



# WATERSTOF

CRUCIAAL ELEMENT IN DE ENERGIETRANSITIE

## › WATERSTOF – 3 WEBINARS

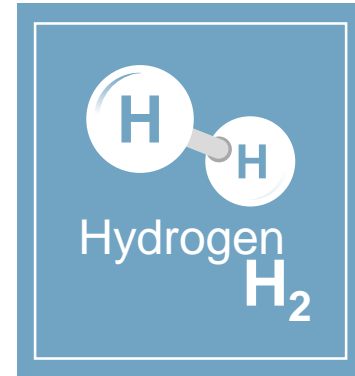
Rol van waterstof  
(vandaag)

Toepassingen  
& risico's  
(29/11)

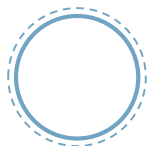
Wat Nederland biedt aan  
de wereld  
(06/12)

## › WATERSTOF WEBINAR HOE WERKT HET?

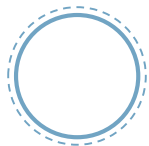
- › Het webinar is direct na de uitzending via dezelfde link on demand terug te kijken.
- › Interactief/poll vragen
- › Vragen stellen via de stel een vraag knop rechts onder in het videoscherm
- › Vragen waar we niet aan toekomen worden later beantwoord
- › Laten we maar direct met een poll beginnen



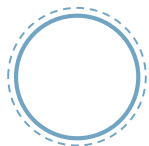
# 1. WAT HOOPT U UIT DIT WEBINAR TE HALEN?



Kennis over de rol van waterstof in de energietransitie



Kennis over wat er allemaal mogelijk is met waterstofp



Niet specifiek iets halen, ik neem deel vanuit interesse



## › WATERSTOF SPREKERS

- › Rogier Elshout - moderator
- › Marcel Weeda - Senior Consultant bij TNO / manager Waterstof TKI Nieuw Gas
- › Faiza Oulahsen campagne leider klimaat en Energie bij Greenpeace

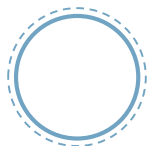


# › VIDEO WATERSTOF IN DE ENERGIETRANSITIE

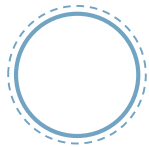


# WAAROM WATERSTOF?

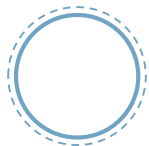
## 2. WAT IS WATERSTOF VOOR U IN RELATIE TOT DE ENERGIETRANSITIE



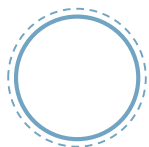
Onderschat



Een hype



Krijgt de juiste aandacht



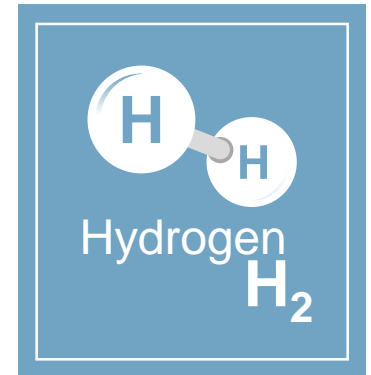
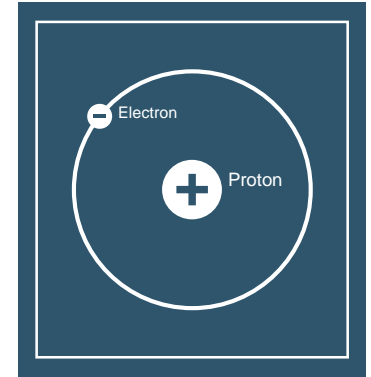
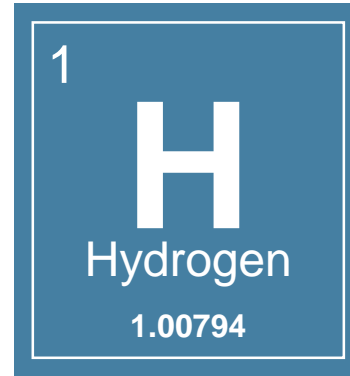
Dat hoop ik na het webinar te weten





