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Integral Energy Exploration 2030-2050

Webinar Kivi 26 March 2021

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The study in general

Climate Agreement: Agreement on II3050

2019	Gasunie en TenneT starten, samen met de regionale netbeheerders, tot een integrale infrastructuurverkenning 2030-2050. Oplevering is voorzien in 2021.

"Gasunie en TenneT nemen samen met de regionale netbeheerders in 2019 het initiatief om een integrale infrastructuurverkenning 2030-2050 op te stellen waarin inzichten vanuit de energiesector, vraagontwikkeling in de industrie en bevindingen vanuit de regionale energiestrategieën (RES'en) worden meegenomen. Daarbij worden relevante stakeholders betrokken, waaronder marktpartijen. Deze infrastructuurverkenning 2030-2050 dient als leidraad voor onder andere de investeringsplannen van de netbeheerders en voor investeringen door marktpartijen. De verkenning is gereed in 2021."

II3050 Participants

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STEDIN

ENEXIS NETBEHEER

TenneT

westland infra netbeheer

gasunie transport services

Liander

Phasing II3050

2019			2020		2021
1 apr	1 jul	1 sep	1 apr	1 okt	1 jan	1 apr
		START				AFRONDING

Phase 0 Preparation	Phase 1 Scenarios 2050	Phase 2 Grid analysis	Phase 3 Infra development pathways
Approval 6 June 2019	Support by Berenschot / Kalavasta. * Spatial impact by EZK	By all participating grid operators	Inclusive total cost of energy system. *
Results →	**Agreed scenarios 2050 Published 15 April 2020**	**Infrastructure solution directions For r 2050**	**Infrastructure development pathways for 2030-2050**

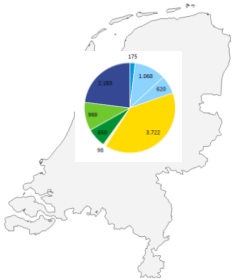
Scenario's

Ruimtelijke impact (EZK)

Kernenergie (EZK)

II3050 The methodology

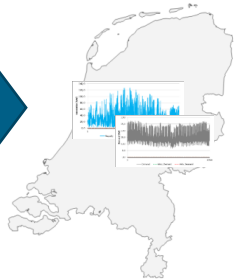
Phase 1



Scenarios
2050

- Regional
- National
- European
- International

Phase 2

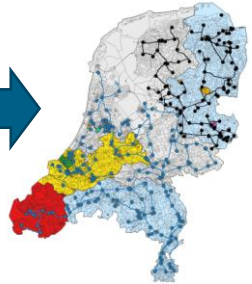


Time series (ETM)
2050

- Electricty
- Hydrogen
- Methane
- Heat

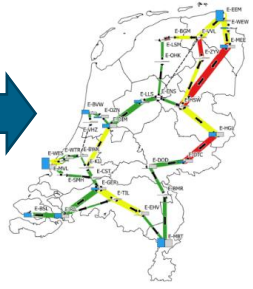
Regionalization
2050

- Supply
- Demand
- Flexibility
- Exchange



Grid modeling & calculations

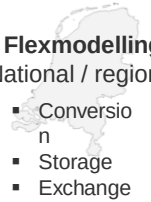
- Base grid (2030)
- Extended grid(s)



Analysis & visualization

- Usage grid nodes
- Usage lines
- Aggregated regions
- …

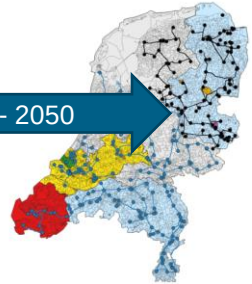
Flexmodelling
National / regional



- Conversion
- Storage
- Exchange

Phase 3

2030 - 2050



Definition of measures
2030 - 2050

- Infrastructure adjustments
- Flex market / technologies

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The scenarios

Scenarios 2050

Regional

SCENARIO CHARACTERISTICS

GENERAL:
- The Netherlands achieve CO_2-targets through regional development
- 100% CO_2-reduction
- Self-supporting
- No import of energy carriers
- Reduction of energy-intensive industry
- Regional projects
- Civilians are highly driven
- Circularity is a key feature of goods and food production

BUILT ENVIRONMENT:
- Heat networks 45%
- Electric heat pump 35%
- Hybrid HP green gas 20%

INDUSTRY:
- Decreasing production volume
- Electrification & green gas
- Circular

ELECTRICITY PRODUCTION:
- Solar PV rooftops 59 GW
- PV solar farms 66 GW
- Wind onshore 20 GW
- Wind offshore 31 GW*
- H_2 powerplants 39 GW

STORAGE:
- H_2 wind power electrolysis
- Batteries (short term)

National

SCENARIO CHARACTERISTICS

GENERAL:
- The Netherlands achieve CO_2-targets nationally, as frontrunner in Europe
- 100% CO_2-reduction
- Very high level of self-sufficiency
- Minimal import of energy carriers
- Energy-intensive industry stays at its current size
- Large national projects
- Circularity important for goods and food production

BUILT ENVIRONMENT:
- Heat networks 25%
- Electric heat pump 55%
- Hybrid HP green gas 20%

INDUSTRY:
- Same production volume
- Electrification & hydrogen
- Circular

ELECTRICITY PRODUCTION:
- Solar PV rooftops 52 GW
- PV solar farms 57 GW
- Wind onshore 20 GW
- Wind offshore 52 GW*
- H_2 powerplants 45 GW

STORAGE:
- H_2 wind power electrolysis
- Batteries (short term)

European

SCENARIO CHARACTERISTICS

GENERAL:
- Europe achieves CO_2-targets and thereby it is the global frontrunner
- 100% CO_2-reduction
- General CO_2-tax, CO_2-taxation on imports and compensation at the European borders
- Energy-intensive industry grows
- Global hydrogen and biomass market
- Important role for CCS

BUILT ENVIRONMENT:
- Heat networks 15%
- Electric heat pump 25%
- Hybrid HP green gas 40%
- Hybrid HP hydrogen 20%

INDUSTRY:
- Growing production volume
- Electrification & hydrogen
- Fossil feedstocks

ELECTRICITY PRODUCTION:
- Solar PV rooftops 24 GW
- PV solar farms 35 GW
- Wind onshore 10 GW
- Wind offshore 30 GW*
- Biogas powerplants 47 GW

STORAGE:
- H_2 wind power electrolysis
- H_2 from gas + CCS
- Batteries (short term)

International

SCENARIO CHARACTERISTICS

GENERAL:
- Entire world aiming to achieve CO_2-targets; fossil fuel is being heavily limited
- 100% CO_2-reduction
- Free trade is being stimulated
- Trade infrastructures are being promoted
- Energy-intensive industry grows
- Global hydrogen and biomass market
- CCS is given scope

BUILT ENVIRONMENT:
- Heat networks 15%
- Electric heat pump 25%
- Hybrid HP hydrogen 60%

INDUSTRY:
- Growing production volume
- E + H_2 + limited use of CCS
- Fossil feedstocks

ELECTRICITY PRODUCTION:
- Solar PV rooftops 18 GW
- PV solar farms 35 GW
- Wind onshore 10 GW
- Wind offshore 28 GW*
- H_2 powerplants 48 GW

STORAGE:
- H_2 wind power electrolysis
- H_2 import
- Batteries (short term)

