ROAD Project Lessons Learnt

Platform Industriële Warmte, 23rd January 2018, Delft
Andy Read, ROAD Technical Director

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GLOBAL CCS INSTITUTE
Government of the Netherlands
Co-financed by the European Union
European Energy Programme for Recovery

Co-operating Partners ROAD

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

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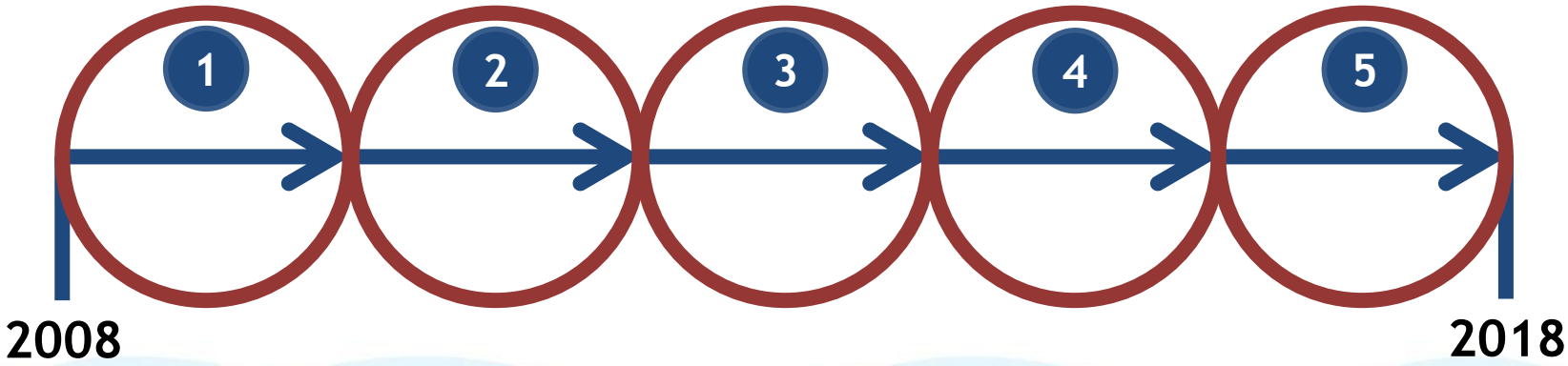
Long and Winding ROAD: 10 Years on CCS



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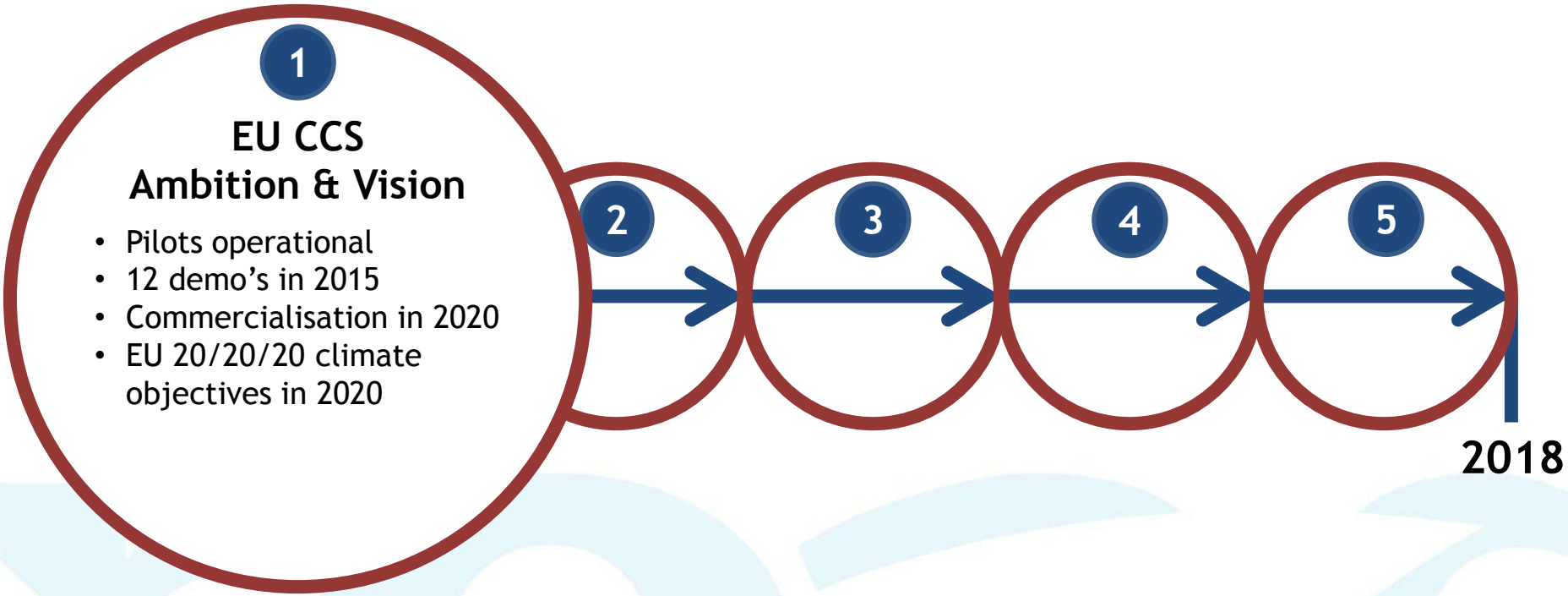

