DE ENERGIE TRANSITIE, KANSEN EN BEDREIGINGEN

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NAP bijeenkomst 7 november 2019

ECN TNO innovation for life

OUTLINE

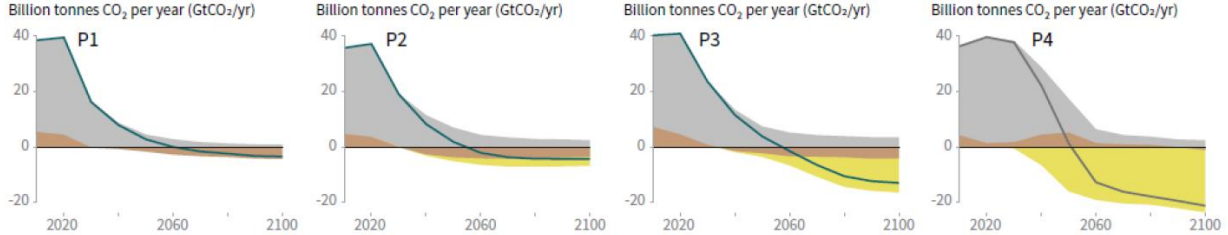
- Energy and climate, the big picture
- The Dutch Climate Agreement
- Recent developments in the energy supply chain
- Energy transition
- The ECN.TNO roadmap ‘Towards a societally embedded energy transition’
- The role of Industry : examples from the MIDDEN project
- Conclusions

INTEGRATED SCENARIO'S MODELING FOR POSSIBLE PATHWAYS

THE IPCC 1,5 OC REPORT: EMISSION PATHWAYS

Breakdown of contributions to global net CO_2 emissions in four illustrative model pathways

Fossil fuel and industry AFOLU BECCS



P1: A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

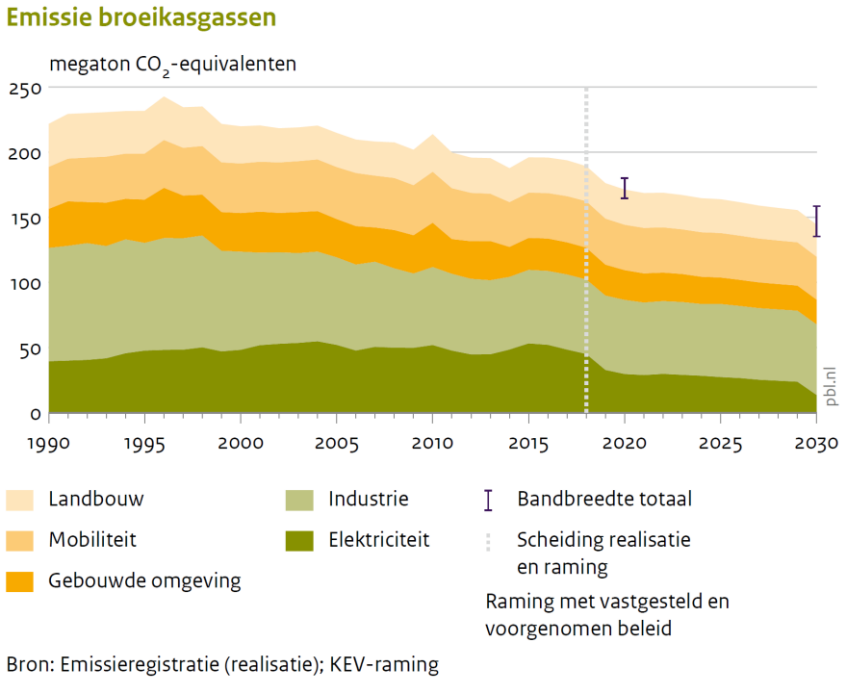
2

CLIMATE AND ENERGY OUTLOOK 2019

- The Climate and Energy Outlook 2019 presents an updated overview of the national greenhouse gas emissions and the energy system until 2030.

Main result:

- The emission of greenhouse gases is decreasing.

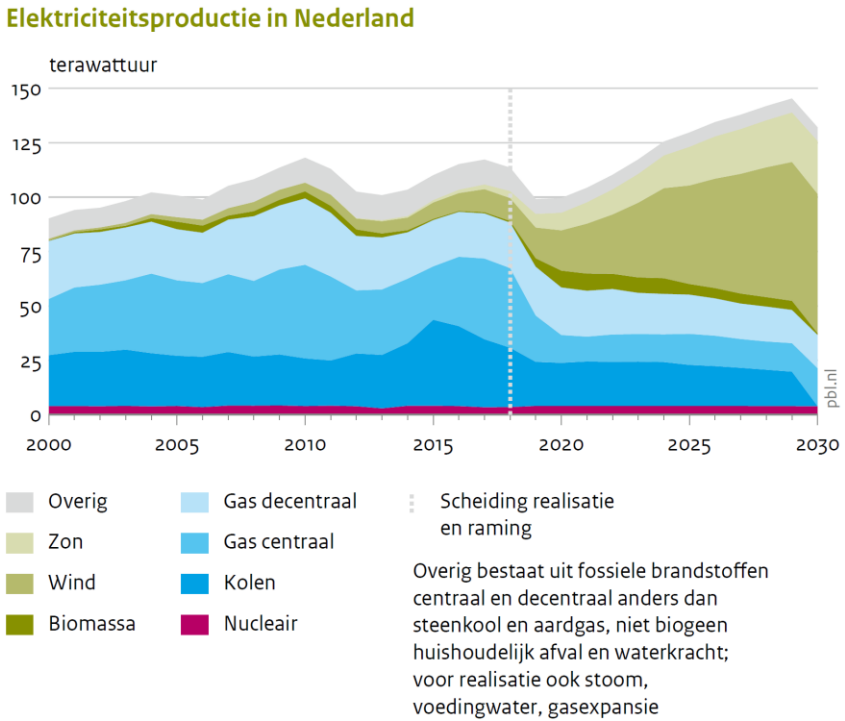


Schoots, K. & P. Hammingh (2019), Klimaat- en Energieverkenning 2019, Den Haag: Planbureau voor de Leefomgeving.

