CO_2 STORAGE FOR COMPLETING THE ENERGY TRANSITION

EuroWorkshop: Geology and the energy transition | Delft | 23 May 2019 | Ton Wildenborg

ECN | TNO innovation for life

GeoNet

INDUSTRIAL EMISSIONS SHARE

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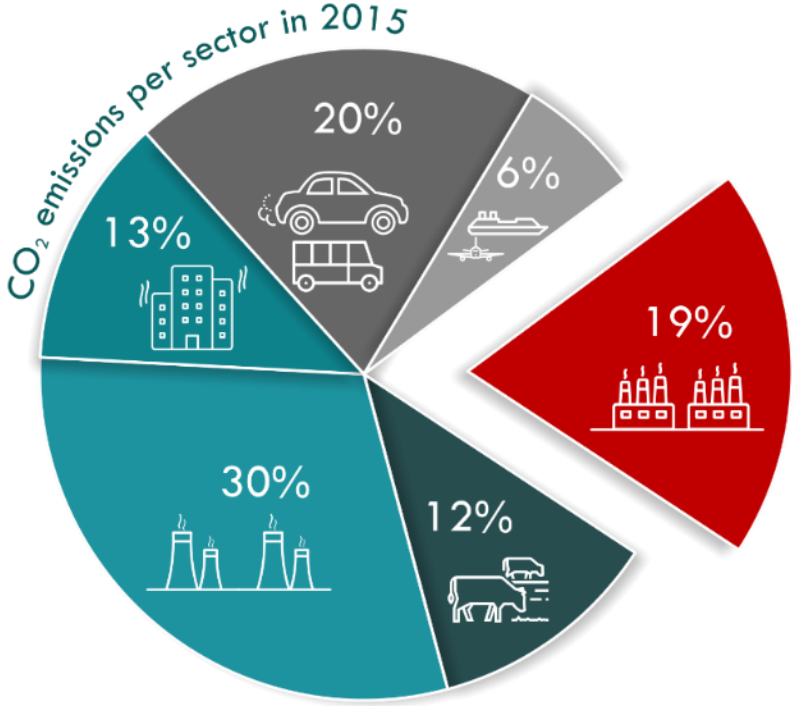
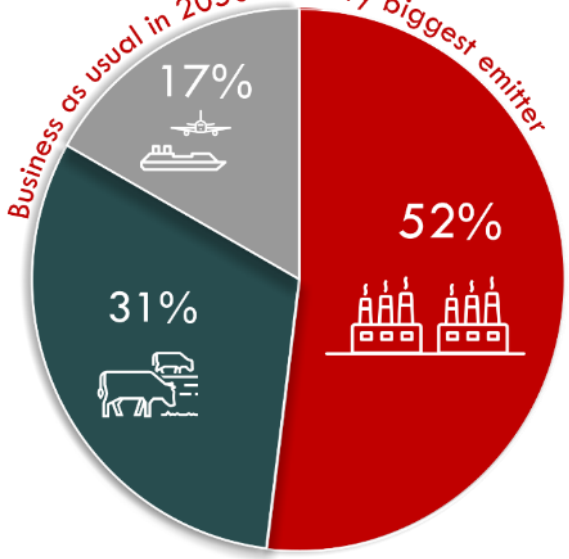


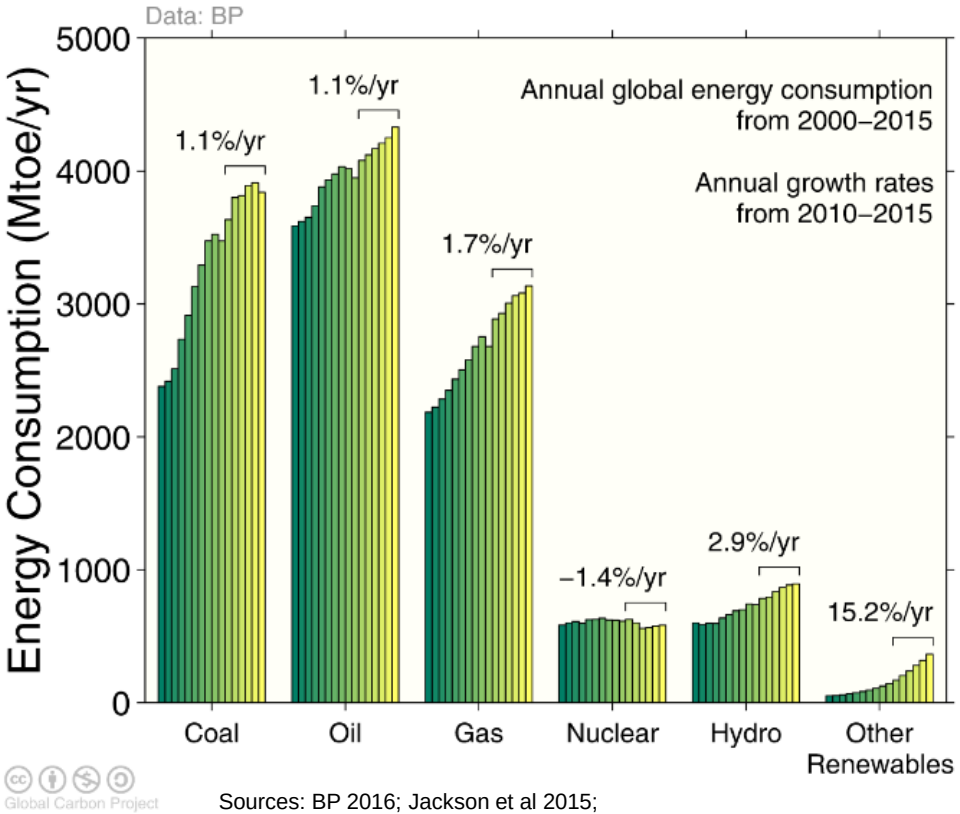


Zep Zero emissions platform

BELLONA EUROPA

REALITY

- Emission levels develop along worst case scenario.
- Energy consumption is going up, not down.
  - Going up faster than renewables
- 2050 is now 30 years away!
- We must reduce emissions, rather than assume that use of fossil fuels will end soon.



Sources: BP 2016; Jackson et al 2015; Global Carbon Budget 2016

CCS is indispensable for reaching the ambitious emission reduction goals in time.