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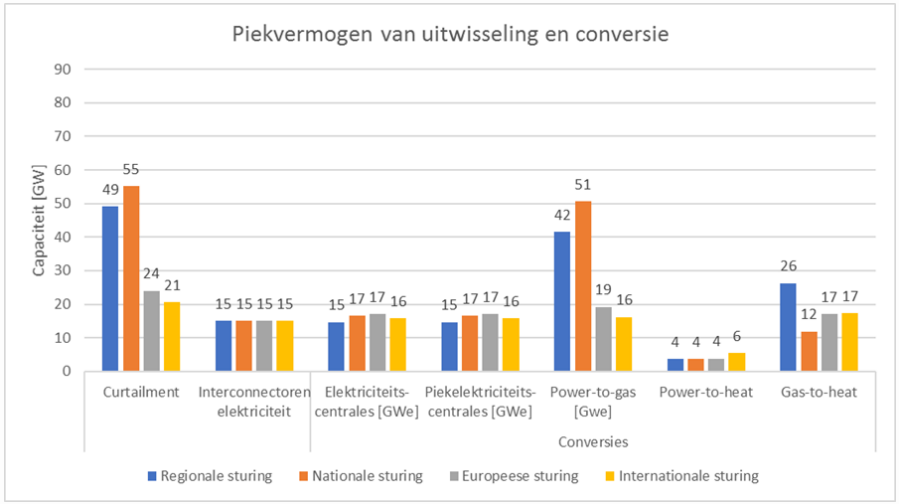
Flexibility requirements

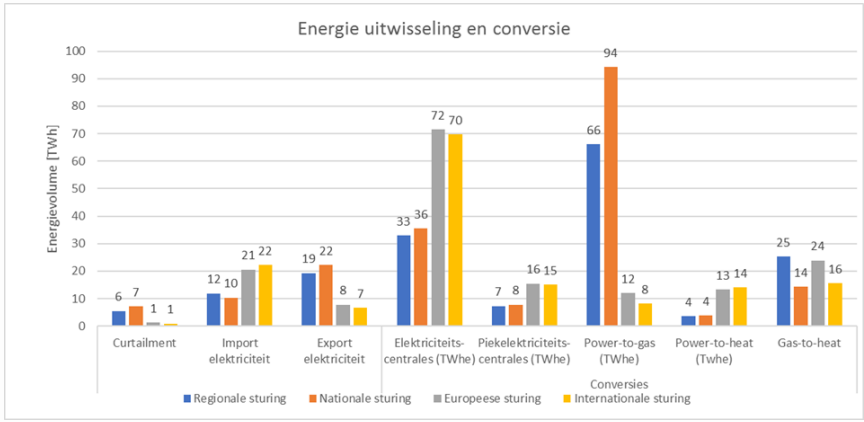
Required capacities of flexibility options



Curtailment powerful instrument to reduce infeeds

Doubling of adjustable gas fired power plants

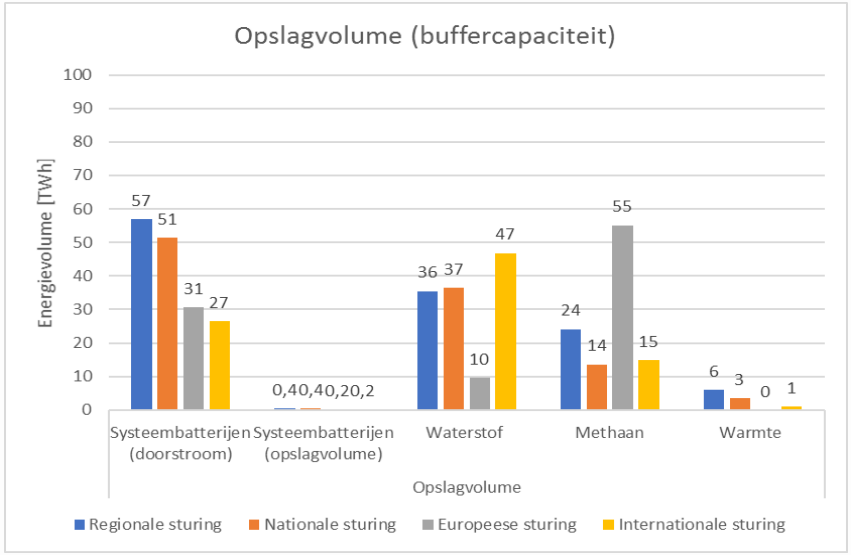
Electrolysers probably smaller amounts economic justifiable

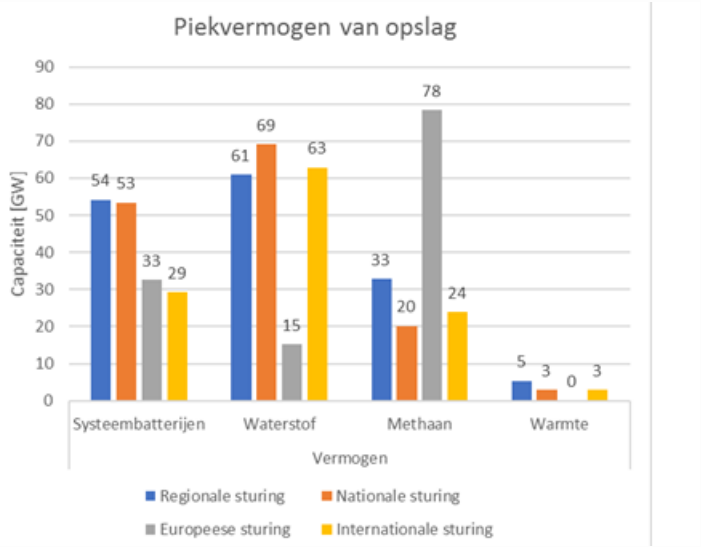


Required storage volumes

High volumes of storage needed:
E.g. batteries 0,4 TWh storage volume corresponds roughly to 30 million home batteries (13kWh per unit)

Total volume of gas storage (hydrogen+ methane) around 90 TWh





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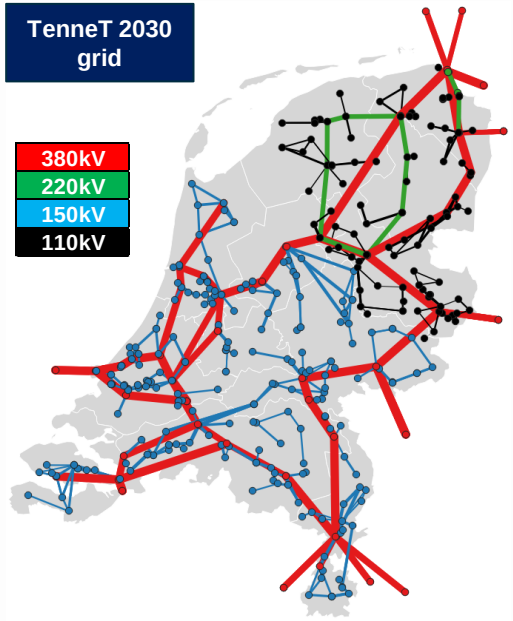
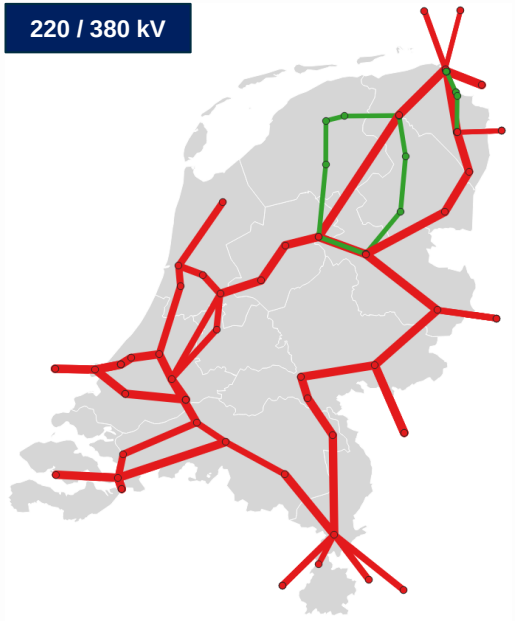
Development pathways national transport grid