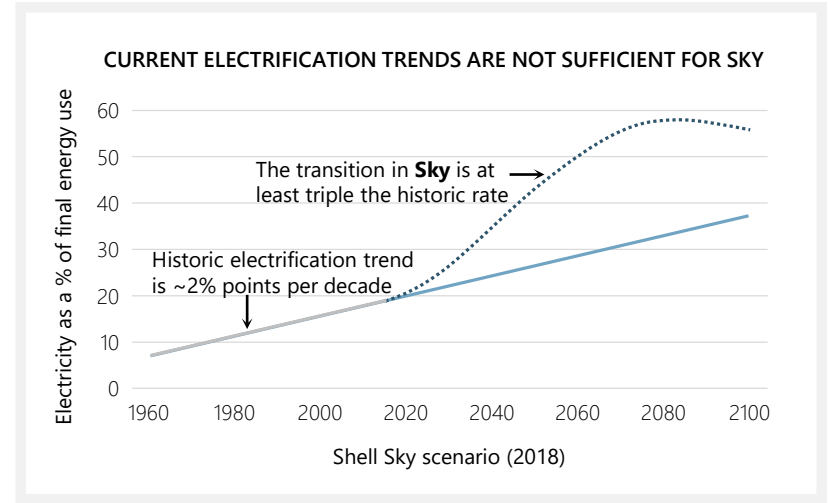
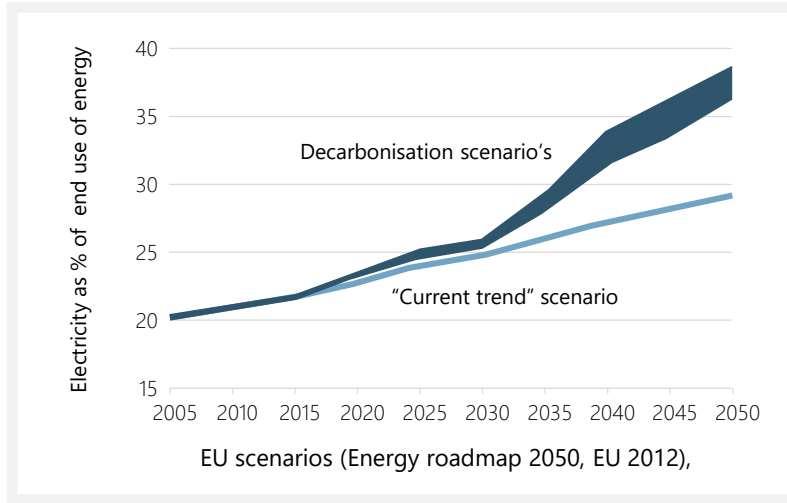
# › HYDROGEN: SOME CHARACTERISTICS

- › **H**: The most common element
- › Usually bonded with:  $\text{H}_2\text{O}$ ,  $\text{CH}_4$ , ...
- › **H<sub>2</sub>**: Energy carrier, not an energy source
- › Colourless, odourless, non-toxic gas
- › Highly combustible
- › Much lighter than air
- › Minimal greenhouse gas effect



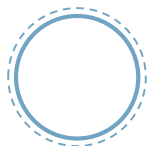


## › THE BENEFITS HYDROGEN CAN OFFER

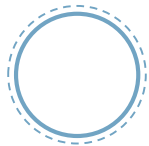


- › Increases the possibilities for use of wind and solar energy
- › Reduces pressure on use of biomass for sustainable 'molecules'
- › Helps to integrate wind and solar energy: storage and controllable demand
- › Reduces pressure on electricity transport infrastructure expansion

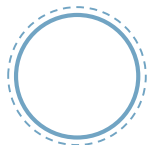
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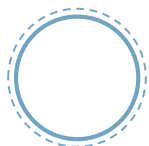
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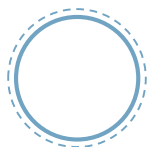
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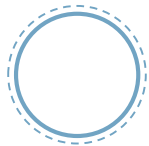