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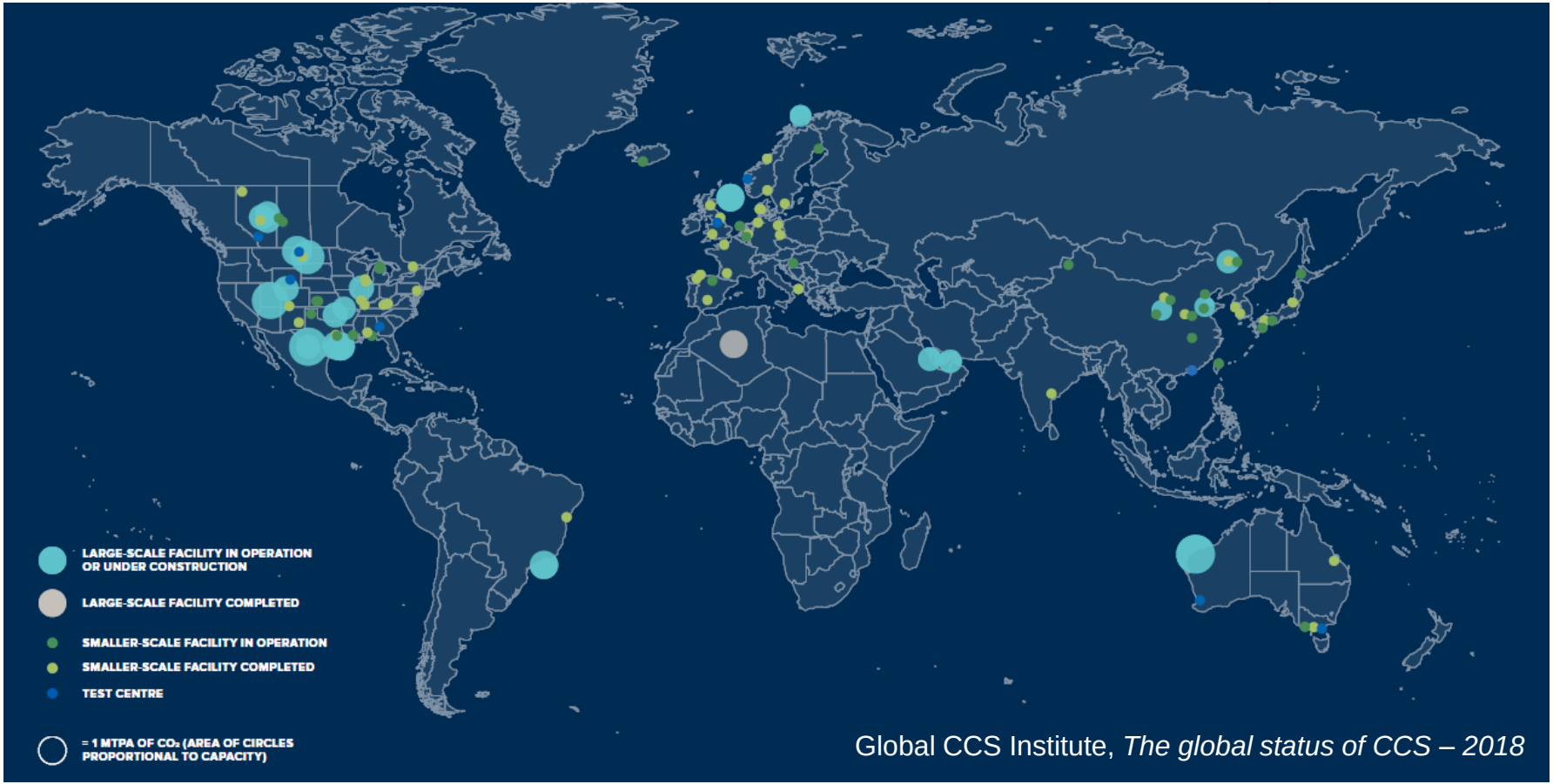
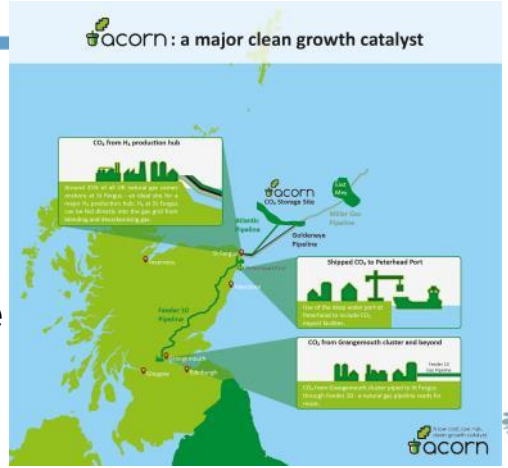
CCS WORLDWIDE



Global CCS Institute, *The global status of CCS – 2018*

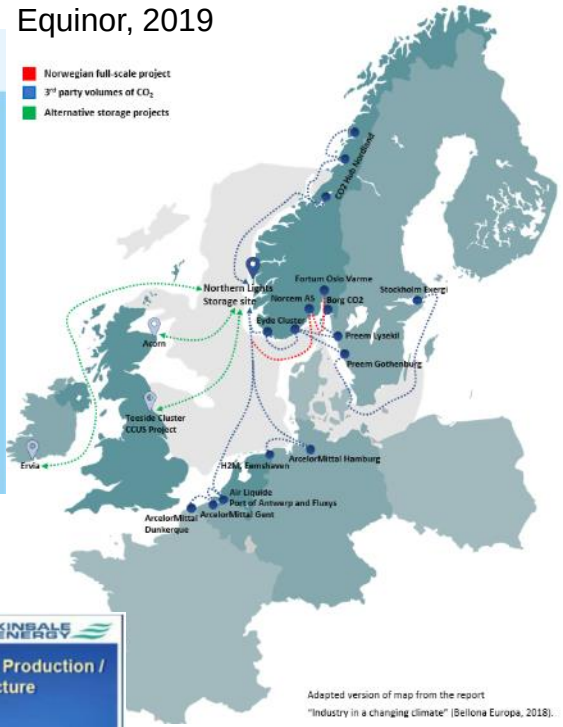
CCS IN EUROPE

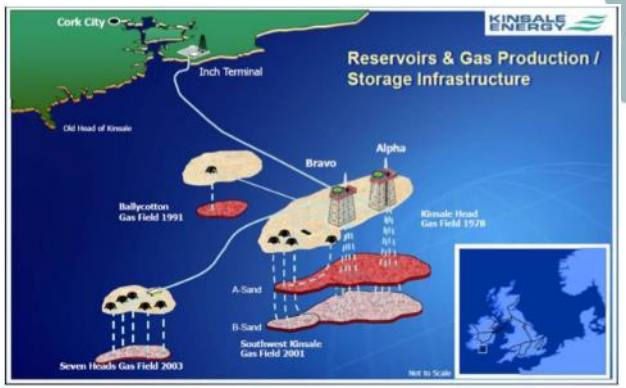
- Norway
  - Sleipner, Snøhvit
  - Northern Lights CCS project
    - Ship transport, **aquifer storage**
    - Potential links to GE, NL, UK, DK, …
- UK
  - Several initiatives
    - ACORN, Grangemouth, hydrogen
    - **Depleted gas field, aquifer**
- Ireland
  - Cork CCS project
  - **Depleted gas field**



