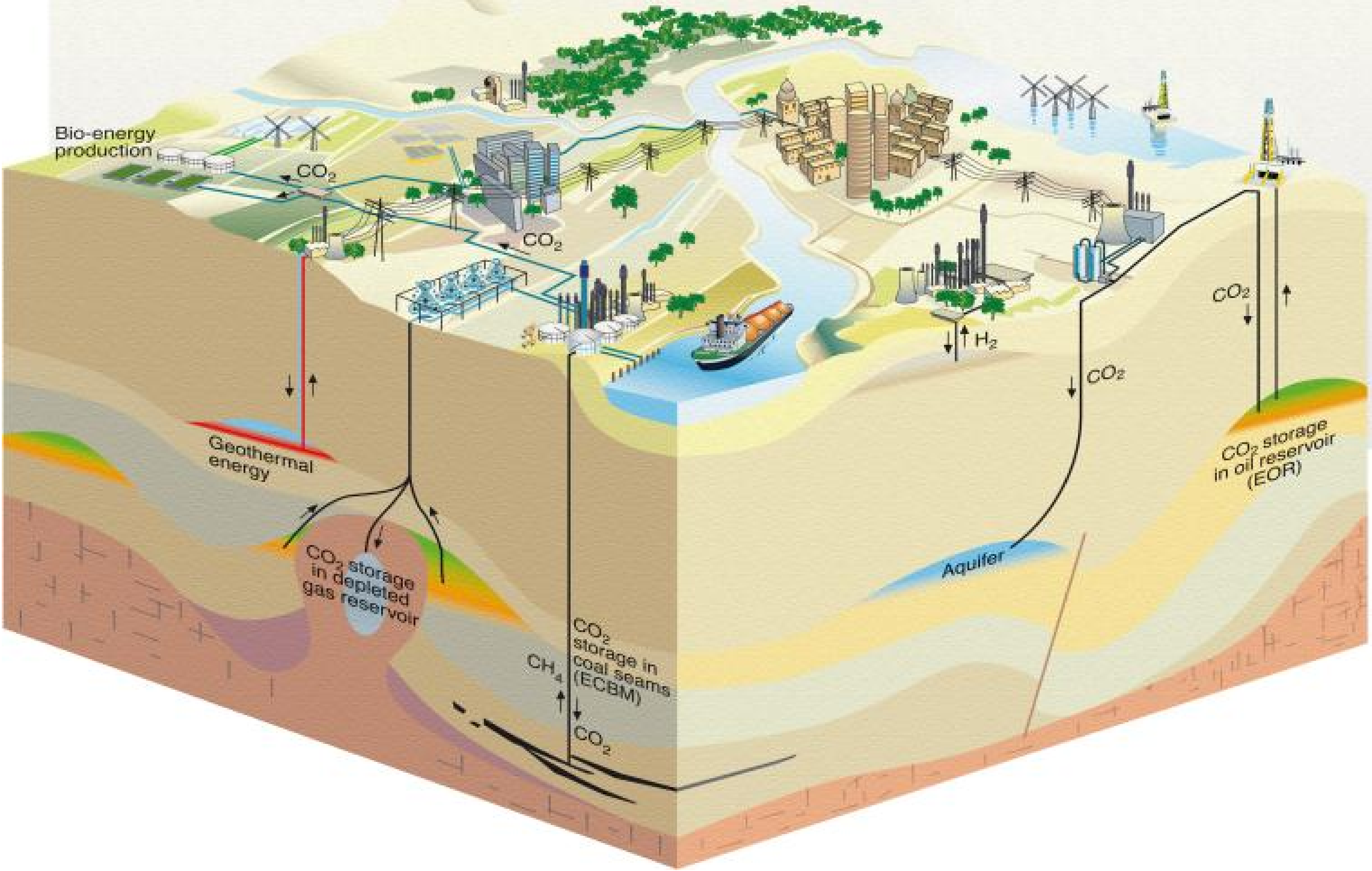



Infrastructure, transport and system aspects on CCS

Maurice Hanegraaf

TNO



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Content

- **Introduction TNO**
- Why CCUS in the Netherlands?
- Status of CCUS in the Netherlands
- Developing industrial CCS clusters: lessons learned from Rotterdam
- Conclusions

   

Questions / discussion:

1. What short-term actions are needed to achieve the long-term goals of deploying CCS (infrastructure)

2. What are the technical and economic challenges in the future deployment of CCS (infrastructure)

3. ~~What RD&D is needed in the short to medium term to support the development of different policy instruments that could help reduce future investment risk in deploying industrial CCS~~



TNO: Netherlands Organization for Applied Scientific Research

- Founded in 1932 by act of parliament (*TNO law*)
  - € 600 turn-over (1/4 direct government funding)
  - ~ 3.600 staff

- *Applied* R&D organization
  - technology development
  - contract R&D
  - non-routine consulting
  - special tasks (*Geological Survey of The Netherlands*)

