The Porto Tolle CCS demonstration project

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Enel - Engineering & Innovation Division

CO_2 Capture and Storage – Response to Climate change

Regional Awareness-Raising Workshop

Vilnius, 13-14 April 2011

Content

- The Porto Tolle CCS demonstration project: objectives and status
- The R&D activities supporting the development of Porto Tolle demo
- Italian policy framework
- Financial challenges in demostrating CCS

The Porto Tolle CCS demonstration project

Objectives and status

The Porto Tolle power plant conversion project

	Old Plant	New Plant
• Gross power output (MW)	2640	1980
• Net efficiency (LHV)	39%	45%
• Fuel	Oil (0,25% S)	Coal
• Emissions SO2/NOx/Dust (mg/Nm3)	400/200/50	80/80/7 (daily basis)

✓ **New main components:**

- USC boilers
- Steam turbines
- SCR denitrification system
- FGD plants
- Fabric filters
- 2 domes for coal storage

✓ **Biomass co-firing capability**

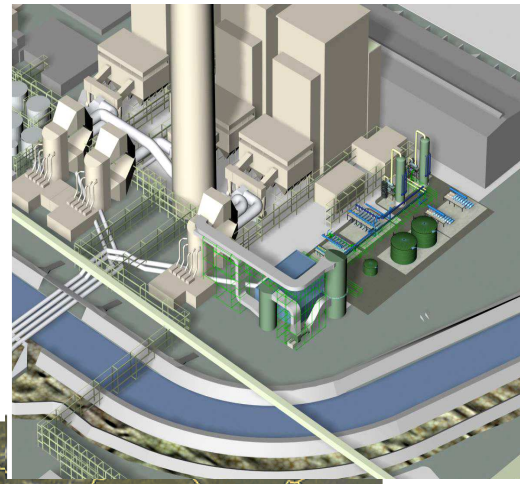
Construction permit for the new plant issued Jan 5, 2011

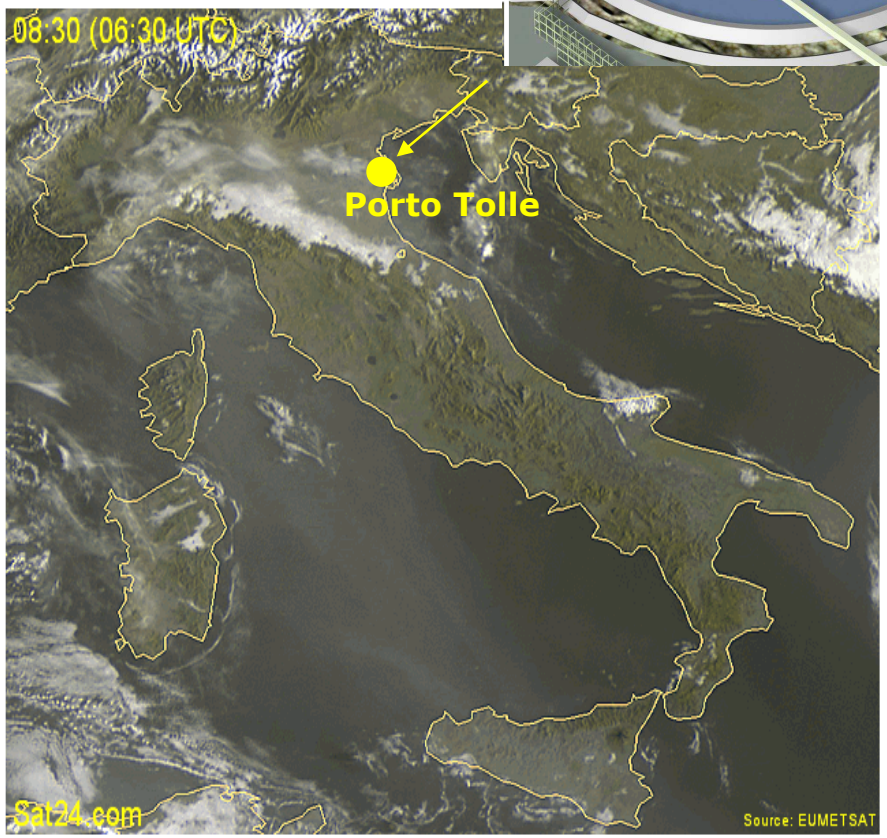
ZEPT- Zero Emission Porto Tolle

The Enel's CCS demo project

Project goal

To retrofit one 660 MW_e coal fired unit of Porto Tolle power station with CO_2 post combustion capture equipment and start CO_2 underground storage in an off-shore saline aquifer by 2015