CLIMATE AND ENERGY OUTLOOK 2019

Messages:

- The share of renewable electricity will increase substantially.
- The use of coal for electricity production will be phased out.
- The Netherlands will no logeer be a natural gas exporter.



Schoots, K. & P. Hammingh (2019), Klimaat- en Energieverkenning 2019, Den Haag: Planbureau voor de Leefomgeving.

CLIMATE AGREEMENT (INDUSTRY)

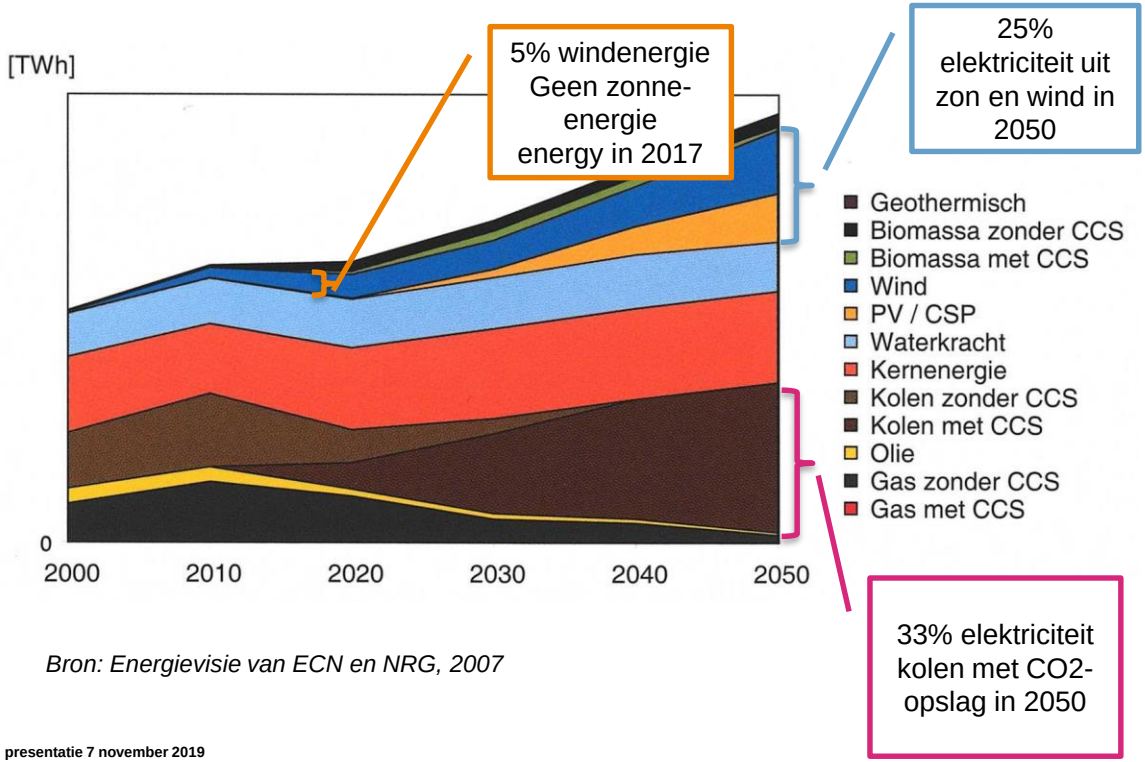
The Dutch industry needs to and wants to be an important driver for the transformation to a sustainable and circular economy.

Instruments include:

- Broadening of the SDE+ subsidy;
- A ‘sensible’ CO_2 tax;
- An innovation program;
- Regional cluster approach.