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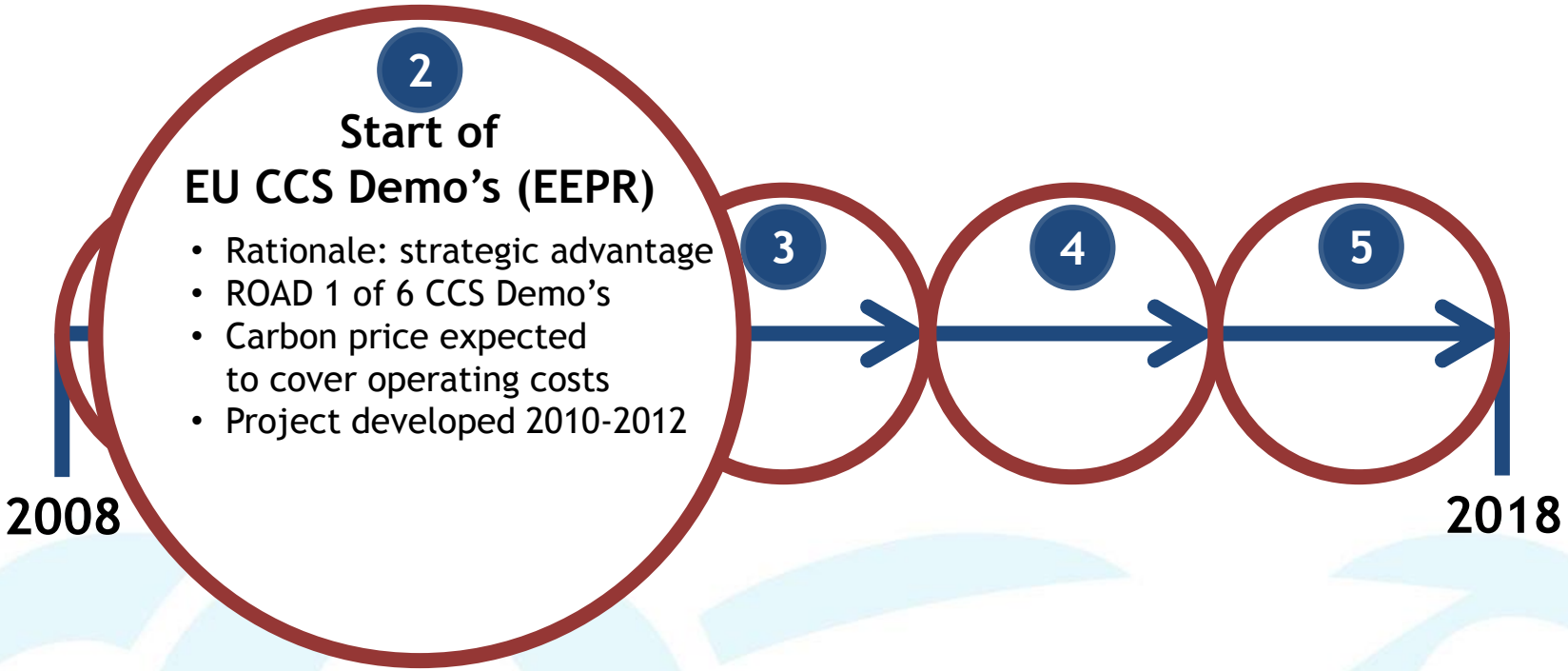

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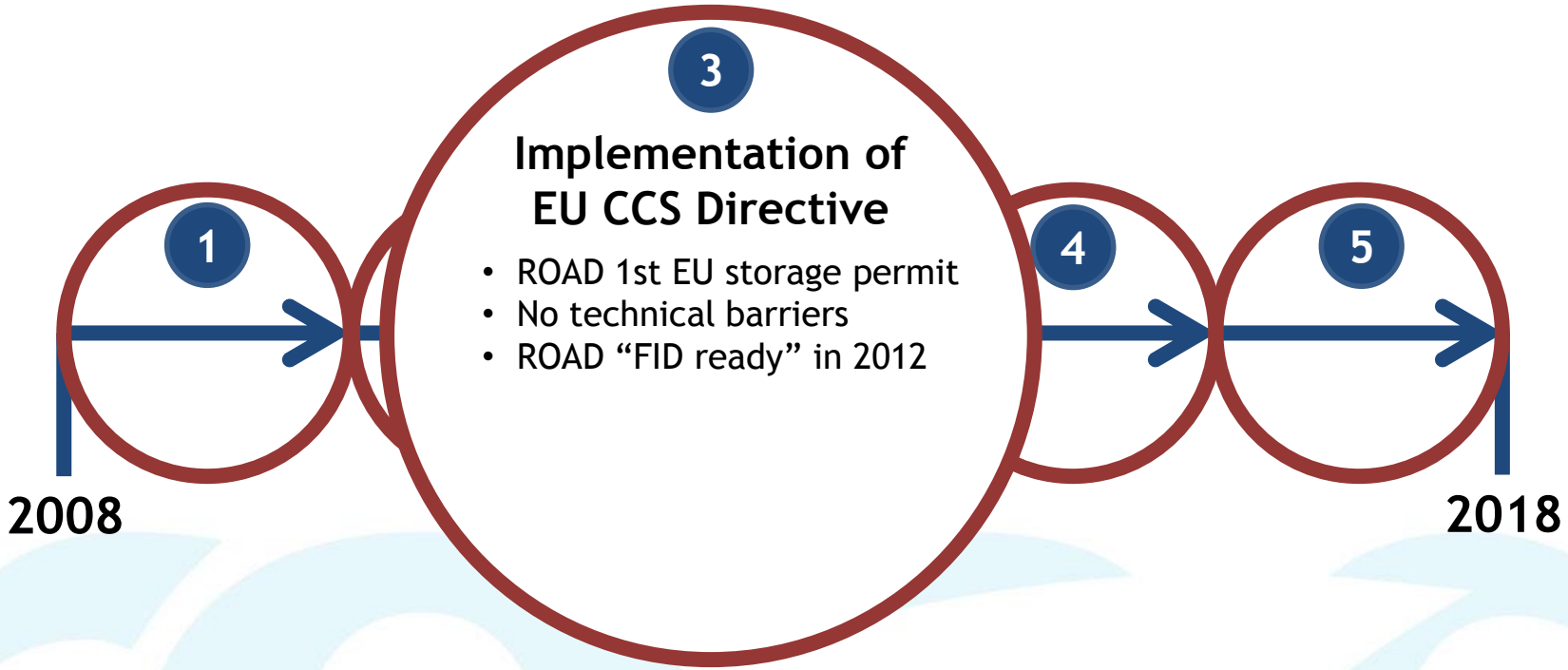

