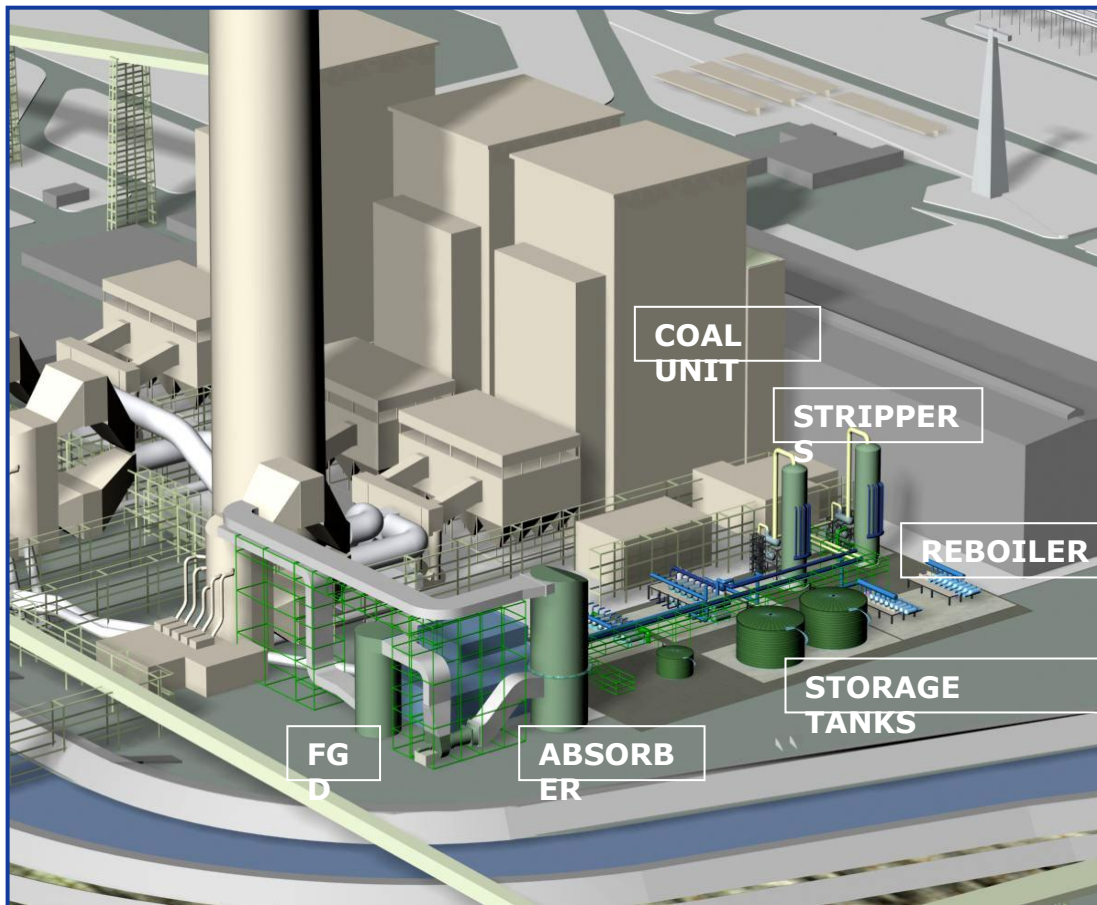
- ✓ **A CO<sub>2</sub> pilot pipeline** to be built in Brindisi to validate design models of CO<sub>2</sub> transport lines, to optimize operating procedures and to study corrosion problems