- Independent, transparent, not-for-profit

- Focus on fundamental understanding & knowledge transfer




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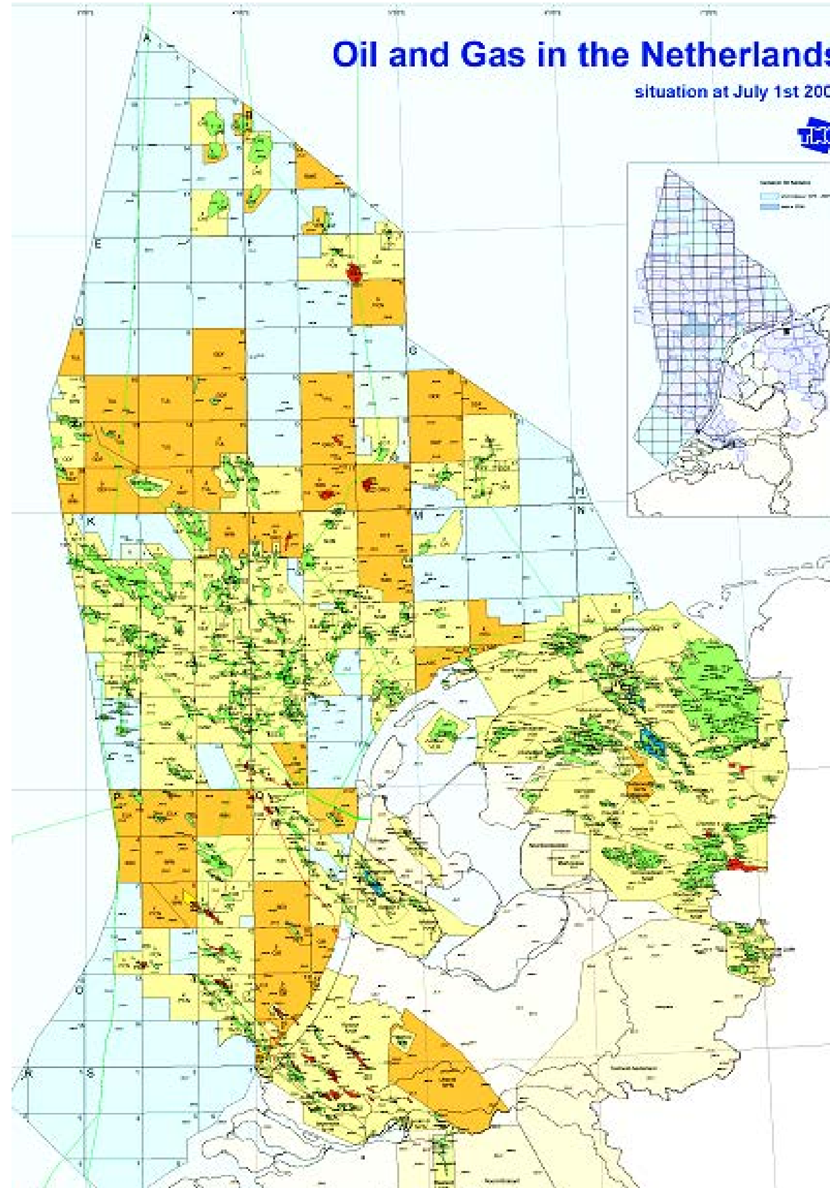
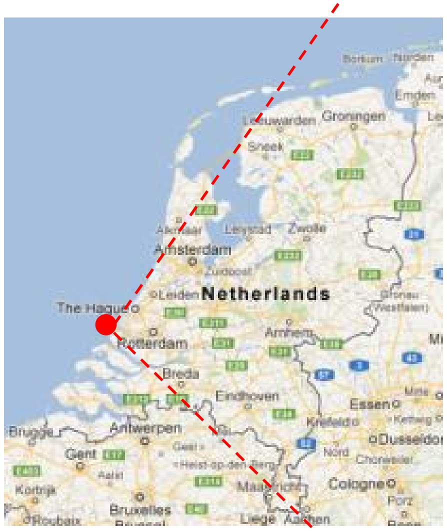
Why CCUS and the Netherlands:

- Availability (clustered) large CO_2 point sources (> 60 % CO_2emissions from industry and power sector)
- Large storage capacity
- Relatively short transport distances
- Extensive knowledge of oil & gas
- CATO R&D program since 2004 (€ 90M)
- Development of large scale demo project(s)
- Existing infrastructure