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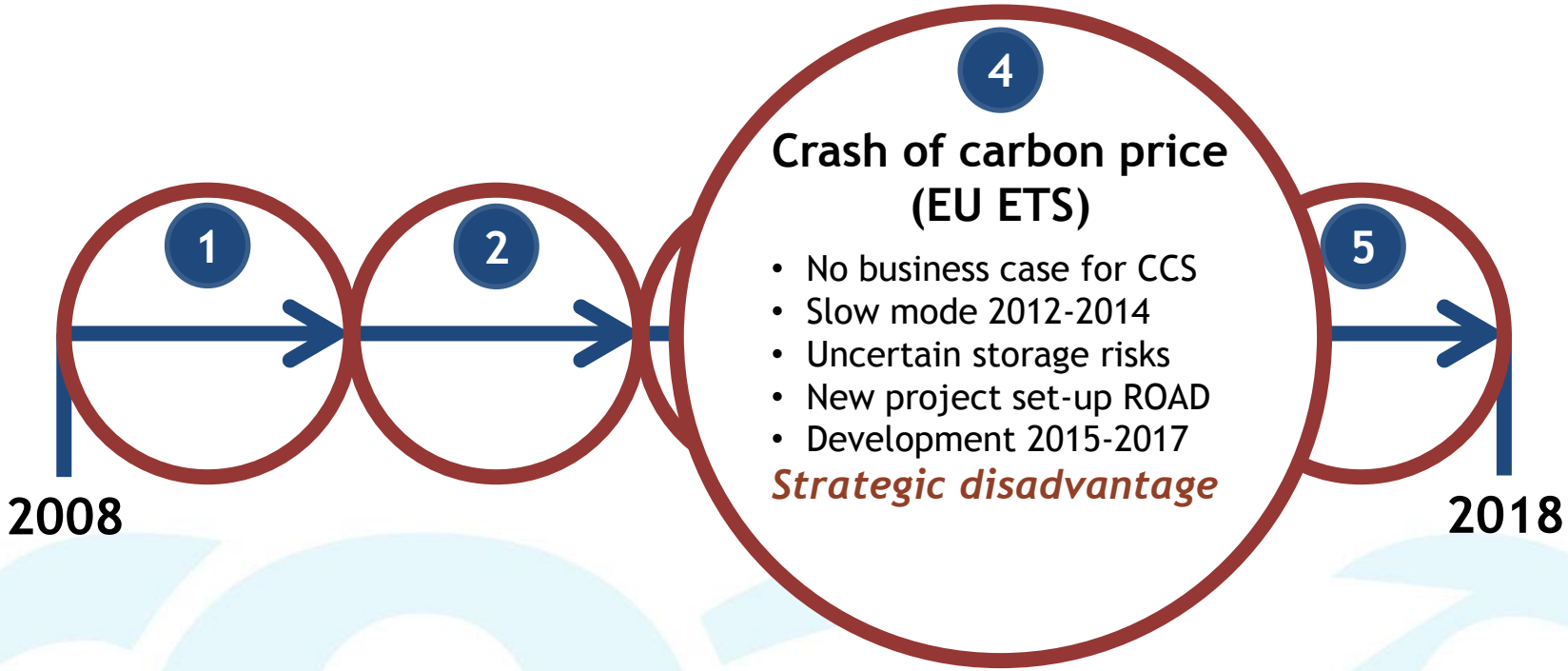