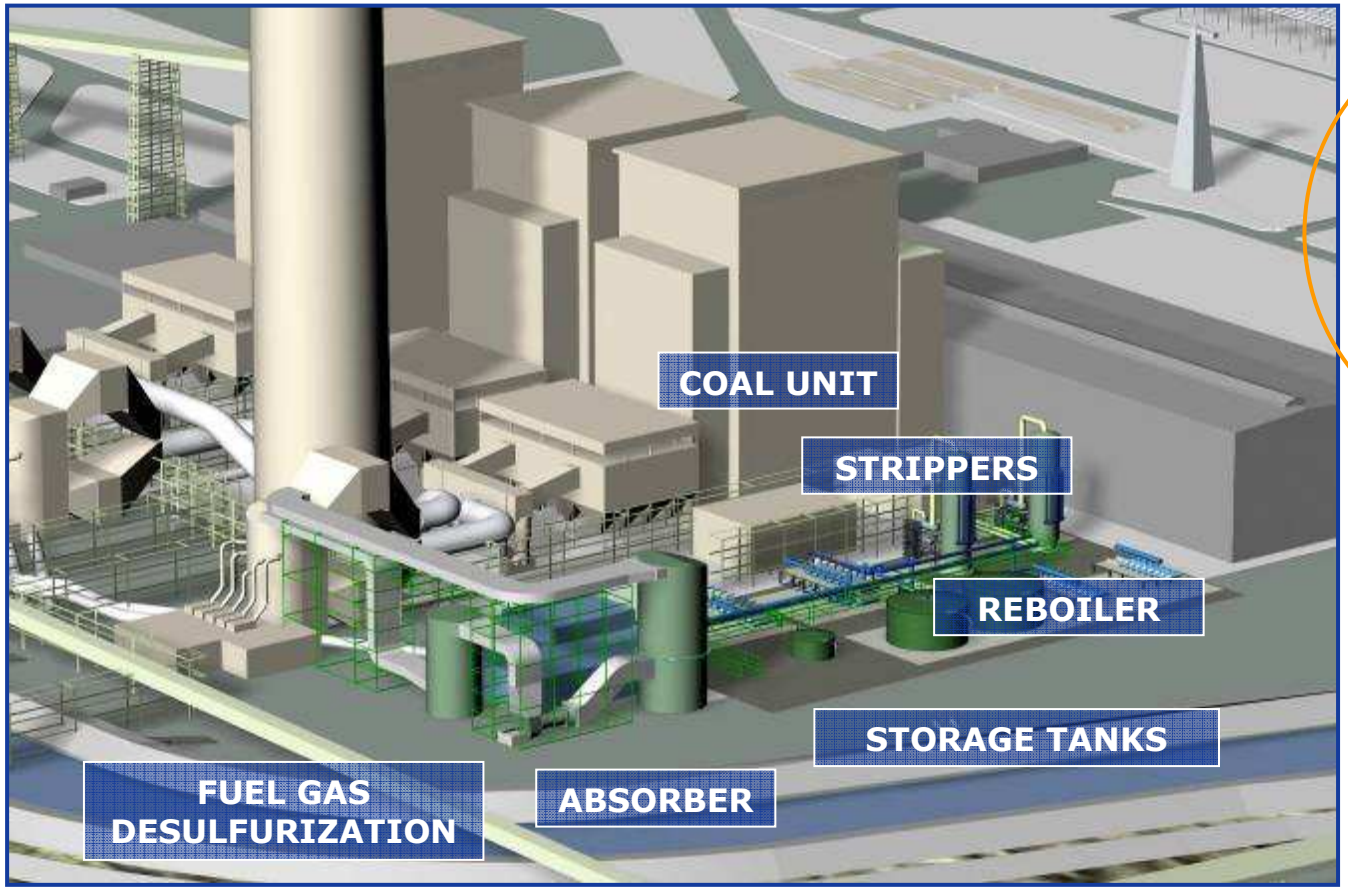




ZEPT- Zero Emission Porto Tolle

CCS demo plant lay-out

Porto Tolle power plant

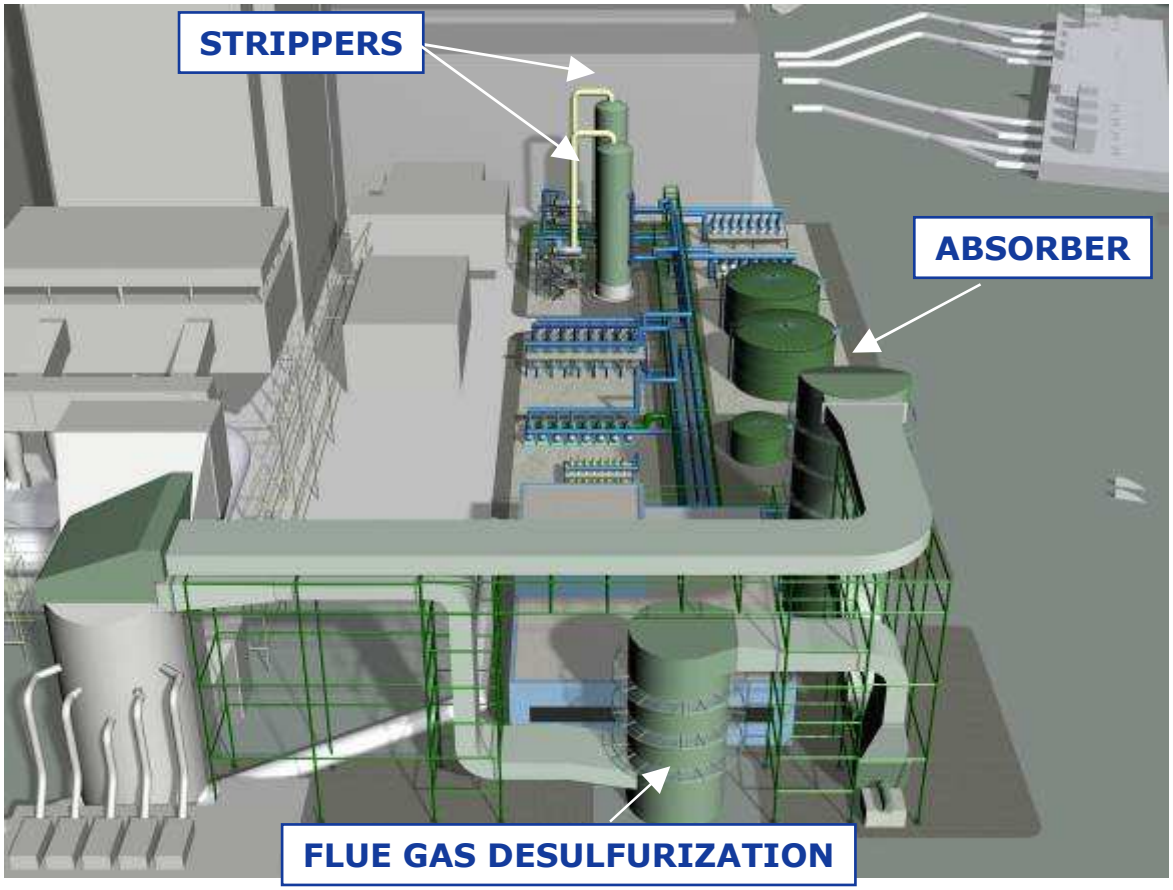


CO_2 storage area (light-blue)

ZEPT- Zero Emission Porto Tolle

Demo main features

Type of Project	**Retrofit**
Power generation	**660 MWe**
Primary fuel	**Bituminous coal**
Secondary fuel	**Biomass**
Power Generation Tech	**USC-PC**
% of flue gas treated	**40%**
CO_2 Capture Tech	**Post Combustion Capture with Amine**
Stored CO_2	**Up to 1 Mt/y**
CO_2 Capture rate	**90%**
CO_2 Storage solution	**Deep saline aquifer**
Storage location	**North Adriatic Sea**
CO_2 value chain	**Pure storage**



Co-financed by the European Union
European Energy Programme for Recovery

ZEPT- Zero Emission Porto Tolle

One of the six EEPR projects

Total EEPR funding: 1 b€

IGCC
Off-shore
gas field

Post-combustion
Off-shore gas field

Oxy-fuel CFB
On shore saline aq.

Porto Tolle
Post-combustion
Off-shore saline aq.

Post-combustion
On shore saline aq.