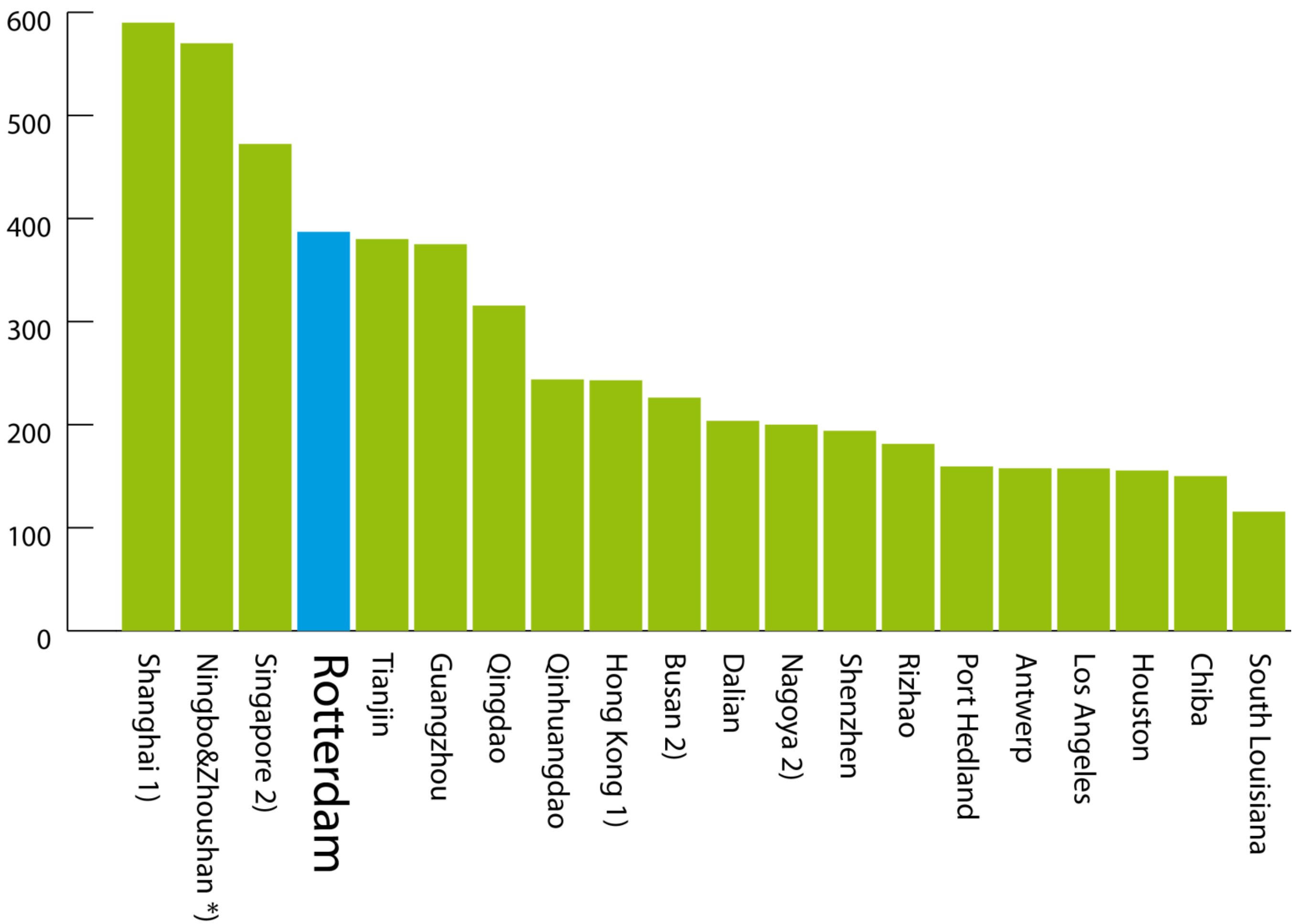
3 new coal power plants operational in 2015

- E.ON and GDF SUEZ constructing new coal fired power plants at Maasvlakte, Rotterdam, The Netherlands (1,100, 800 MW resp.).
- RWE is constructing a new 1800 MW coal fired power plant in Eemshaven





Rotterdam: 4th largest port in the world



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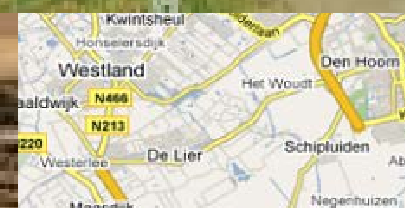
AMOCO P18/A-DP
AMOCO-P18/A-DP

P18-A
TAQA


ROAD
WORK
AHEAD


ROAD
CLOSED


Kwintsheul
Honselersdijk
Westland
Den Hoorn
Het Woudt
N466
N213
De Lier
Schipluiden
Maasdijk
Negenhuizen

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Introduction TNO

Why CCUS in the Netherlands?

Status of CCUS in the Netherlands

Developing industrial CCS clusters: lesons learned from Rotterdam

- Build on existing CCUS network → economy of scale?!
- Role of CO2 Utilisation
- Existing infrastructure and decline prodcution
- Role of EOR
- Pipeline vs ship transport
- R&D gaps infrastructure