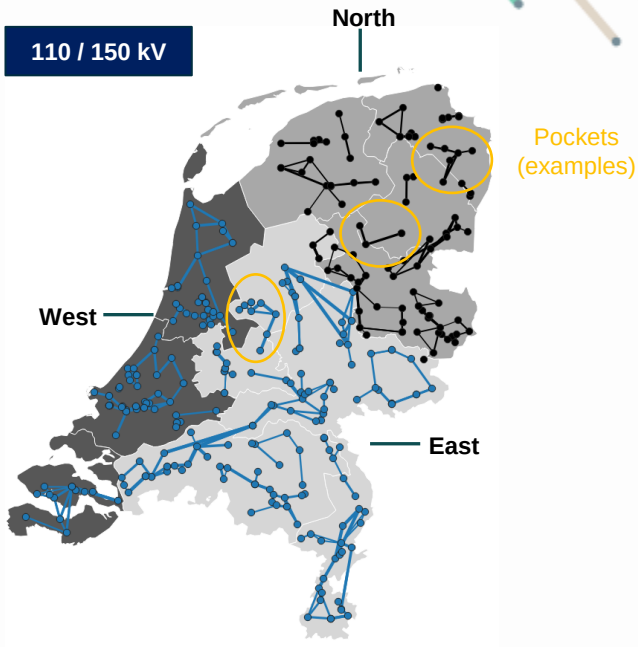
National transport grid 110- 380 kV



- Today's electricity grid TenneT (110 / 150 / 220 / 380kV)
- Future foreseen projects (including projects in study phase)

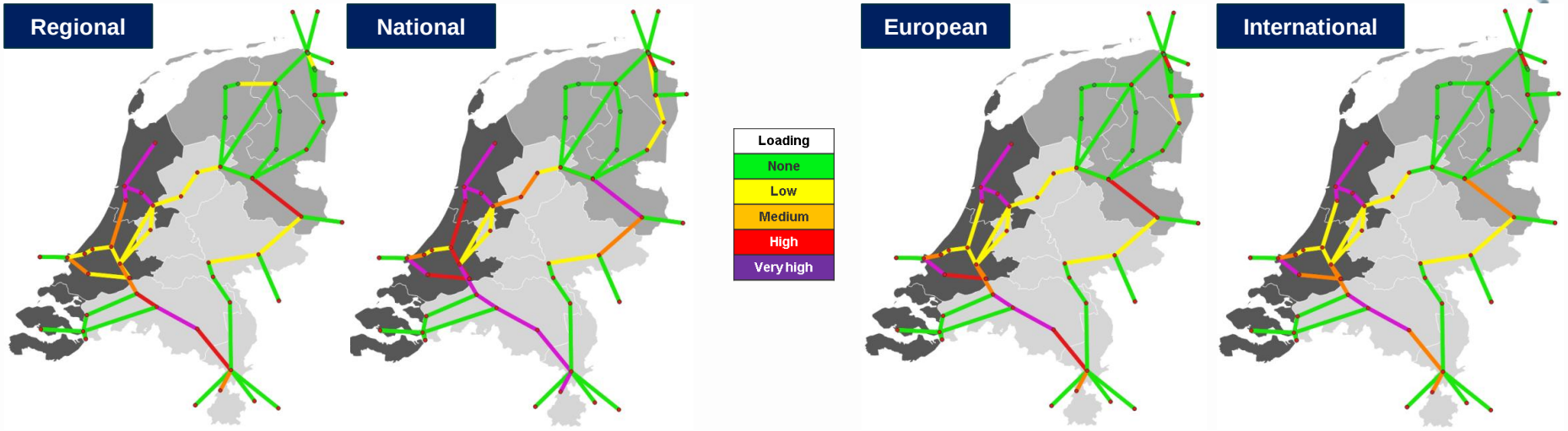


- Many circuits upgraded to 4 kA
- New connections, e.g. extra 380kV from Eemshaven to Ens



- New connections
- Creation of pockets

220/380kV-grid



Infeed of high volumes of offshore wind biggest challenge for 380kV-network

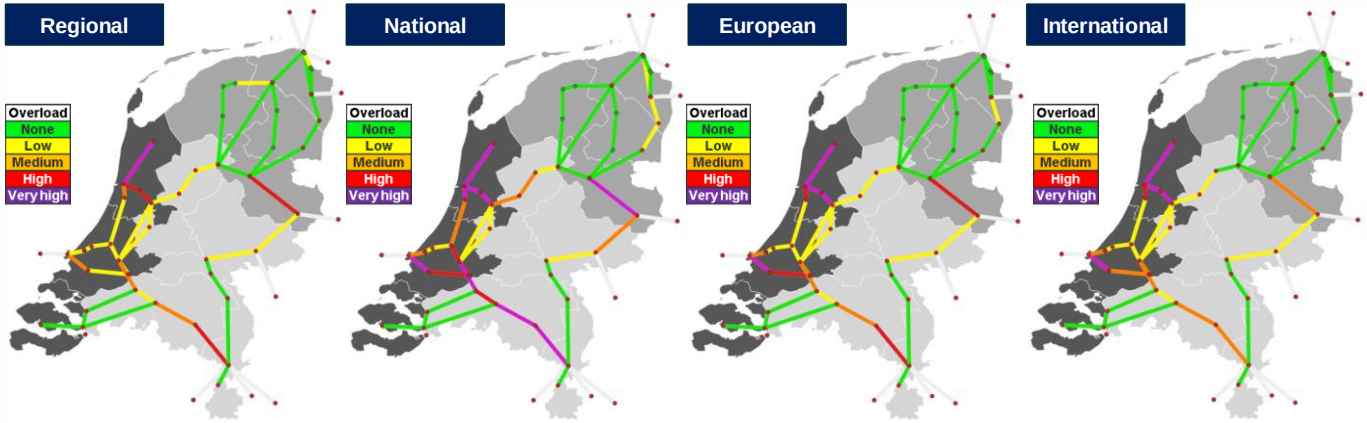
220/380kV-network – upgrade to 4kA

Upgrade to 4kA
Not necessary
Already done
Necessary

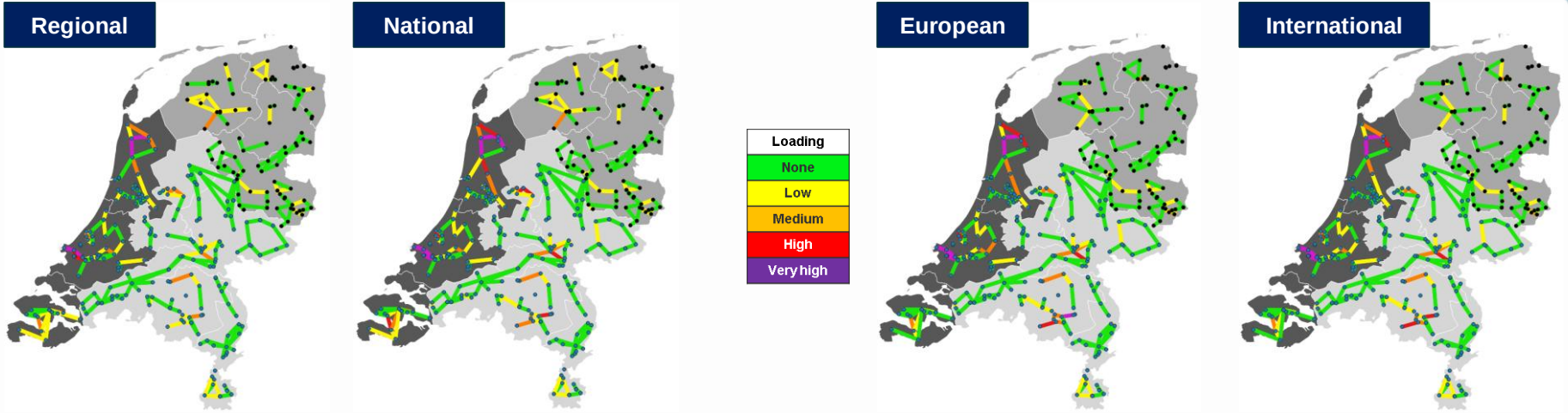
220/380kV-grid – Extra lines

Strongly dependent on distribution of offshore wind over landing locations

Most likely extra 380kV-lines needed for :
- Tilburg – Eindhoven – Maasbracht line
- North of Noord-Holland
- Maasbracht-area