Oxy-fuel and
post-combustion
On shore storage

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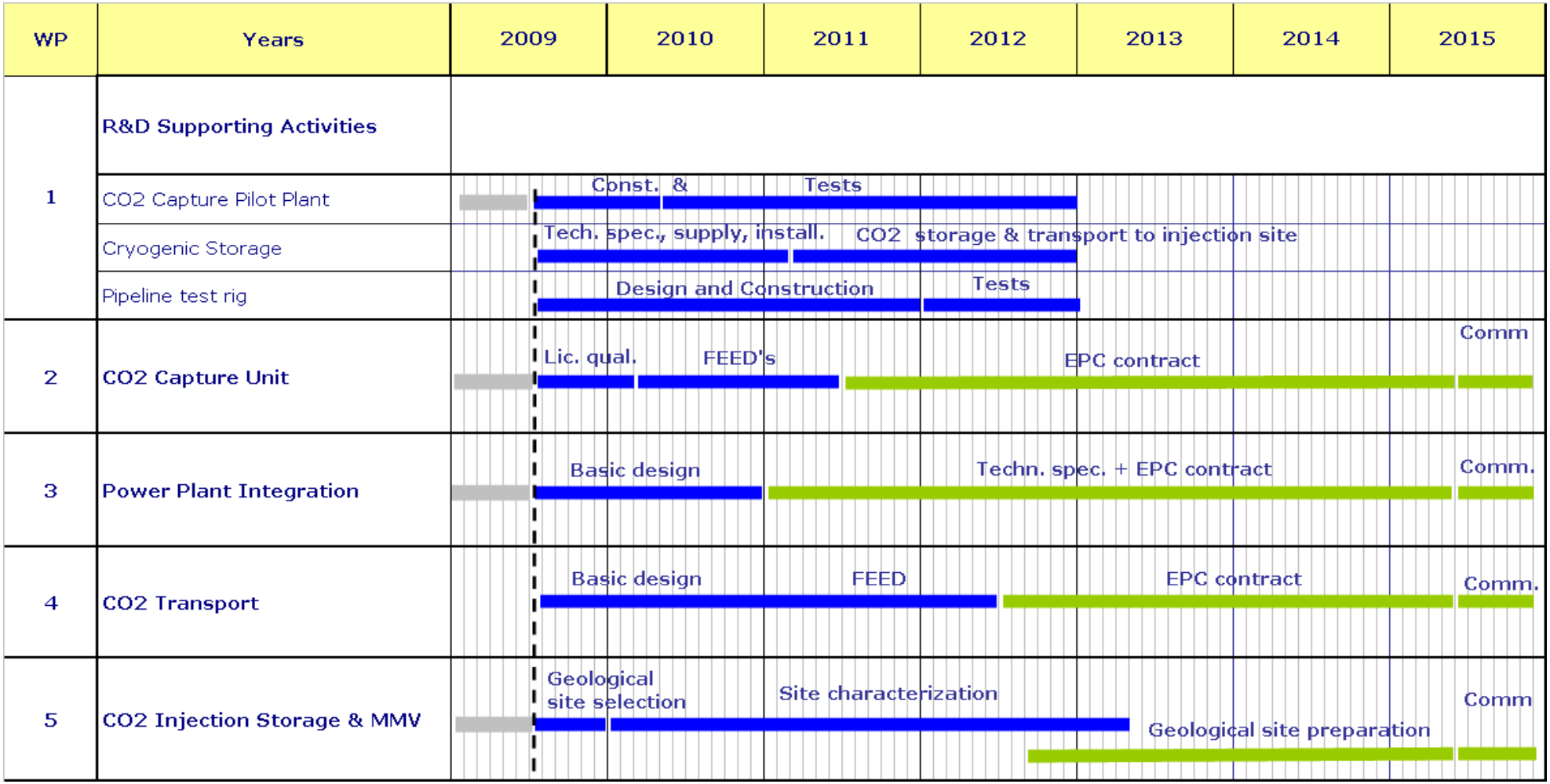
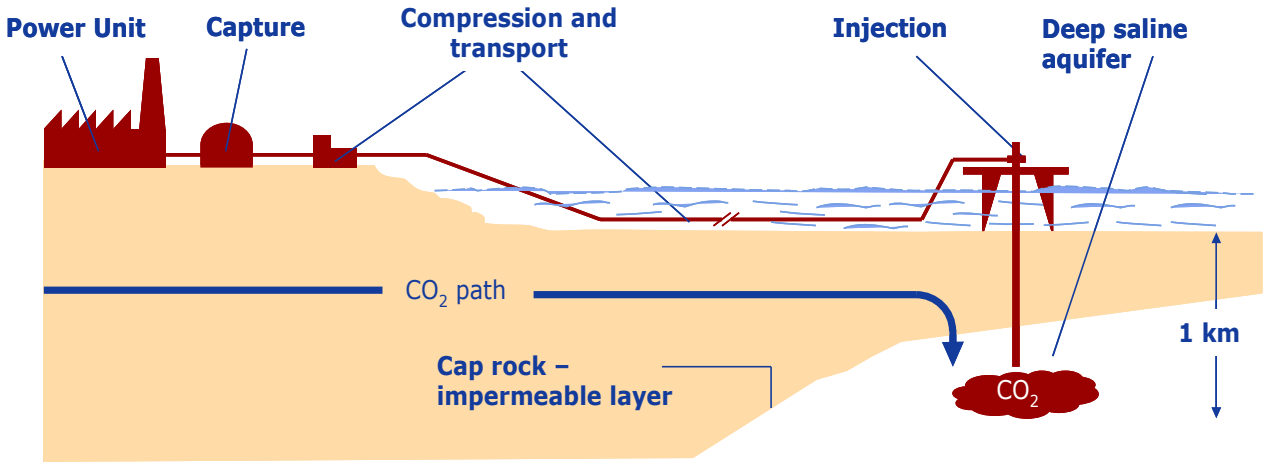
Project time schedule



Activities carried out in the frame of the EEPR Grant Agreement signed in December 2009 with European Commission

ZEPT – CCS Demo Activities



Activities in progress:

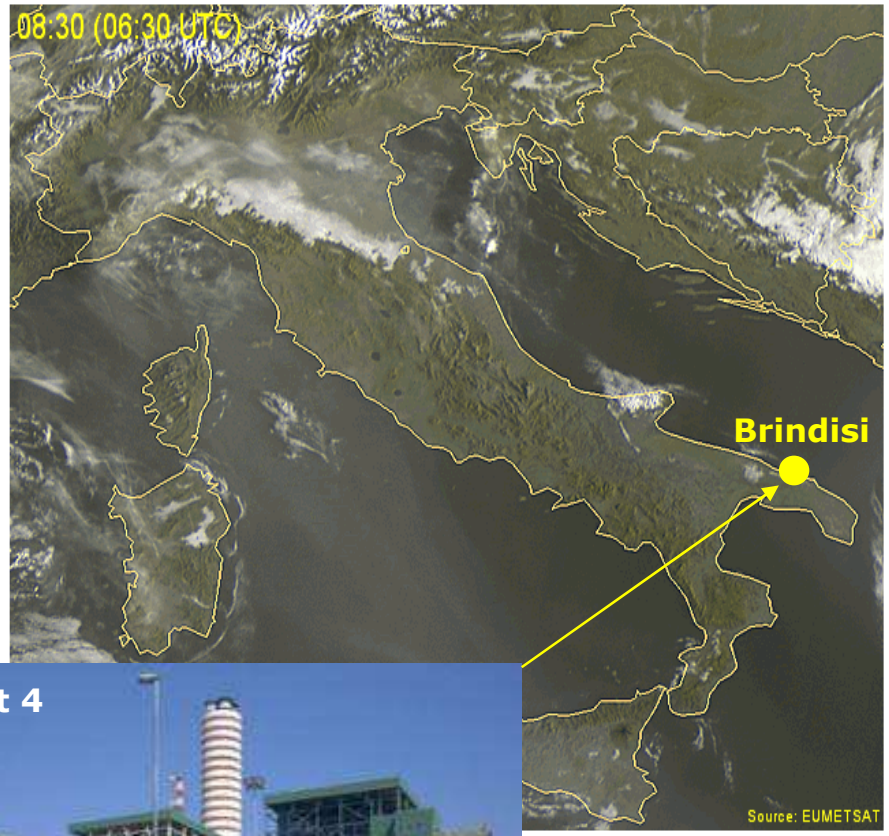
- Selection of the CO_2 capture technology : execution of 4 parallel FEED's under way (completion Apr. 2011; selection Jun. 2011)
- Development of the FEED for transport pipeline and injection infrastructure (contract award Jun. 2011)
- Selection and assessment of the storage site : geological site modelling and appraisal well design in progress
- Development of the financial plan

R&D activities supporting the development of Porto Tolle demo

ZEPT- R&D Supporting Activities

CO_2 capture pilot plant

- At the site of **Brindisi** coal fired power station a pilot plant for CO_2 separation via amine scrubbing was built and is now in operation. The pilot plant is installed on the Unit 4.
- The pilot plant is composed by a flue gas pre-treatment section (able to remove completely the particulate and the SO_3 and to reduce SO_2 level below 20 mg/Nm^3) and by a CO_2 separation unit
- The plant size is **10.000 Nm³/h** of flue gas, capturing up to **2,5 t/h of CO_2**
- Goal: to gain experience in CCU designing and operation, and to assess the environmental impact of the process



