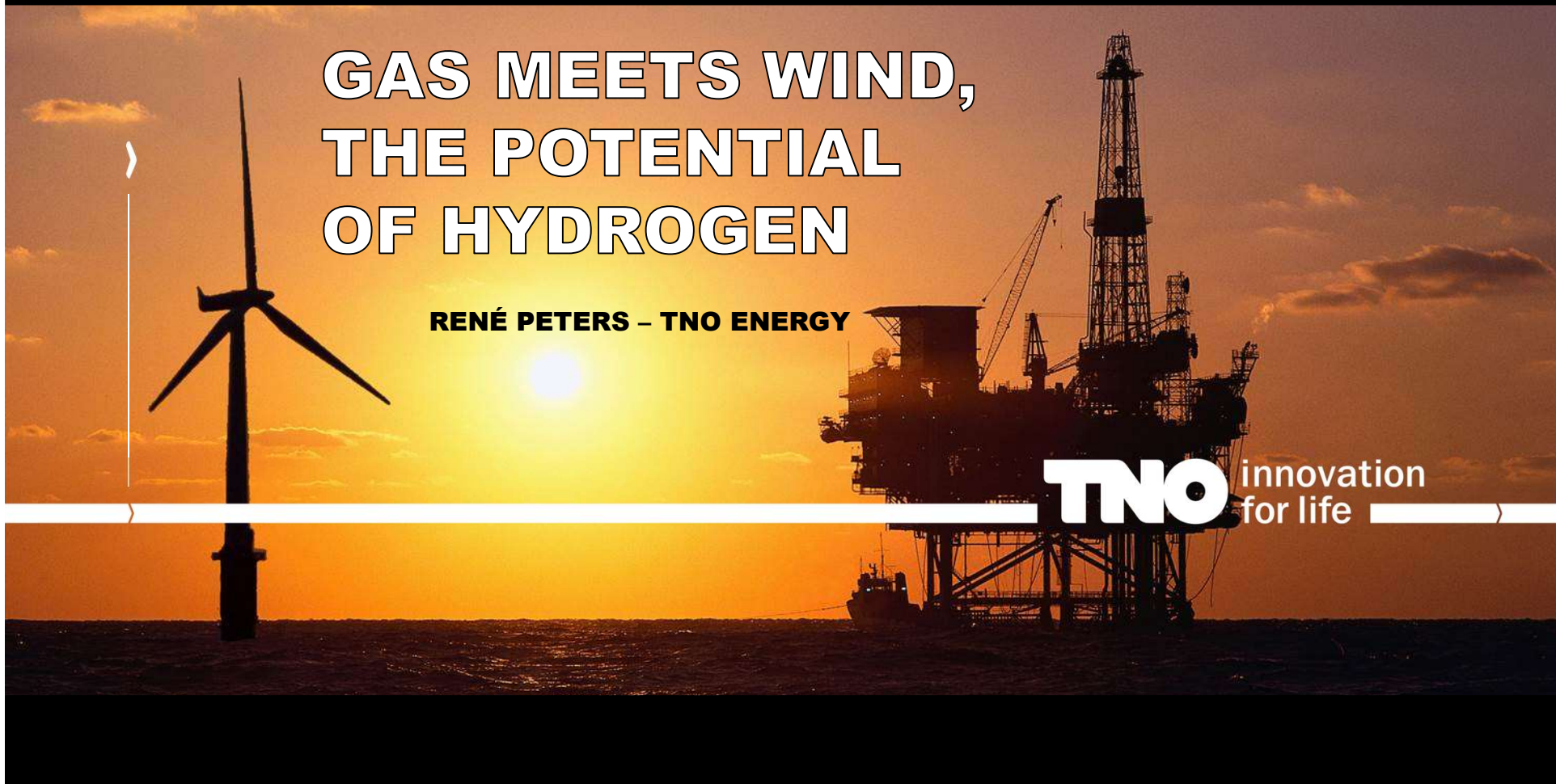


Power-to-Gas for offshore wind in the North Sea
Power-to-Gas for offshore wind in the North Sea