Conclusions

Carbon Compact Rotterdam - CO_2 Network Capture, storage & utilisation

CO_2 sources

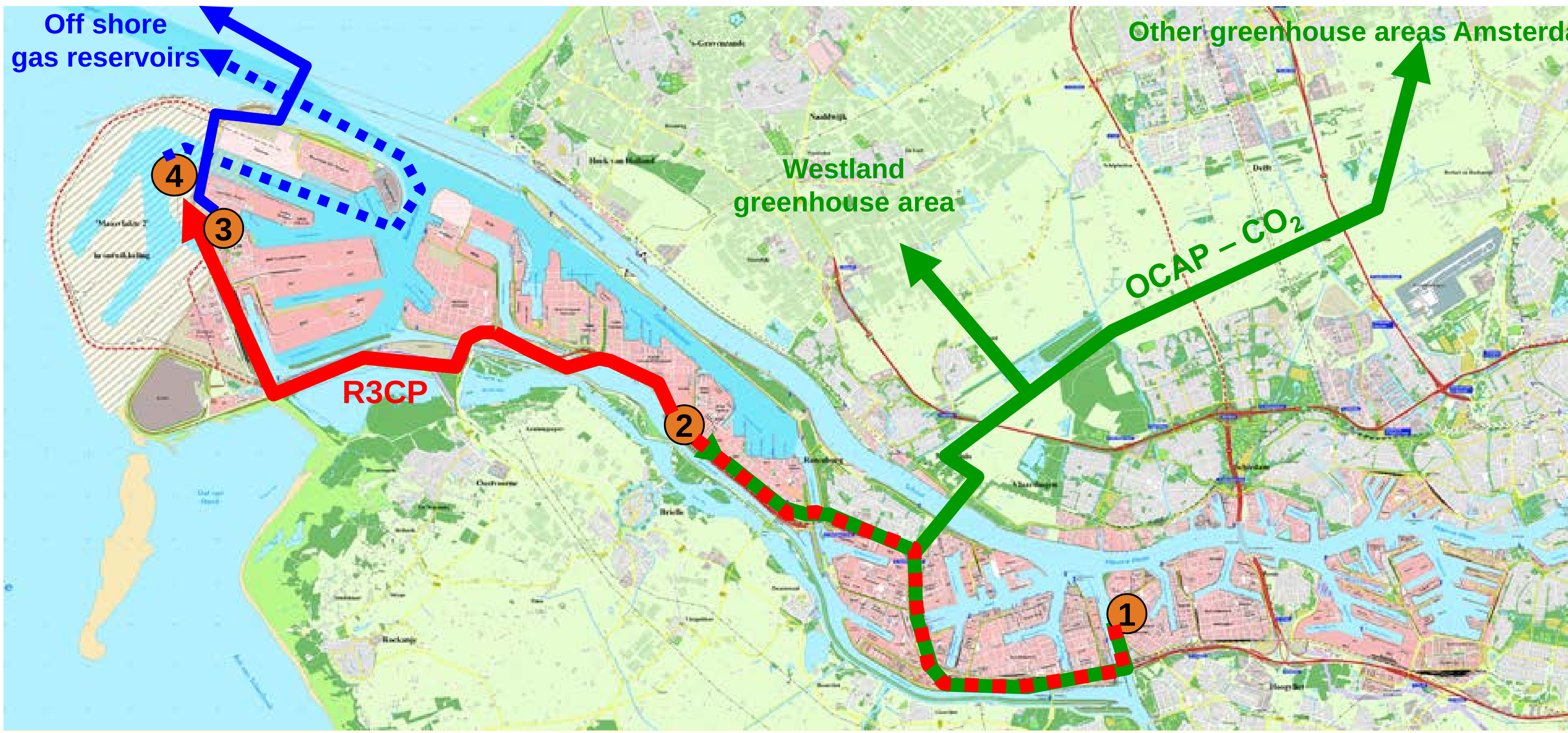
1. Shell – since 2005
2. Abengoa - since 2011
3. ROAD - 2018
4. CO_2 Terminal (>2020)

CO_2 logistics

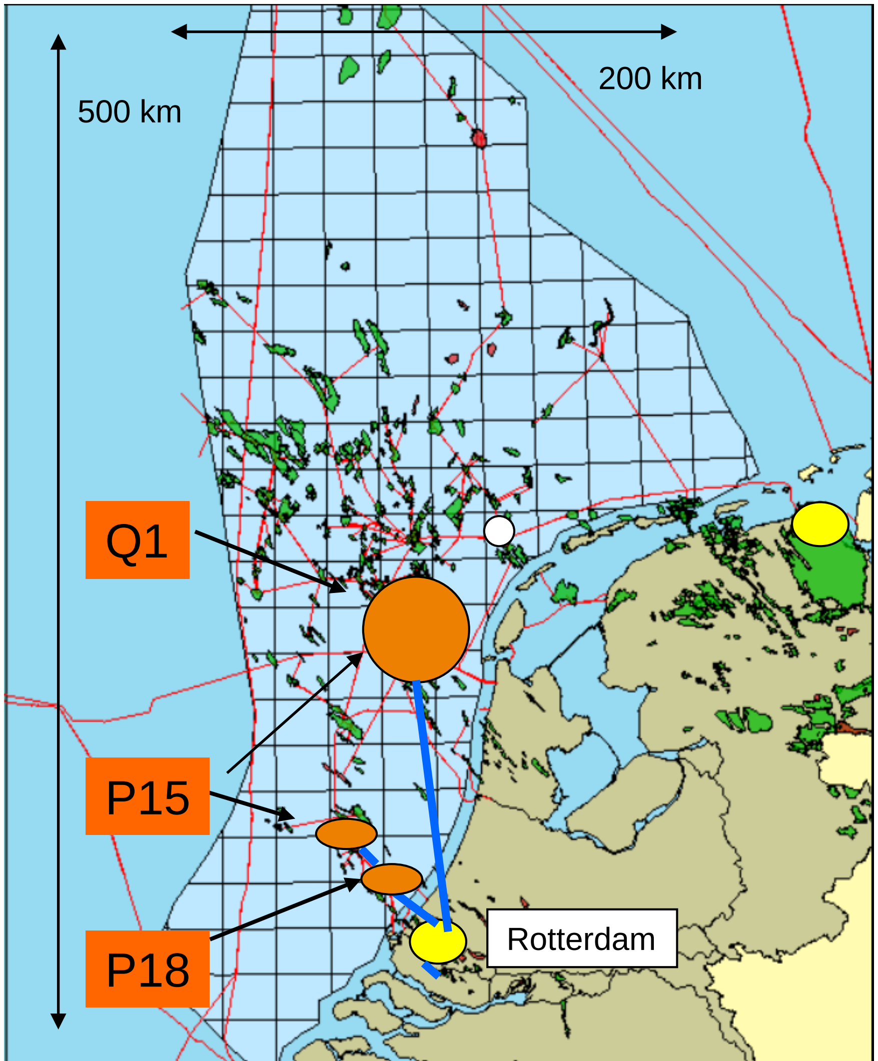
- OCAP
- Common carrier CO_2 pipeline
- Offshore pipeline to CO_2 Terminal