110/150kV- grid

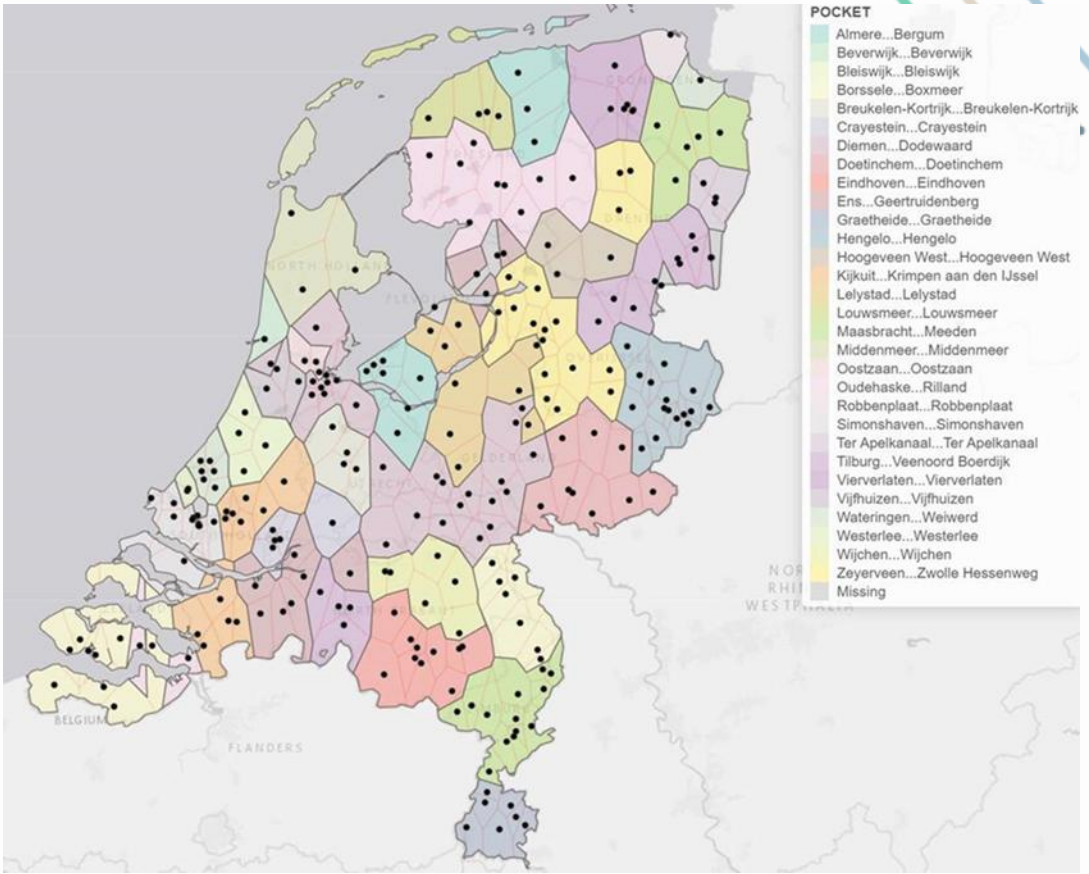


- Doorvoeren pocketvorming rond Maasvlakte en kop van Noord-Holland
- Op basis van ontwikkeling opwek of belasting (groter dan 1000-1500 MVA) kan een verdere opsplitsing in twee of meerdere pockets nodig zijn (bijvoorbeeld Oudehaske en Eindhoven).
- Grotere initiatieven direct aansluiten op 220/380kV-netwerk

110/150kV- grid

Further split up in load pockets as currently foreseen

Such as in the Maasvlakte area



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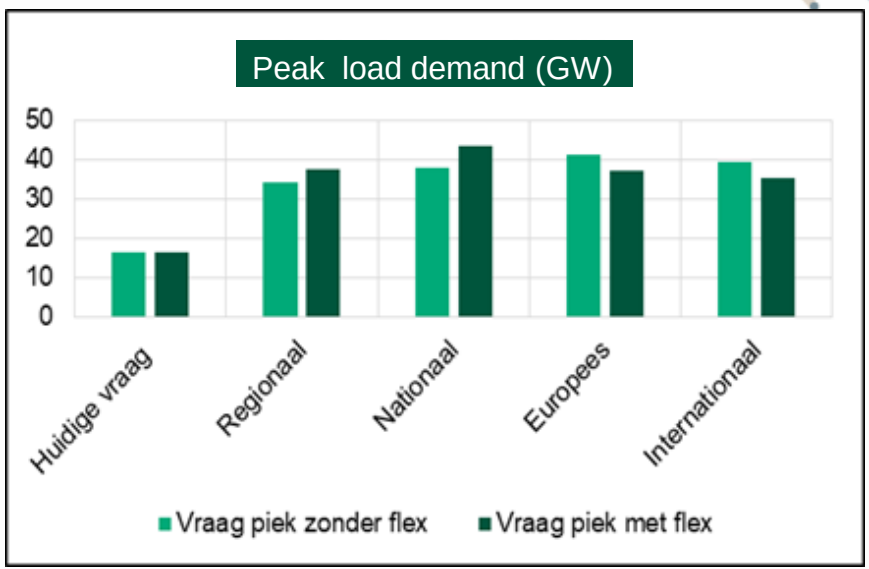
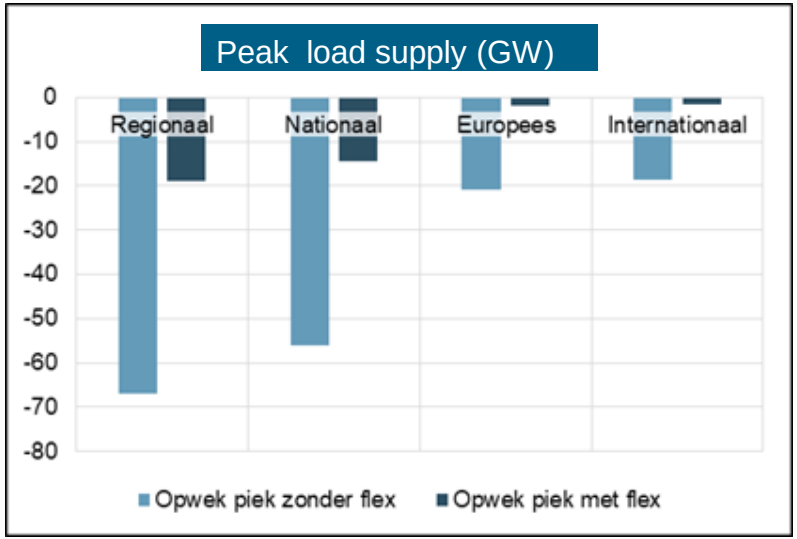
Development pathways Regional grids

2050 Peakloads

More than two times higher peak load due to demand

In the absence of batteries peak load due to production grow with a factor 3 to 4 for self-sufficient scenarios.