GAS MEETS WIND, THE POTENTIAL OF HYDROGEN

RENÉ PETERS – TNO ENERGY

TNO innovation
for life



CHALLENGES ENERGY TRANSITION



GHG emissions & air quality



Capacity and stability grid

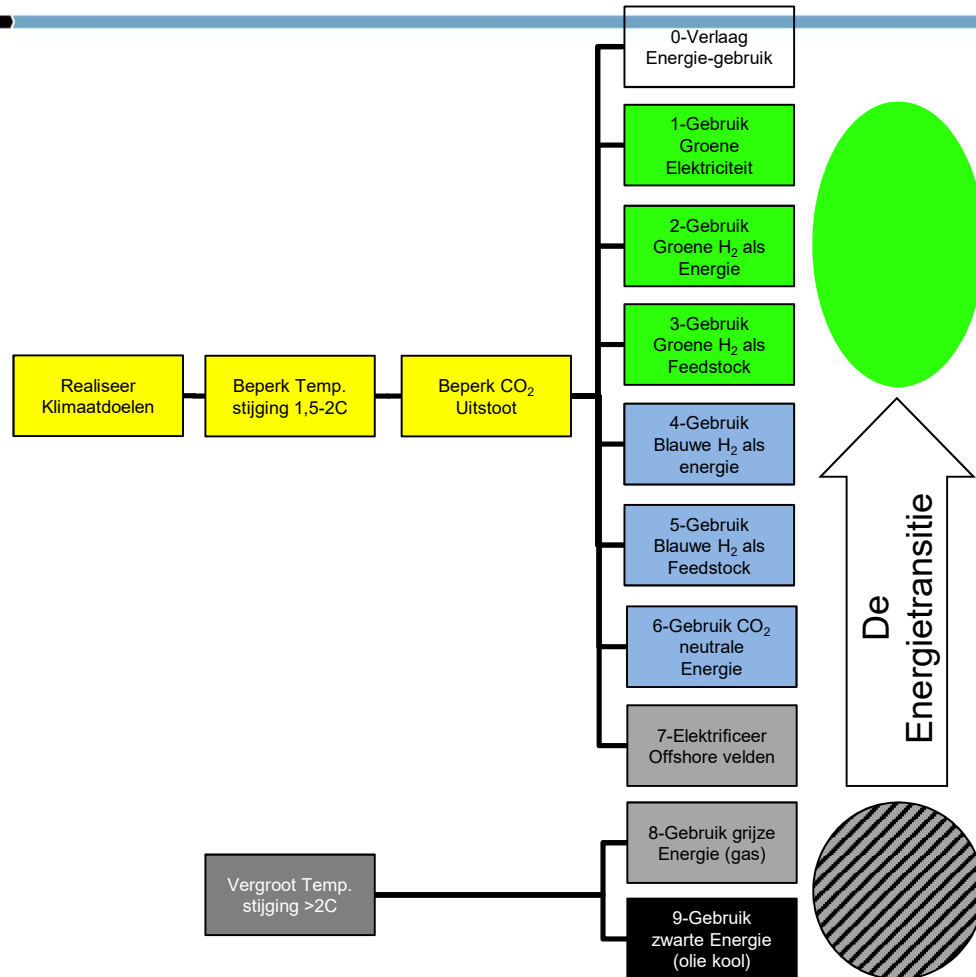


Decommissioning cost



Re-use existing infrastructure

ENERGY TRANSITION MODEL FOR INDUSTRY

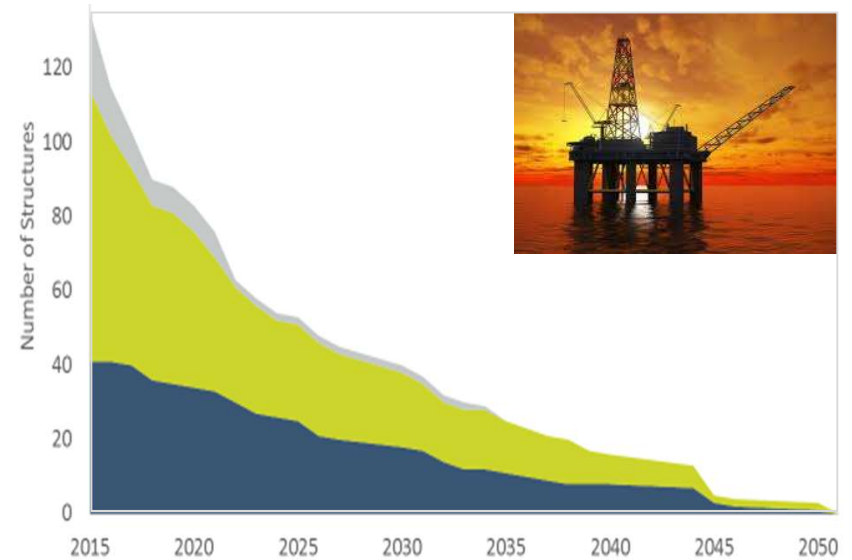
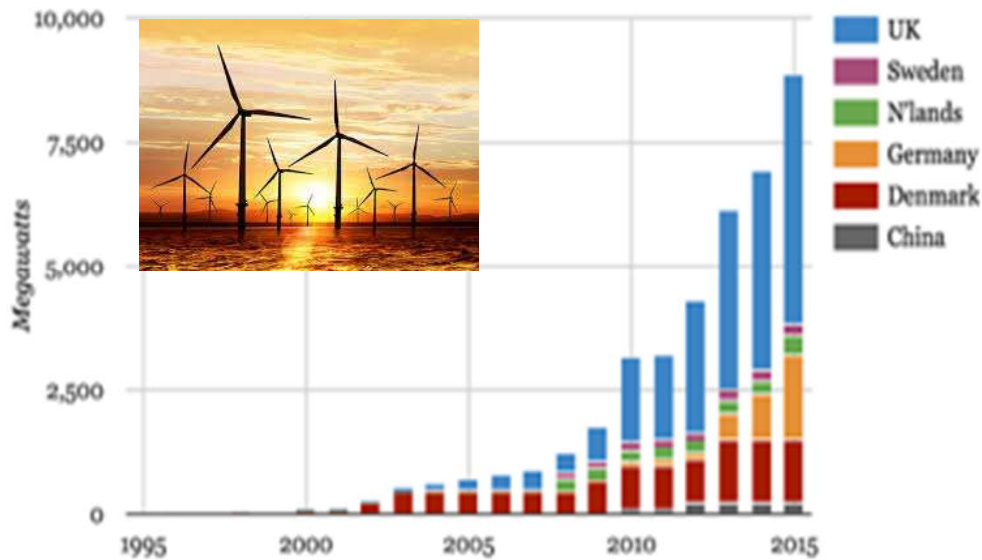


1. Focus on CO₂ emission reduction to realise climate targets Paris agreement.
2. Green Energy and Feedstock is the ultimate sustainable solution
3. Blue energy and feedstock is the use of fossil energy combined with CO₂ storage as a temporary solution
4. Elektrification of the industry will reduce the CO₂ emissions provided green electricity is used

➤ *How can system integration accelerate the transition?*

OFFSHORE ENERGY DEVELOPMENT NORTH SEA

› The North Sea is taking the lead in offshore wind.....while oil and gas is phasing out



VISION: FROM SEGREGATION TO INTEGRATION



Is there a potential for integration and re-use of gas infrastructure for offshore wind?

What can be the role of Hydrogen?

- Emission reduction
- Grid balancing