ZEPT- CO_2 capture pilot plant

✓ About one year for site construction activities

✓ Less than 2 years to first CO2 separation since detailed engineering start

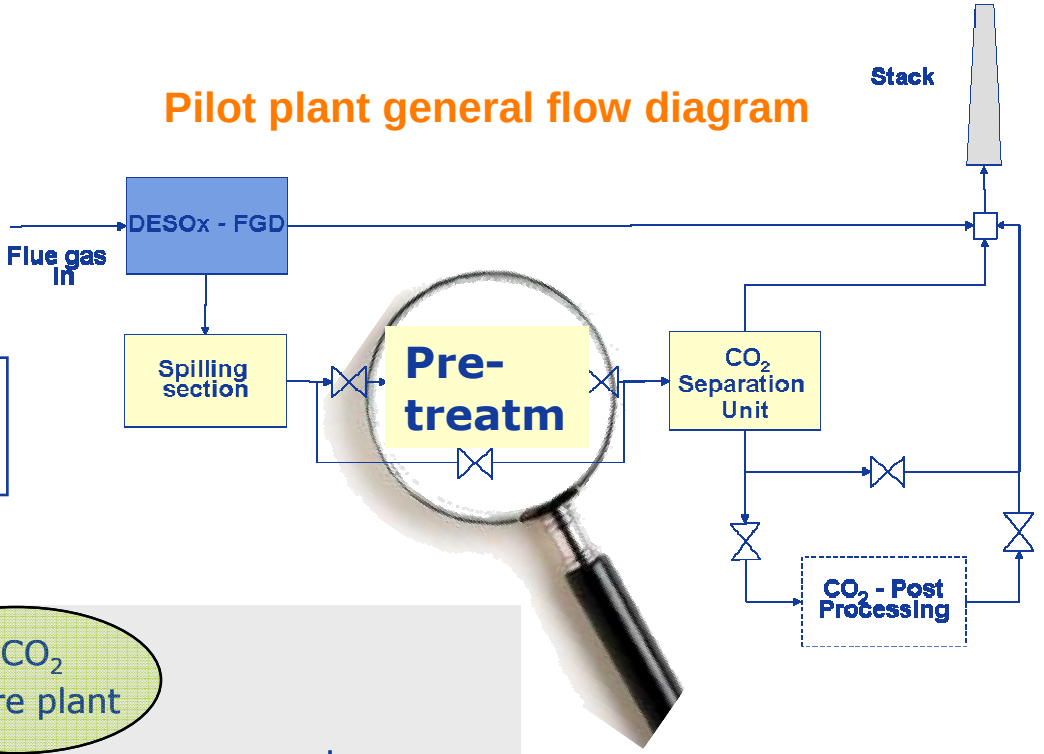
✓Operation start: **Oct 2010**

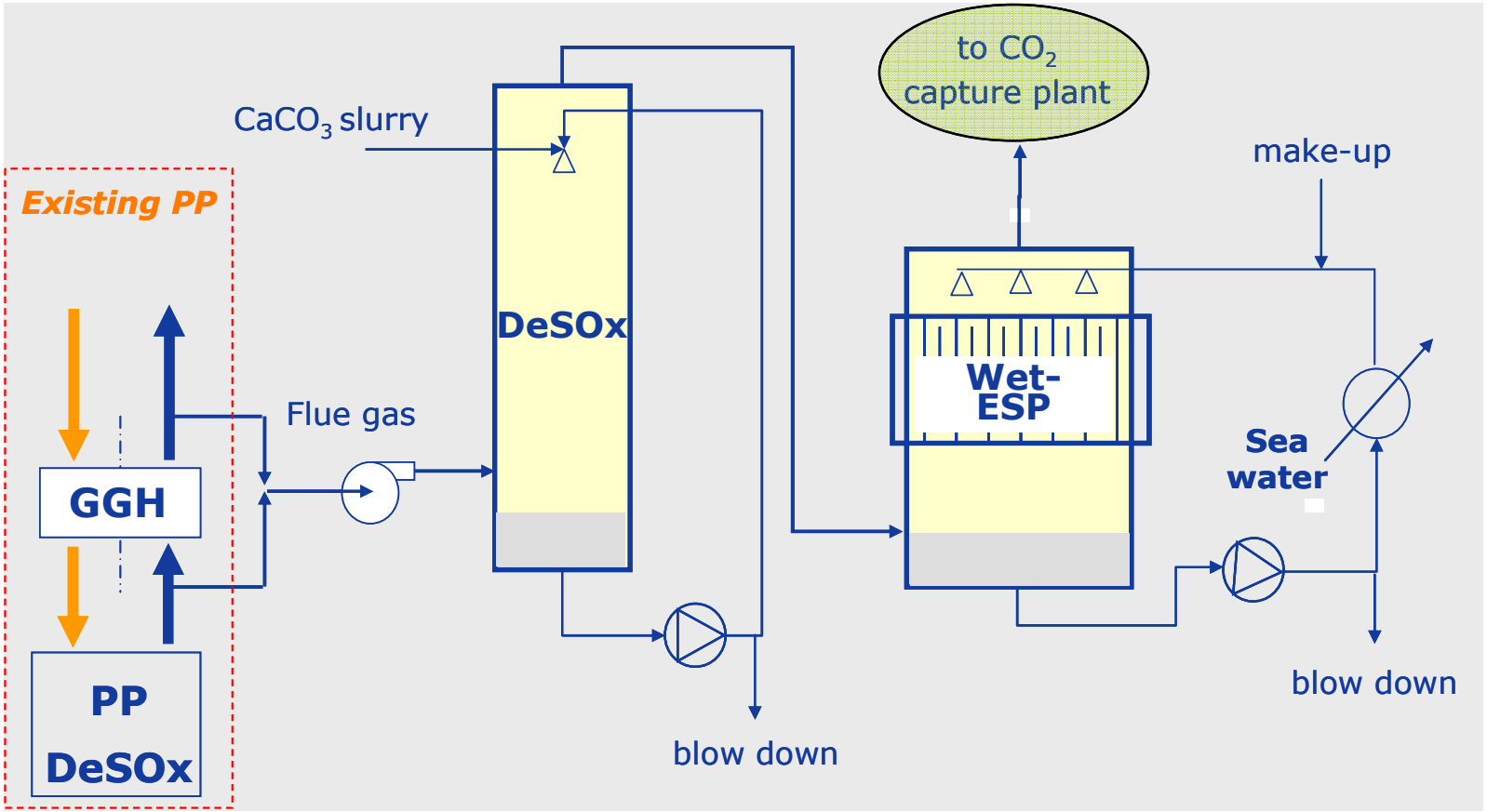
ZEPT- CO_2 capture pilot plant

Flue gas pre-treatment

The pre-treatment system gives the possibility to partially bypass both the WFGD and the WESP

Pilot plant general flow diagram





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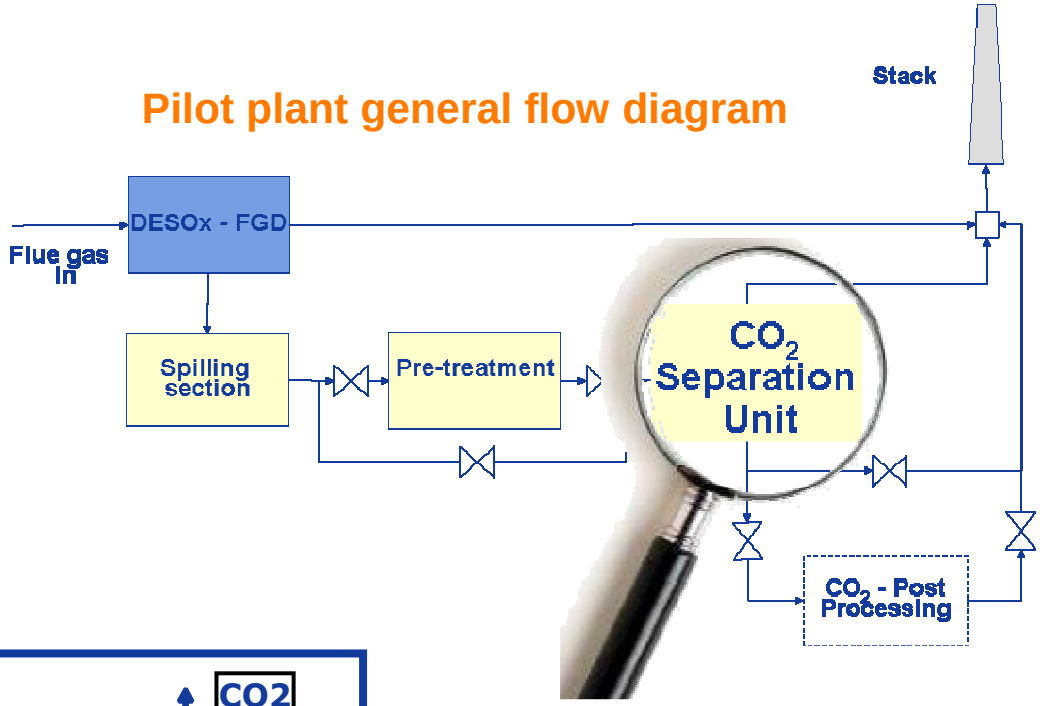
ZEPT- CO_2 capture pilot plant