# ZEPT - Zero Emission Porto Tolle

## Phase 4 – Porto Tolle post-combustion demo plant

### Porto Tolle power plant



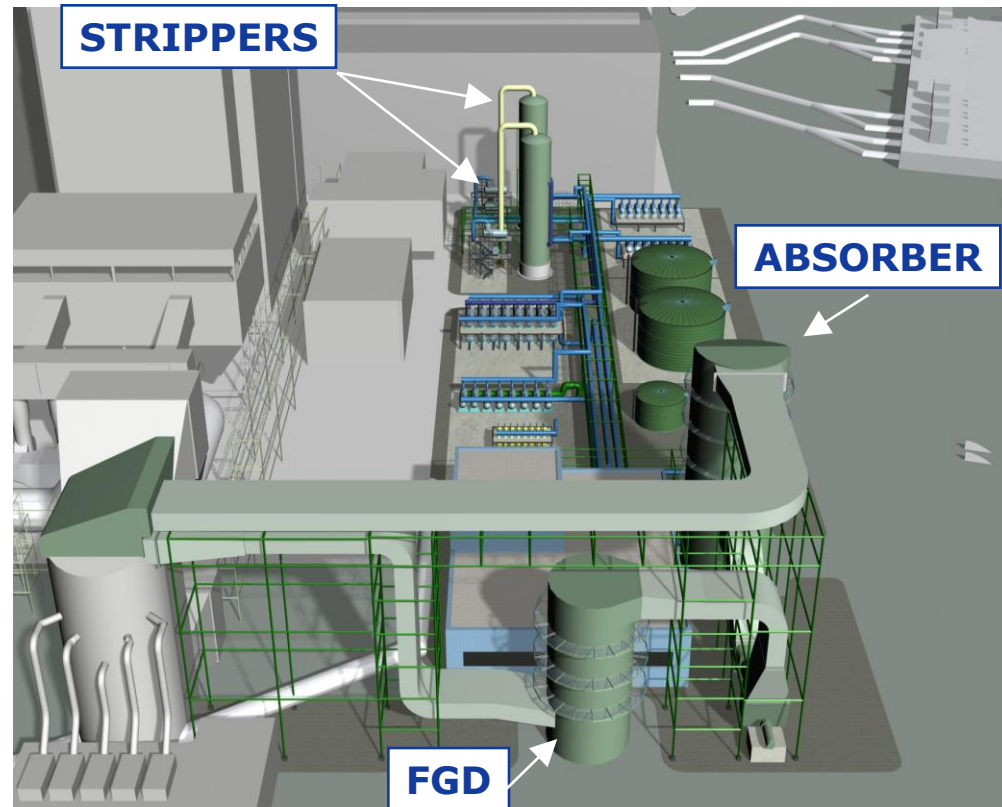
CO2 storage area

# ZEPT - Zero Emission Porto Tolle

## Phase 4 – Porto Tolle post-combustion demo plant

### Demo main features

Type of Project	<b>Retrofit</b>
Power generation	<b>660 MWe</b>
Primary fuel	<b>Bituminous coal</b>
Secondary fuel	<b>Biomass</b>
Power Generation Tech	<b>USC-PC</b>
% of flue gas treated	<b>40%</b>
CO <sub>2</sub> Capture Tech	<b>Post Combustion Capture with Amine</b>
Stored CO <sub>2</sub>	<b>Up to 1 Mt/y</b>
CO <sub>2</sub> Capture rate	<b>90%</b>
CO <sub>2</sub> Storage solution	<b>Deep saline aquifer</b>
Storage location	<b>100 km South-East – Nord Adriatic Sea</b>
CO <sub>2</sub> value chain	<b>Pure storage</b>

