12th EC-EURACOAL Coal Dialogue - on the future of coal after COP21
Brussels, 10 June 2016

Rotterdam Storage & Capture Demonstratie Project (ROAD)
Stepping Stone for CCS in Europe

Hans Schoenmakers, Project Director ROAD
Agenda

- Specific COP21 Challenges
- Need & Necessity of CCS in Europe
- State of Play ROAD
- ROAD: Stepping Stone for Sustainable Transition in Rotterdam en Europe
Specific COP21 Challenges

• Coal under severe political pressure in Europe
  • UK
  • Germany
  • Netherlands
• 1,5 °C scenario requires negative carbon emissions by energy sector
Ongoing Coal Debate in The Netherlands (1)

- Dutch Energy Agreement of 2013 - closure of 5 “old” coal units in return for abolition of the coal-tax - 5 units remain
- Urgenda Case, June 2015 - A civil court ruled that Dutch CO₂ emissions should (must) be reduced by 25% by 2020:
  - Resulting campaign from NGOs for complete closure of all coal plant
- Dutch Parliament motion requires the Government to develop plans to phase out the coal plants:
  - Government will report back in Autumn 2016 with a proposal
  - No date is in the motion, but 2020 and 2025 discussed
  - Neither the Minister nor Prime Minister support the early closure of all coal units, but a majority in the current parliament supports it
  - Now matter of much argument over costs and benefits
- The Government will also appeal against the Urgenda ruling
Ongoing Coal Debate in The Netherlands (2)

• Biomass co-firing is also contentious:
  • Part of the 2013 Energy Accord but some politicians strongly oppose it
  • NL will miss it’s 2020 renewable targets without it

• Problems with earth tremours in Groningen (north Netherlands) associated with natural gas production mean:
  • Restrictions on existing on-shore Dutch gas production
  • Tight regulation of new production permits
  • Concern over dependency on imports, and a desire to reduce natural gas demand

• Government is looking at other low carbon options - including district heating and reducing CO₂ emissions from greenhouses
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Need and Necessity of CCS

CCS contributes to 3 strategic objectives of energy policy

- Costs of climate policy 40-70% higher without CCS
- CCS realizes large-scale reductions of CO₂ emissions in both power sector and (heavy) industry
- CCS strengthens security of supply (e.g. diversification of fuel mix)
Need for Carbon Negative Emissions
Bio-Energy combined with CCS (BECCS) allows for negative carbon emissions

Carbon balance of energy from different systems

- Carbon positive: energy from fossil fuels
  - Emissions (grams CO₂/kWh): +350 to +850
- Less carbon positive: fossil fuels with carbon capture and storage
  - Emissions: +50 to +150
- Almost carbon neutral: solar, wind, nuclear, tidal, geothermal,...
  - Emissions: +10 to +100
- Carbon negative: bio-energy with carbon capture and storage
  - Emissions: up to -800
EU CCS Demonstration Projects

ROAD is one of last EEPR projects

- **Don Valley** (UK)
  - Pre combustion
  - Offshore
  - Gas reservoir

- **Rotterdam**
  - Post combustion
  - Offshore
  - Gas reservoir

- **Belchatów** (Poland)
  - Post combustion
  - Onshore
  - Saline aquifers

- **Jänschwalde** (Germany)
  - Oxy fuel / post combustion
  - Onshore

- **Compostilla** (Spain)
  - Oxyfuel CFB
  - Onshore
  - Saline aquifers

- **Porto Tolle** (Italy)
  - Post-combustion
  - Offshore
  - Saline aquifers

**SELECTED PROJECTS**

CO₂ CAPTURE AND STORAGE
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Co-operating Partners ROAD

- **Maasvlakte CCS Project C.V.** is a joint venture of:
  - Uniper
  - ENGIE
- In **co-operation** with intended partners:
  - Oranje-Nassau Energie
  - Port of Rotterdam
- With **financial support of**:
  - European Commission (EU)
  - Government of the Netherlands
  - Global CCS Institute
Timeline and Milestones

14 Jul 2009: Project proposal submitted for EEPR grant at European Commission
September 2009: Project selected by EC
May 2010: Dutch Government grant decision published
EEPR grant agreement signed (covers period 2010-2014)
September 2010: FEED studies for capture plant completed
Start notice published for EIA for project
June 2011: Start IEA and permitting procedure
May 2012: Capture permit definitive and irrevocable
September 2013: Storage permit definitive and irrevocable
2015: New project set-up
2016: Final Investment Decision
2019: CCS chain operational
2019-2022: Demonstration phase CCS chain
2022 -...: Further roll-out of CCS
**Status Quo ROAD**

### Engineering
- Detail engineering of capture plant underway
- Some long lead suppliers chosen and components engineered
- Pipeline route engineered and ‘flow assurance’ study completed
- ‘Tie-ins’ (i.a. flue gas, steam) with power plant installed
- Storage design complete, detail FEED ready to start

### Permits
- Permitting procedures finalized (beginning 2012)
- Capture permits are definitive and irrevocable
- Storage permits are definitive and irrevocable (TAQA) - Sept 2013
- Transport permits agreed, with publication imminent

