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CO2TRACCS Project

Task 1.2: Design of the pipeline network for the transportation of CO_2

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General overview

Task 1.2: Design of the pipeline network for the transportation of CO_2: Start date M6, End date M22

<u>Deliverables/Milestones</u>

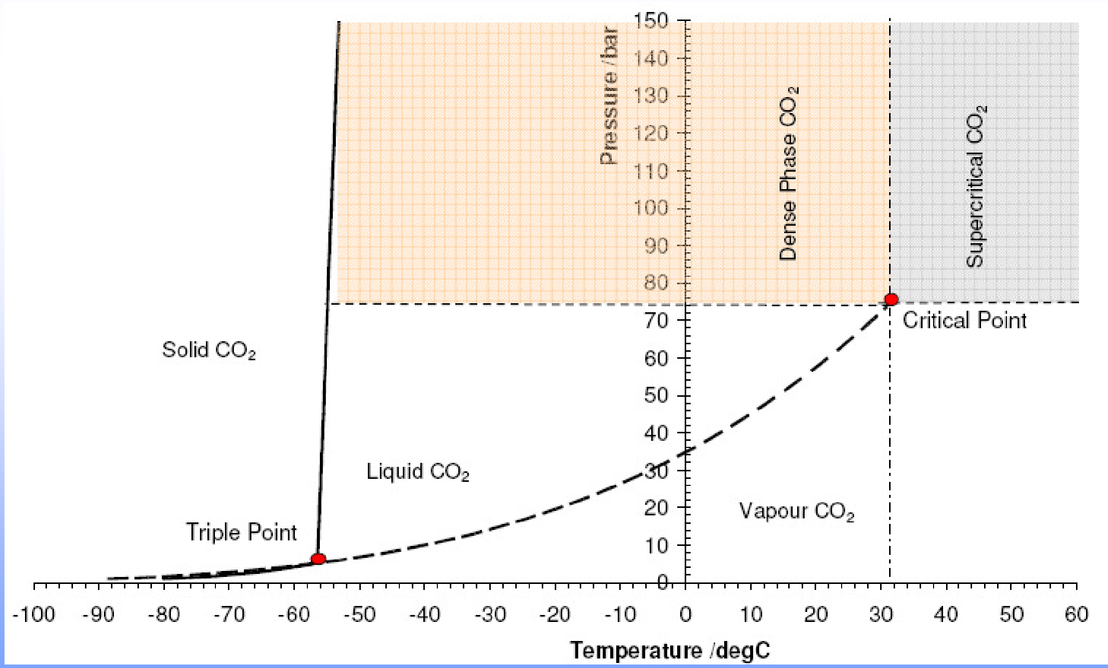
- D1.3: Design of pipeline network for CO_2 transportation (M22)

Task 1.2 aims in the design of a pipeline network for CO_2 transportation in the Black Sea Region, corresponding to a situation representative of the countries involved in the project, namely large lignite-fired power plant clusters at a distance of 100-200 km from candidate storage sites with a mixed geographical terrain.

CO_2 Pipeline design (1)

CO_2 condition for transportation

For CO_2 pipelines CO_2 should be at the Dense or Supercritical phase (high density and low viscosity), at high pressure > 96bar (For current CO_2 pipelines: minimum operating pressure 86 bar, maximum operating pressure 200bar, 4-30 °C)



CO2 Pipeline design (2)

Predicted composition (Element Energy Limited, "CO2 pipeline infrastructure: An analysis of global challenges and opportunities", Final report for IEA GHG, 2010)

- The post-combustion process needs to have a relatively low sulphur content because SO2 poisons the solvent
- The IPCC report suggests that for oxyfuel and pre-combustion capture, leaving sulphur compounds in the CO2 product stream could be economically beneficial as it will reduce the cost of capture

Coal Fired Power Plants	Component	Coal Fired % Volume	Gas Fired % Volume
Post-Combustion Capture	SO_2	<0.01	<0.01
	NO	<0.01	<0.01
	$N_2/Ar/O_2$	0.01	0.01
Pre-Combustion Capture (IGCC)	H_2S	0.01-0.6	<0.01
	H_2	0.8-2.0	1
	CO	0.03-0.4	0.04
	CH_4	0.01	2
	$N_2/Ar/O_2$	0.03-0.6	1.3
Oxyfuel	SO_2	0.5	<0.01
	NO	0.01	<0.01
	$N_2/Ar/O_2$	3.7	4.1