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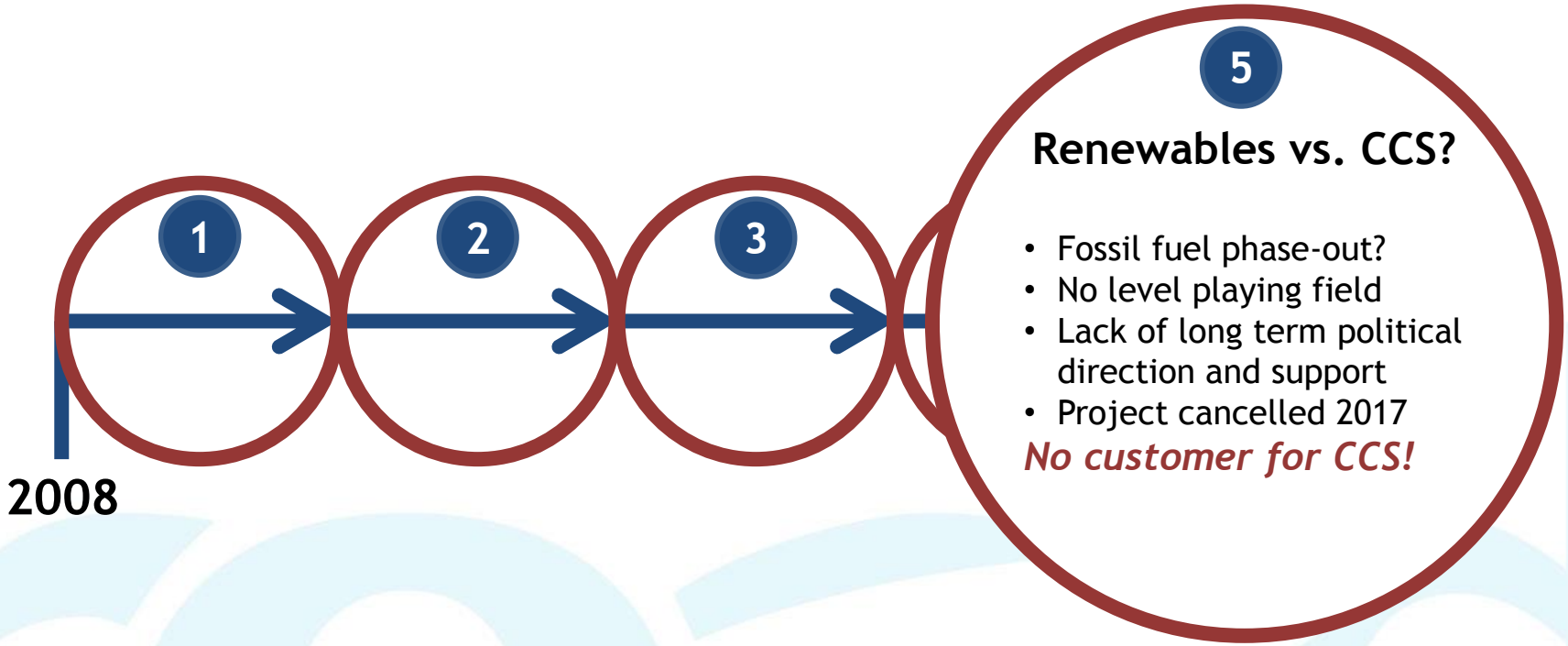
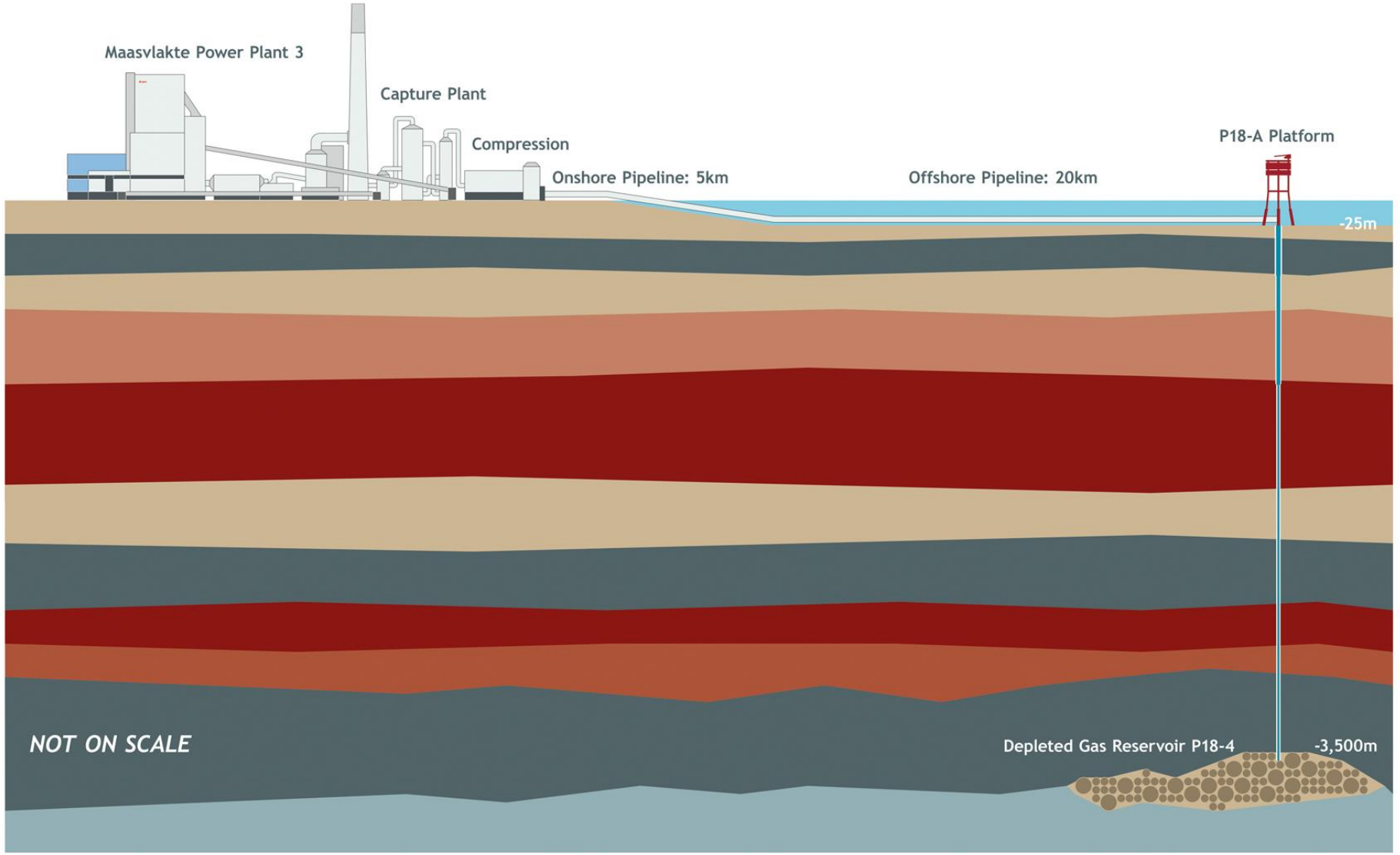


ROAD Project - Version 1 (2010-2014)



ROAD Project - Version 1 (2010-2014)