# TOEPASSINGEN VAN WATERSTOF

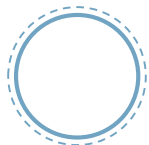
### 3. WAT IS DE BELANGRIJKSTE TOEPASSING VAN WATERSTOF



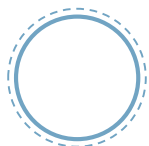
Buffer voor het elektriciteitsnet



Middel voor transport van duurzame energie over lange afstand



Vervanger voor aardgas/brandstoffen waar stekker en batterij geen optie zijn

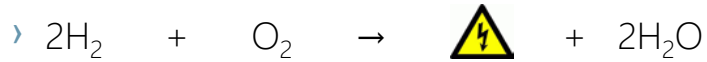


Grondstof voor chemische industrie

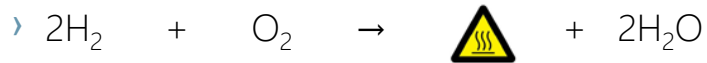


## › USE OF HYDROGEN

### › Energetic use:



Fuel Cell / Gasturbine

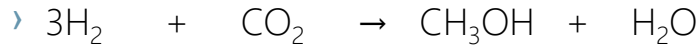


Heating/Steam boiler / Furnace

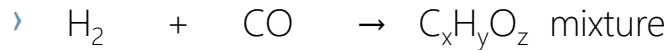
### › Non-energetic use (as 'feedstock'):