CO2 Pipeline design (3)

Case / Component	Type	*Process Concerns*: CO2 Com-Pression Train*	*CO2 quality requirements*: Transport – Pipeline	Transport – Ship	Storage – Ability to move oil ("EOR")	Storage – Injection Equipment	Storage – Cap rock	Storage – Reservoir	Environment, health – Risk Trans-port	Environment, health – Risk storage	*Requirement scenarios for CASTOR SP2*: *Design case*	*EOR case*	*Severe limit case*
H_2O	1	C	<75-500 ppm	<1-50 PPM	NC	500 ppm; T > 15°	NC	NC	NC	NC	< 500 ppm [1]	< 50 ppm[1]	< 5 ppm[1]
CO_2	2	C	NA	NA	> 90 mole %	NA	NA	NA	NA	NA	> 90 vol%	> 90 vol%	> 95 vol%
SO_2	2	NA	<10 mole %	NA	< 10 mole %	< 3 %	C	C	C	C	From MB[2]	< 50 ppm[5]	5 ppmv[6]
NO	2? 3	NA	NA	NA	NC	C	C	C	C	C	From MB[2]	From MB[2]	5 ppmv[6]
H_2S	2	NA	1,6 mole % works **	C	< 10 mole %	500 ppm; < 3 %; T > 30°C	NC	NC	C	C	< 1.5 vol%	< 50 ppm[5]	5 ppmv[6]
CO	2? 3	NA	700 ppm works	C	NC	NC	NC	NC	C	NC	< 4 vol %[3]	< 4 vol %[3]	5 ppmv[6]
Ar	3	C	4 mole % ***	C	4 mole % ***	NC	NC	NC	NC	NC	< 4 vol %[3]	< 4 vol %[3]	< 4 vol%[3]
O_2	3	C	100 ppmv works	C	100 ppmv	100 ppmv works	C	C	NC	NC	< 4 vol %[3]	100 ppmv	100 ppmv
N_2	3	C	4 mole % ***	C	4 mole % ***	NC	NC	NC	NC	C	< 4 vol %[3]	< 4 vol %[3]	< 4 vol&[3]
H_2	3	C	4 mole % ***	C	4 mole % ***	NC	NC	NC	C	NC	< 4 vol %[3]	< 4 vol %[3]	< 4 vol %[3]
CH_4	3,4	C	0,4 mole % works **	C	< 2 mole %	T > 20°C	NC	NC	NC	NC	< 4 vol %[3]	< 2 vol%[3,8]	< 2 vol%[3,8]
Hydrocar-bons	4	NA	NC	NC	NA	NC	NC	NC	NA	NA	From MB[2]	From MB[2]	From MB[2]

Quality requirements according to CASTOR project

CO2 Pipeline design (4)