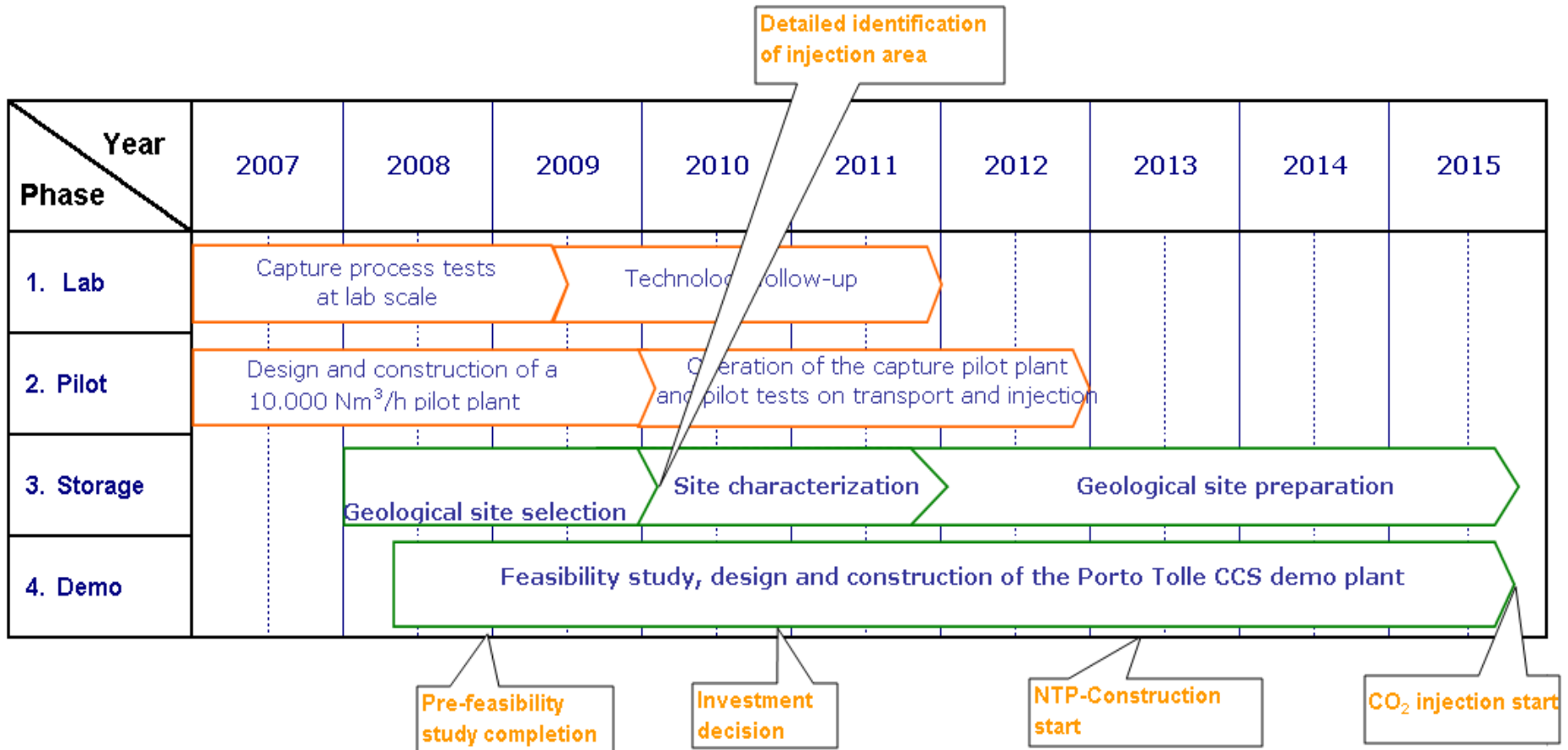


**This is one of the 6 demo projects proposed for funding under the EEPR (European Energy Programme for Recovery).**

# ZEPT - Zero Emission Porto Tolle

## Phase 4 - Porto Tolle post-combustion demo plant

### Time schedule

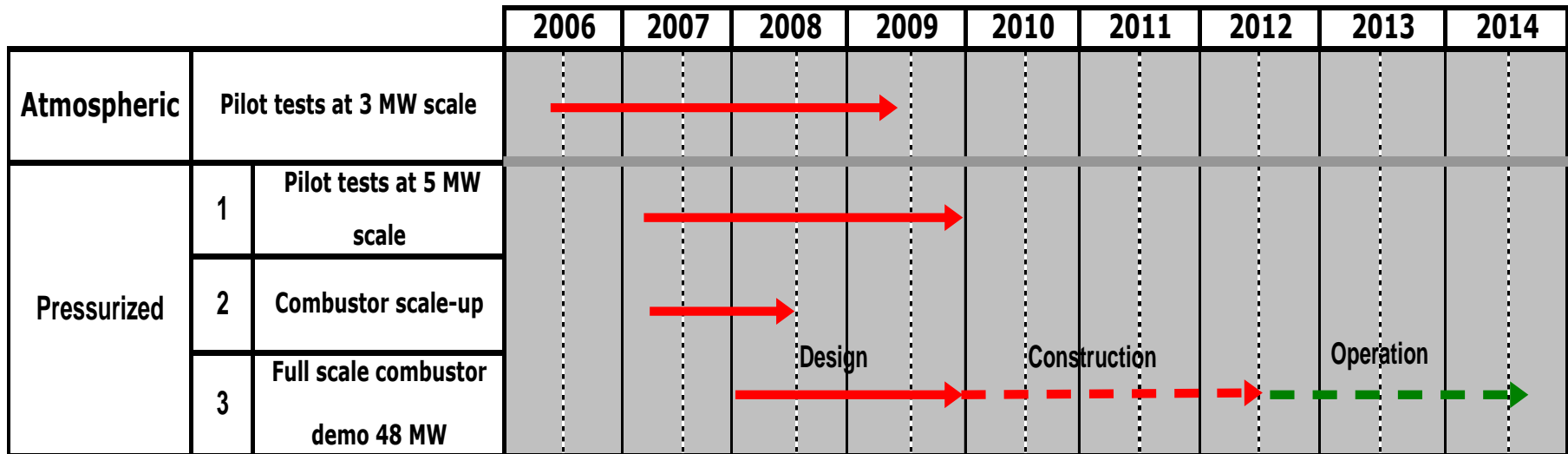




# The oxy-coal combustion project

# The oxy-coal combustion project

## The development program



# Pressurized oxy-coal combustion project

- ✓ **The combustion process:** coal combustion with oxygen under pressurized conditions
- ✓ **Project objective:** develop and demonstrate on industrial scale a patented pressurized coal-combustion process with the purpose to make it possible CO<sub>2</sub> capture and sequestration with energy penalties lower than those expected from other CCS technologies
- ✓ **Pilot tests:** extensive tests at 5 MW<sub>th</sub> scale at ITEA facility have shown that the process can operate reliably while fed with coal water slurry