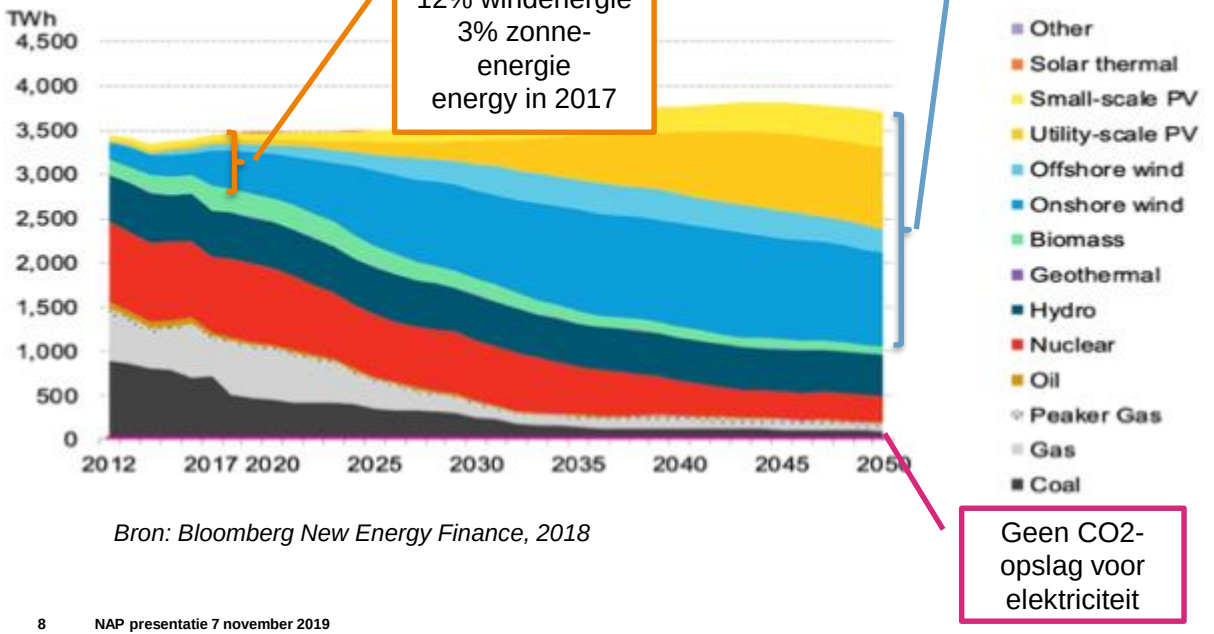
https://www.klimaatakkoord.nl/

ENERGIEVISIE 2007



Bron: Energievisie van ECN en NRG, 2007

ENERGIEVISIE 2007 IS NIET UITGEKOMEN



Bron: Bloomberg New Energy Finance, 2018

WINDTURBINES ZIJN VEEL GROTER GEWORDEN

Verwachting 2007: Windturbines op zee zijn gemiddeld 5 MW in 2050

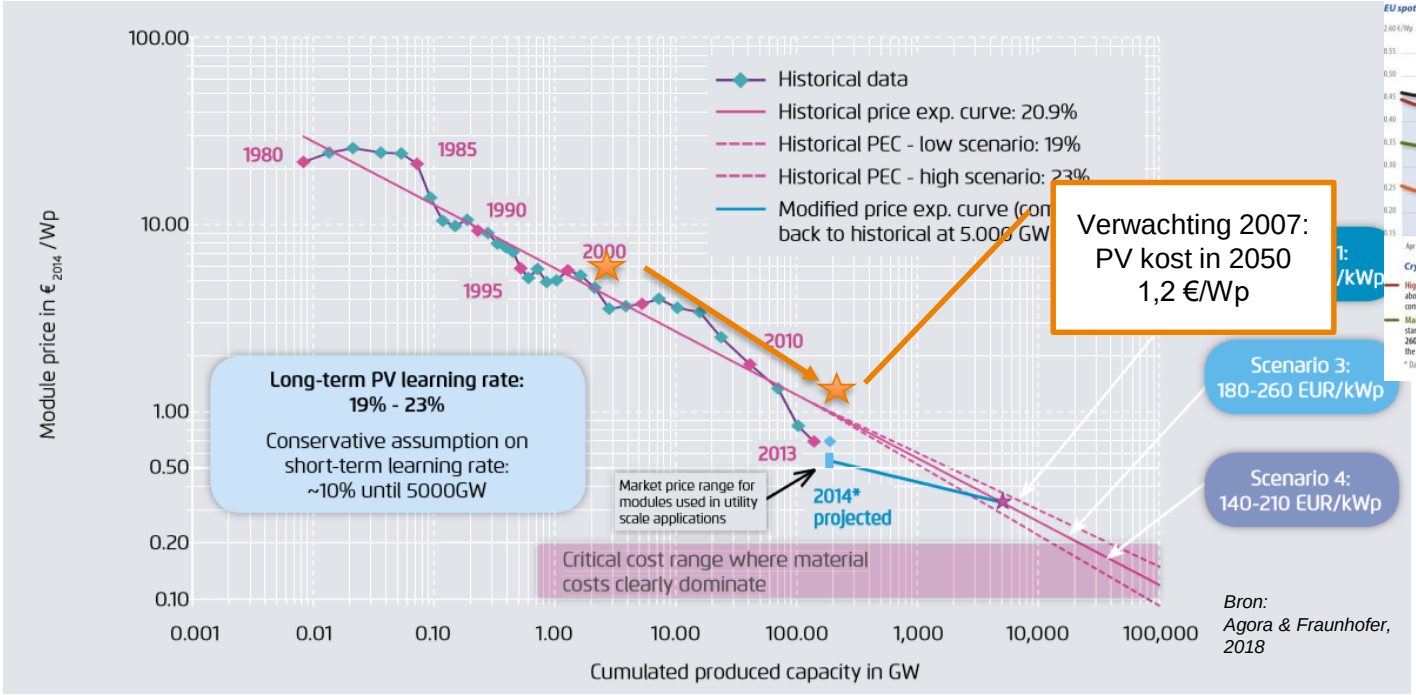
300m
200m
100m

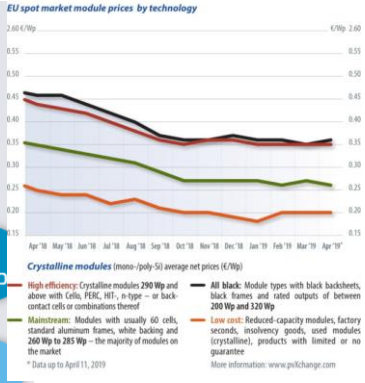
1-12kW
0.5 MW
1.2 MW
2 MW
4 MW
7 MW
9 MW
13-15 MW