2050 grid: Large expansions for all voltage levels

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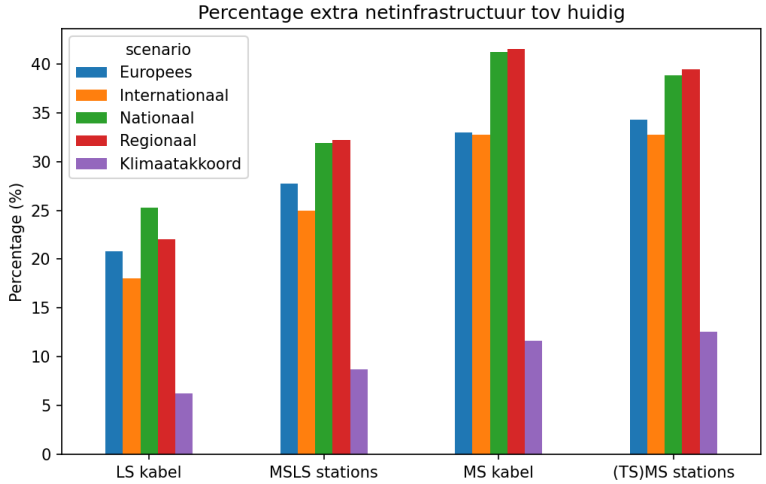
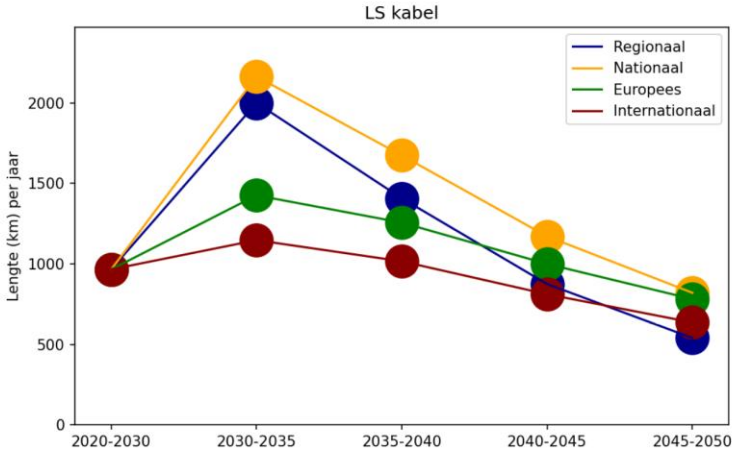
Higher growth rates for the high voltage grids due to solar and wind farms

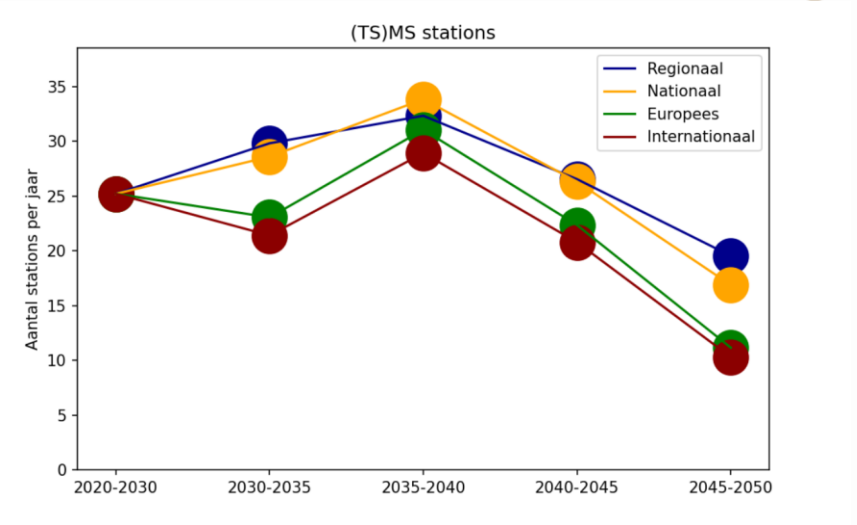


Development pathways:

Growth from current number of 1200 substations to 1800-2000 stations in 2050

Additional need for 60.000 to 80.000 km of low and mid voltage cables





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Development pathways- Gas transport grid.

2050 Grid: High pressure grid

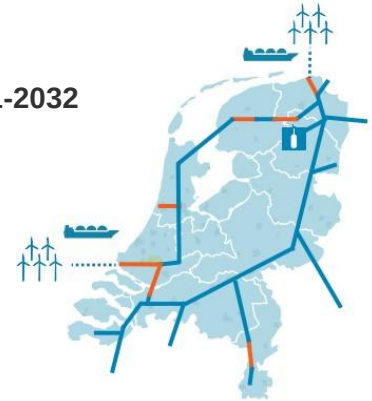
Current Groningen low-calorific grid used for green methane transport

Current high-calorific grid used for hydrogen transport

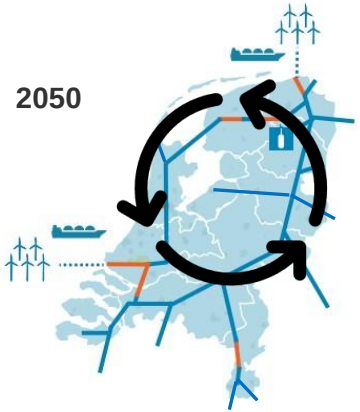
Development pathway : from H2-backbone to H2-roundabout

2027

2031-2032



2050



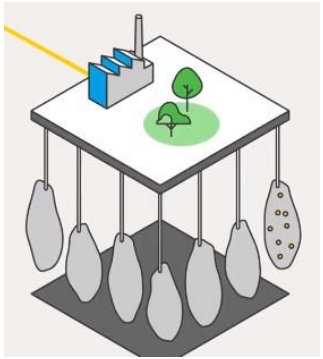
Able to accommodate transfer flows

Reinforcement of connections to:

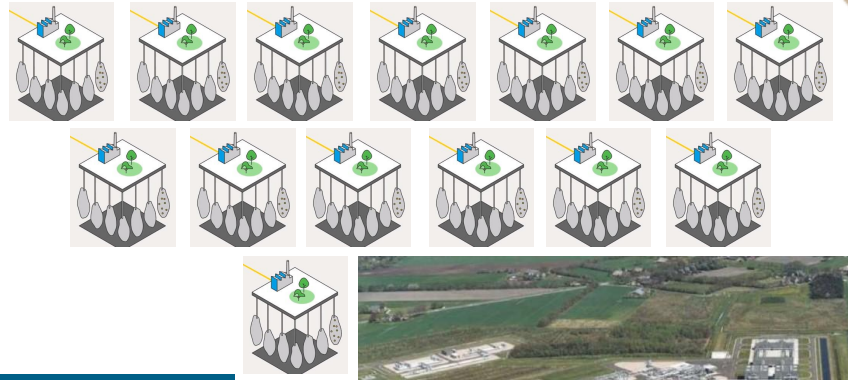
- Industries and storage facilities
- Germany and Belgium

Development pathway : high-need for H2-storage

2027



2050



2027- first cavern in Zuidwending for H_2

Scaling up to 45 to 225 caverns in 2050 (130 caverns technical potential)

Growth rate exceeds rate of current rate of salt production.