Pipeline specification – Typical values of design parameters

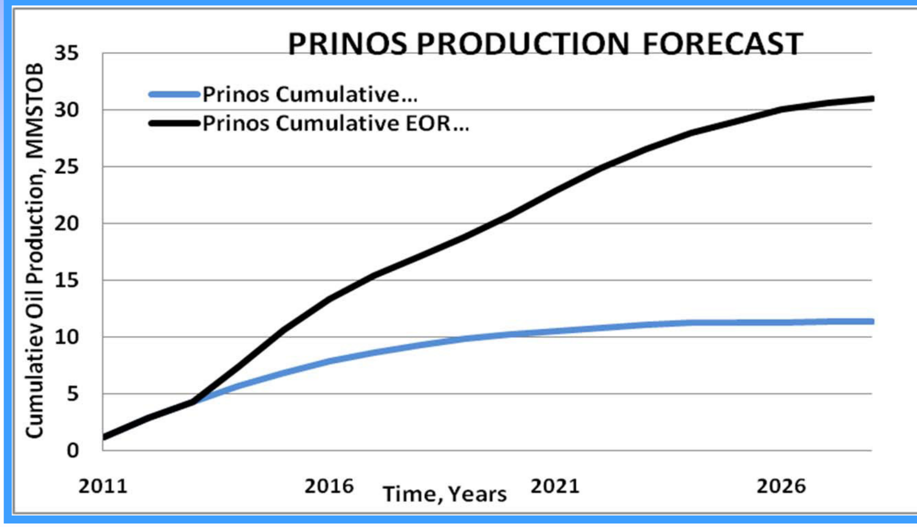
- Minimum operating pressure Pmin: 80 bar – 110 bar
- Maximum operating pressure for on-shore pipeline Pmax: 130 – 200 bar, typical value: 150 bar
- Maximum operating pressure for off-shore pipeline Pmax: 200 – 300 bar, typical value: 250 bar
- Ambient temperature range 4-30 ^oC
- CO_2 velocity for on-shore pipelines: 1-2 m/s (lower than errosional velocity)
- CO_2 velocity for off-shore pipelines: 2.5-4 m/s (lower than errosional velocity)
- CO_2 viscosity μ: $6\text{-}10*10^{-5}$ Pa.s
- CO_2 density ρ: 700-900 kg/m^3, typical value 800 kg/m^3
- Compressors/ pumps efficiency: 75 %

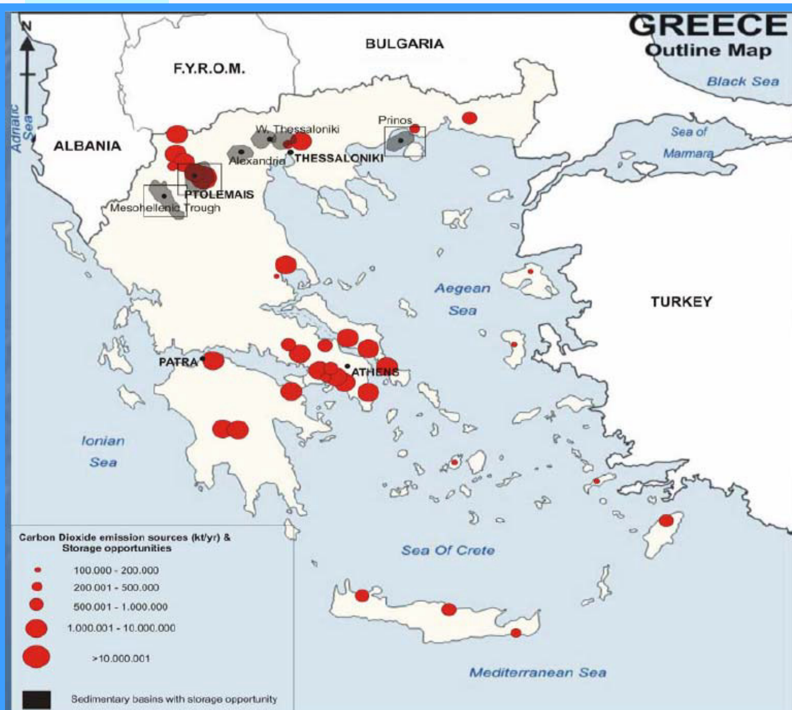
Pipeline safety equipment

- Crack arresters
- Block valves: isolation of sections during maintenance and repair/ accident)
- Pressure increase/ control stations centrifugal pumps

CO_2 Storage in Greece

CO_2 Storage in Greece
- Prinos Basin
- Ptolemais Basin
- Mesohelenic Trough





Prinos Basin
- **Storage capacity assessment (Gestco): 17Mtn CO_2**
- **Recoverable reserves with EOR: 32 MMboe**