19th C
1990
1995
2000
2005
2010
2015
2025

ZONNEPANELEN ZIJN HEEL SNEL GOEDKOPER GEWORDEN

https://www.pv-magazine.com/features/investors/module-price-index/



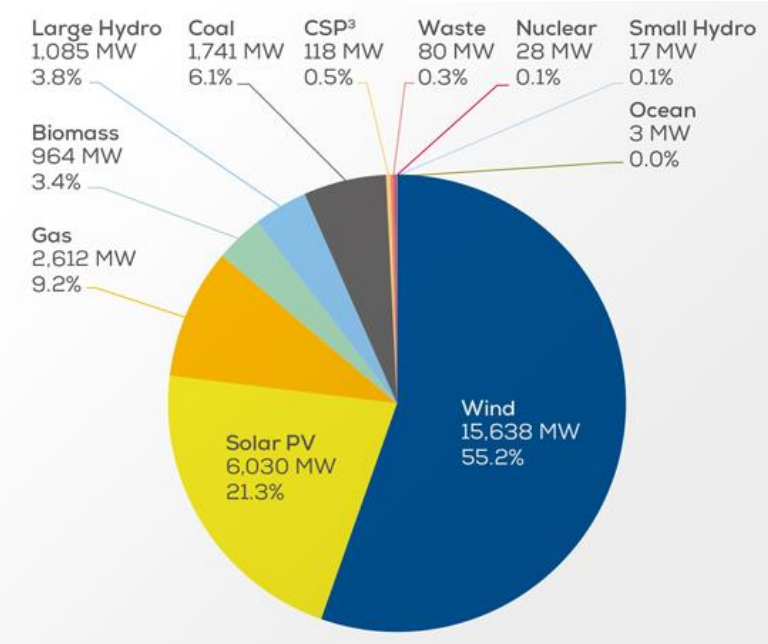


Bron:
Agora & Fraunhofer, 2018

NIEUWE ELEKTRICITEITSOPWEKKING IN EUROPA IS VOOR 80% DUURZAME ENERGIE

- Energietechnologie die sterk in kosten in gedaald:
  - Zon-PV
  - Windenergie op Zee
  - Li-ion batterijen voor o.a. elektrische auto's
- Energietechnologie die niet veel goedkoper is geworden:
  - CO_2-afvang en – opslag
  - Kernenergie
  - Waterstof
  - Biomassa

Nieuwe elektriciteitsopwekkingscapaciteit in Europa in 2017



Bron: Wind Europe, 2018

ENABLING THE ENERGY TRANSITION

Technically possible

Economically possible

Socially possible

Solutiuons that contribute to the energy transition

TECHNOLOGY IS IMPORTANT

ENABLING THE ENERGY TRANSITION

Technically possible

Economically possible

Socially possible

Solutiuons that contribute to the energy transition

Pieter Elbers (CEO KLM): 'Gewone man accepteert niet dat politiek vliegen afpakt'