Further investigate use of current natural gas storage facilities for hydrogen

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Development pathways- Gas distribution grids

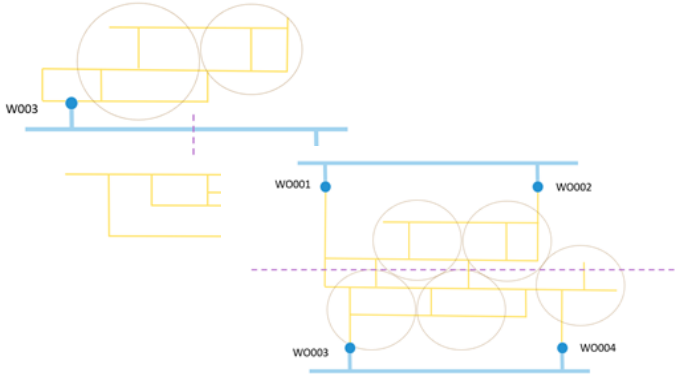
Development pathway gas distribution grids

Diversification: different gases and qualities

- 2020-2030 Increase in biogas infeed
- >2030 export to high pressure grids ➔ installation of booster
- >2035 Hydrogen in built environment

Simultaneous transport of different gases

- Temporarily more infrastructure needed
- Complex partition puzzle which requires involvement of citizens, local administration, regional grid operators and also Gasunie
- Requires direction (by government)



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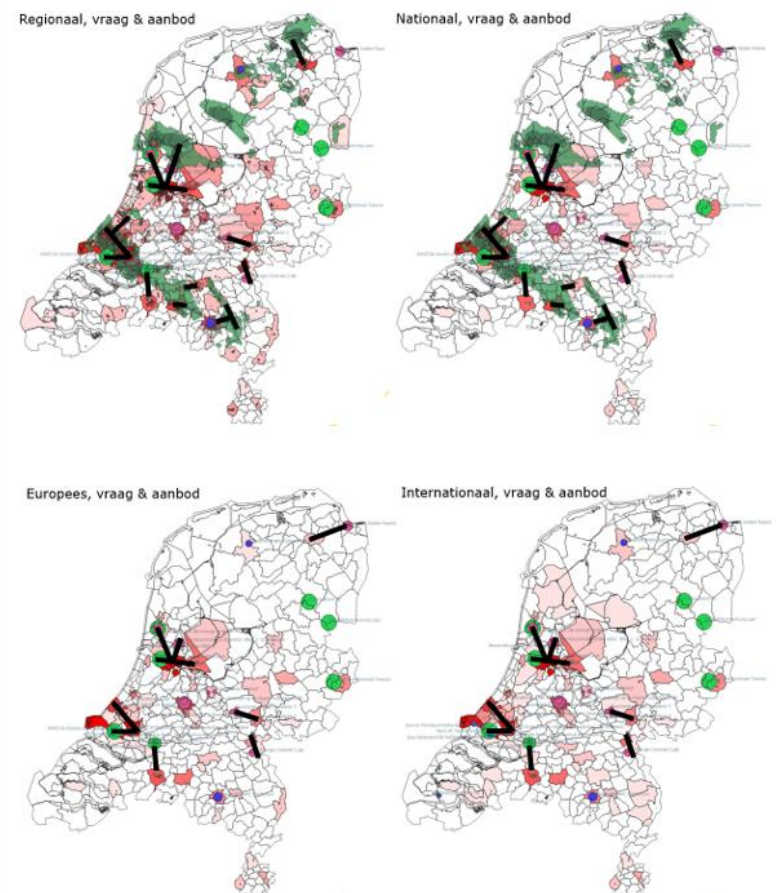
Development pathway district heating and CO2

Development pathway district heating



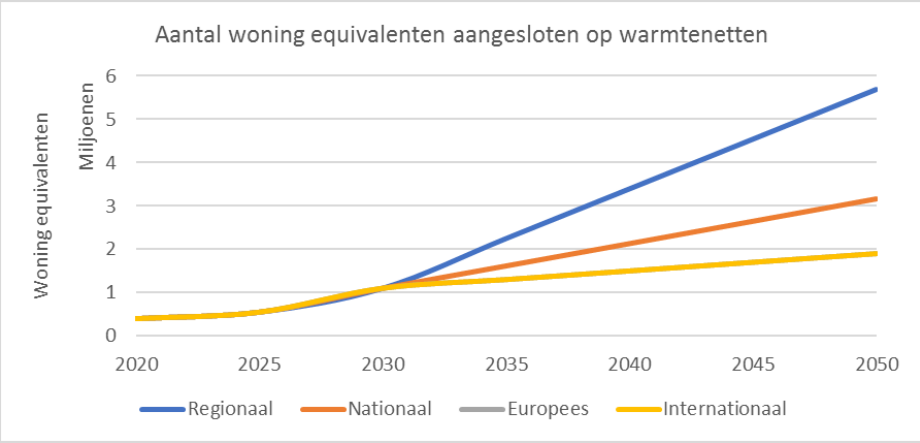
In all scenarios development of heat transport infrastructure foreseen in the areas:

- Rotterdam-Den Haag
- Amsterdam
- Groningen
- Nijmegen

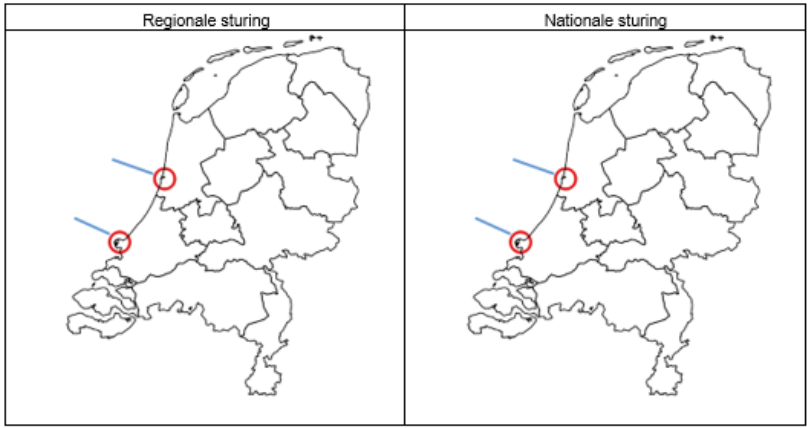
Development pathway district heating

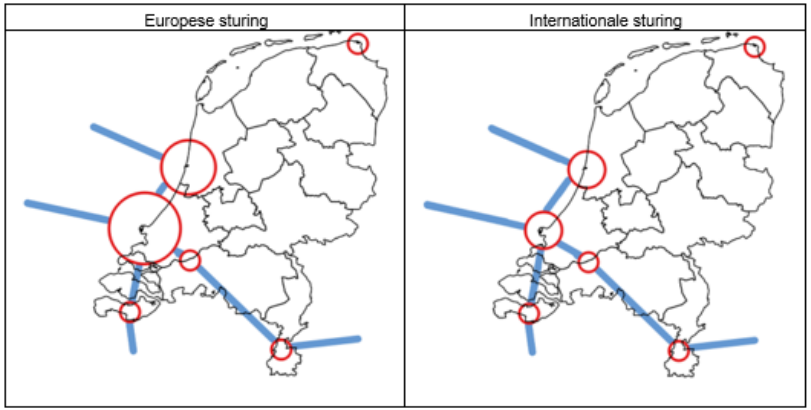
Expectations of owners of the larger district heating are in line with Climate Agreement target of 1 million connections in 2030

For 2030 onwards there is much more uncertainty.