- Clean energy storage
- Clean energy transport

FIND SYNERGIES IN OFFSHORE ENERGY

ALIGN DRIVERS FOR KEY STAKEHOLDERS

Offshore O&G



Offshore Wind



Society

Cost reduction
GHG Emission reduction
License to Operate
Efficient spatial use

SYSTEM INTEGRATION OFFSHORE ENERGY

Accelerated transition
Human Capital offshore
Stability offshore grid
Minimise societal costs

INTEGRATION REQUIRES COLLABORATION

June 15, 2016 “Gas meets Wind”:
‘Declaration of Coordination and
Cooperation North Sea Region’



NOGEPA



Branch Oil and Gas

Branch Wind Energy



Grid Operator



Branch industry sector



NGO environment



Technology Institute

PRE STUDIES ON SYSTEM INTEGRATION

➤ **2015 System Integration Offshore Energy (project SIOE)**

Project partners



➤ **2016 Smart Sustainable Combinations (Power to Hydrogen)**

Project partners



➤ **2016: Project SENSEI**

”Strategies towards an Efficient future North Sea Energy Infrastructure”

Project partners:



Supported by wind and gas sector and NGOs:



SYSTEM INTEGRATION OPTIONS

Development of large-scale offshore wind can be integrated with offshore gas infrastructure along the following main options:

**Electrification
of offshore
gas platforms**

**Power to Gas
(P2G) & H2
transport**

**Carbon
Transport and
Storage (CCS)**

Gas to Wire

**Energy
storage
(CAES, H2)**

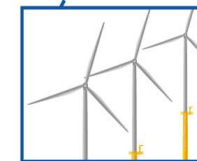
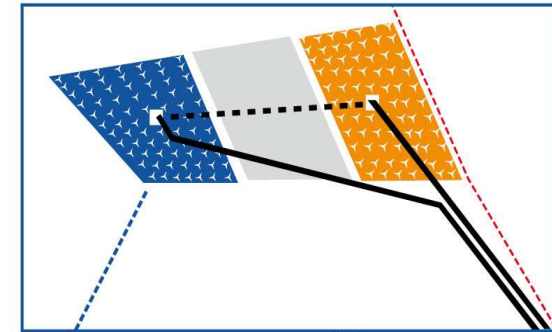
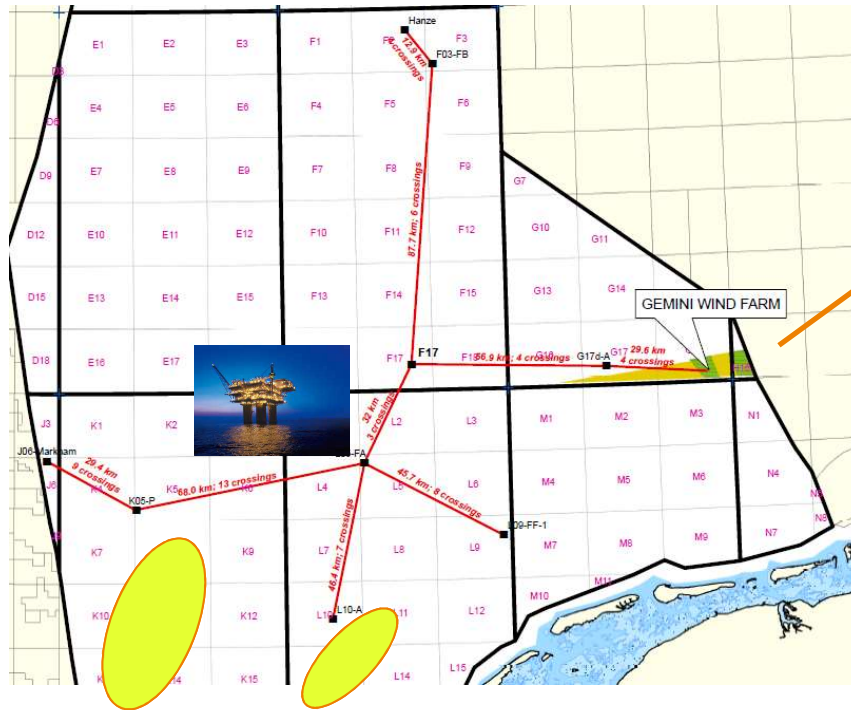
Targets:

Emission reduction (CO₂, NO_x)
Grid balancing
Efficient use of socialised cost
Re-use of invested capital