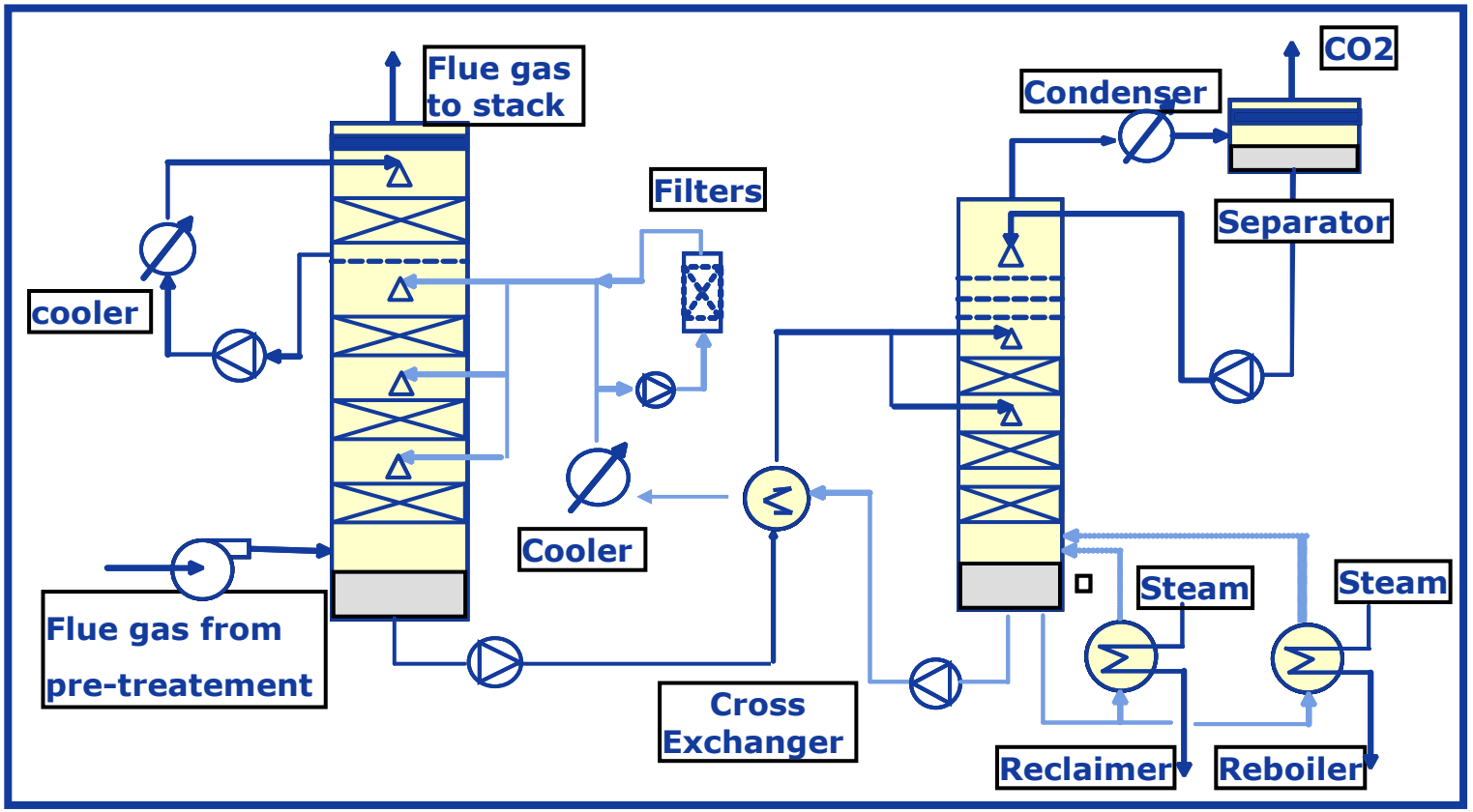
CO_2 separation unit

Pilot plant general flow diagram



Absorber

- 1.5 m internal diameter
- 3 structered packing sections (22 m total)
- Solvent flow rate : 20 to 80 m^3/h



Stripper

- 1.2 m internal diameter
- 3 random packing sections (10 m total)
- Operative pressure up to 2.5 bar

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ZEPT- CO2 capture pilot plant

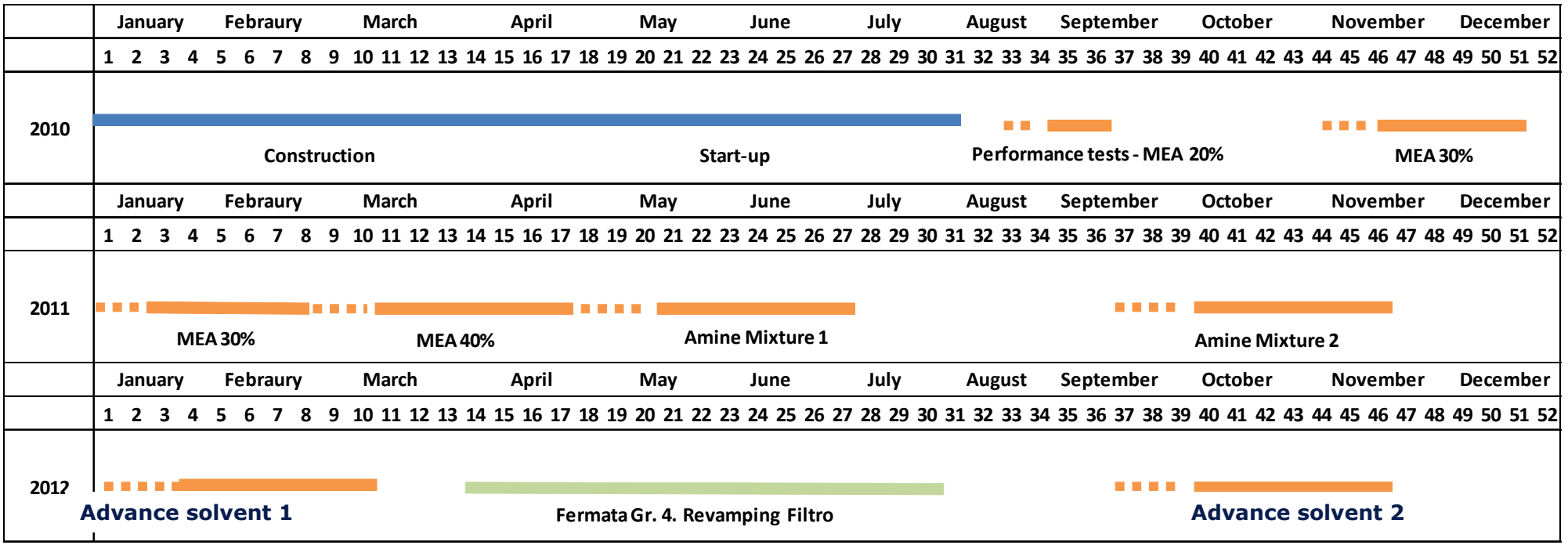
Research Program Objectives

- **Develop operational experience (MEA 20%- 30%-40% + inhibitors)**
  - Assessment of the MEA absorption technology: reliability, environmental impact, power consumption and capture performance
  - Definition of operating procedures, management
  - Cost evaluation at different operating conditions for retrofit application: solvent consumption, inhibitors, waste treatment management
  - Flue gas composition: CO2 stream and emissions