Power plant
Output: 1 070 MWe
Efficiency: 46%
Capture ready

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Power plant
Output: 1 070 MWe
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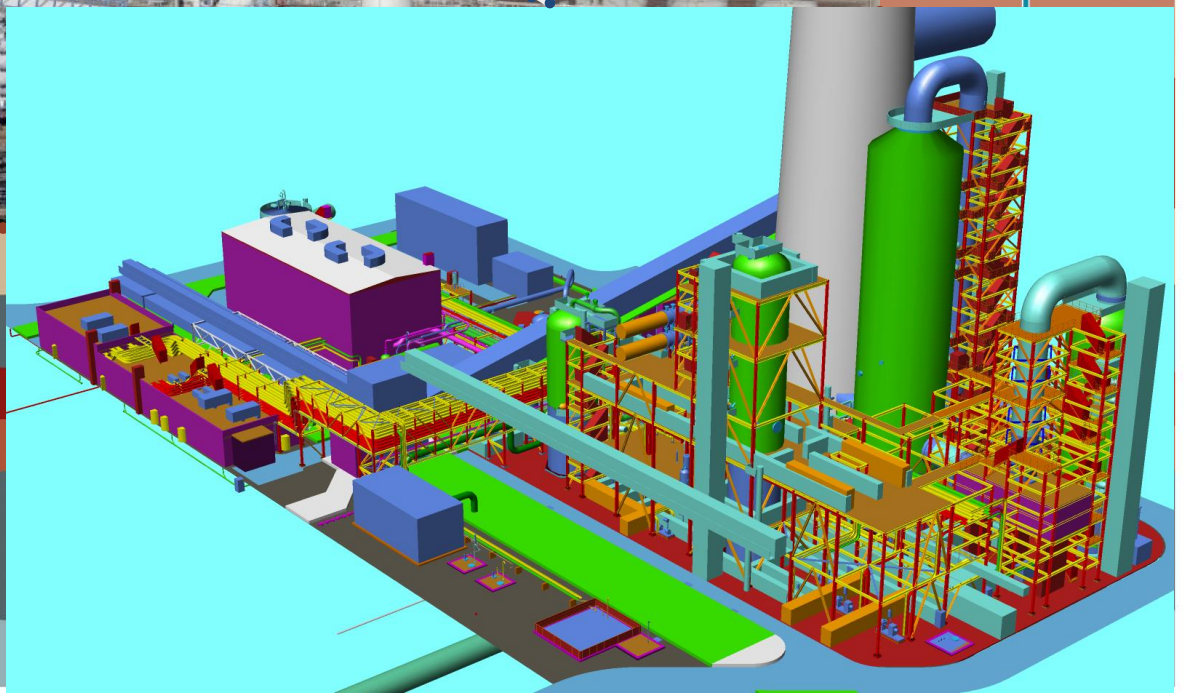
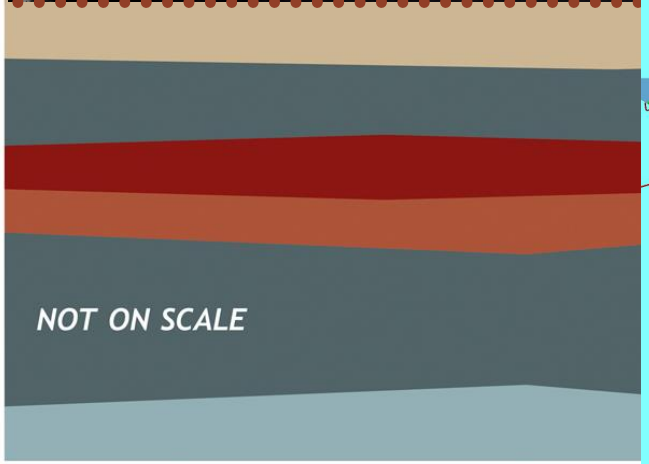
Capture Plant: Fluor

- Output: 169 t/h CO_2 on 250MW_e
- Capture Efficiency: 90%
- CO_2 purity >99.9%
- 22% reduction in power plant output (if full scale) due to steam and power use (includes compression).