Klimaatakkoord

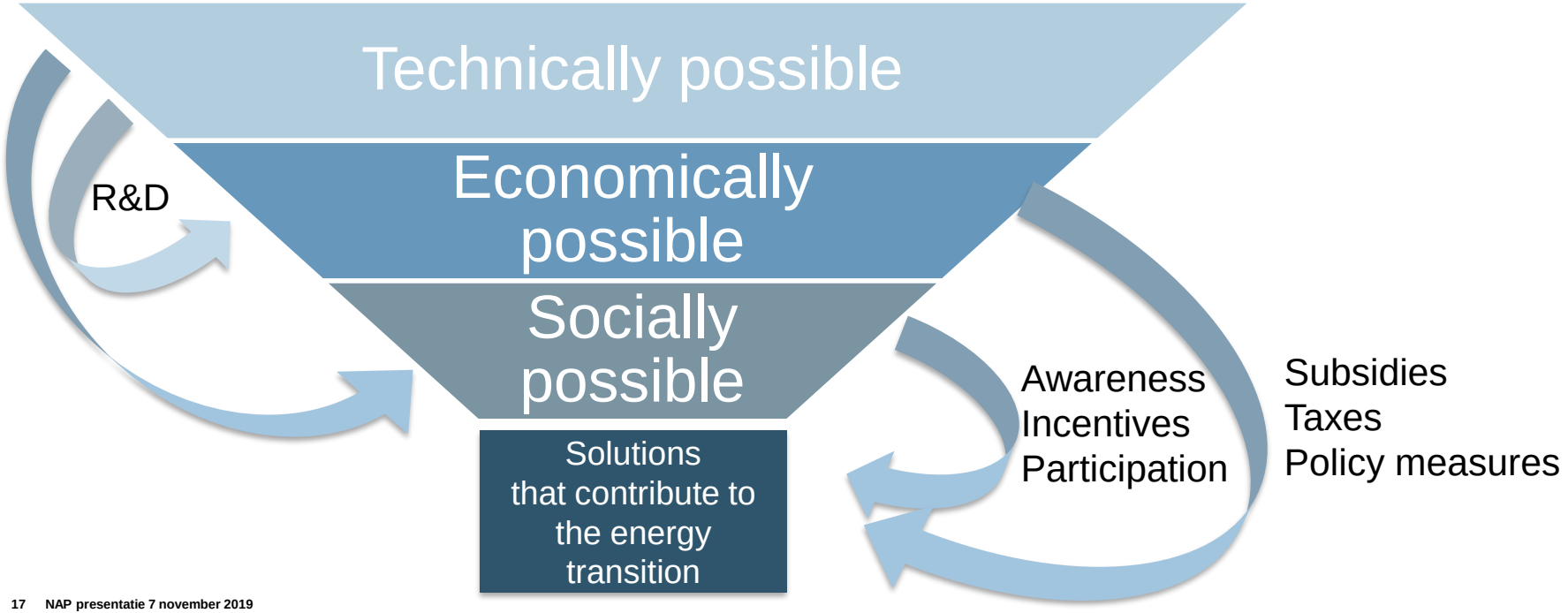
Kostendaling zonne- en windenergie

Gasbesluit

PUBLIC PERCEPTION IS IMPORTANT

Opslag CO2
Barendrecht
afgeblazen

ENABLING THE ENERGY TRANSITION



Naar een overvloed aan
ZONNESTROOM

Naar grootschalige opwekking van
WINDSTROOM

Naar een energieproducerende
GEBOUWDE OMGEVING

Naar een
CO_2-neutrale
INDUSTRIE

Naar CO_2-neutrale
BRAND- & GRONDSTOFFEN

Naar duurzaam gebruik van
ONDERGROND

Naar een duurzaam en betrouwbaar
ENERGIESYSTEEM

Naar een breed gedragen
ENERGIETRANSITIE

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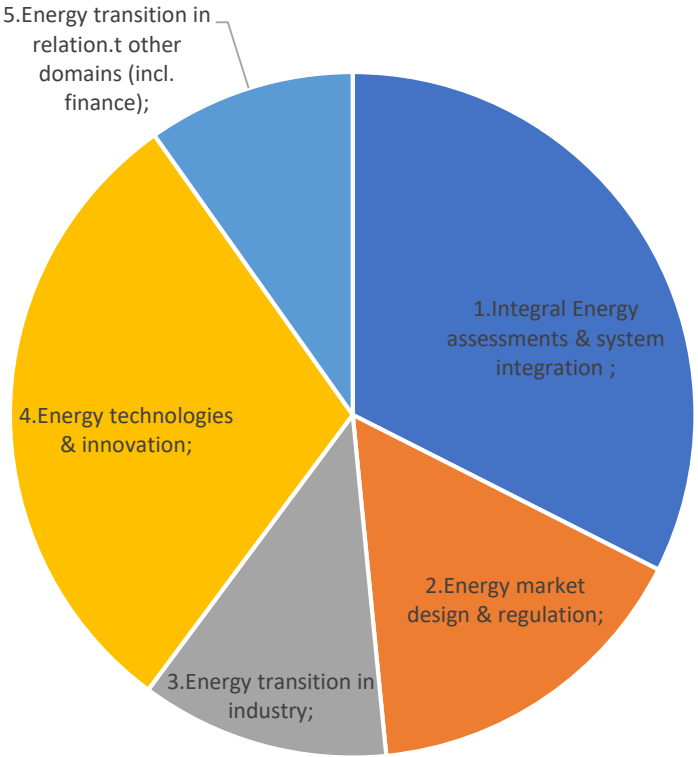
PMC CLUSTER ENERGY TRANSITION PATHWAYS

1. Integral energy assessments and system integration
2. Energy market design and regulation
3. Energy transition in industry
4. Energy technologies and innovation
5. Energy transition in relation to other domains including finance



PMC-CLUSTER ‘SOCIAL INNOVATION & STAKEHOLDER ENGAGEMENT’

(Concept) Portfolio elementen

- Consumer choice behavior
- Decision making in industry
- Public perception and participation
- Energy justice
- Legal aspects of the energy transition
- Complex decision processes
- Innovation readiness engineering

WHAT IS MIDDEN?

- **M**anufacturing **I**ndustry **D**ecarbonisation **D**ata **E**xchange **N**etwork
- Joint initiative with PBL
- Aims to create a public dataset on Dutch energy-intensive industry ETS sites, including:
  - Site specific and infrastructure information
  - Current process flows of products, energy and emissions
  - Decarbonisation options of the processes, including costs and implementation conditions
  - Product applications, prices
- Deliverables:
  - Report describing industrial site/sector with suggestions for decarbonisation options
  - Dataset with technology information and CAPEX/OPEX data

WHY MIDDEN?

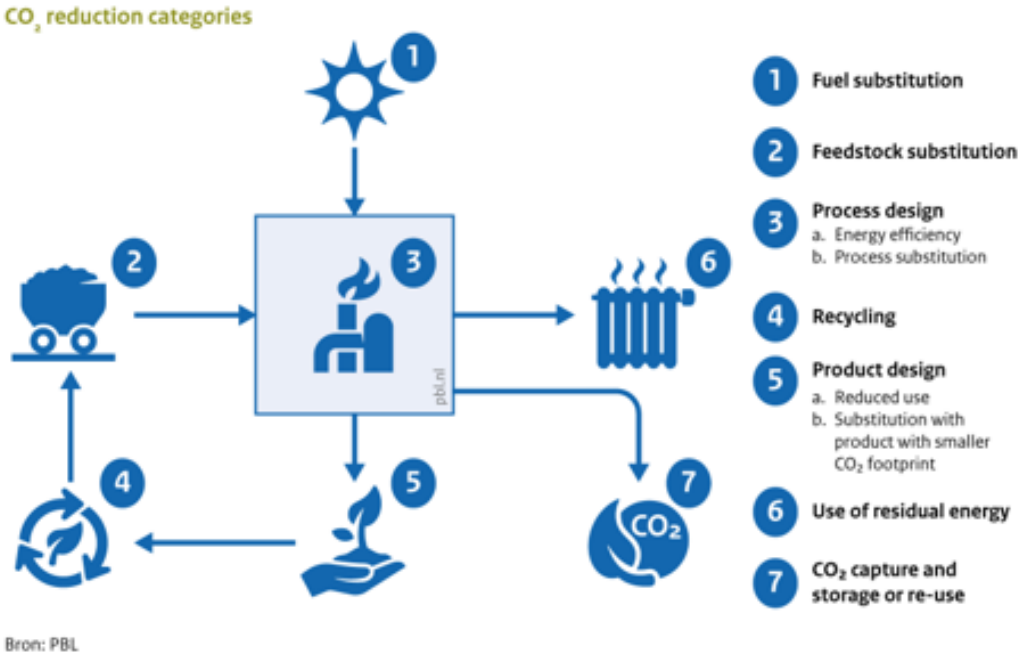
The heavy industry has to change dramatically for the energy transition, and this cannot be solved alone within the site perimeters.

- Location-specific solutions needed (cluster approach) with customized policies and local support.
- A new energy supply system will de developed with electrification, hydrogen, CCS: government, network companies, technology suppliers and users have to find optimal choices together.
- A new materials system will emerge, with more biomass and circular flows.
- Public funding has to be mobilised to facilitate the large investment required.

Transparent, reliable, up-to-date and comprehensive public information is essential for these decision processes → MIDDEN has the purpose to:

- Provide a knowledge base for studying transition paths to 2050
- Build a trustworthy overview of Dutch industry configuration
- Support policy-making regarding CO2 reduction
- Provide insights into economical perspective for industry and cleantech opportunities