- **Test advanced solvents and inhibitors**
  - Reduction of power consumption (reduction of operating cost)
  - Solvent degradation (reduction of operating cost)
  - Assessment of corrosion (reduction of capital cost)
  - Reaction rate (check of design parameters)
  - Environmental performances

ZEPT- CO2 capture pilot plant

Tests schedule



- 2011 → 4000 hr continuos operation; ~ 8000 ton of separated CO_2
- 2012 → 3000 hr continuos operation; ~ 6000 ton of separated CO_2

  Tests with advanced solvents

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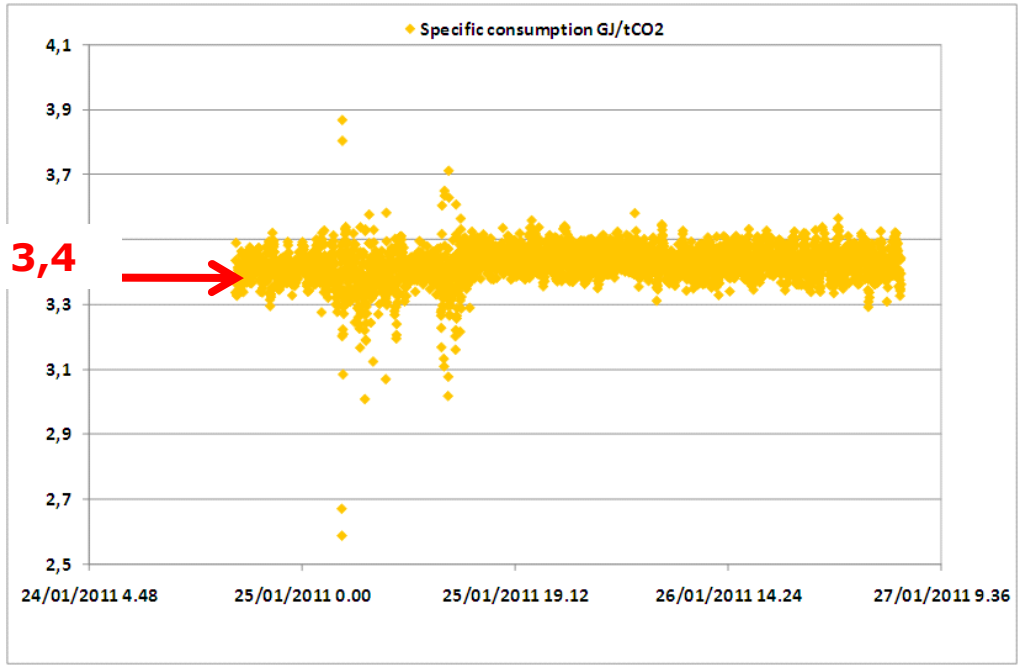
ZEPT- CO_2 capture pilot plant

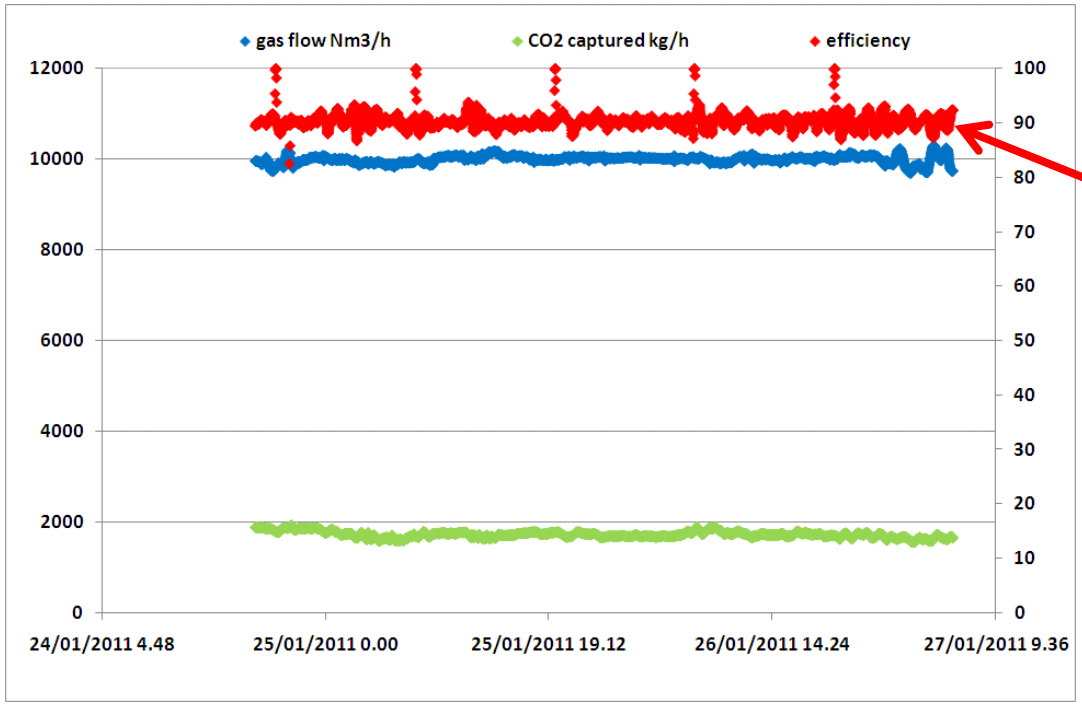
Test campaign with 30% MEA

The following settings have been applied in the 500 hours test (Jan 07 – Feb 11; continous operation):

- Flue gas flow: 10.000 Nmc/h
- Solvent flow: 30 mc/h
- Stripper pressure: 0.8 barg
- Corrosion coupons are installed: CS 018; SS 316; SS 304

Steam consumption: ~ 3.4 GJ/t CO_2





Average CO_2 capture: ~ 90 %

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– CO_2 capture pilot plant

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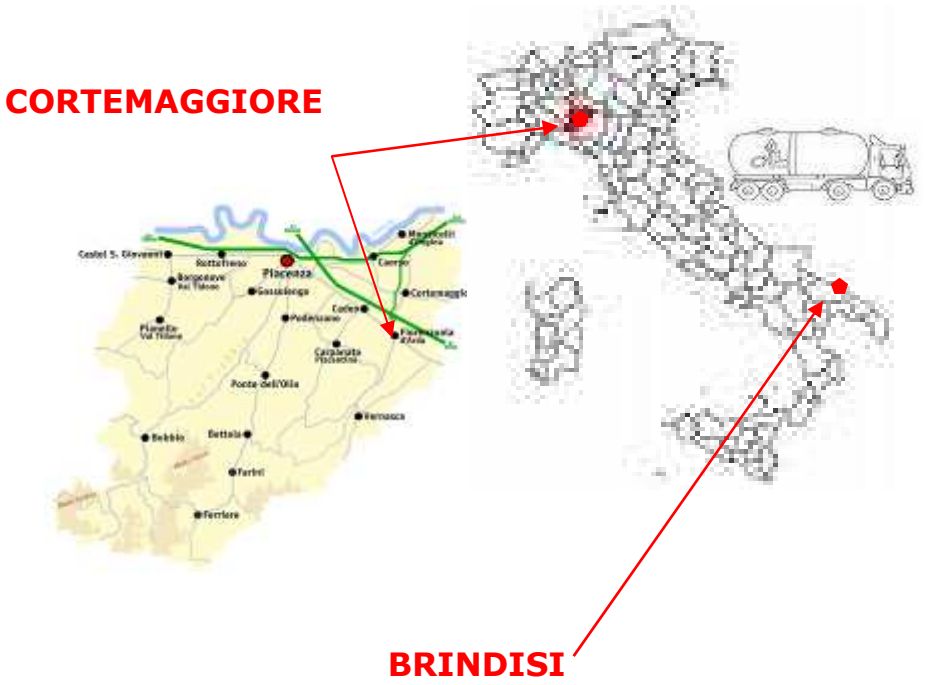
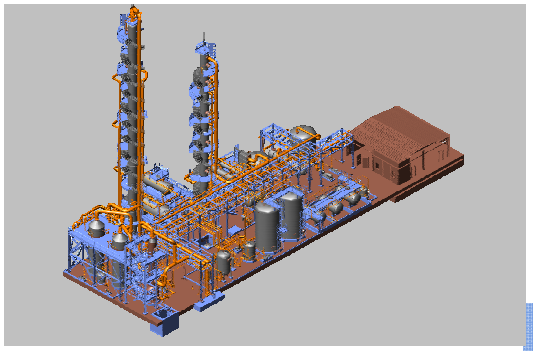
ZEPT – CO2 capture pilot plant