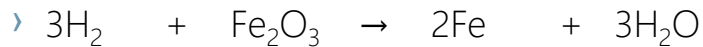
Ammonia



Methanol



FT-synthese

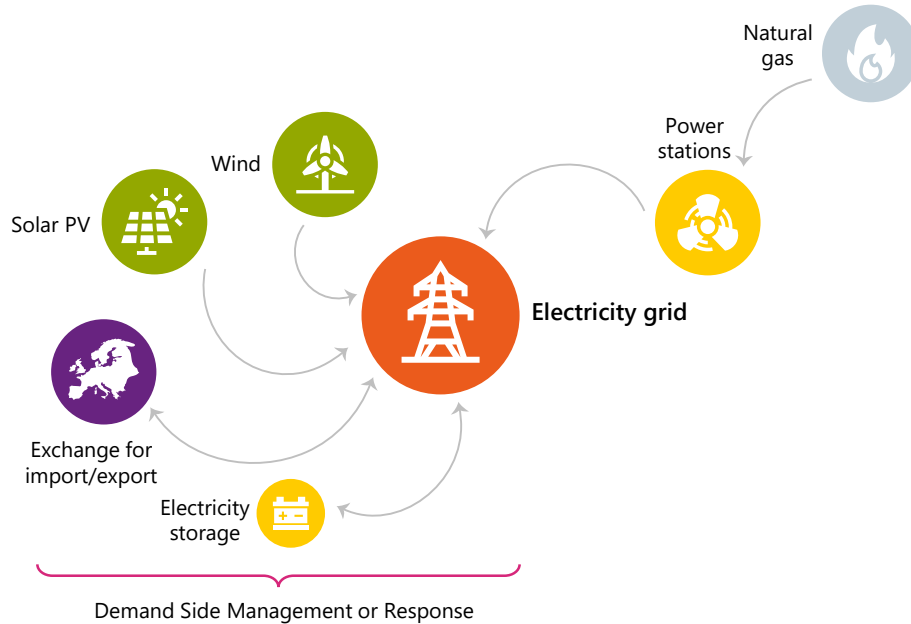


Steel production

› ... and many other industrial applications

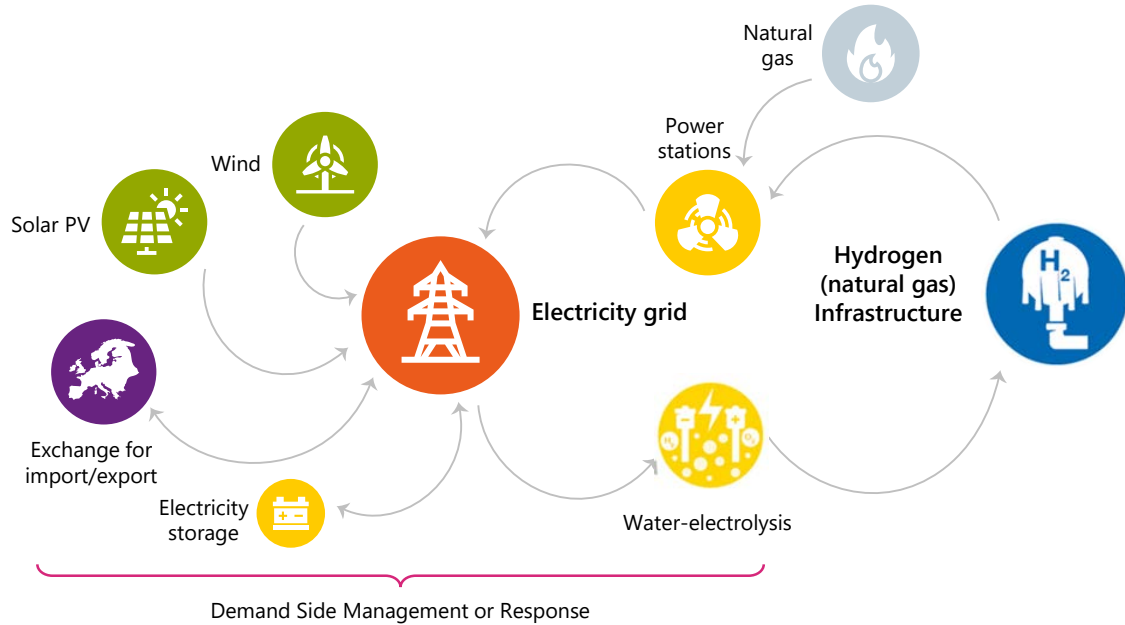
} Chemical products  
and materials,  
and synthetic fuels