DIFFERENT OPTIONS TO REDUCE CO_2



Bron: PBL

EXAMPLE OF DUTCH SUGAR INDUSTRY

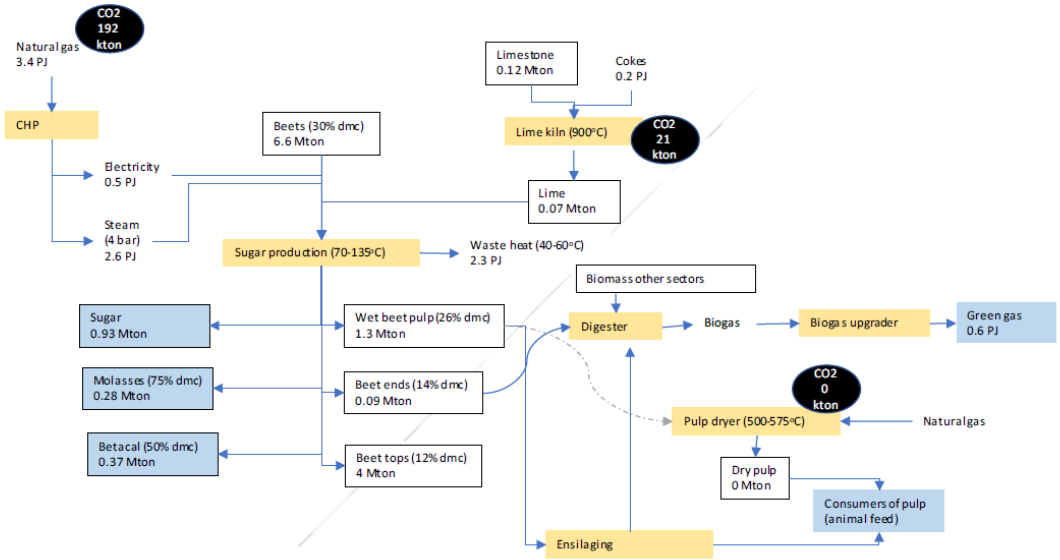
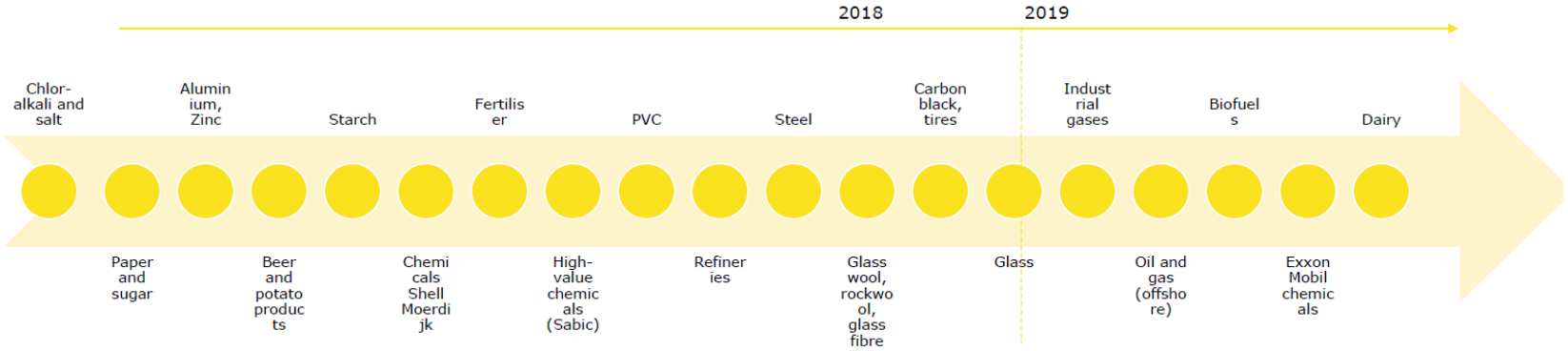
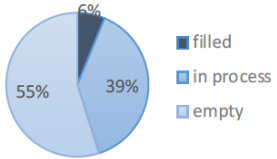


Figure 2 Overview of material and energy consumption Dutch sugar industry in 2016

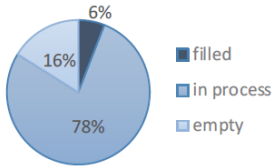
CURRENTLY INVESTIGATED INDUSTRIAL SITES AND PROCESSES



Percentage of companies accounted for:



Percentage of emissions accounted for:



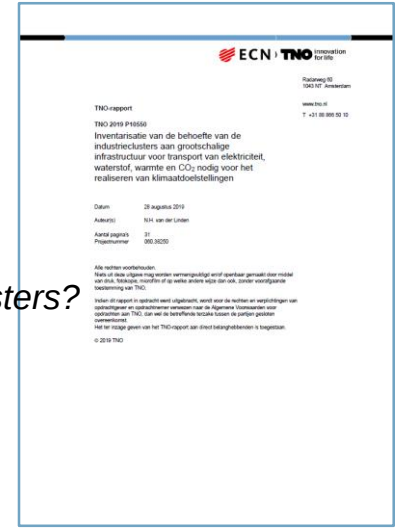
HIGHLIGHTS (1)

- Publications [4]:
  - Aluminium
  - Zinc
  - Sugar
  - Paper

- Finalisation stage [11]:
  - Fertilizer, Salt, Glass wool, Carbon black, Stone wool, Glass fibre, Tires, Chlorine, Sabic Geleen, Shell Moerdijk, Activated carbon

HIGHLIGHTS (2)

- Publication **“Inventarisatie van de behoefte van de industrieclusters aan grootschalige infrastructuur voor transport van elektriciteit, waterstof, warmte en CO_2 nodig voor het realiseren van klimaatdoelstellingen”.** Author: van der Linden, N.H. Report: TNO 2019 P10550
- Published on August 28, presented at the sounding board meeting of June 20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TNO-rapport

TNO 2019 P10550

Inventarisatie van de behoefte van de industrieclusters aan grootschalige infrastructuur voor transport van elektriciteit, waterstof, warmte en CO_2 nodig voor het realiseren van klimaatdoelstellingen

Datum 28 augustus 2019
Auteur(s) N.H. van der Linden
Aantal pagina's 31
Projectnummer 060.38250

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Het ter inzage geven van het TNO-rapport aan direct belanghebbenden is toegestaan.