ZEPT – R&D Supporting Activities

Integrated CCS pilot project

- The first Italian integrated CCS pilot project is under development in the frame of the Eni - Enel cooperation agreement signed in 2008. It will include:
  - ✓ **Capture** – Enel's post-combustion capture pilot plant in Brindisi in operation from Oct. 2010 and separating at least 5000 tCO_2/y
  - ✓ **Liquefaction** – CO_2 liquefaction and criogenic storage system to be built in Brindisi treating the CO_2 produced by the pilot capture plant
  - ✓ **Transport** – by truck
  - ✓ **Storage** – Eni's pilot CO_2 injection project in an exhausted gas field in Cortemaggiore (Piacenza). Injection start: summer 2012. Total CO_2 injected: 24000 ton
- It is also foreseen to build in Brindisi a closed loop CO_2 pilot pipeline to develop knowledge to be used in the demo transport system design.



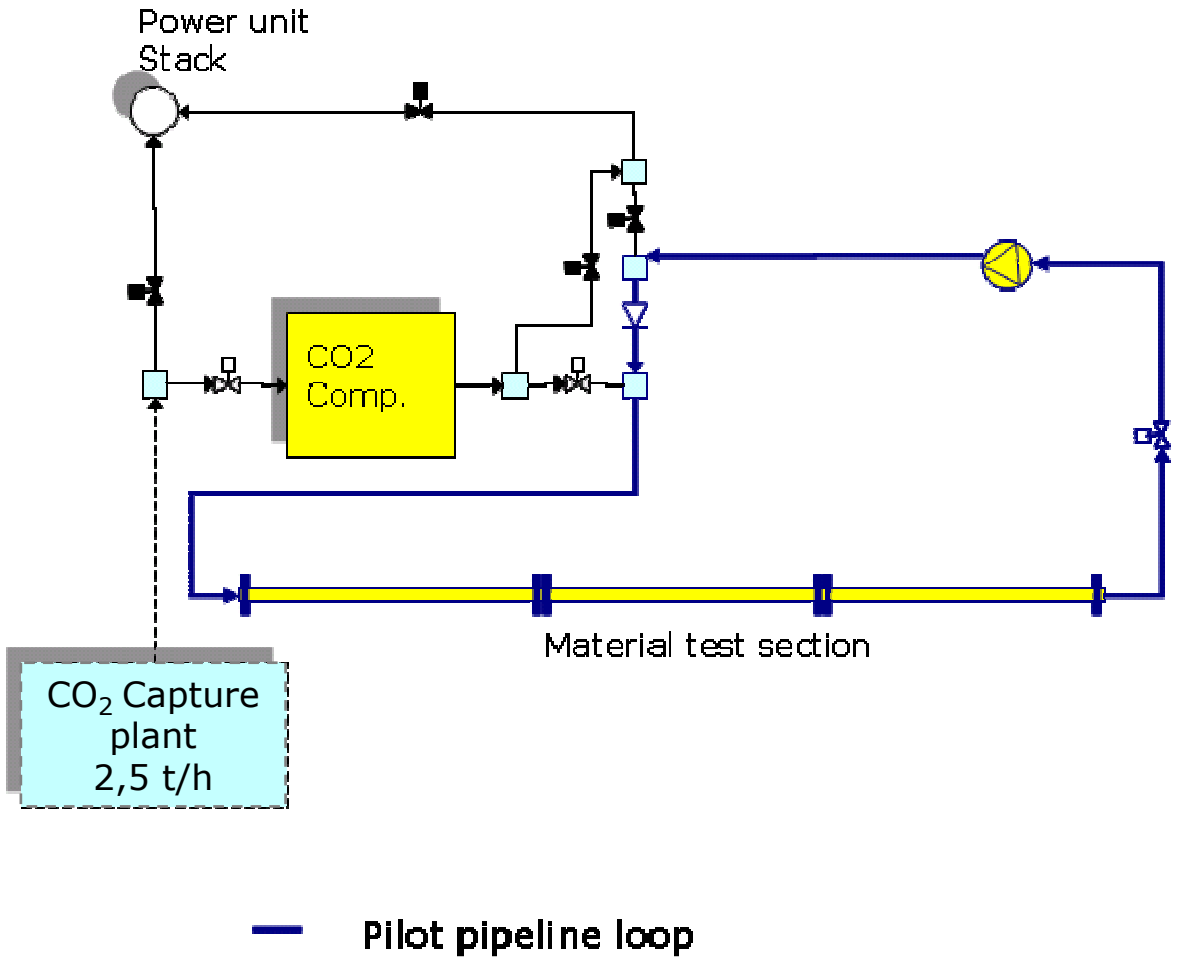


ZEPT – R&D supporting activities

CO_2 pilot pipeline

This will allow to collect experimental data to be used to:

- Validate design models (both stationary and dynamic) of the CO_2 transport line
- Optimize operating procedures
- Study corrosion problems related to the presence of impurities in the CO_2 stream



FEED completed in Feb. 2011. Permitting under way, order to be issued 2H 2011. Expected operation start in 2012

Italian policy framework

The Italian energy strategy

The role of CCS

- **Coal is a key element** of the Italian energy sources diversification policy.
  The strategy for new coal is based on the use of BAT's while promoting the transition to near-zero emissions (advanced materials, ultra-high efficiency systems, **CCS**).

- **The transposition of the European directive on CO_2 geological storage** in the Italian legislation will be realised through a base decree followed by various administrative acts (see next slide).

- **Law 99/2009 (New energy strategy)** includes provisions for the promotion of innovation in the energy sector. Priority fields for R&D&D are CCS, nuclear and distributed generation. Financial support to the realisation of CCS demo projects is also foreseen (source of funds not specified).

- **Law 111/2010** provides for the use of revenues of the auctioning of ETS allowances for the aims quoted in art 10.3 of the European directive 2009/29/EC, which include "the environmentally safe capture and geological storage of CO_2…"

Italian regulatory framework

The trasposition of the European directive 2009/31/EC on CO2 geological storage into the Italian legislation is in progress:

- **The tool used is a Legislative decree.** This is an act from the Government which was empowered by a vote of the Parliament (Law 96/2010, the so-called "Legge comunitaria 2009").