# DISCUSSION ABOUT WIND, SUN AND FLEXIBILITY UNTIL NOW FOCUSED MAINLY ON THE ELECTRICITY SYSTEM

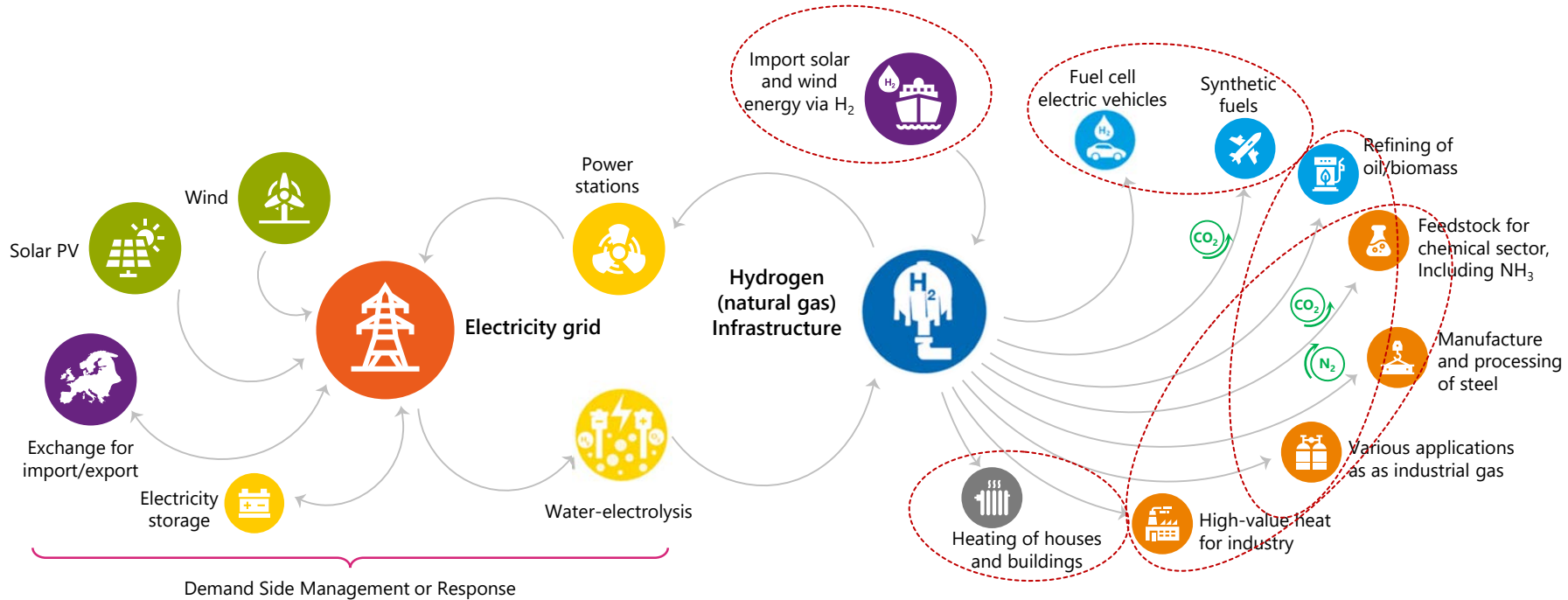




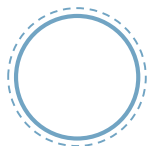
# 'MISUNDERSTANDING' HYDROGEN: THE STORAGE OF RENEWABLE ELECTRICITY SURPLUSES



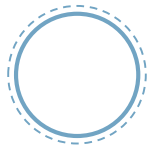
# INTEGRAL SYSTEM PERSPECTIVE ON HYDROGEN



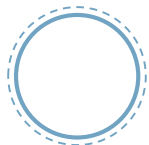
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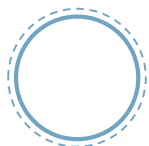
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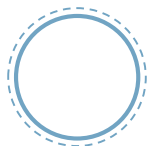
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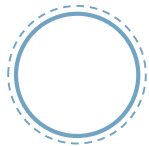


# TRANSITIE VAN NU NAAR GROEN

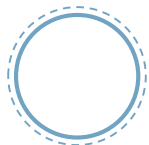
## 4. IS ER EEN ROL VOOR LOW-CARBON WATERSTOF UIT AARDGAS?



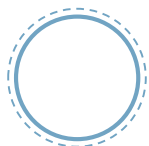
Nee, alleen groene waterstof; 'low-carbon' uit aardgas leidt tot 'lock-in'



Ja, maar alleen als nodig om korte termijn CO<sub>2</sub>-reductie doelen te halen



Ja, low-carbon waterstof uit aardgas is nodig als opstap naar groene waterstof



Ja, als import van 'low-carbon aardgas' uit het buitenland; koolstof eraf bij de bron