ACORN

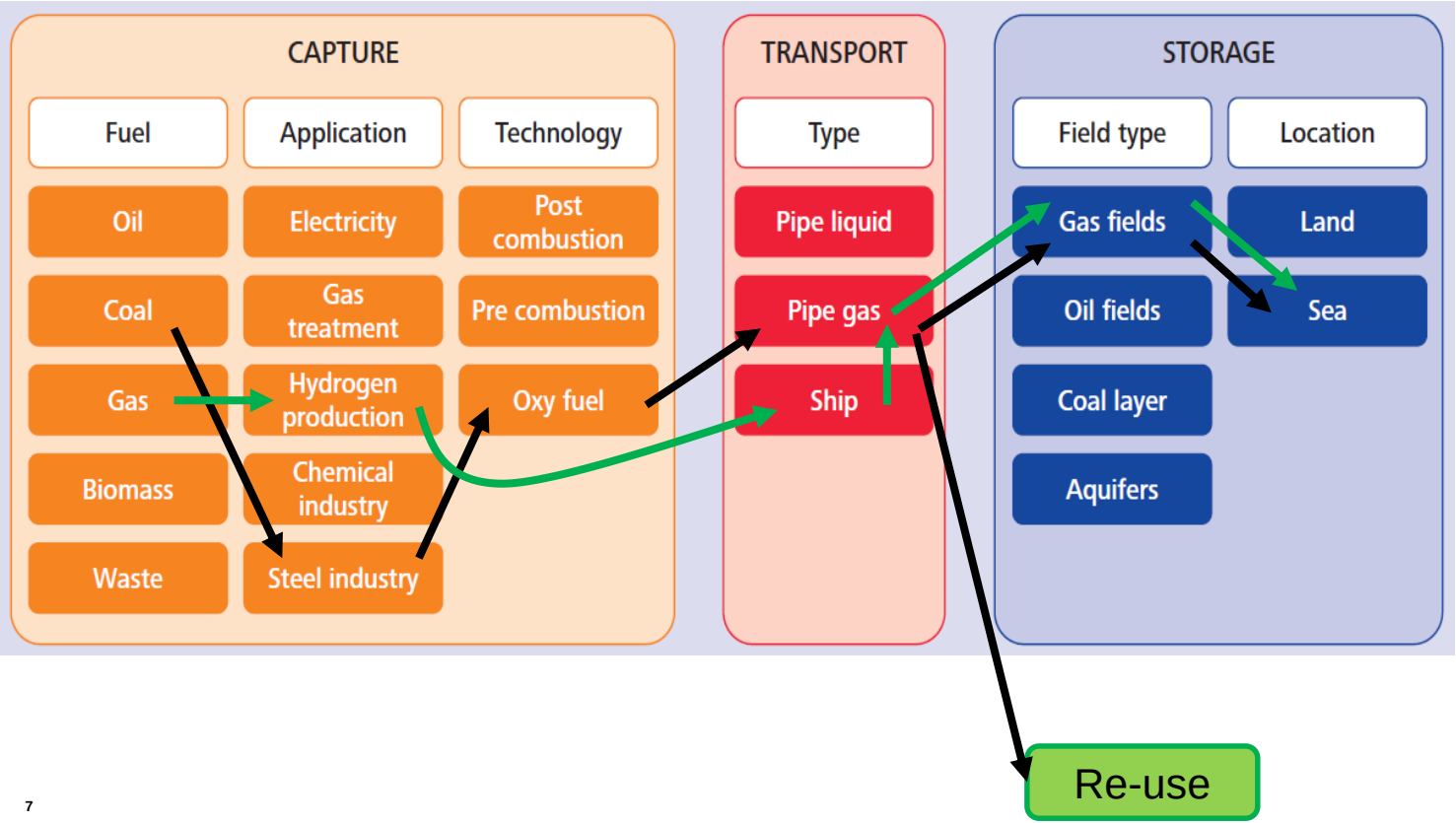
Source:
Equinor, 2019





Ireland CCS
ERVIA

CC(U)S is a flexible emission reduction instrument.



Source: Utrecht University

CCS is real and it is working.

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CCS IN THE NETHERLANDS

- Government target: meet Paris agreement targets
  - 49% reduction in CO_2 emissions in 2030 (compared to 1990 levels)
  - Emissions reduction of 56 Mtpa
    - 12 Mtpa by closing down coal fired power plants
  - Industry contribution: 22 Mtpa emission reduction
    - Process efficiency: 3 Mtpa
    - Recycling: 1 Mpta
    - CCS: 18 Mpta
      - May 2018: ambition reduced to 7 Mtpa by 2030

'No to CO_2' (Barendrecht storage plans)

CURRENT CCS AND CCU DEVELOPMENT ACTIVITIES

- Rotterdam harbour: Porthos consortium
  - 20% of national emissions
  - Develop into ‘green port’
  - Continue economic activity under increasingly strict greenhouse gas emission regulations
  - Target ~5 Mtpa by 2030; to grow beyond 2030 with storage in gas fields
- Steel plant (TATA Steel)
  - HIsarna process: pilot – demo – full scale plant
- Waste processing
  - Capture projects (CCU) starting

TATA Steel, IJmuiden

AVR, Duiven

ROAD CCS PROJECT (CANCELLED 2017)