CO_2 destinations

- Greenhouses for enhanced crop growing
- Depleted gas fields
- EOR / EGR North Sea



Network development:



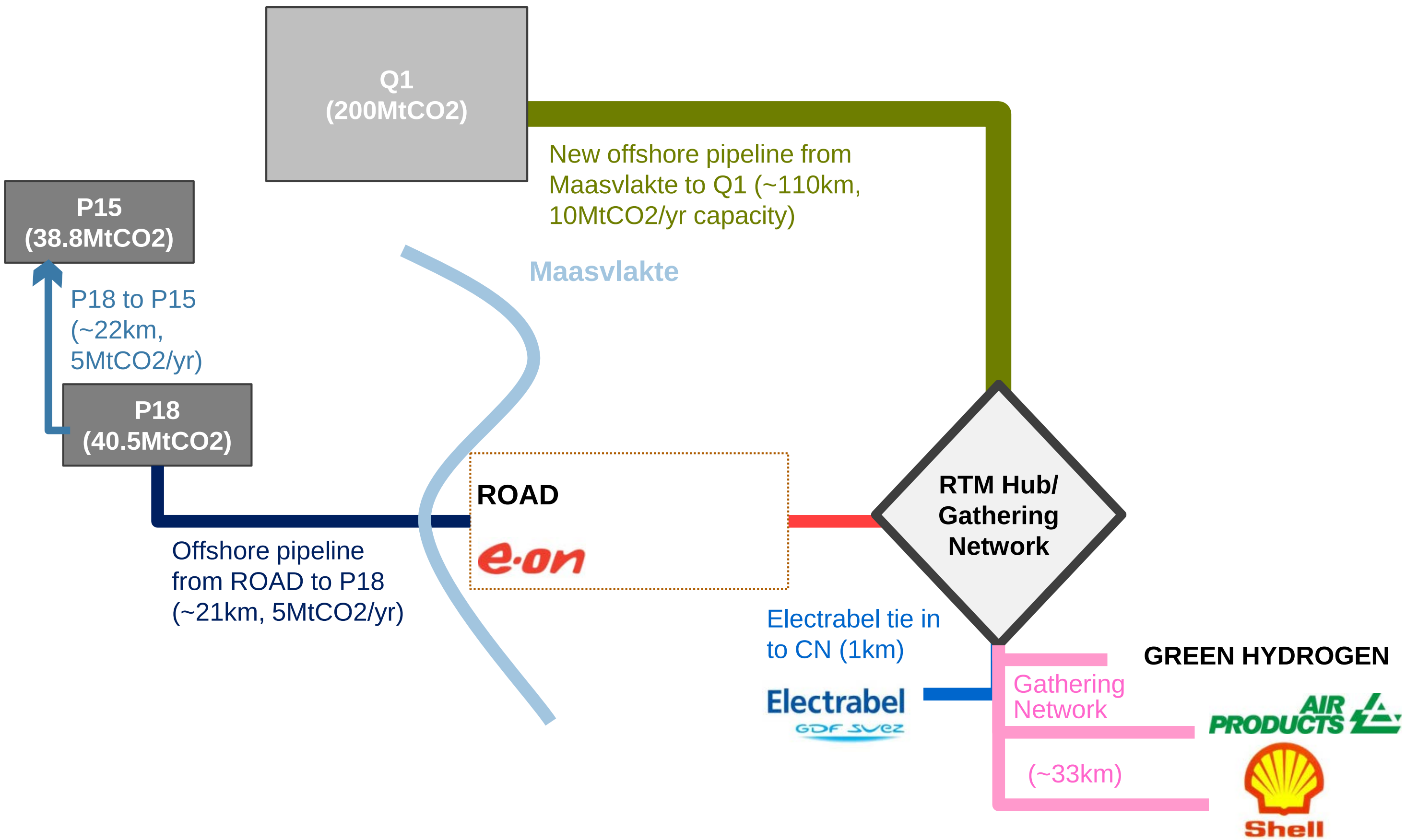
- **Storage options**
  - **P18 (ROAD) 40 Mt -18 km**
  - **P15 40 Mt -28 km**
  - **Q1 200Mt 110 km**