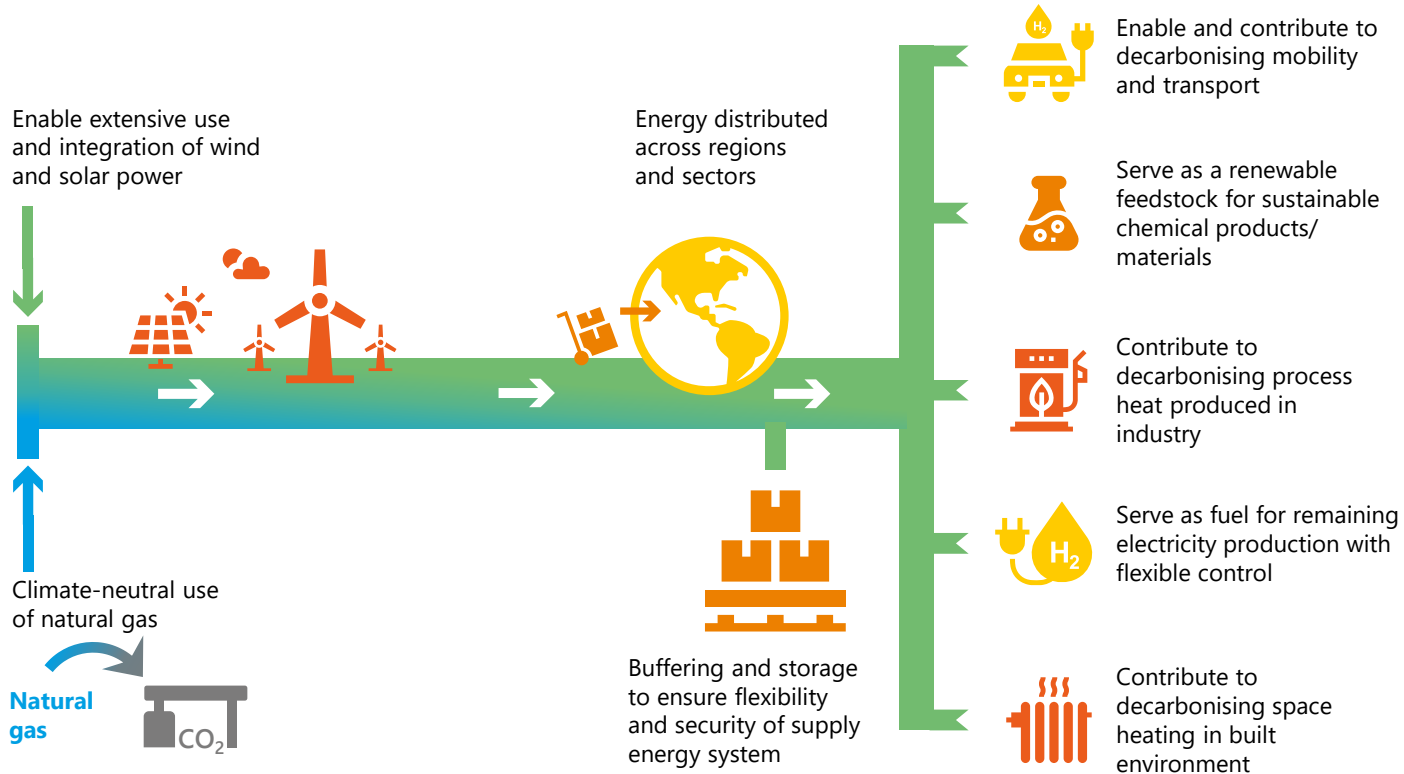
## › ROLE LOW-CARBON NATURAL GAS BASED HYDROGEN?

- › Production based on natural gas reforming with CO<sub>2</sub> capture and storage (CCS):



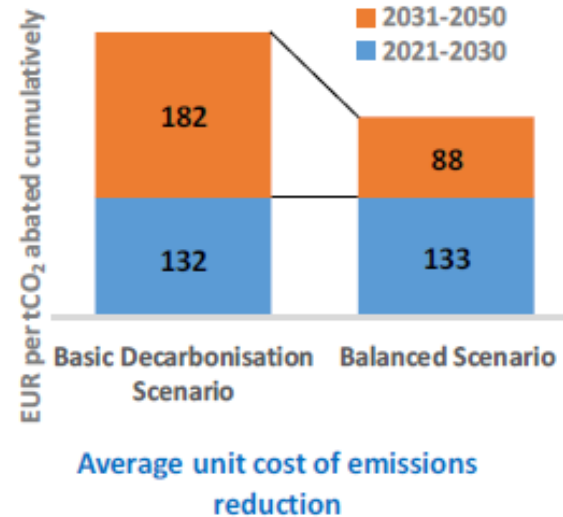
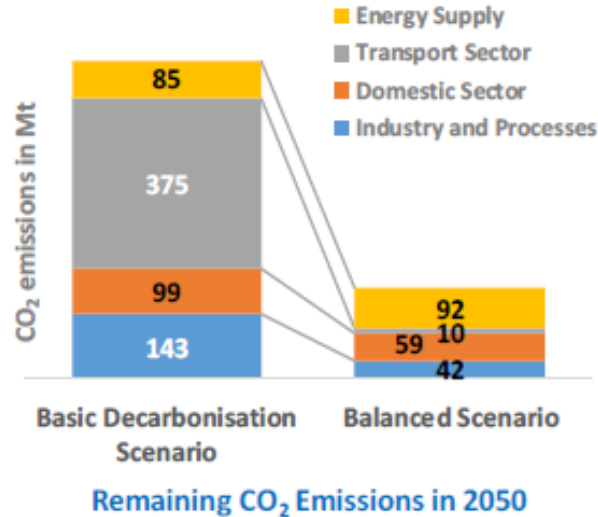
- › Can contribute to achieving short-term CO<sub>2</sub> reduction goals
- › Large volume quickly may facilitate infrastructure conversion
- › Creates perspective for market development end-use applications
- › Import hydrogen instead of natural gas (carbon removal at/near the source)