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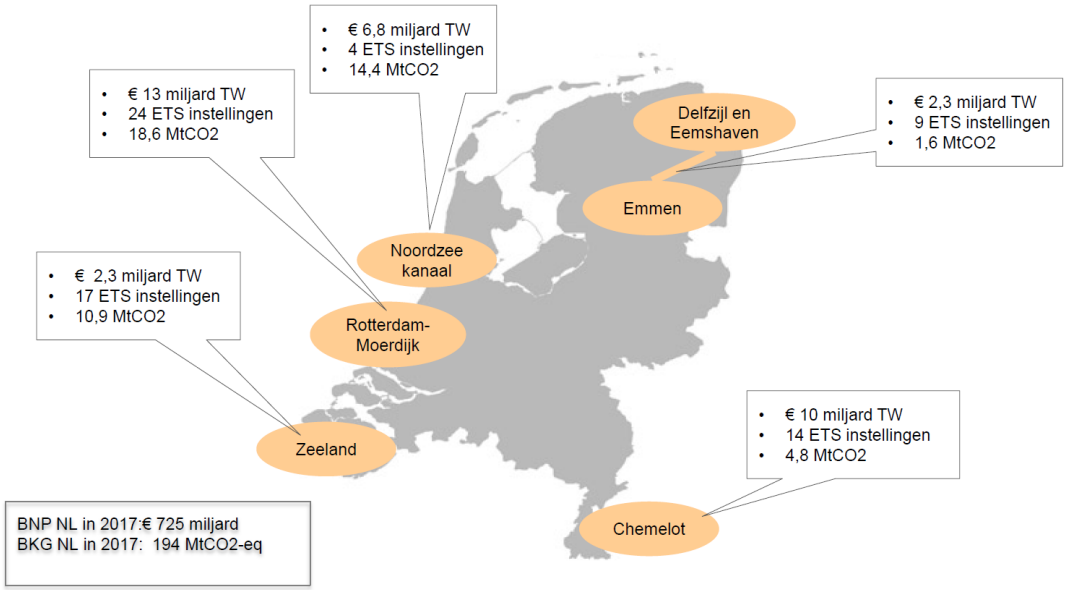
- Industry clusters aim to become climate neutral clusters by 2050
- The energy infrastructure is mentioned by all clusters as a necessary condition
- Research questions:
  1. *Which energy infrastructure is essential for achieving the climate goals of the clusters?*
  2. *What are important uncertainties?*
  3. *Can an estimate be given of the investments required for this infrastructure?*
  4. *Which technical, institutional and spatial bottlenecks are there?*

INDUSTRY CLUSTERS NEEDS FOR ENERGY ENERGY INFRASTRUCTURE



- The need of industrial clusters for new energy infrastructure consists of:
  - CO_2 transport and storage infrastructure
  - Hydrogen infrastructure
  - Electricity network
  - Heat networks

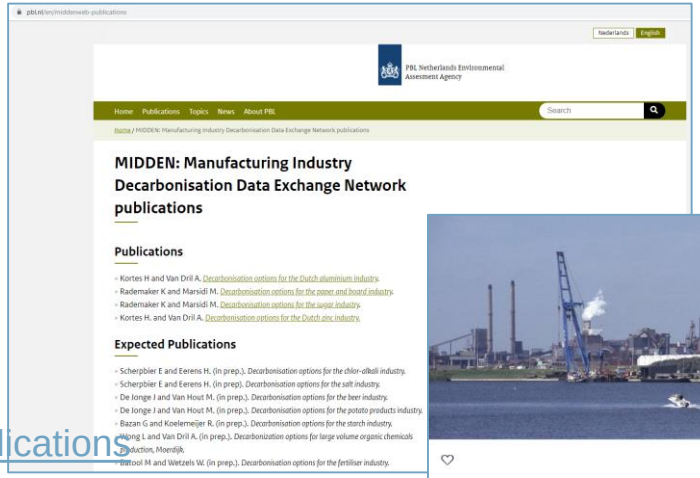
CONCLUSIONS MIDDEN EN INDUSTRY

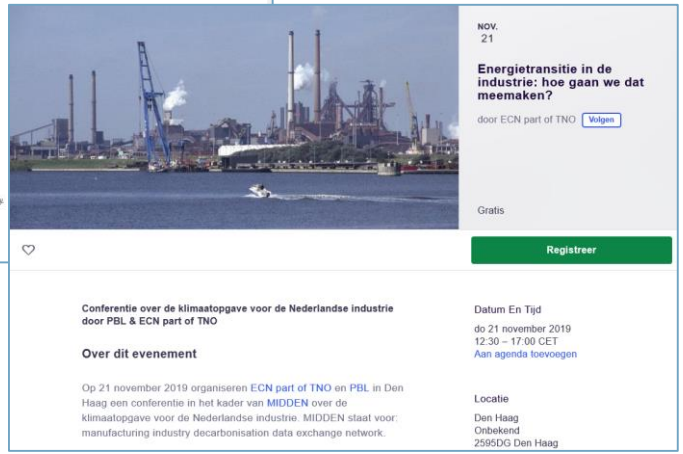
- An estimate of the investments that are required until 2030 for the necessary large-scale energy infrastructure is in the range of € 12,1 – 18,1 billion. For comparison, PBL estimates the cumulative investments up to 2030 for:
  - Implementation of the draft climate agreement at € 56 -75 billion
  - The industry: at € 2,8 – 4,5 billion

- Main uncertainties / risks that make private parties reluctant to investments are:
  - Financial conditions are still insufficient to arrive at a positive business case
  - Legislation and regulations are not yet adapted to new energy infrastructure (energy law 1.0 and heat law 2.0)
  - Social support for some energy carriers is still insufficient

IMPACT AND FOLLOW-UP

- **Target audience:**
  - Science and consultants
  - Policy makers
  - Industry itself
  - Energy companies
  - Technology suppliers
- **How to reach the audience?**
  - MIDDEN website at:
    https://www.pbl.nl/en/middenweb-publications
  - Conference about MIDDEN results on 21 November →
    Interesting for: heavy industry, sector organizations, advisors, government, technology companies, energy & infrastructure sector, representatives of industry clusters.