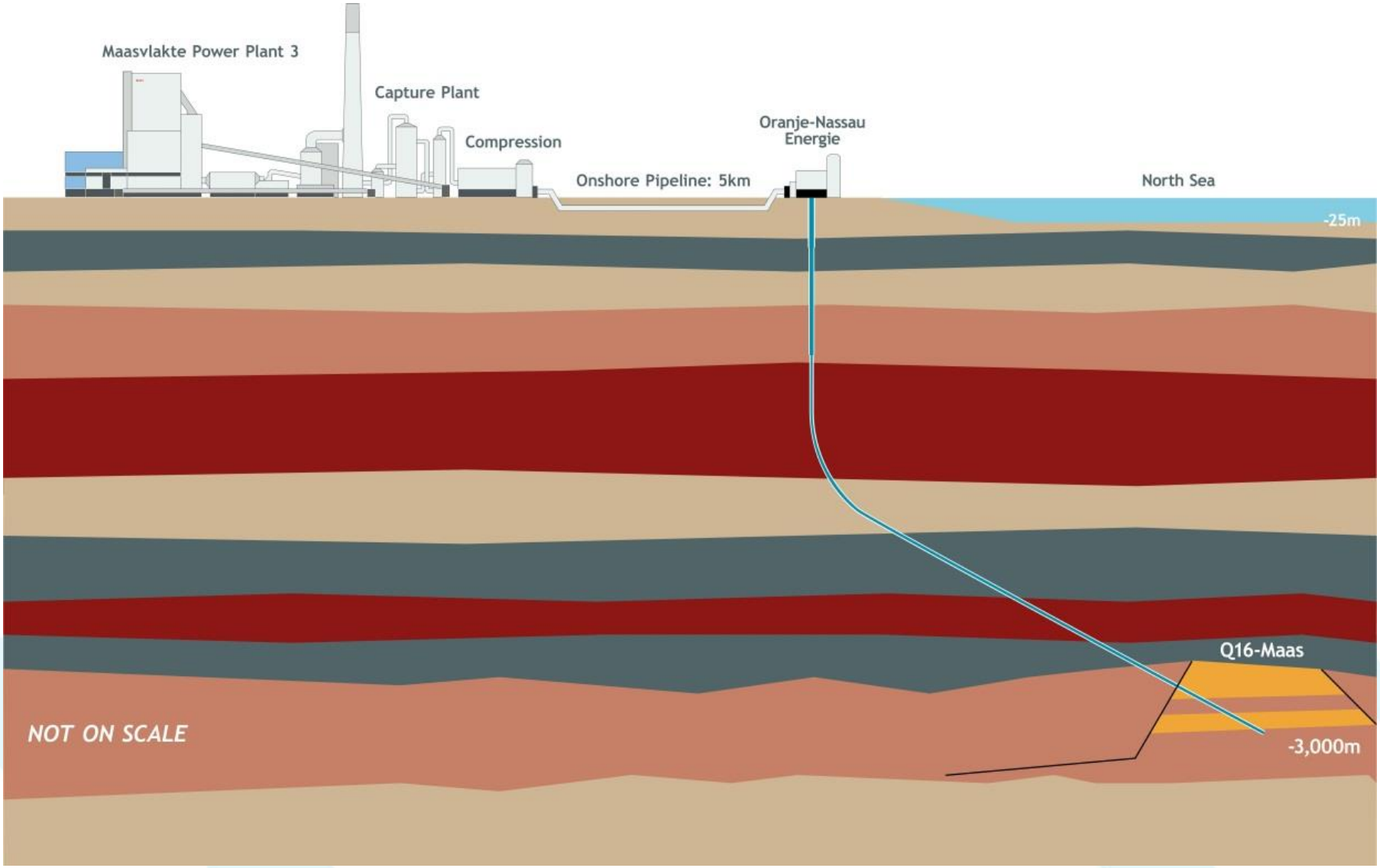
ROAD Project - Version 1 (2010-2014)

- Pipeline length:
  - 5 km onshore, 20 km offshore
- Diameter: 16 inch
- Transport capacity:
  - 5 Mt/yr (dense)
- Design specs:
  - 140 bar (max.)
  - 80 °C (max.)
- Pipeline insulated

ROAD Project - Version 1 (2010-2014)

- Depleted gas reservoir P18
- Operator: TAQA
- Depth: -3,500 m
- Storage capacity:
  - 35 Mt (P18)
  - 8 Mt (P18-4)
- Available: 2014
- Alternatives / future expansion options are in focus

ROAD Project - Version 2 (2015-2017)



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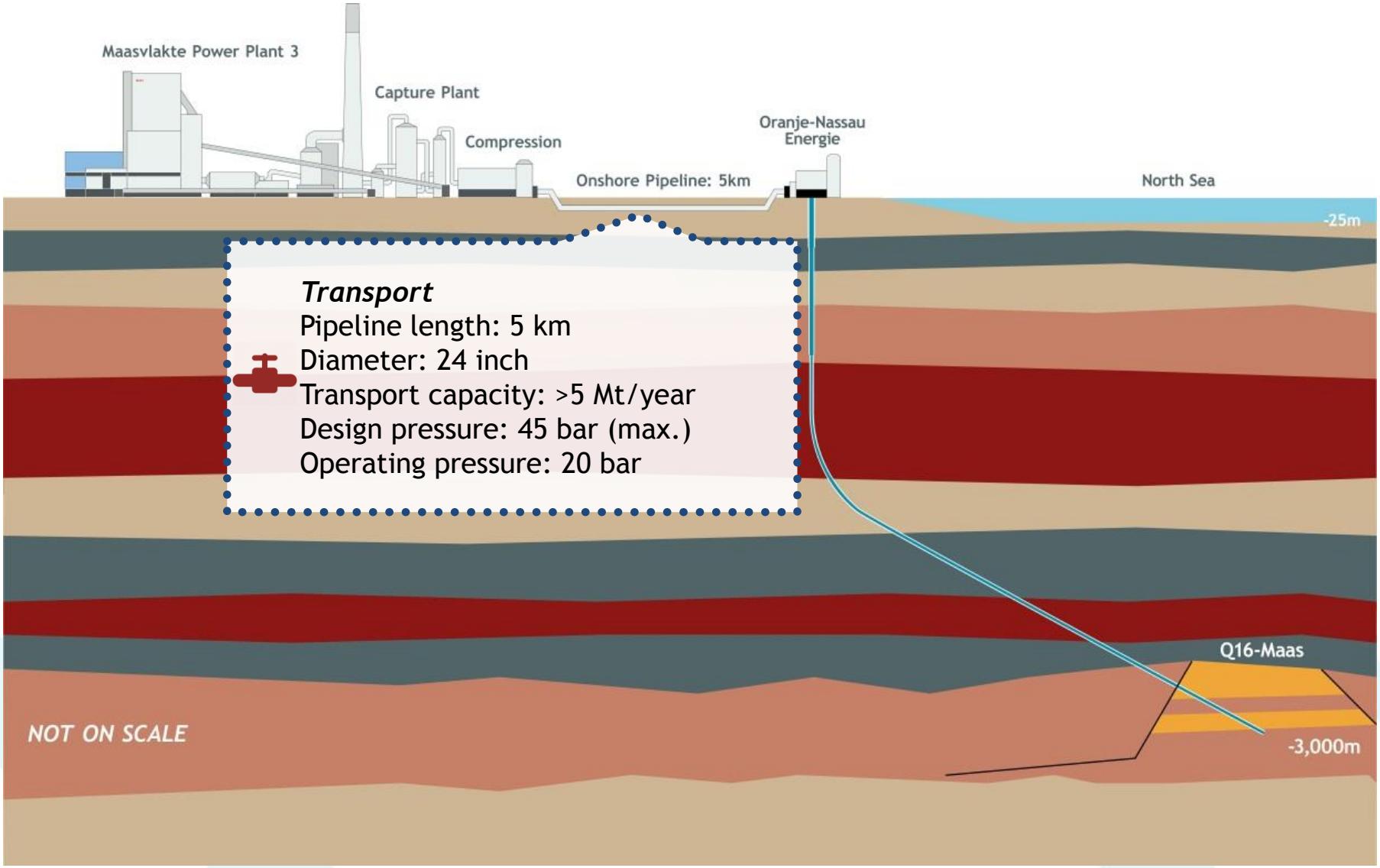