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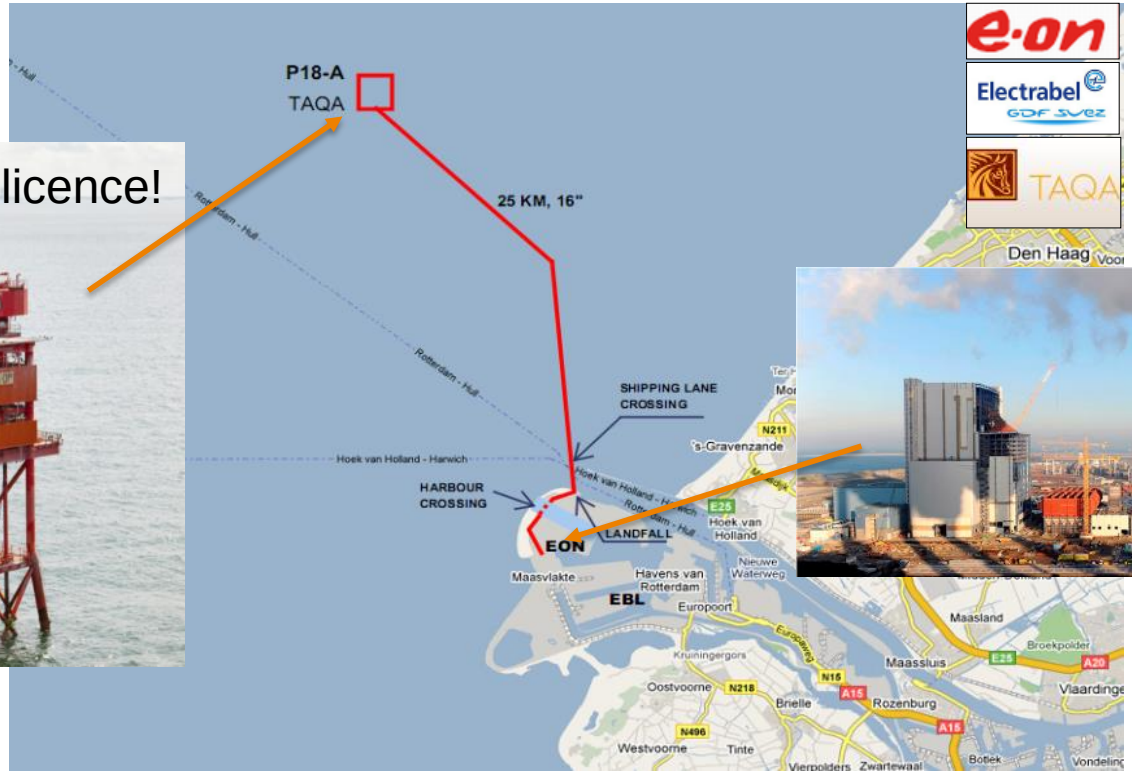
CO_2 storage licence!
~8 Mt



Coal-fired power plant (Maasvlakte)

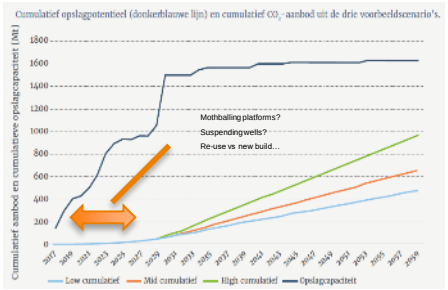
DEVELOPING STORAGE CAPACITY

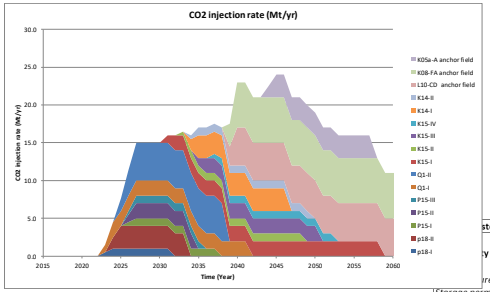
- Abundant storage capacity, but how to develop it?
  - Timeline of field development
  - Ranking of options – unit storage cost, location, capacity

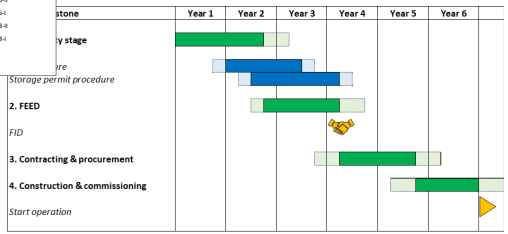
Potential transport and storage network in North Sea

OFFSHORE CO_2 STORAGE CAPACITY - CHALLENGES

- Re-using facilities, installations, wells
  - Cost reductions?
  - ‘Mothballing’ platforms, suspending wells
- Timely development of storage capacity
  - Many depleted fields to be developed
  - Long lead time
- Governance, regulatory environment
  - Role government, role industry
  - Liability stored CO_2