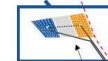
OFFSHORE GRID DEVELOPMENT CONNECT WIND FARMS TO PLATFORMS



CAPACITY: 600 MW
POWERING 785,000 HOUSEHOLDS

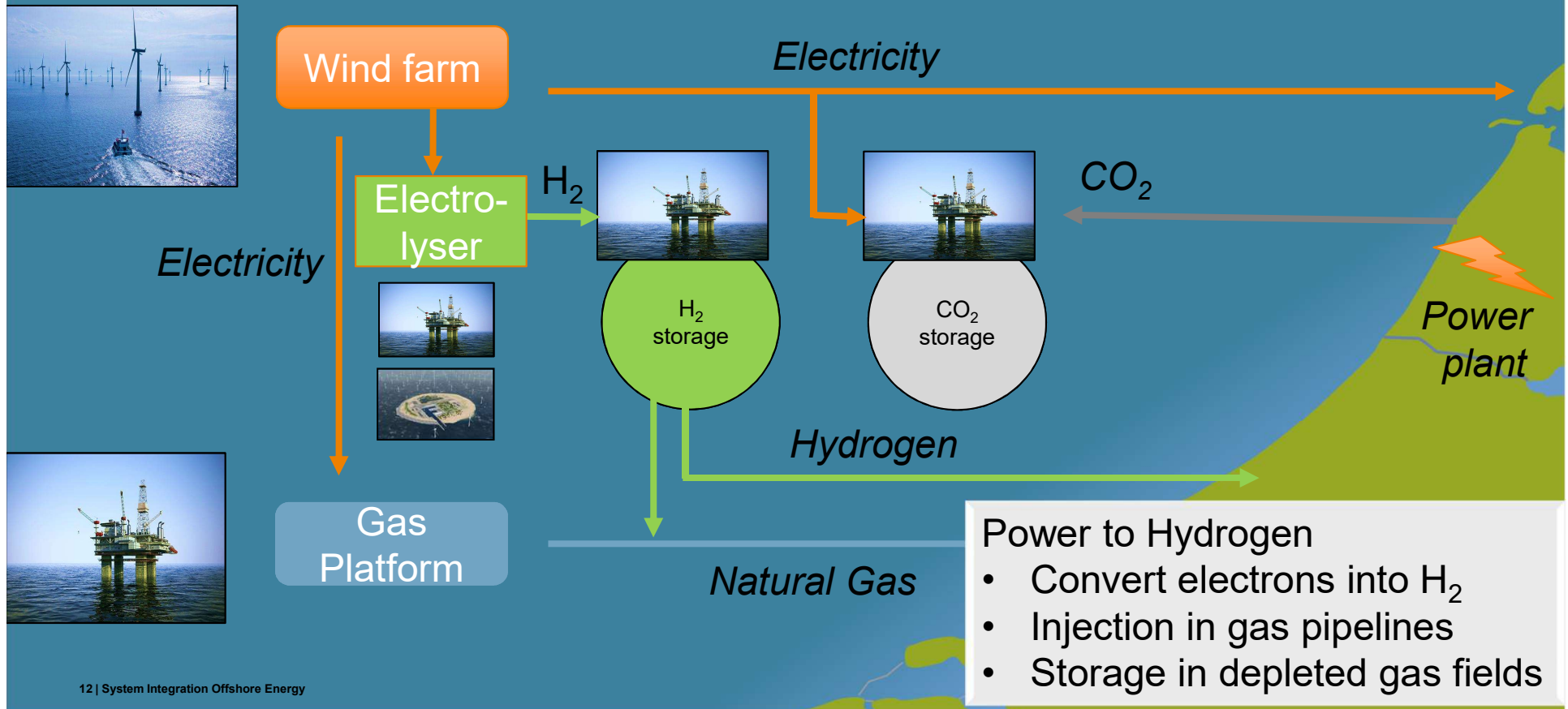


150 X SIEMENS 4.0 WTG



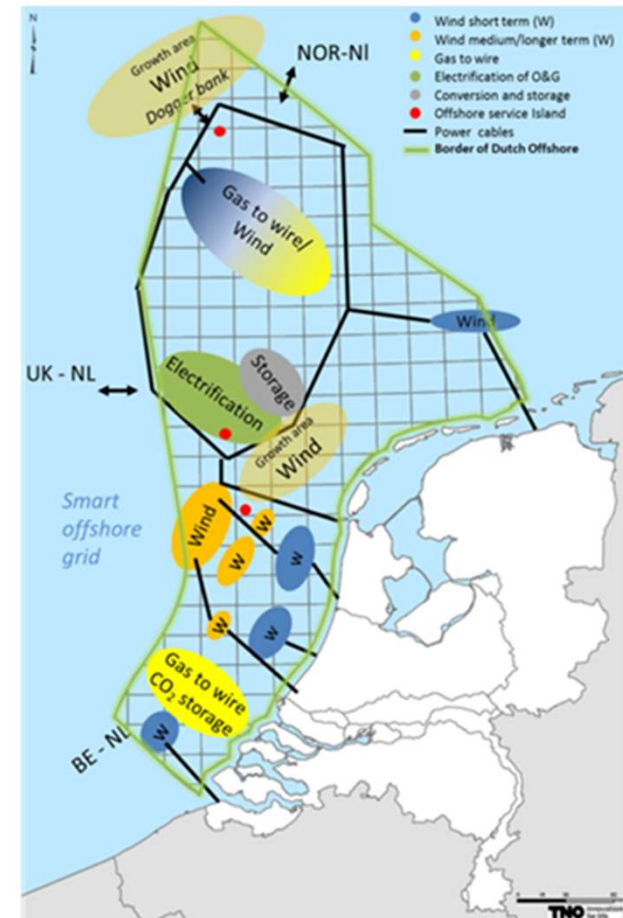
FUTURE OFFSHORE ENERGY SYSTEM

POWER TO HYDROGEN



VISION ON INTEGRATION OFFSHORE ENERGY

- CO2 transport and storage near shore (Rotterdam / IJmuiden area)
- Electrification of offshore infrastructure (Central North Sea)
- Offshore Electric Grid development (connecting wind and gas, towards North)
- Conversion Electricity <> Gas/Hydrogen (near windparks central area, far offshore)
- Energy transport via Hydrogen and Electric (existing pipelines and new offshore grid)



NORTH SEA ENERGY CONSORTIUM



- › Visualise current and future energy streams on the North Sea and impact of system integration
- › Techno-economic analysis of system integration options
- › Human Capital Agenda for gas and wind offshore
- › Analyse legal and regulatory aspects of system integration