### Contracts
- Capture supplier selected and EPC contract was ready to be signed
- Contracts with power plant (utilities etc) ready for signature
- Commercial contracts for transport (GDF Suez) and storage (TAQA) are agreed textually, and will be signed at FID
- But, price validity has expired - reconfirmation once funding gap is closed

### Finance
- Very low CO₂ prices have caused a financing gap compared to plan (>$100M)
- Delay in CCS role-out and loss of confidence in EU low carbon energy policy has also weakened the strategic case for the demo
- In the ‘slow mode’ period, ROAD has been investigating alternative funding sources, improving project economics and phased project approach

Main challenge: Building a business case
Overview P18-4 en Q16-Maas
Locations of ROAD / ONE / Q16-Maas
Storage
Gas reservoir Q16-Maas
Operator: Oranje-Nassau Energie
Depth: -3.000 m
Storage capacity: 2-4 Mt
Available: 2019
Current Discussions with EC and Government NL

- Permitting regime for storage location
- Solutions has to/will be found under harsh political conditions
Next Steps ROAD (Short Term)

- Remobilisation of project team depends on “in principal” agreement over new project set-up with all funders and partners:
  - Shareholders ROAD: Uniper and Engie ✓
  - Port of Rotterdam ✓
  - Government of the Netherlands ✓
  - Oranje-Nassau Energie ✓
  - European Commission ✓

- Final Investment Decision (FID) depends on:
  - Final permit for MPP3 ✓
  - Agreement on operation funding (in principle) ✓
  - Some certainty on the future lifetime of MPP3
  - State aid clearance
  - Re-engineered costs within budget
  - Clarity on (new) storage permit
Planning ROAD (Long Term)

- **2015**: Finalise Feasibility Study
- **2016**: Remobilise ROAD Project Team
- **2017**: Final Investment Decision (FID)
- **2018**: Finalise Finance CAPEX + OPEX
- **2019**: Environmental Impact Assessment (EIA) / Permit Application Procedure
- **2020**: Grant Application Horizon 2020/ERA-NET
- **2021**: Construction Phase
- **2022**: Demonstration Phase
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Rotterdam Vision:
CO$_2$ Hub of Northwest Europe

- Industrial area with many large-scale CO$_2$ point sources
- Depleted offshore gas fields available next coming years
- CO$_2$ pipelines
- CO$_2$ barges
Many Large-scale CO₂ Point Sources
Rotterdam CO₂ Hub: First Steps

Current Situation: CO₂ Supply to Greenhouses

Next Step: ROAD Project
Rotterdam CO₂ Hub: Vision 2030

Expanding CO₂ supply to greenhouses

Connection (pipeline/barges) with Antwerp and Ruhr area

- Power plants
- Industrial gases
- Refineries
- Chemicals and biofuels

40 km
Synergy between CO₂ Hub and Heat Roundabout

- Heat supply (from Rotterdam port and industrial complex and geothermal) to greenhouses and urban areas
- Important contribution to security of supply, CO₂ emission reductions, local air quality and regional economy
- Combination of CO₂ and heat supply essential for sustainable development of greenhouses
- Heat supply to greenhouses saves 450 mln. m³/yr on natural gas
- Substantial positive effects on local NOx deposits
**CO$_2$ emissions MPP3 (stand alone)**

**Coal**
for 7,000 operating hours

- **+5,500,000**
  - ton CO$_2$ per year
  - $\approx$ 700 gram CO$_2$ per kWh

**Overall efficiency >47%**

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**CO$_2$ emissions Energy Hub West**

- **CCS**
  - Carbon Capture & Storage
  - Joint venture with ENGIE

- **Biomass**
  - Co-firing: 1 million t/yr

- **Heat Supply**
  - Greenhouses, district heating, industry (co-siting)

- **CO$_2$ Supply**
  - Greenhouses, industry

**Energy penalty**

- **Net CO$_2$ reduction**
  - 3,000,000 ton per year
  - $-50\%$

- **+2,500,000**
  - ton CO$_2$ per year
  - $\approx$ 250 gram CO$_2$ per kWh

(e.g. modern gas-fired power plant 330 gram CO$_2$ per kWh)

**Overall efficiency >65%**

Getallen bij benadering
Full Decarbonization of Coal-fired Power Plant
Combination of Low Carbon Energy Technologies allows for negative emissions

- Old Coal (2010 - 100%)
- Modern Coal (2020 - 80%)
- Modern Coal + 20% Efficiency (2020 - 60%)
- Modern Coal + 20% Efficiency + 25% CCS Demo (2020 - 40%)
- Modern Coal + 20% Efficiency + 25% CCS Demo + 25% Co-firing Biomass (2020 - 20%)
- Modern Coal + 20% Efficiency + 25% CCS Demo + 25% Co-firing Biomass + 25% Heat Supply (2030 - 0%)
- Modern Coal + 20% Efficiency + 25% CCS Demo + 25% Co-firing Biomass + 25% Heat Supply + 75% CCS (full-scale) (2030 - -75%)

CO₂ emissions

2010 2020 2030
Conclusion

- Coal is an indispensable part of fuel mix over next coming decades
- Application of CCS is conditio sine qua non
- There are several ways to reduce CO\textsubscript{2} emissions from coal-firing
ROAD | Maasvlakte CCS Project C.V.

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