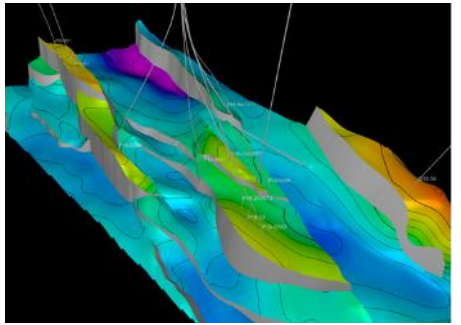


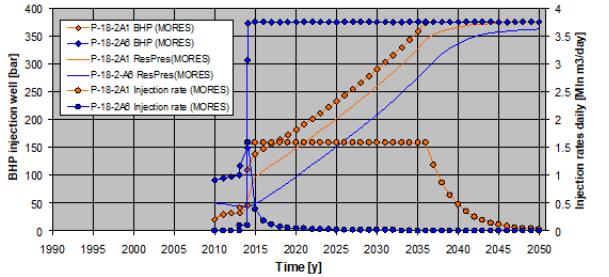


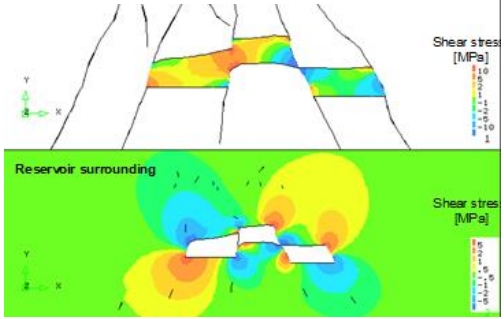


STORE DEVELOPMENT & REQUIRED GEOSCIENTIFIC EXPERTS

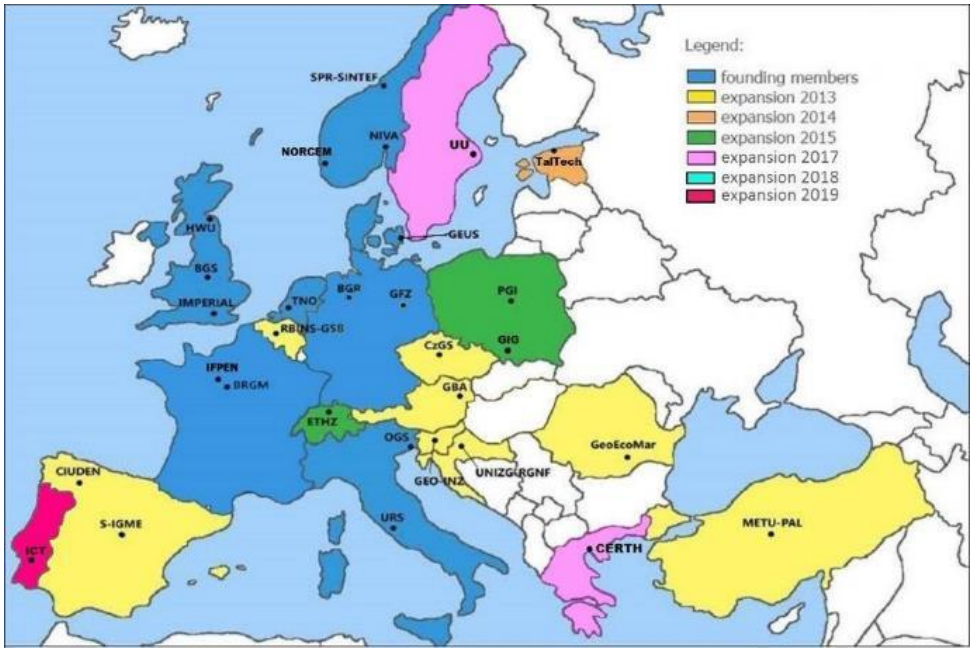
Activity in feasibility study	Experts
1. Define storage complex: hydraulic connectivity and flow barriers	➢ Geologists and reservoir engineers
2. Develop static earth model	➢ Geologists
3. Perform flow simulations	➢ Reservoir engineers
4. Do geochemical analysis	➢ Geochemisters
5. Geomechanical modelling	➢ Geomechanical eng.
6. (Analyse well integrity)	➢ (Well engineers)
7. Risk assessment and risk reduction	➢ Geo-risk analysts with all experts
8. Develop monitoring plan	➢ Geophysicists
9. Develop corrective measures plan	➢ Reservoir (and well) engineers







CO_2GeoNet - The European Network of Excellence on the geological storage of CO_2



- ✓ **Pan European coverage** with **30** research institutes from **21** countries and still growing

- ✓ Come and visit our annual dissemination highlight in Venice:

  CO_2GeoNet Open Forum

  Save the date for the 15th edition:

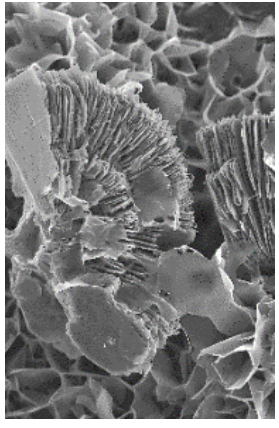
  From 11 to 14 May 2020

  info@co2geonet.com

H2020 ENOS: Enabling Onshore Storage – 2019 Highlights

GeoEnergy Test Bed

Rock core testing underway
Soil gas station installed



Coordination with local communities

Talking to local groups of citizens in the Netherlands and UK

CO_2-EOR optimization model for LBr-1

Model for optimisation of storage and oil production
Lab tests on oil

Monitoring tool development at Hontomin pilot:

Deep sampling tool tested

Sotacarbo Fault Lab

Near-final sensor array design

TAKE-AWAY MESSAGES

- CCS is real and works.
- CCS is indispensable for achieving deep reductions in CO_2 emissions.
- Geoscientists have a central role in developing and implementing CO_2 storage activities.


THANK YOU FOR YOUR ATTENTION
TNO.NL/ECNPARTOFTNO
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CLOCK IS TICKING

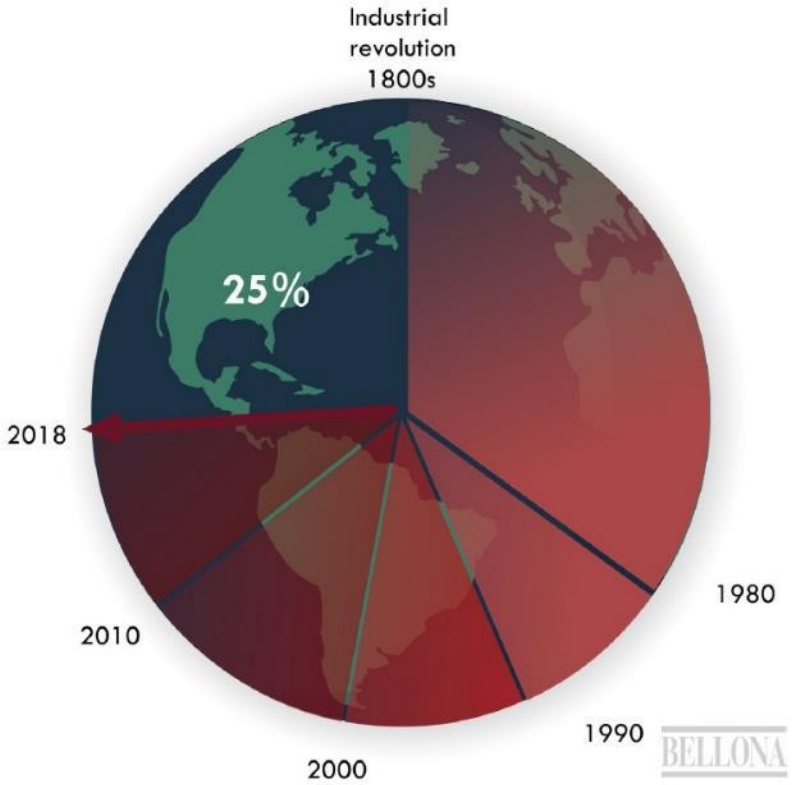
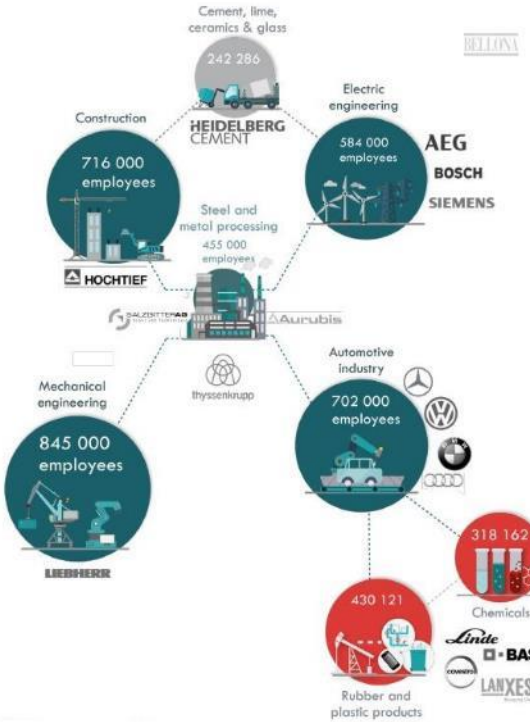
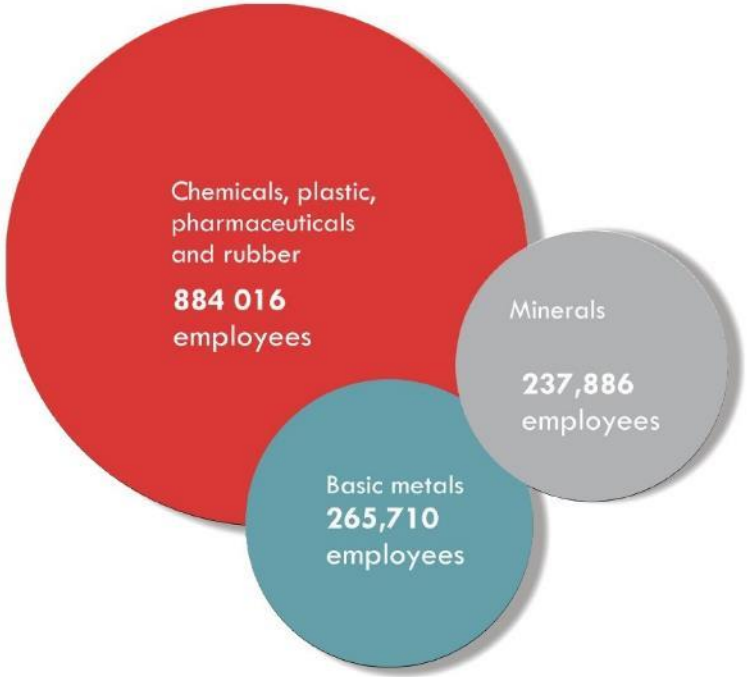