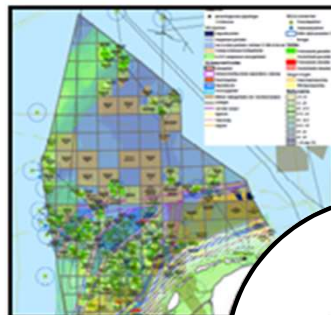
NORTH SEA ENERGY PROGRAM

Strategic Spatial Planning

Spatial synergies

Scenario development

Restricted areas



Physical Network

Connections

Nodes

Services

Maintenance



Society and Governance

Human Capital

Public Participation

Regulations



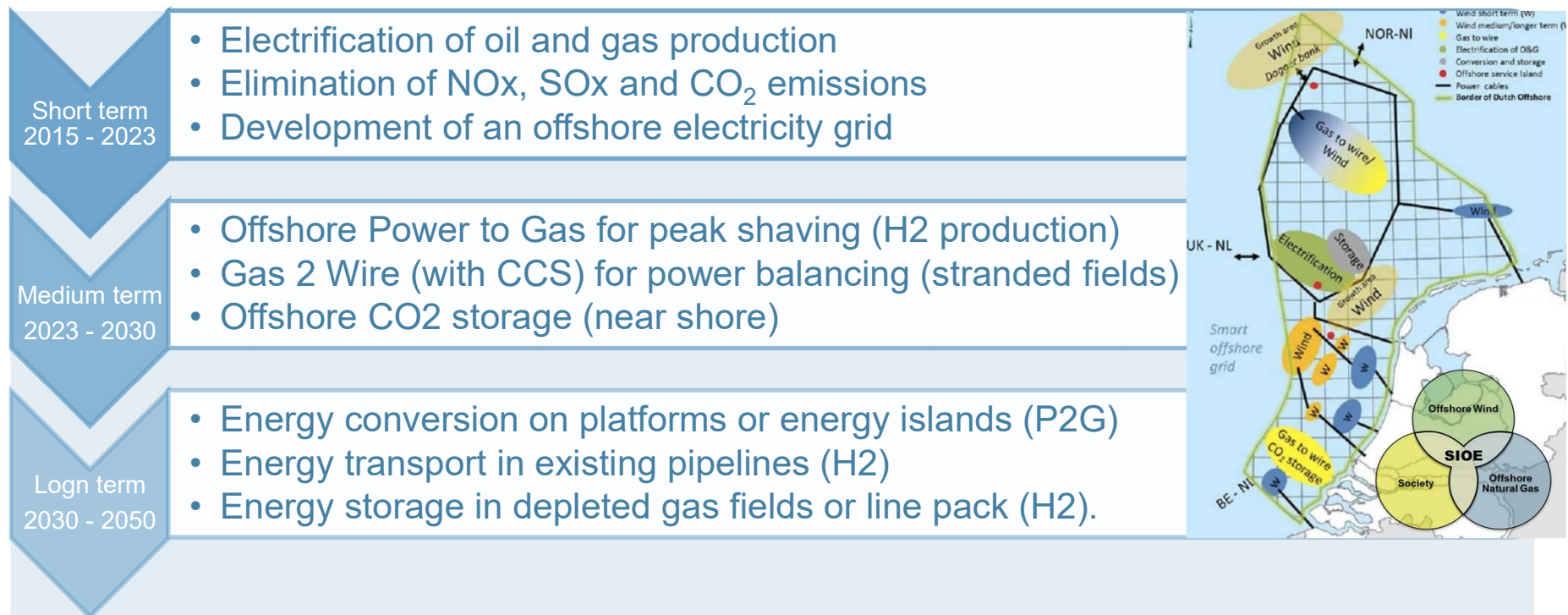
Health, Safety & Environment

Health and Safety

Emissions and Environment



ROADMAP INTEGRATION OFFSHORE ENERGY

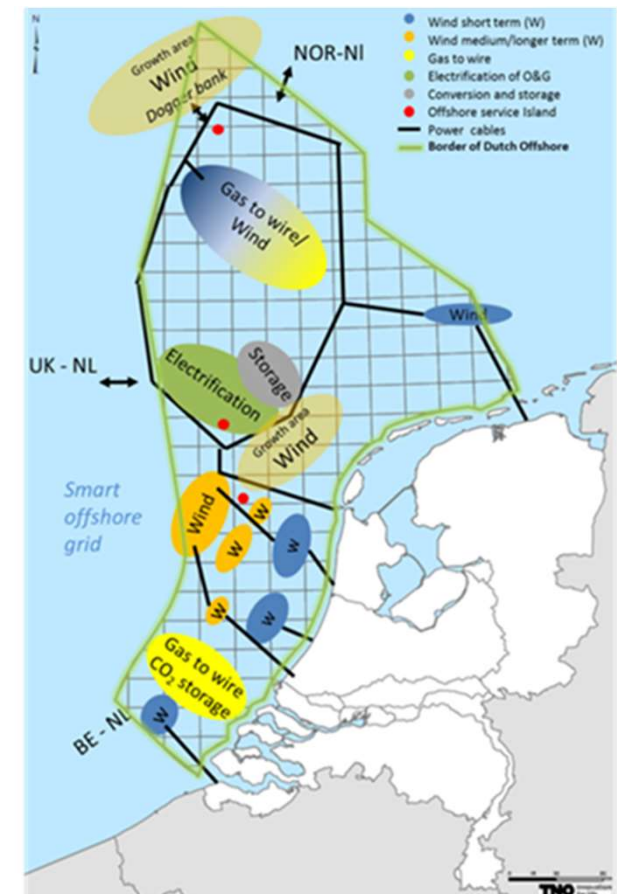


CONCLUSION NORTHSEA ENERGY

- › Connecting offshore windfarms and re-using gas platforms can create a stable, affordable and clean energy system in the Northsea
- › **Electrification** of platforms will reduce the emissions of NOx, CO2 and CH4 to zero
- › Conversion technology on platforms will create potential for grid stabilisation
 - › **Power to gas** (H2, CH4)
 - › **Gas to Wire** (with CCS)
- › Pipeline infrastructure can be used to **transport energy** at large distances (via H2 or in CH4)
- › Depleted gas fields can be used for **energy storage and balancing** (H2, CAES, UGS, CO2)
- › Reuse of infrastructure will
