roac ccs

Joint CO₂GeoNet - EERA Research Workshop Venice, 13 May 2015

Rotterdam Opslag en Opvang Demonstratieproject (ROAD) Project Update and Lessons Learnt

Onno Tillema, Project Director ROAD









Agenda

- Introduction to ROAD
- Lessons Learnt:
 - Permitting Process
 - Capture Integration
 - Project Management and Funding
- ROAD: Stepping Stone for CO₂ Hub in Rotterdam and Europe



Agenda

Introduction to ROAD

- Lessons Learnt:
 - Permitting Process
 - Capture Integration
 - Project Management and Funding
- ROAD: Stepping Stone for CO₂ Hub in Rotterdam and Europe



Co-operating Partners ROAD

- Maasvlakte CCS Project C.V. is a joint venture of:
 - E.ON Benelux
 - GDF SUEZ Energie Nederland
- In co-operation with intended partners:
 - TAQA Energy
 - GDF SUEZ E&P
- With financial support of:
 - European Commission (EU)
 - Government of the Netherlands
 - Global CCS Institute
 - Private partners (discussions pending)









Co-financed by the European Union

European Energy Programme for Recovery



Government of the Netherlands





Integrated CCS Chain ROAD

Maasvlakte Power Plant 3				
	Capture Plant			
	Compression		P18-A	Platform
	Onshore Pipeline: 5kg	m Offshore	Pipeline: 20km	Ħ
				4 -25m
	Contraction of the local distance of the loc			
NOT ON SCALE			Depleted Gas Reservoir P18-4	-3,500m
			OHIOFTOPOPO	
			. O	0000



Capture Location: Maasvlakte Power Plant 3



- Output: 1,070 MWe
- Efficiency: 46%
- Operational: 2015 (currently in hot commissioning)
- Capture ready





CO₂ Capture Unit





CO₂ Transport





CO₂ Storage Location



- Depleted gas reservoir P18
- Operator: TAQA
- Depth: -3,500 m
- Storage capacity:
 - 35 Mt (P18)
 - 8 Mt (P18-4)
- Available: 2017
- Alternatives / future expansion options are in focus (i.a. EOR)



Agenda

• Introduction to ROAD



Project Management and Funding

• ROAD: Stepping Stone for CO₂ Hub in Rotterdam and Europe



Complexity and Dynamics of Permitting Process

- Dutch government structure comprising four layers of governments:
 - Local: municipalities
 - Regional: water authorities
 - Provincial: provinces
 - National: ministries and national advisors
- New environmental acts came into force during permitting process :
 - Decision on State Coordination Scheme Energy Infrastructure Projects (March 2009)
 - Act on Modernising Environmental Impact Assessment (July 2010)
 - Amendment of Mining Act as implementation of EU CCS Directive 2009/31/EC September 2011)
 - Act on General Conditions in Environmental Law (October 2010)
 - Decision on Environmental Impact Assessment (April 2011)

Dutch ministry of Economic Affairs was essential in coordinating permitting stakeholders



Permitting Framework ROAD: General

Legislative requirement	Law	Competent Authority	Applicant
Environmental Impact Assessment (EIA)	Environmental Protection Act	Ministry of Economic Affairs, Agriculture and Innovation and the Ministry of Infrastructure and Environment; Province of South-Holland (delegated to DCMR Environmental Protection Agency Rijnmond)	Proponent (ROAD)
Emission permits (for capture, transport and storage)	Environmental Protection Act	Dutch Emission Authority	Proponent



Permitting Framework ROAD: Capture

Legislative requirement	Law	Competent Authority	Applicant
All-in-one permit for physical aspects			
Environmental Permission	General Environmental	Province of South-Holland (delegated to DCMR	Proponent
Building Permission	Conditions Act	Environmental Protection Agency Rijnmond)	
Natural Protection Act Permit	Nature Protection Act 1998	Province of South-Holland	Proponent
Water Permit	Water Act	Ministry of Infrastructure and Environment (delegated to the State Water Authority, Department South-Holland)	Proponent