Figure 1: Over the past few decades, the pace of emitting greenhouse gases has hastened substantially. We now only have about a quarter of our carbon budget left before we cross the 2°C mark.

An industry's guide to climate action, Bellona, 2018

NOT JUST A TRANSITION, BUT A JUST TRANSITION





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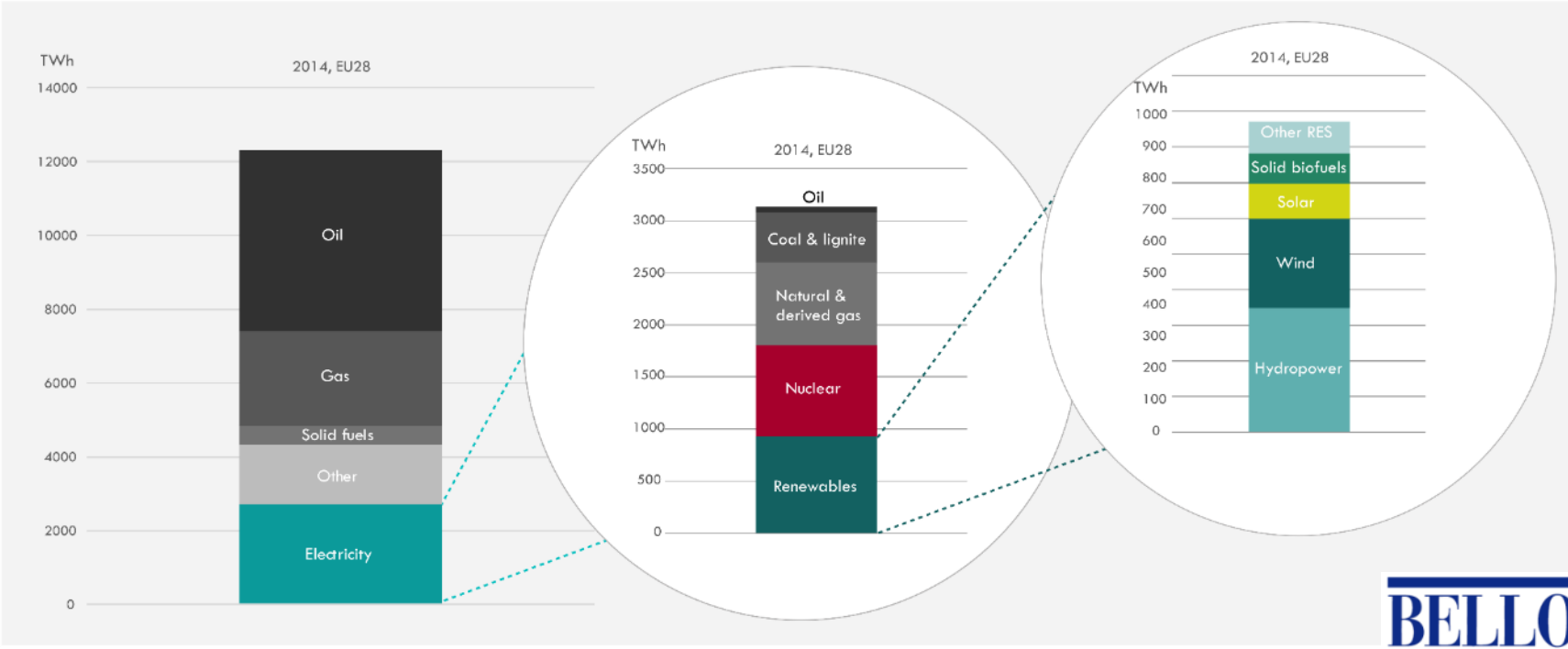
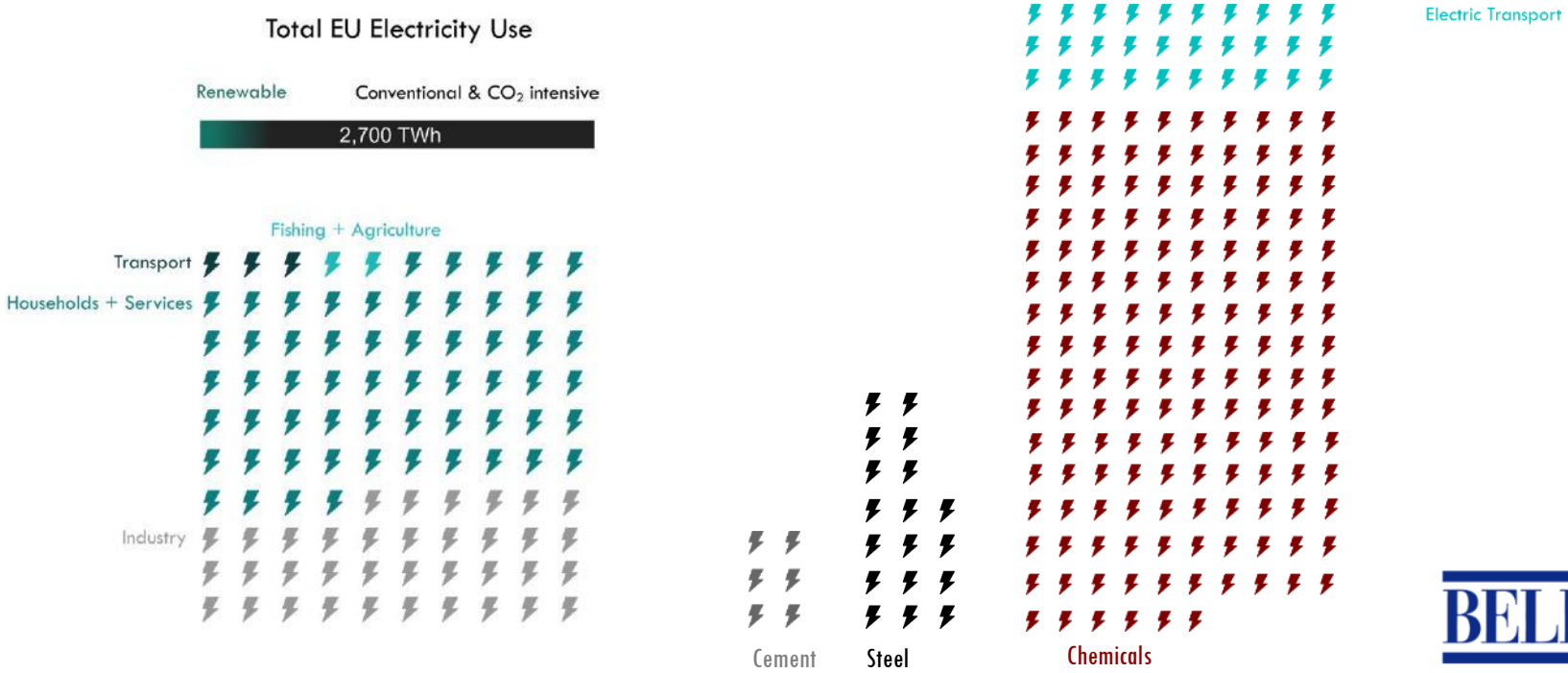
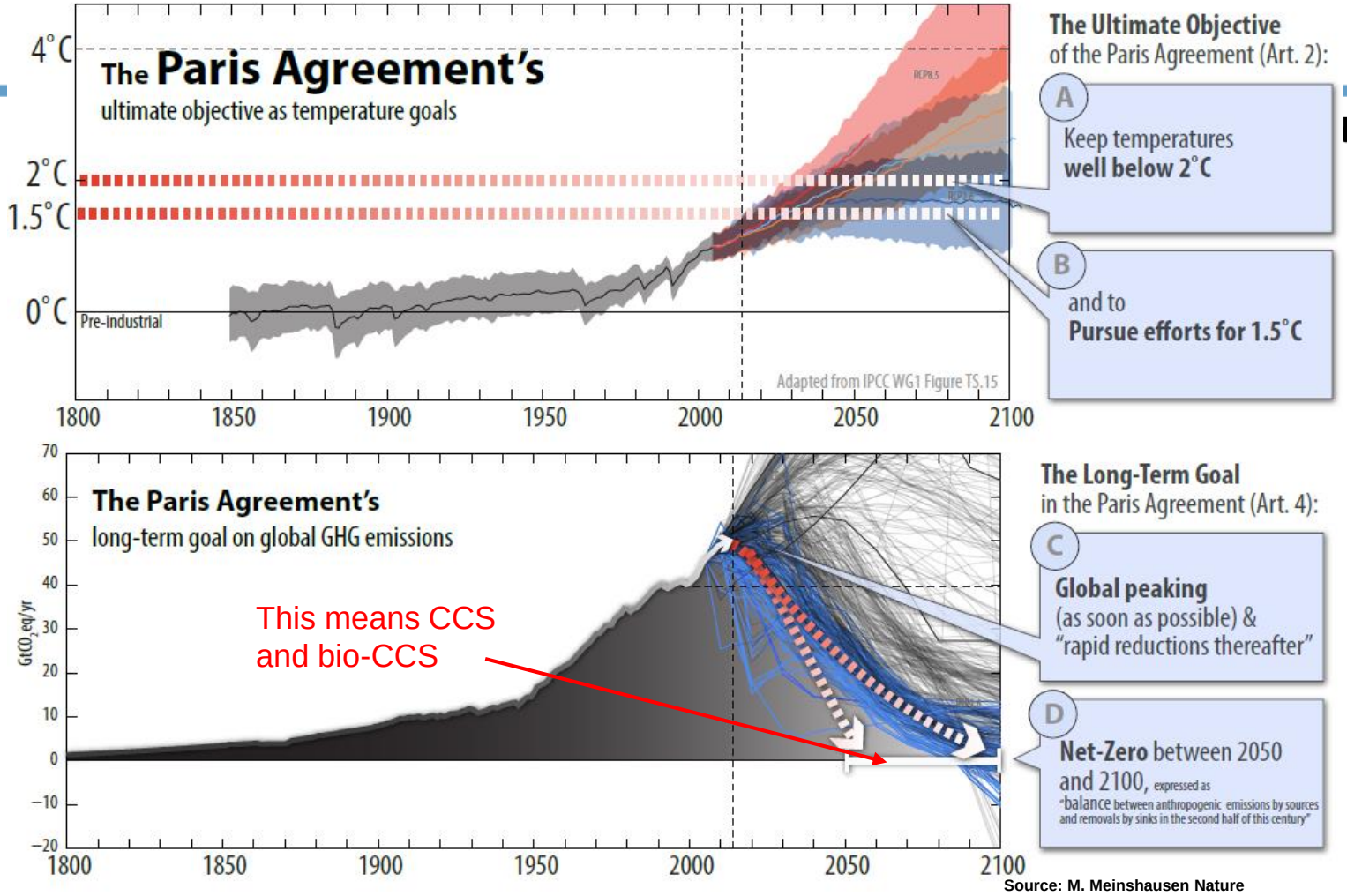
LIMITS OF ELECTRIFICATION