 - › **Reduce the societal cost** of offshore energy (decommissioning and power grid)
 - › **Maximise economic revenues** of energy sources offshore with zero emission
 - › **Create employment** and business opportunities for the offshore sector

NEXT STEPS (2018 – 2020)

- › FID on electrification of key platforms near (future) wind farms (Engie, NAM, Taqa, Total ?)
- › Pilot demonstration of Offshore Power to Gas (1 – 10 MW unit), H2 feed into gas pipeline
- › First project for CO2 storage near shore Rotterdam (Taqa P15, ONE Q16 maas?)
- › Feasibility study on H2 transport via existing pipelines
- › Decision based roadmap for system integration offshore energy



PARTIES INVOLVED IN NORTH SEA ENERGY



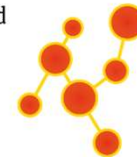
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Rijksdienst voor Ondernemend
 Nederland



TOTAL



TOPSECTOR ENERGIE
 Empowering the new economy



NAM

SIEMENS



GasTerra



Oil & Gas
 Reinvented Community





North Sea Energy Challenge
SEARCHING FOR SYNERGIES

**REPORT AVAILABLE AT:
WWW.GASMEETSWIND.EU**

**THANK YOU
FOR YOUR ATTENTION**

TNO innovation
for life

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