2050 CO_2 infrastructure requirements





For all scenarios a certain amount of carbon dioxide storage is foreseen (3,5 Mt- 17 Mt)

This will require development of offshore storage in empty gasfields

For the two import scenarios, with higher levels of carbon dioxide emissions, the development of a pipeline infrastructure is proposed als connecting the industrial clusters at Antwerp and the Ruhr area

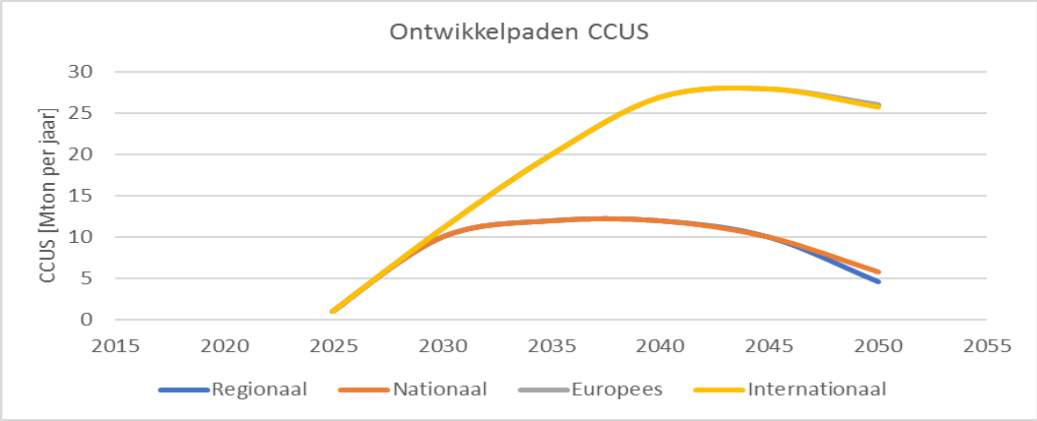
Development pathways CO_2 infrastructure

In the Climate Agreement it is agreed that half of the CO_2 –reduction by the industry can come from CCS

The total amount of CCS in 2030 is capped in the Climate agreement at 10 Mt per year.

For the long term it is foreseen that the role of CCS will decrease, due to:

- The rate at which EU or national government wants to decrease CO_2-emissions.
- The availability of cheaper alternatives



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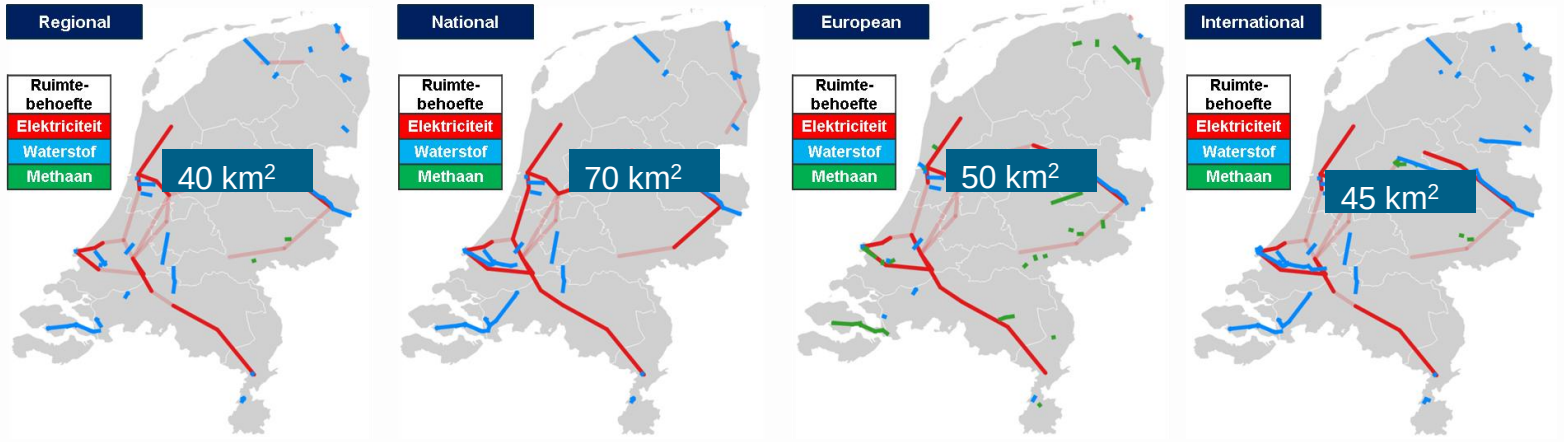
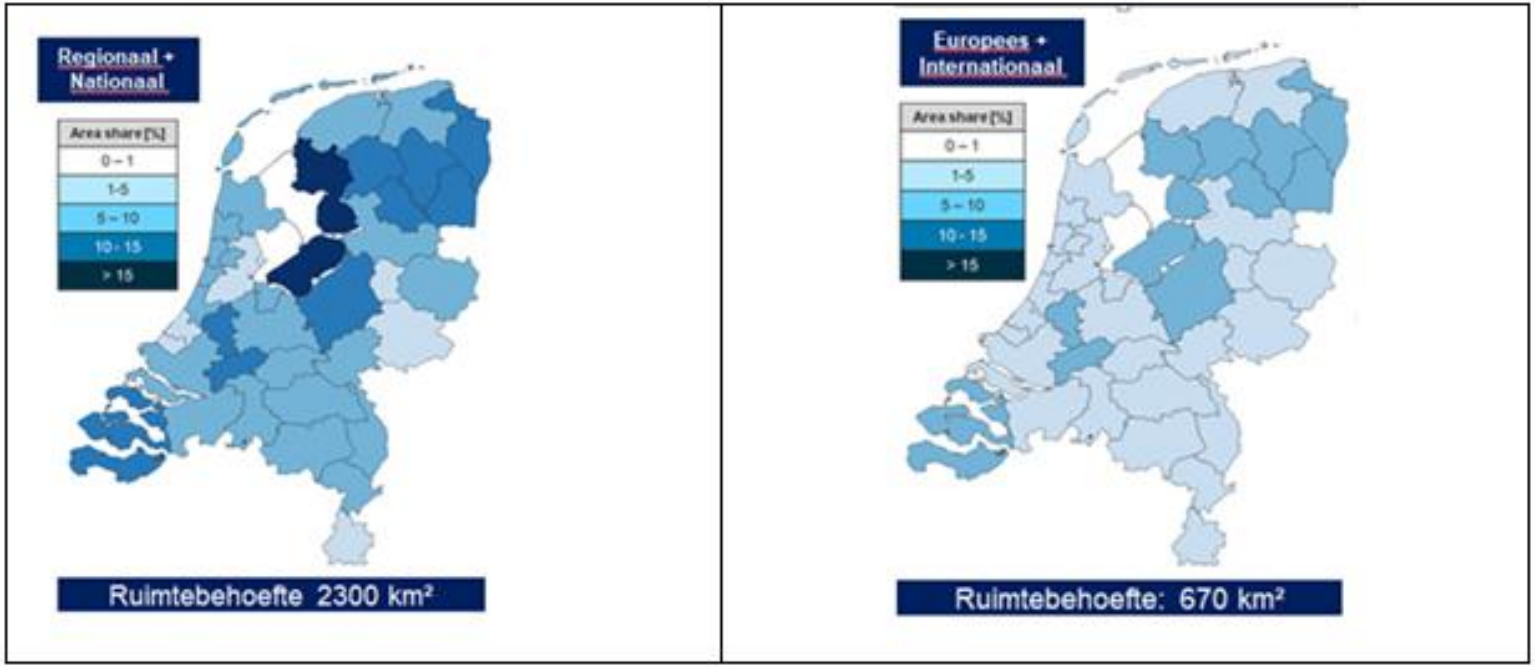
Spatial requirements

Spatial use: infrastructuur

Landelijke netten



Spatial use: renewables



Remarks on spatial use

- For both overhead lines and wind turbines is direct spatial use limited
- However acceptance of these assets in the living environment by citizens is low
- Also small-scale expansions such as new low-voltage transformers spaces in inner cities is more and more a challenge.
- It is now up to the different consultation structures, such as the Regionale Energie Strategieën, the Programma Energie Hoofdinfrastructuur and the Programma's Regionale Energie Infrastructuren to compare the long term views from this study with theirs.