- **Point tot point transport vs oversized infrastructure**

Economy of scale Transport & storage network:

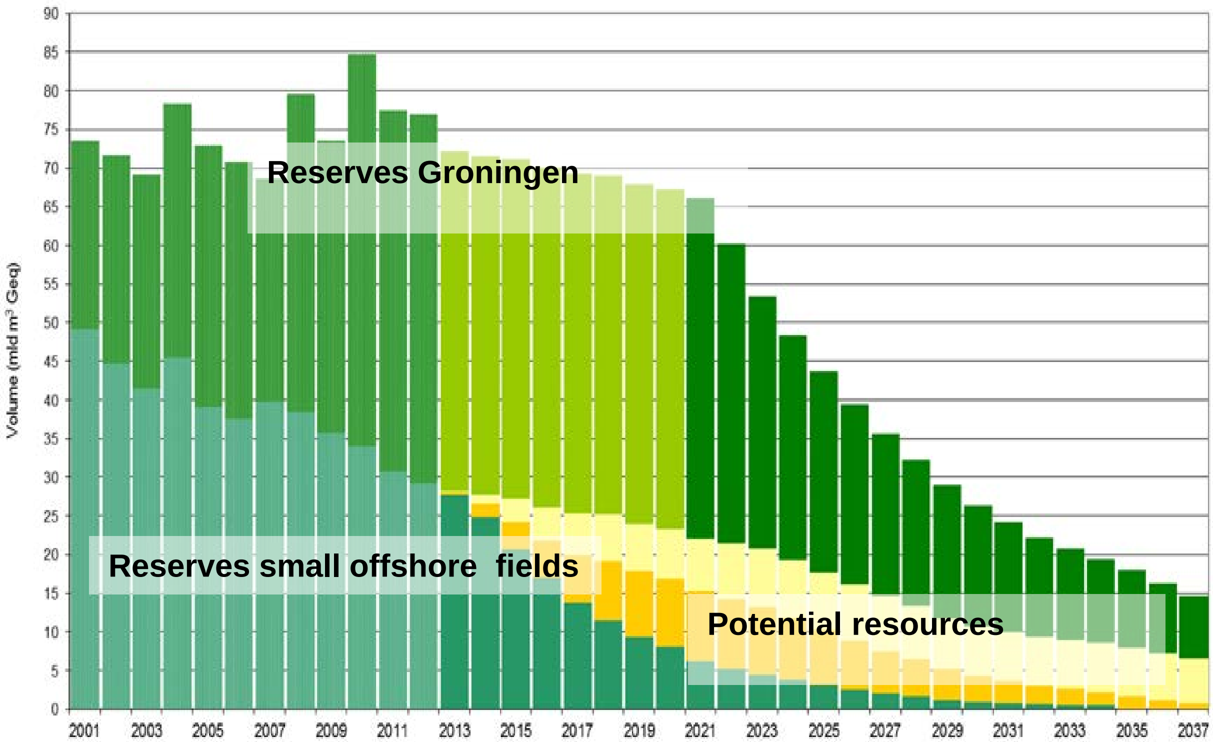
~ T&S tariff € 30 / ton (demo phase, 1 Mton/y, 2018)

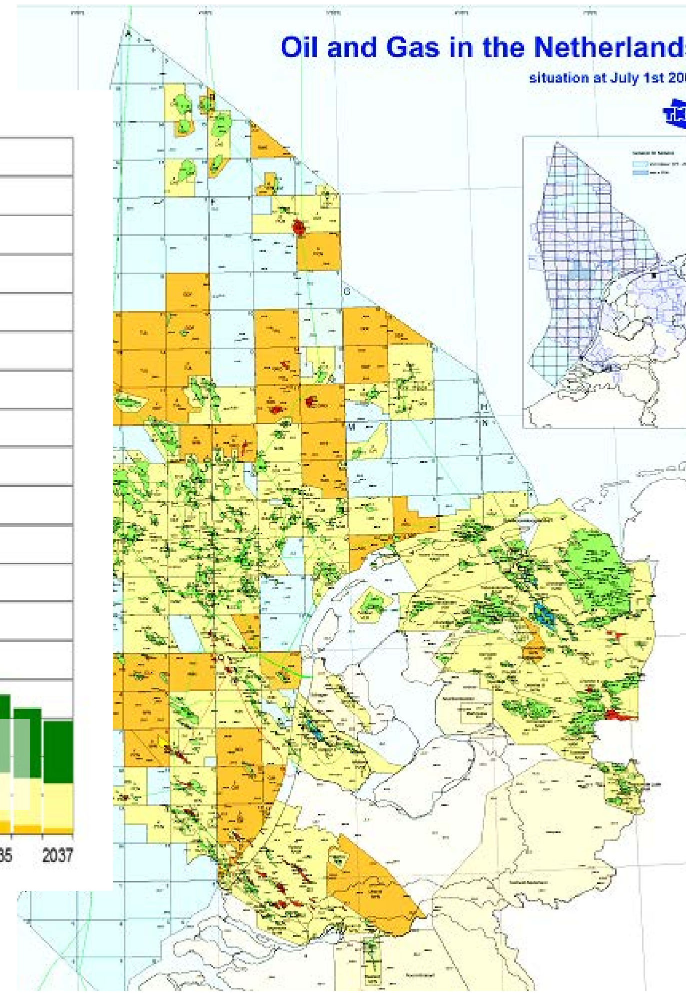
~ T&S tariff € 22 / ton (network, 15 Mton/y, 2030)