- **Process status**

May 2010	First draft of the decree
Jun - Oct 2010	Stakeholders consultation
Nov 2010 - Feb 2011	Legal review
23 Mar 2011	Approval by Council of Ministers
By mid- May 2011	Opinion from Parliament Commissions
End May 2011 (expec.)	Final approval and publication

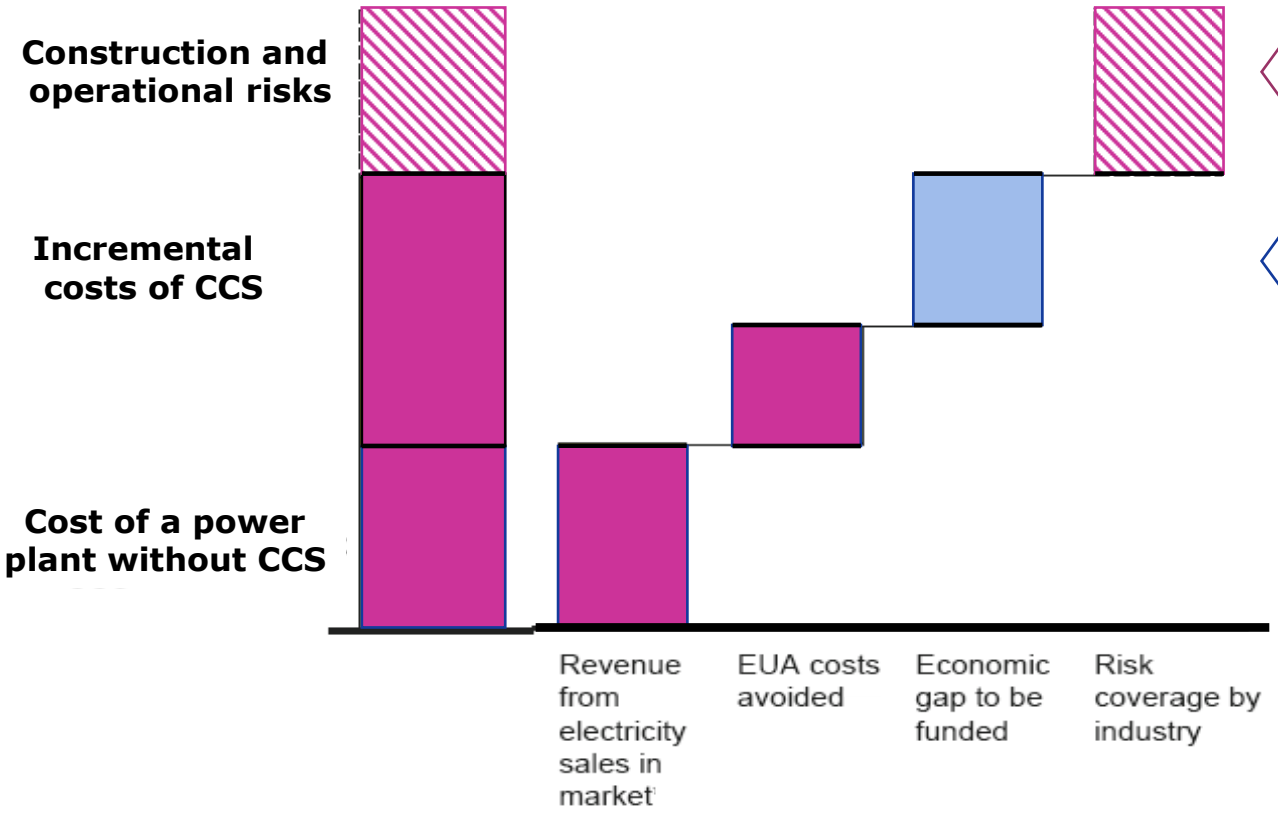
- According to the draft text **the competent authority** in the permitting process is the **Ministry of the Economic Development** in concert with the **Ministry of the Environment.**

- Details about the implementation of some articles will be contained in ministerial decrees to be issued within 6 months from the publication of the legislative decree.

Financial challenges

in demonstrating CCS

Financial feasibility of CCS demos



- Project promoters are bearing relevant constructions and operational risks
- Public needs to cover most of the economic gap

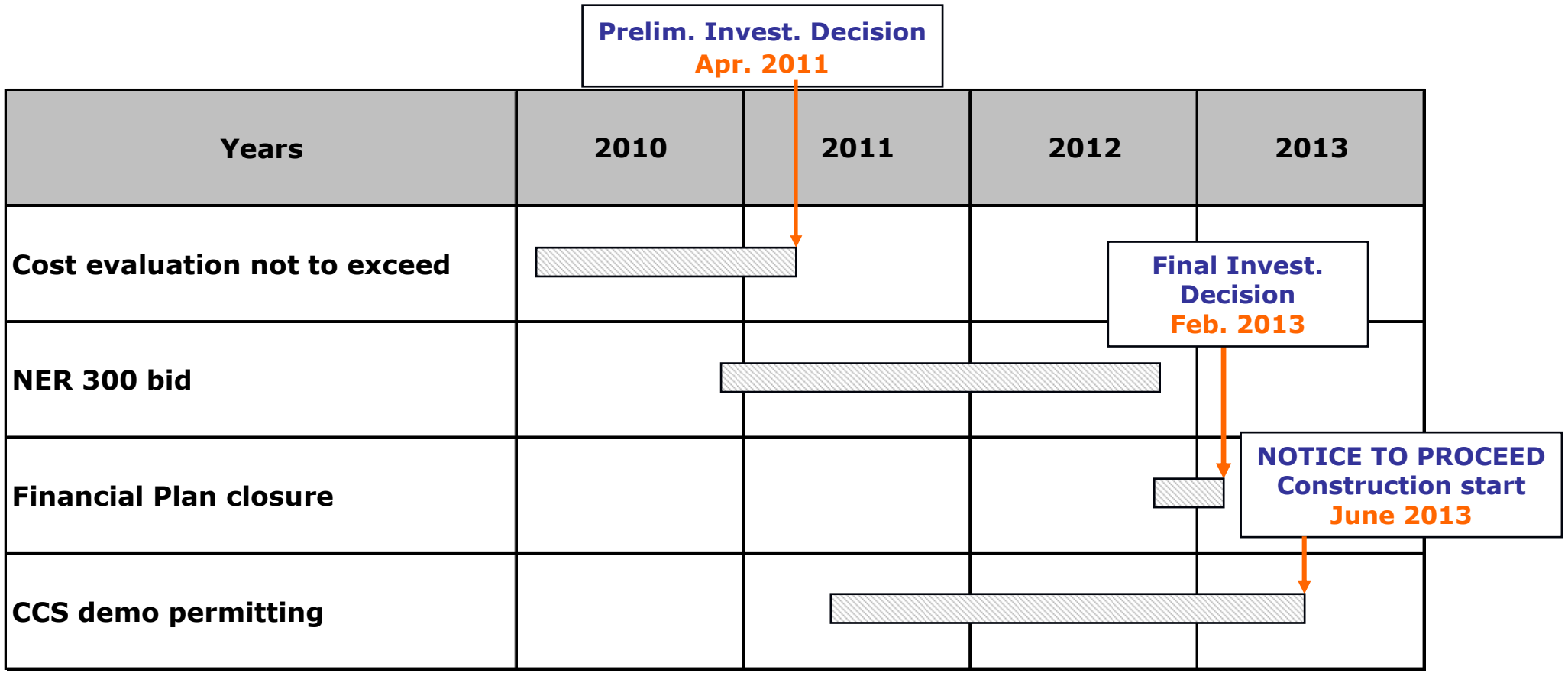
Not at scale

The economic gap for a typical CCS demo project is of the order of 1b €

Public funding assumptions for ZEPT demo

- **A grant from the EEPR fund** → 100 M€ under the Grant Agreement signed in Dec. 2009
- **A substantial contribution from NER 300 fund** → Call for proposal issued Nov. 2010; process ongoing
- **A significant funding from Italian Government** → Under discussion

ZEPT- Decision gates




Thank you
for your kind attention