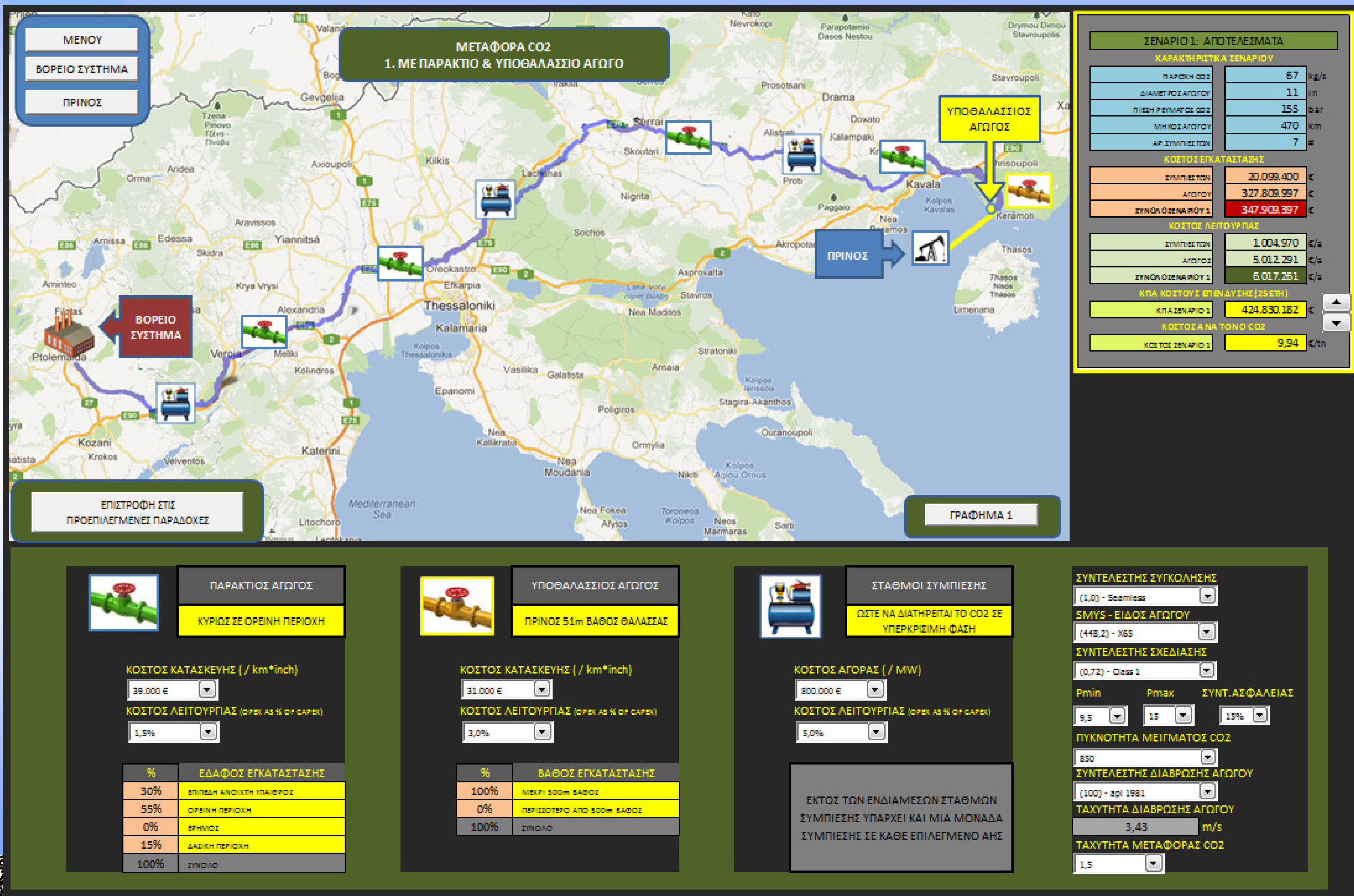
CO_2 Transportation – Case Study for Greece (1)

CO_2 capture/ transportation from low grade lignite fired power plants in northern Greece

- SES Meliti: 1 Unit, installed capacity: 330 MW
- SES Amynteon: 2 Units, installed capacity: 2x300 MW
- SES Kardia: 4 Units, installed capacity: 4x300 MW
- SES Ptolemais: 3 Units, installed capacity: 2x125 MW and 300 MW
- SES Agios Dimitrios: 5 Units, installed capacity: 2x300 MW, 2x310 MW and 375 MW

CO_2 Storage in Prinos Basin

CO2 Transportation – Case Study for Greece (2)



CO_2 Transportation – Case Study for Greece (3)

CO_2 Transportation cost as a function of investment economic lifetime

Scenario 1: Transportation with pipeline

Scenario 2: Transportation with ships and lorries

Scenario 3: Transportation with ships and pipeline