Decline Oil &gas production and availability of infrastructure





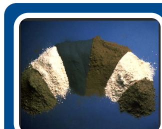


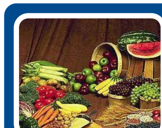

Existing and emerging Industrial Uses of CO_2

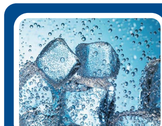

Enhanced Oil & Gas Recovery


Urea fertiliser production


Water Treatment

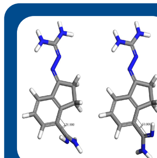

Carbonate mineralisation (aggregate production)

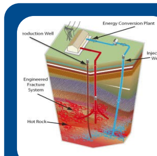

Food processing, preservation and packaging


Beverage Carbonation


Algal bio-fixation and bio-fuel production


Horticulture


Polymer Processing


Green Hydrogen production


CO_2 concrete curing

Potential volume for re-use (all combined): 6.5 Mtpa

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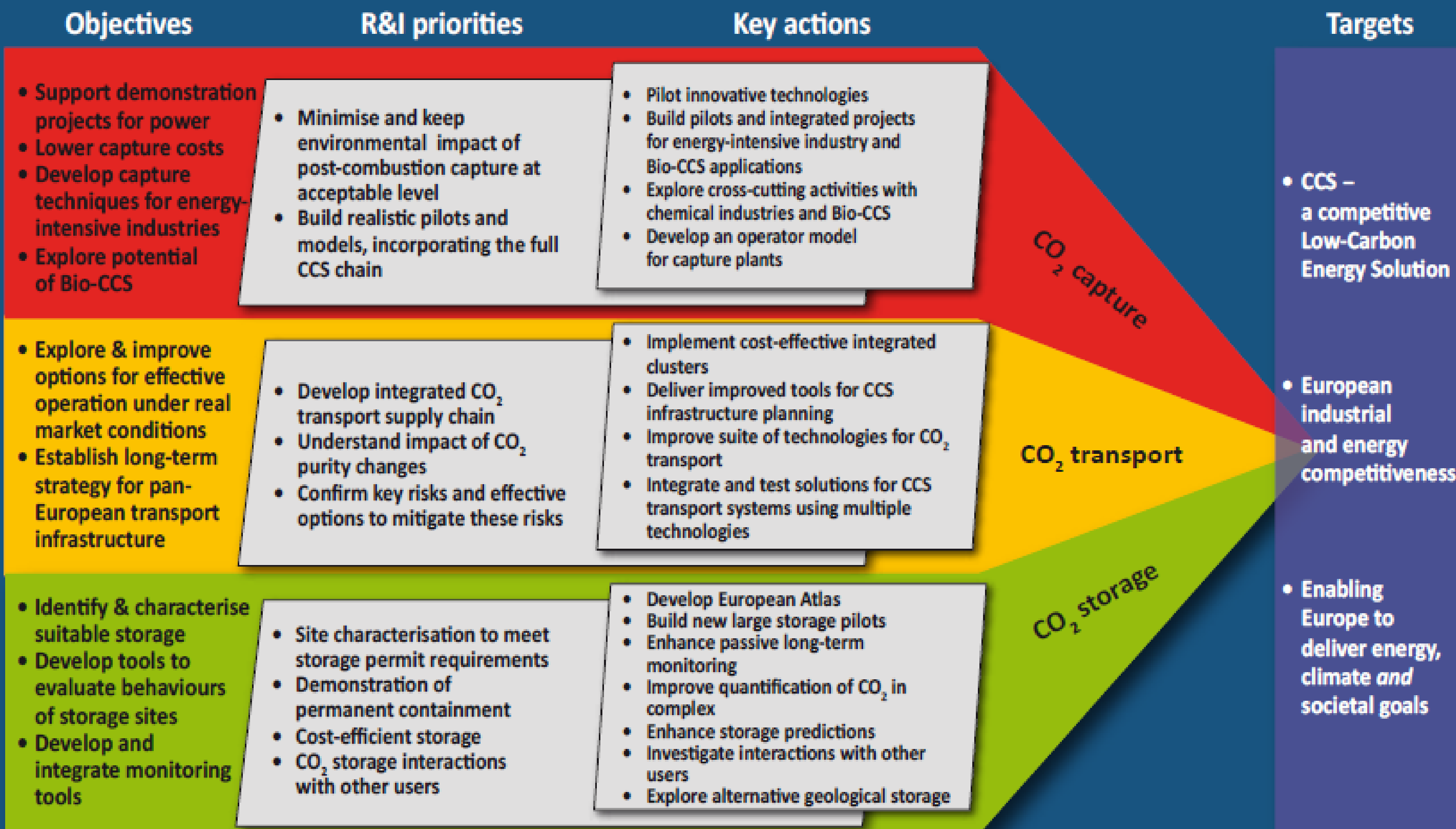
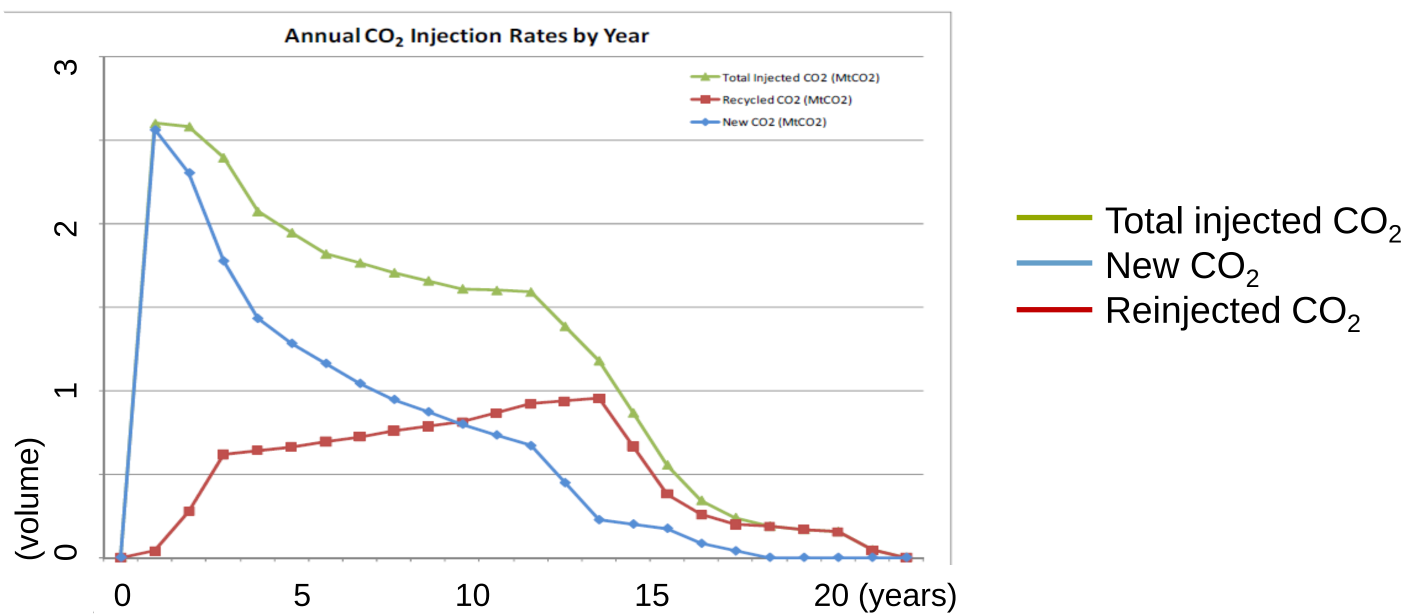
R&D priorities for CCS in Europe (EERA)