Permitting Framework ROAD: Transport

Legislative requirement	Law	Competent Authority	Applicant
State Zoning Plan	Spatial Planning Act	Ministry of Economic Affairs, Agriculture and Innovation and the Ministry of Infrastructure and Environment	Ministry of Economic Affairs, Agriculture and Innovation and the Ministry of Infrastructure and Environment
Environmental Impact Assessment	Environmental Protection Act	Ministry of Economic Affairs, Agriculture and Innovation and the Ministry of Infrastructure and Environment	Ministry of Economic Affairs, Agriculture and Innovation and the Ministry of Infrastructure and Environment / Proponent
Water Permit	Water Act	Ministry of Infrastructure and Environment (delegated to the State Water Authority, Department South-Holland)	Proponent
Railway Permit	Railway Act	ProRail	Proponent
Flora and Fauna Act Exemption	Flora and Fauna Act	Ministry of Economic Affairs, Agriculture and Innovation	Proponent

Page 14



Permitting Framework ROAD: Storage

Legislative requirement	Law	Competent Authority	Applicant
All-in-one permit for physical aspects	General Environmental Conditions Act	Ministry of Economic Affairs, Agriculture and Innovation	TAQA
Storage Permit	Mining Act	Ministry of Economic Affairs, Agriculture and Innovation	TAQA





Environmental Impact Assessment (EIA)



ROAD submitted final version of EIA Notification in September 2010



Permitting Process Timeline

- September 2010 : Starting note Environmental Impact Assessment published
- June 2011 : Submitting Environmental Impact Assessment and publication of all permit applications
- May 2012 : Capture permits definitive and irrevocable
- September 2013 : Storage permits definitive and irrevocable
- May 2015 : Transport permits agreed, with publication ready



Lesson Learnt on Permitting Process ROAD

- 1. Alignment of permitting authorities: Dutch ministry of Economic Affairs was essential in coordinating permitting stakeholders and showing national relevance of project via State Coordination Scheme
- 2. Education and building trust of stakeholders: permitting authorities not only want to be informed on procedures, but also want to be educated on technical details of the project, as early as possible
- 3. Commitment of permitting authorities: contact persons at permitting authorities have to be well-connected and committed to project. Lack of sufficient resources (e.g. time, knowledge) can severely delay project



Agenda

- Introduction to ROAD
- Lessons Learnt:
- Permitting Process
 Capture Integration
 Project Management and Funding
 - ROAD: Stepping Stone for CO₂ Hub in Rotterdam and Europe



Location of Capture Plant: Maasvlakte Power Plant 3





Interactions Between Power Plant and Capture Plant





Key Interfaces

- Flue gas
- Steam and condensate
- Electrical power
- Cooling water





Flexibility of Capture Plant and Control Philosophy

• In highly competitive power market controlled shut-down and return to service of capture plant on hourly basis is necessary

Operation modes of capture plant:

- Start-up capture plant with MPP3 already in operation at any load*
- Ramping up and down capture plant and MPP3 in parallel at the same ramp rate*
- Ramping up and down capture plant and MPP3 in parallel at different ramp rates
- Ramping up and down the capture plant leaving MPP3 in stable operation at any load
- Stable operation capture plant with MPP3 ramping up and down*

* Expected to be used mostly. Capture plant shall be optimized for these modes, without restricting operation in other modes mentioned



Lessons Learnt on Capture Integration

- 1. Way ROAD project is funded, with substantial capital grants, but a low reward for operation, created a strong incentive to minimise capital costs, with a much lower focus on reliability
- 2. Focus on minimizing capital costs had a high impact on some major design choices. Capture plant is single train (including a single compressor). For interfaces with MPP3, capacity margins in MPP3 design are used for capture plant where possible
- 3. Because of relatively small capture plant size, capture plant could make use of MPP3's electric auxiliary system, MPP3's cooling water system, extraction of steam from existing steam cycle of MPP3
- 4. Engineering capture plant together with power plant would have led to other solutions with lower CAPEX, e.g. more optimal lay-out and combining utility system