The flameless reactor

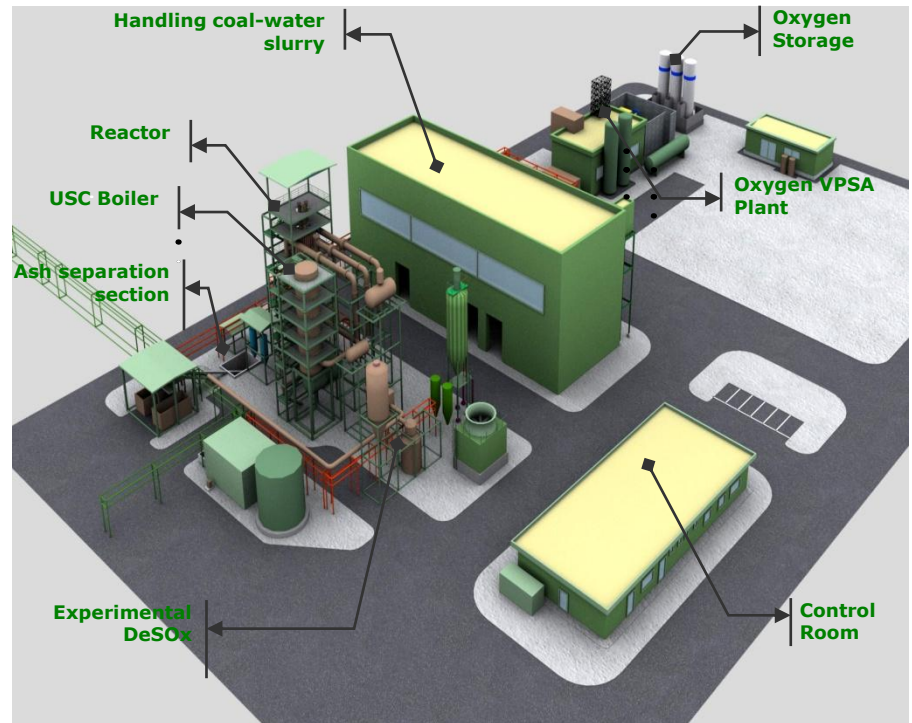


Melt ashes removal



# Pressurized oxy-coal combustion project

- Analyses of the power cycles based on this process concluded that a 300 MW<sub>e</sub> unit would achieve a net efficiency of about 35%
- Next step – Process scale-up  
A full combustor demo (48 MW<sub>th</sub>) is in planning stage:
  - ✓ Design completed
  - ✓ Partnership being built