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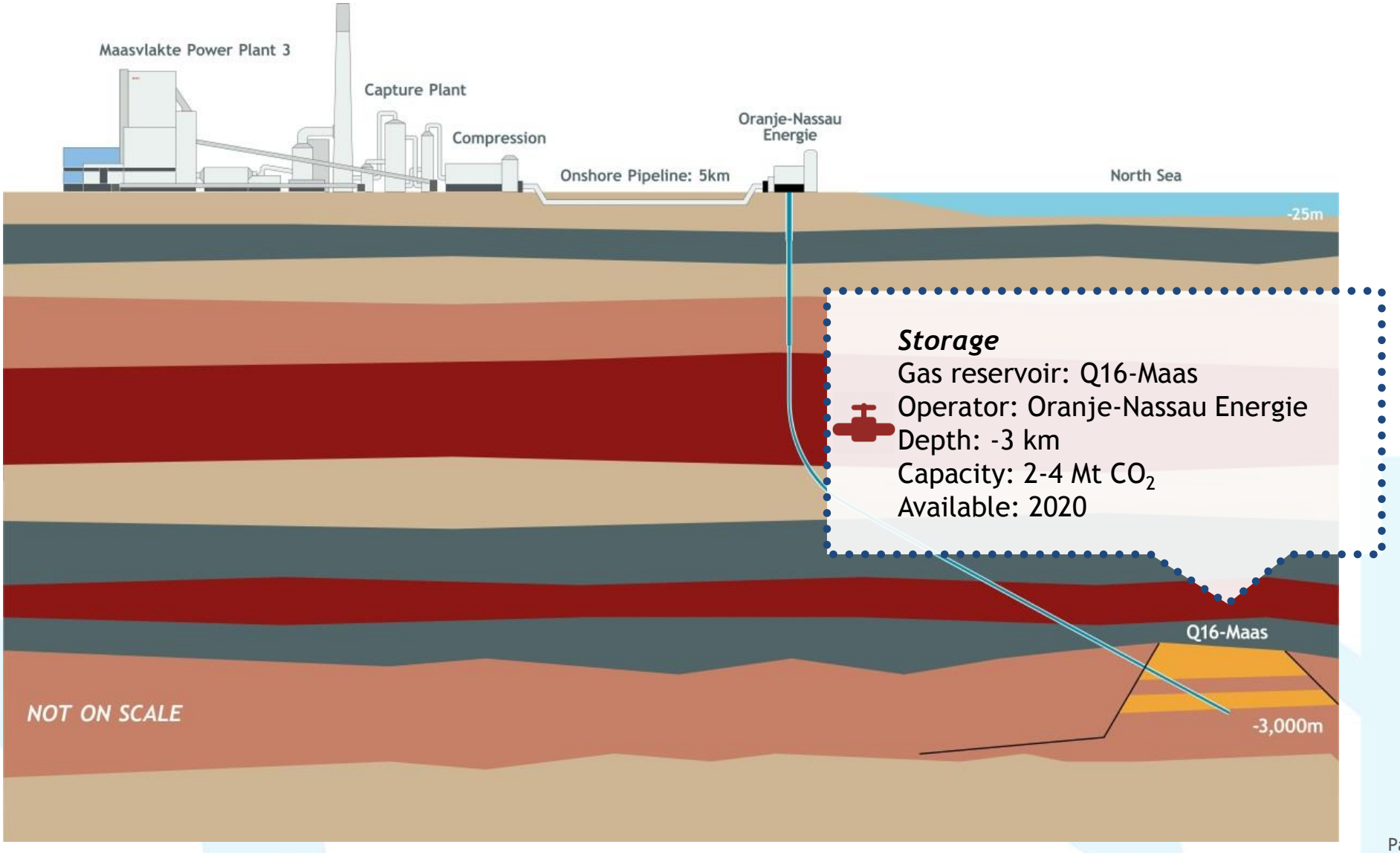
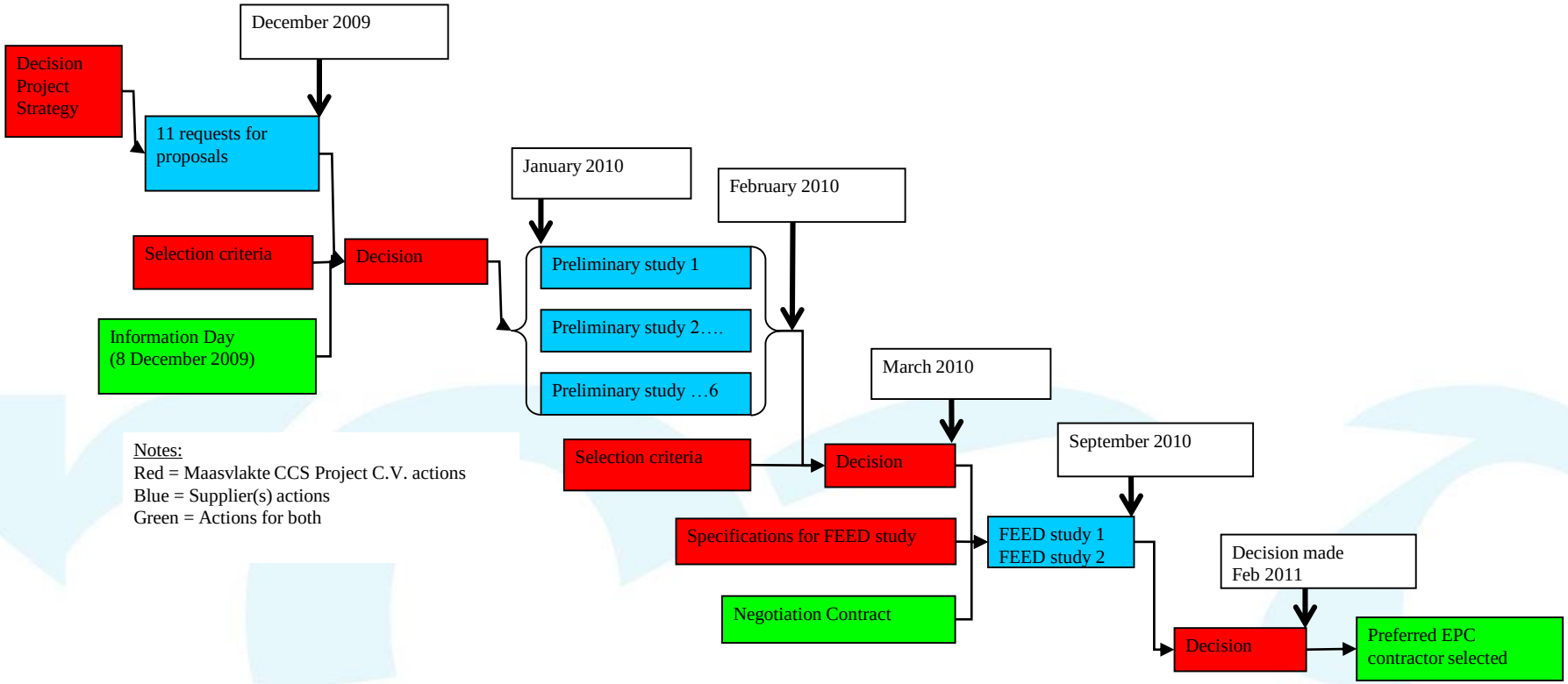