Agenda

- Introduction to ROAD
- Lessons Learnt:
 - Permitting Process
 - Capture Integration
- Project Management and Funding
- ROAD: Stepping Stone for CO₂ Hub in Rotterdam and Europe



Project Management





Project Schedules and Impact of Delays

- Phase 1 (2009 and 2010): target FID by end 2010
- Phase 2 (2011 and Q1 2012): target to finish construction by end 2014 (FID by implication end 2011 or early 2012), again driven by an EC grant timetable (subsequently relaxed)
- Phase 3 (Q2 2012 onwards): "slow mode". Since Q2 2012, the project has focused on only work that would avoid significant cost escalation, or improve funding



Funding and Commercial Issues

- CAPEX cost estimate has risen because of:
 - Inflation, as construction is delayed at least 3 years
 - \circ Some design modifications add cost (principally provision for a wet ESP for emissions control and a tie-in for future CO₂ network in Rotterdam)
 - Cost of demobilization and remobilization
 - Cost of maintaining project team during "slow mode"
- OPEX cost estimate has reduced because:
 - Forecast electricity prices are lower. ROAD uses about 1 MWh of electricity for every 3 tonnes of carbon captured, making electricity costs of order half total OPEX
 - Minimum amount of CO₂ stored has been reduced to 4 Mt, with possibilities under discussion to lower it further. Intent is that a later separate funding scheme will pay for longer term operation. It is not intent to build plant and then decommission it after 4 years operation
- Forecast carbon prices have reduced substantially





ROAD remains ready to start construction as soon as the funding gap has been closed



Agenda

- Introduction to ROAD
- Lessons Learnt:
 - Permitting Process
 - Capture Integration
 - Project Management

ROAD: Stepping Stone for CO₂ Hub in Rotterdam and Europe



Rotterdam Vision: CO₂ Hub of Northwest Europe





Rotterdam CO₂ Hub - Existing OCAP* System

OCAP System:

- Supplies 400 kt CO_2 to ≈ 600 greenhouses
- Shell Pernis CO₂ is from natural gasbased hydrogen production facility
- Abengoa is a first generation bioethanol plant
- OCAP claims CO₂ emission reduction of ≈200 kt/year through avoidance of natural gas use in the greenhouses
- There is additional CO₂ demand OCAP can't meet







ROAD as Stepping Stone for CCS in Europe

ROAD is one of best positioned CCS demonstration project in EU ready to be implemented:

- Efficient, new generation power plant (capture ready)
- Port and industrial area of Rotterdam (local support)
- Proximity of source to sink (25 km)
- Offshore storage (available storage capacity)
- National regulation and required permits completed
- Start of integrated CO₂ network in Rotterdam and NW Europe







Rotterdam CO₂ Hub: First Steps





The Proposed Link between ROAD and OCAP

- OCAP cannot expand due to lack of CO₂ in summer peak (usually a few days only)
- ROAD could supply OCAP with summer peak CO₂
- Expansion is desirable to reduce CO₂ emissions by greenhouses
 - Estimate of greater than 200kt/yr further reduction achievable (with heat pipe to be confirmed)
- In winter CO₂ from Shell and Abengoa (bio-CCS) could be sent for geological storage by ROAD





Rotterdam CO₂ Hub: Vision 2030





Rotterdam Vision: CO₂ Hub of Northwest Europe



- Europe will need CCS to meet climate targets
 - Not only in power, but essential in industry
- CO₂ hubs will strengthen sustainable economic growth at lower costs
- Rotterdam is ideal place in North-west Europe: "Gateway to 350 mln. customers"
- ROAD is the next step



ROAD | Maasvlakte CCS Project C.V.

Visit Parallelweg 1 3112 NA Schiedam The Netherlands

Contact

- T: +31 (0)10 75 34 000
- F: +31 (0)10 75 34 040
- E: info@road2020.nl
- W: www.road2020.nl











European Energy Programme for Recovery

Post P.O. Box 133 3100 AC Schiedam The Netherlands