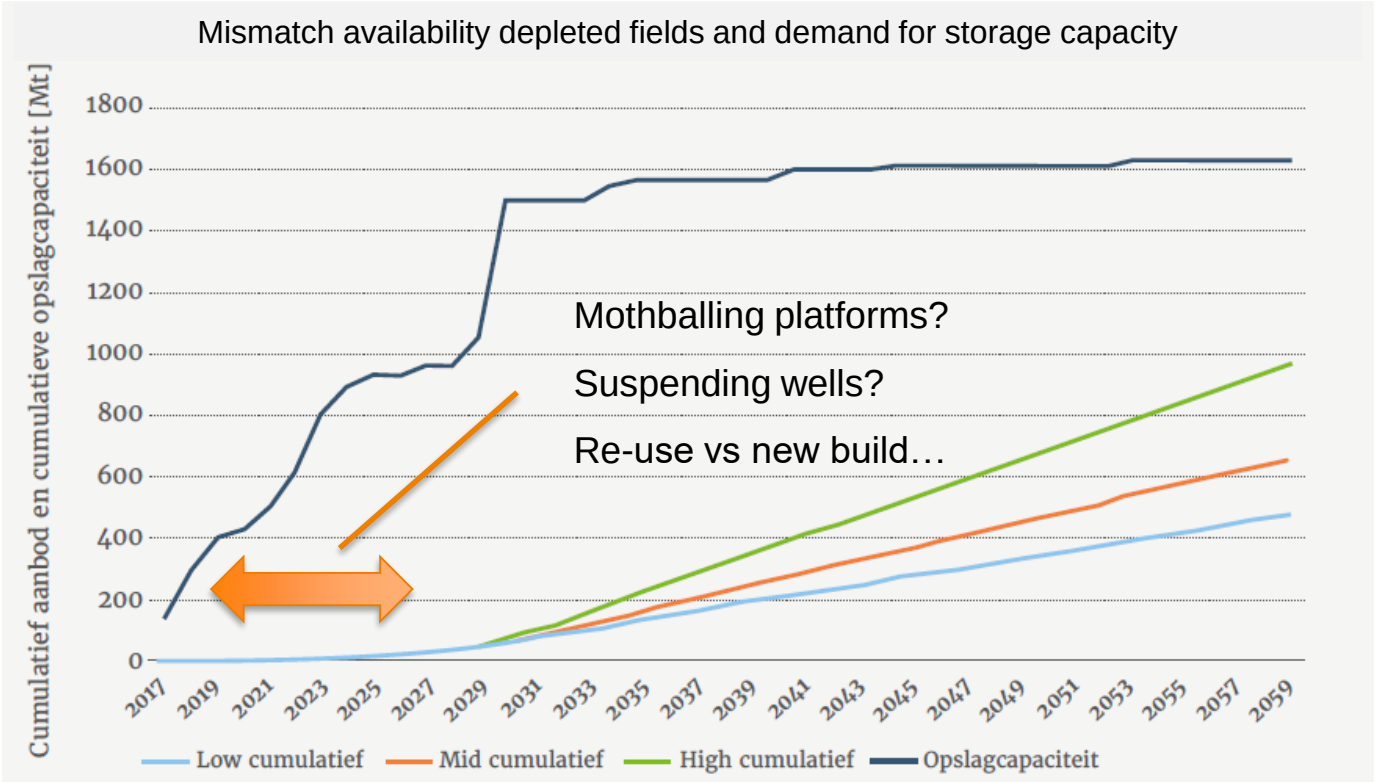
LIMITS OF ELECTRIFICATION





Source: M. Meinshausen Nature

CO_2 SUPPLY VS. STORAGE CAPACITY

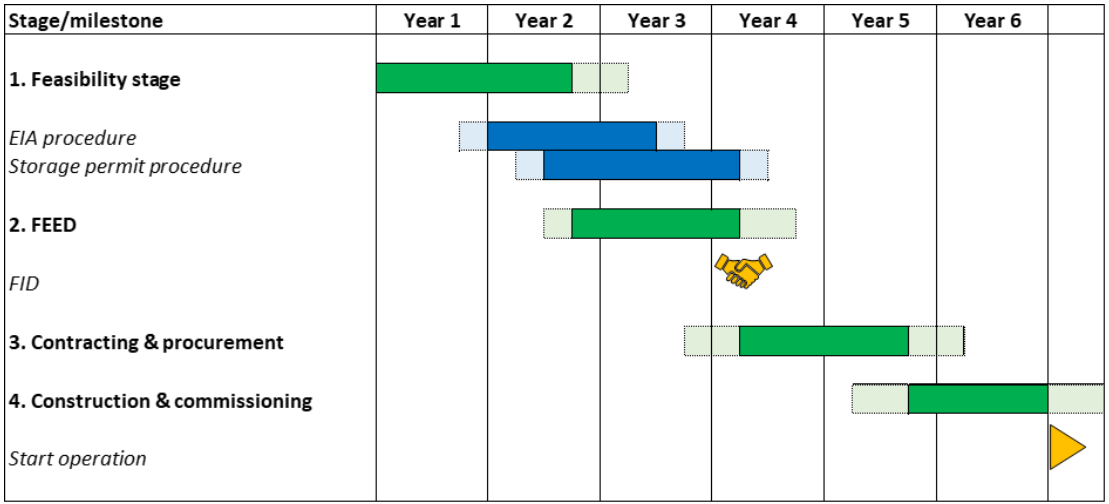


Source: EBN-Gasunie, 2017

STORAGE DEVELOPMENT LEAD TIMES

- Re-using platforms, wells
- New build pipelines

- Developing a depleted gas field into a CO_2 storage site takes at least 6 years



DEVELOPMENT OF CO_2 STORAGE SITE: DEPLETED GAS FIELDS

- Gas fields: typical capacity 15-50 $MtCO_2$
- Developing field clusters
  - Connect several fields to central hub
- Storage capacities 15-20 Mtpa reached by stacking several fields
  - Up to10 fields online in parallel in this example
- High rate of development
  - Fields brought online on yearly basis