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Total Cost

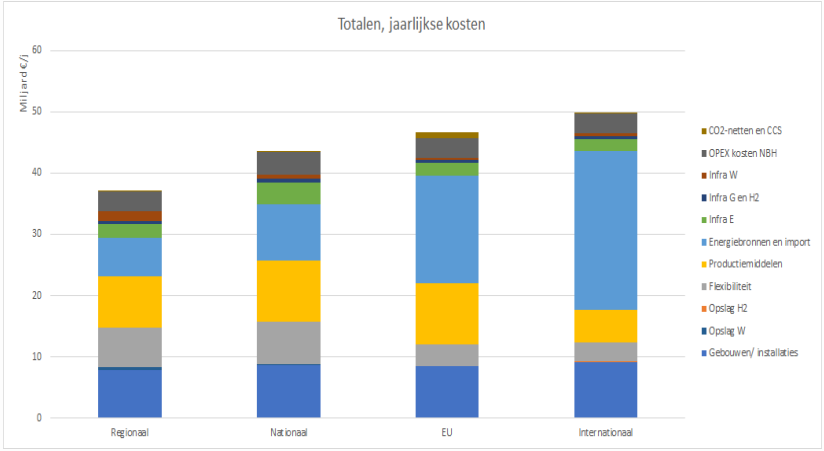
Total Cost

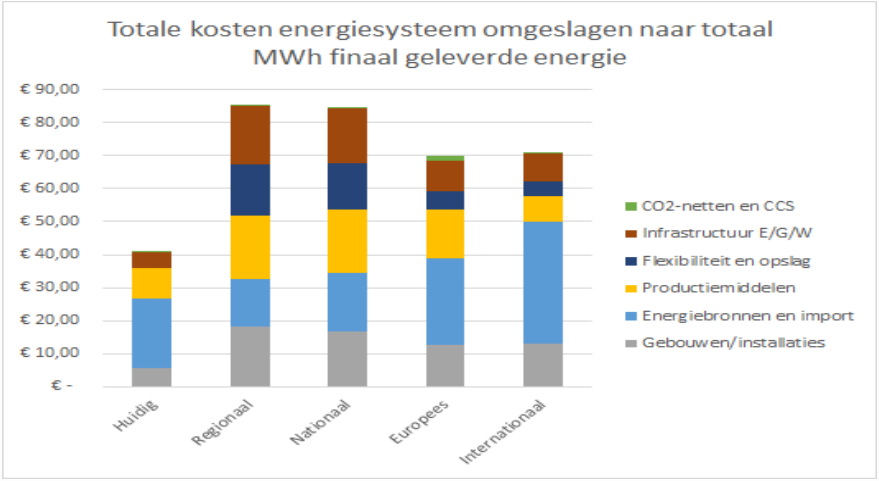
Roughly a doubling of cost is calculated for all scenarios

For the self-sufficient scenarios the costs are dominated by production assets and flexibility

For the import the costs are dominated by the procurement of green gases

The infrastructure costs vary between 11 and 20% of total costs.





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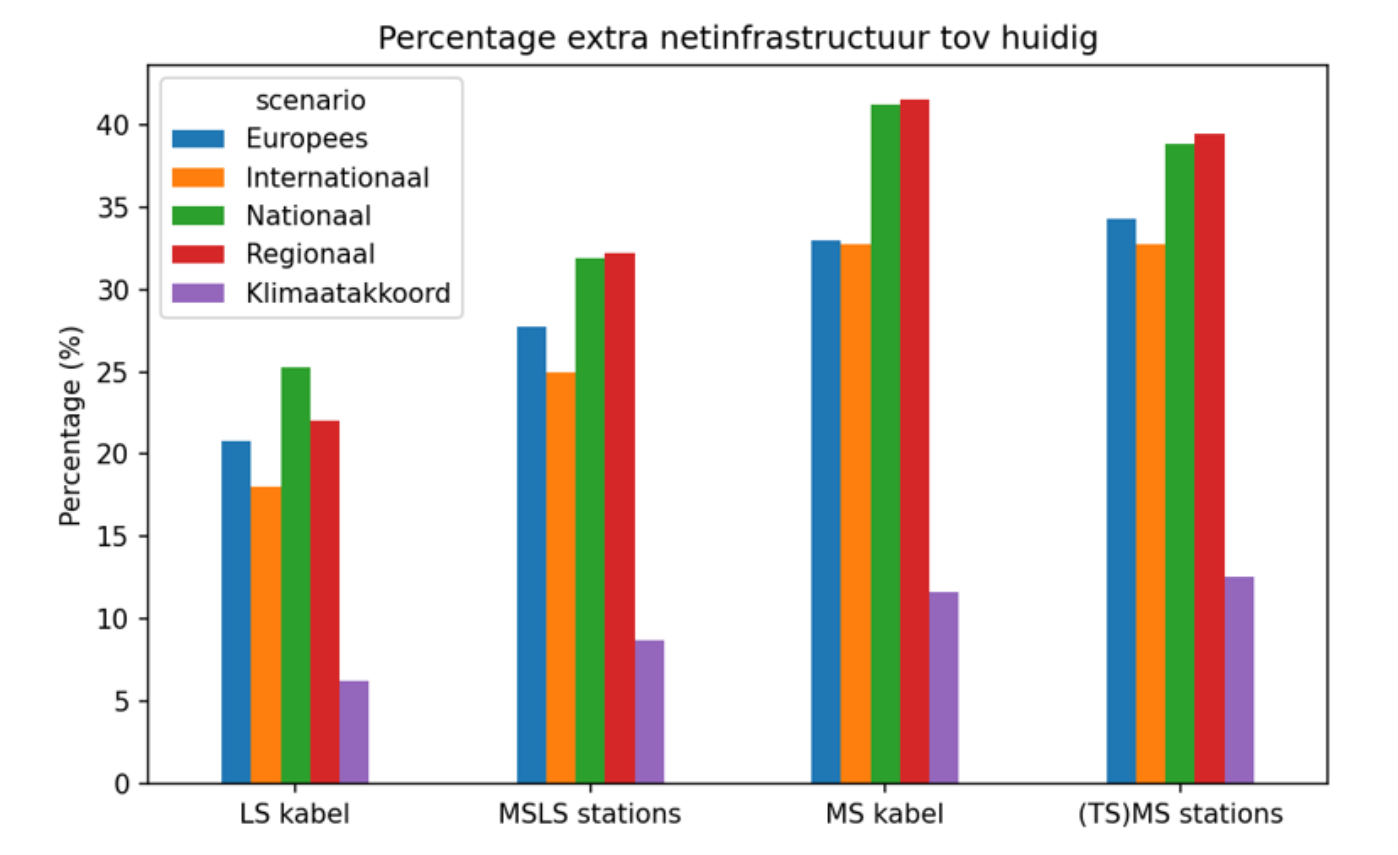
Practicability

Practicability: large speed up required



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Questions