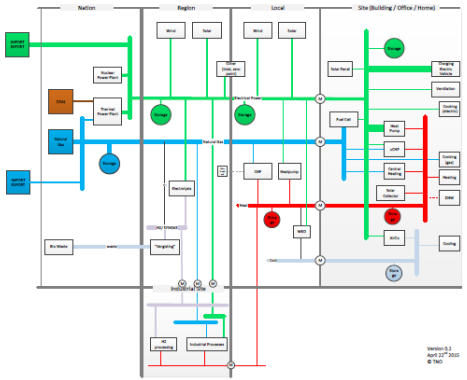
CONCLUSIONS

KLIMAAT AKKOORD EN VOORTGANG

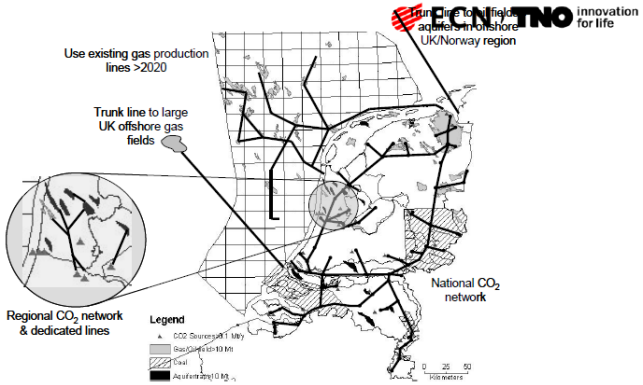
Tabel 1 Emissie broeikasgassen per sector in 2018 en 2030 in actueel basispad (KEV 2019) en bij uitvoering van het Klimaatakkoord

Sector	2018[a] [Mton]	2030 Raming KEV 2019 [Mton]	2030 Klimaatakkoord [Mton]		Belangrijke aanknopingspunten voor sturing op onzekerheden
			Reductie	Restemissie	
Gebouwde omgeving	24,4	19	1,3 – 3,8	15,2 – 17,7	• Realisatie kostendalingen • Focus op aardgasverbruik bij doelstelling dienstensector
Mobiliteit	35,6	32,9	1,3 - 3,6	29,3 – 31,7	• Omvang inzet biobrandstoffen • Omvang en criteria zero-emissie zones • Vormgeving autobelastingen na 2025
Industrie	57,2	54,2	14,3[d]	39,9[d]	• Methodiek vaststelling traject heffingsvrije emissieruimte op bedrijfsniveau, tarief CO_2-heffing en toelatingscriteria SDE++ • Borgen van totstandkoming benodigde infrastructuur
Elektriciteit	45,2	13,7	-0,3 - 2,5	11,2 - 14	• Wel/niet CCUS-project Tata Steel
Landbouw	26,9	24,5	1,7 - 4,3	20,2 – 22,8	• Bereidheid bedrijven tot investeren
Landgebruik	5,6[c]	5,6	1,5 - 2,4	3,2 – 4,1	• Draagvlak maatregelen (veenweiden)
Totaal[b]	189,3	144,3	18 - 28	116 – 126	
totaal incl. landgebruik	195	149,9	20 - 31	119 - 130	

THE FUTURE ENERGY SYSTEM IS COMPLEX

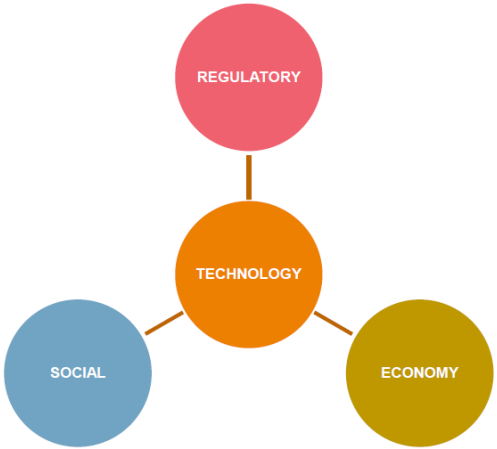


Decentralized, heat networks, energy cooperations, consumer preferences and behaviour, new and more comptetitive energy technologies, ICT driven, incentives, reliability, affordabiliy, new business vs. Current energy sector, regulation, data security, business models…



Possible future configuration Of CCS infrastructure…

AND MULTI DISCIPLINARY



Technology
Energy models
Economic models
Advanced Control Modellen
Forecasting-, simulation- & scenario analyses
…model collaboration!.

Economics
Value chains, business cases

Regulation
Impact of incentives

Social
Societal support
Consumer behaviour and preferences.

Spatial Dimensions: factory - industrial sites – city – province – country – multilateral – Europe – global.

INDUSTRIAL TRANSFORMATION TO A ZERO CARBON FOOTPRINT IS VERY COMPLEX

- **~50% of primary energy use**
- **Many options** :
  - Energy Efficiency improvement existing processes
  - New processes with inherent better efficiency
  - Renewable feedstock (biobased industry)
  - Renewable energy carriers (green hydrogen, green power)
  - Carbon capture and storage
  - Recycling/ re-use/circular value chain
- **Over roughly 3 decades, overall one investment cycle**
- **Factory level, regional level, structural changes in economy and energy system**

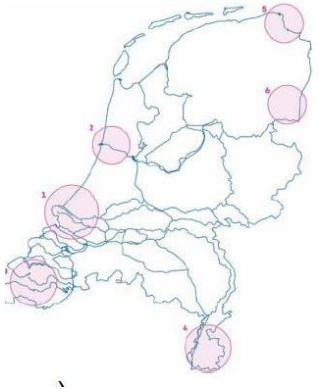


Figure 2 Location and size of the main industrial emission clusters. 1) Rotterdam - Moerdijk (16.9 Mt CO_2); 2) Noordzeekanaalgebied (12.0 Mt CO_2); 3) Zeeland - W-Brabant (7.9 Mt CO_2); 4) Chemelot (4.5 Mt CO_2); 5) Eemsdelta (0.7 Mt CO_2); 6) Emmen (0.5 Mt CO_2).[8,9]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