ROAD Project - Version 2 (2015-2017)

Highlights on Capture,

- Supplier selection process went very well
- Multiple suppliers available
- Was accepted by EC Auditors as demonstrating best value



Highlights on Capture

Capture

- "Proven" capture technology available on market:
  - Multiple suppliers offering robust designs
- But some technical unknowns due to limited experience:
  - Design of 2012 would have needed some modification:
    - Corrosion / degradation caused by leaching of coal ash
    - Aerosols in flue gas causing high solvent emissions
  - Solutions were found in pilot test campaigns and added to 2016 design, so it is wise to allow for some contingency and some 'teething' problems
  - ... but engineers can solve all the engineering problems
- **Conclusion: the technology is available and will work**

Highlights on Transport

Transport

- Some remaining technical uncertainties:
  - How to predict and manage two-phase flow behaviour (including transients)
  - QRA modelling for (onshore) CO_2 transport pipeline needs further development (e.g. “domino effect”)

- But the pipeline is largely conventional technology.

- **Conclusion: the technology is available and will work**

Highlights on Storage

Storage

- Some remaining technical uncertainties:
  - Transients and two-phase flow in the well
  - Tolerance of the well to repeated temperature changes
- But a safe design was developed.
- Major regulatory barrier: Storage Liabilities.
  - The costs of long term storage liabilities are largely controlled by regulators and/or Government, and are largely out of the control of the operator. These liabilities need to be carried by the Government.
  - Especially true for large-scale or long-term projects.

- **Conclusions:**
  - **The storage technology is available and will work,**
  - **But storage regulation is not (yet) fit for purpose.**

Why did ROAD fail?

- **Nobody was prepared to pay for it**

- Industrial partners do not have a business case:
  - Neither short-term nor long-term (CO_2 price doesn't work on its own)
  - Perception that "industry must contribute" was not shared by industry!

- Public funders did not have sufficient public and political support:
  - CCS perceived as extending life-time of coal plants
  - CCS "competes" with investments in renewables
  - CCS positioned as (optional) measure of 'last resort'

- **In summary: ROAD was a project without a customer**

Key lesson learnt

- Government **has to fund CCS**:
  - There is no other customer

- To succeed the projects must be designed and run to maximise long term Government support.

- Therefore do things which make it easy for the Government to support you, and hard for them to stop.

Personal recommendations for a new project

- Start small – if expensive, it's too tempting to cut the budget
- A "no regrets" first step:
  - No implied lock-in to follow-on projects – that scares people
  - But scalable – support the long term decarbonisation vision
- Select non-controversial capture and storage sites
  - e.g. waste incinerator (avoid fossil fuel if possible) and off-shore gas storage
- Create a local (public) value proposition and local supporters – e.g. supporting jobs, local industry, CO_2 use if possible (e.g. greenhouses)
- Avoid large profits for private parties (politically inexplicable)
  - Therefore Government / public bodies must carry long term risks (e.g. storage liabilities)
- Create / support an active pro-CCS political lobby
  - Publicly, proactively advocate the project and CCS in general

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