CO_2-EOR

- Volumes of CO_2 :
  - ~3 - 5 Mt/yr for single North Sea oil field
  - Required volume of CO_2 decreases after start of EOR
  - Limited duration 10 - 15years?
- **Combination of sources required**






Ships vs pipelines

Pipelines +	Pipelines -	Ships +	Ships -
Low OPEX	High CAPEX	Low CAPEX	High OPEX
Onshore need for compression	Relatively low flexibility	Large flexibility (volume, route)	Need for onshore intermediate storage and liquefaction
Both onshore and offshore	Low potential for re-use	**Re-use potential**	
Large volumes	Large sunk cost	Lower sunk cost	
		Shorter development time	

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Summary & way forward

- **Netherlands**
  - FID ROAD in 2015?!!
  - New CATO R&D program in 2015
  - Further development of CO_2 utilisation and collection network in Rotterdam
  - Mothballing essential infrastructure (change mining act)
  - Prepare detailed roadmap → detailed site characterisation large storage formations
  - Create additional incentives for CCS (EU level)

- **Storage clusters in North Sea**
  - Early phase of CCS should benefit from EOR in North Sea
    - Combine CO_2 from early clusters to EOR projects to build significant and dependable volumes (~5 Mtpa)
    - Use ships to collect and transport the CO_2

Conclusions:

What short-term actions are needed to achieve the long-term goals of deploying CCS infrastructure:

- Mothballing ←→detailed site characterization large sinks
- FID demo projects in Europe
- Combine early clusters for developing EOR North Sea

What are the technical and economic challenges in the future deployment of CCS infrastructure

- Limited technical / R&D challenges related to infrastrcuture
- Only economic driver is ETS → CCS development > 2035
- Tax incentives for EOR required to enhance post demo projects