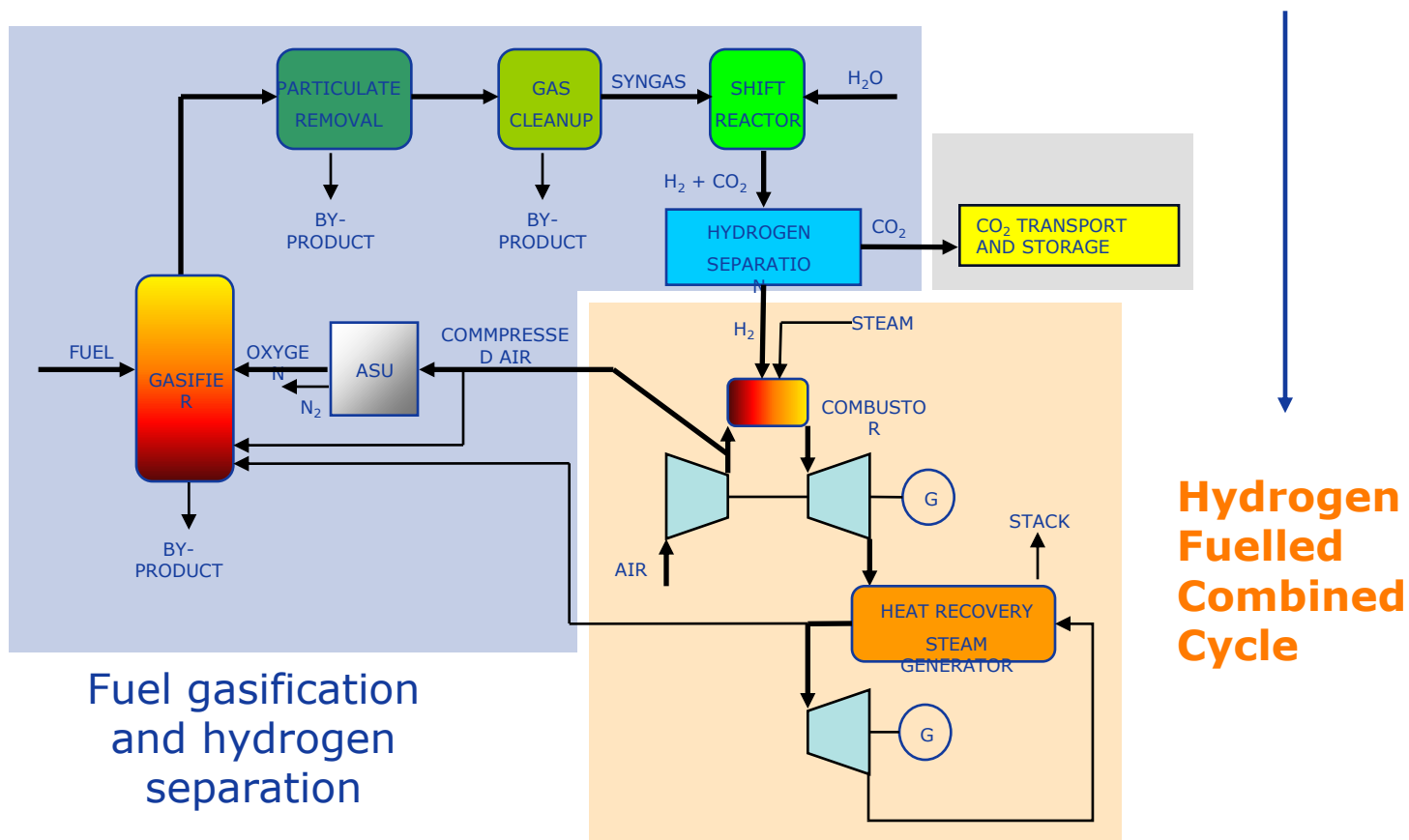


# Power from Hydrogen

# Power from Hydrogen

## Zero emission IGCC (ZEIGCC)

- On the IGCC and pre-combustion technologies, Enel shares the experience of Elcogas IGCC plant and is now focusing its attention on proving, at industrial scale, the power generation from hydrogen.



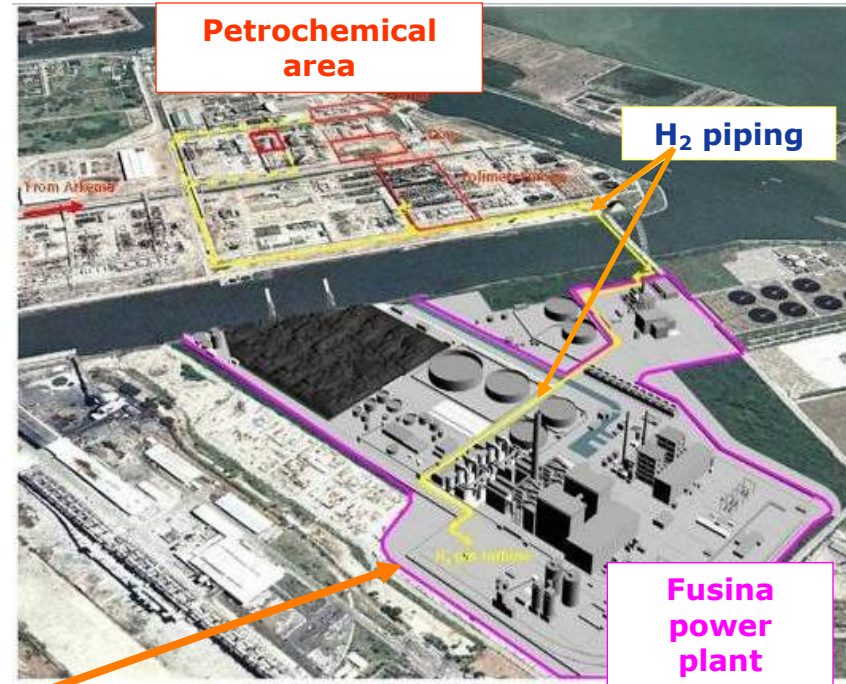
Fuel gasification and hydrogen separation

Hydrogen Fuelled Combined Cycle

# Power from Hydrogen

## The Fusina hydrogen burning power plant

- A 12 MW<sub>e</sub> combined cycle fed by hydrogen produced by petrochemical industries was built in Fusina power plant.



Full power on NG

May 2009





Commissioning  
on H<sub>2</sub> start

July 2009

# Demonstrating and deploying CCS

## The challenges ahead

### Four key challenges for CCS deployment:

-  **Technical/Industrial:** to be addressed by large-scale demonstration projects and industry
-  **Regulatory:** implementation of CO<sub>2</sub> Storage Directive will address main challenges, but appropriate long-term liability needs to be defined. An even level playing field for decarbonised power generation is needed.
-  **Financial:** partially addressed by demo funding, but MS support still needed; while a level playing field for all decarbonised power sources is required for deployment
-  **Public support:** early communication on projects and the benefits of CCS is essential

Source: ZEP 2009 General Assembly – J. Heithoff “Deploying CCS: Meeting the Challenges Ahead”



**Thank you  
for your kind attention**