# DECARBONISATION OF NATURAL GAS AS A TRANSITION OPTION



# SECTOR COUPLING: WIN-WIN OPTION FOR SUSTAINABILITY AND AFFORDABILITY?

## Results of the balanced scenario

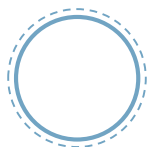


Bron: Asset, Sectoral integration, February 2018

Bron: EU COM(2018) 773, November 2018



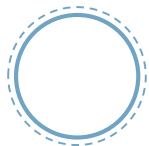
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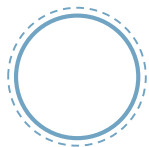
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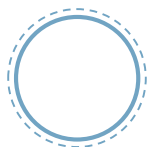
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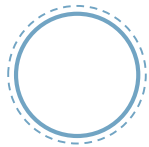


# UITDAGINGEN WATERSTOF

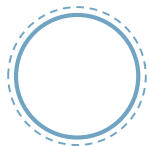
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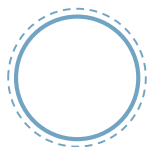
Technologie ontwikkelen



Infrastructuur creëren



Zorgen voor voldoende aanbod



Veiligheid waarborgen



# HYDROGEN: NO DISTANT FUTURE BUT NEAR REALITY



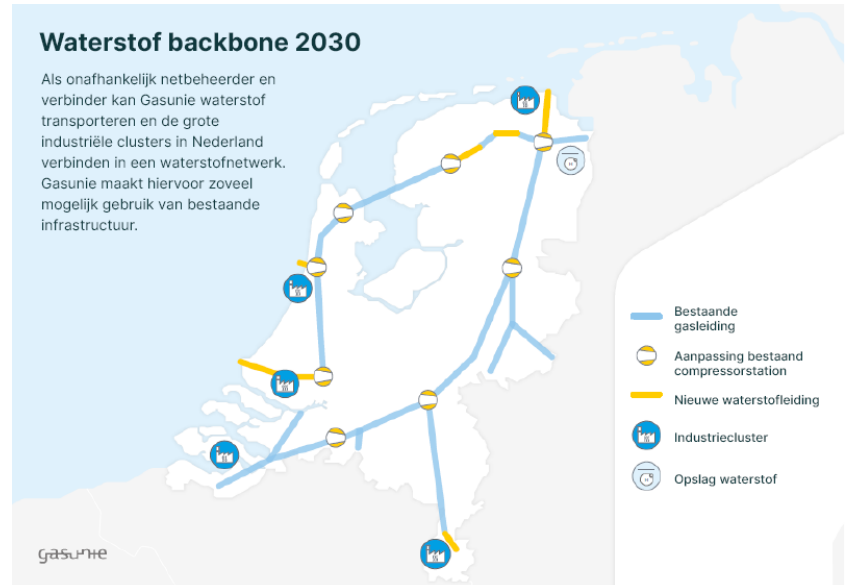


# HYDROGEN: WORK IN PROGRESS

› Unlocking the energy potential of the North Sea



› Conversion of natural gas infra to hydrogen



## 5. ANTWOORD WAT ZIJN DE BELANGRIJKSTE UITDAGINGEN OM WATERSTOF GROOTSCHALIG UIT TE ROLLEN?



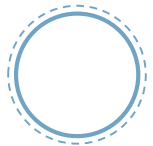
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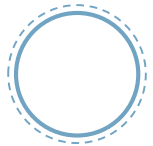




**TNO** innovation  
for life

EN NU?

## › 6. WAT MOETEN WE DE KOMENDE JAREN GAAN DOEN?



Niets, waterstof gaat het niet worden



Technologie ontwikkelen (R&D)



De optie demonstreren en praktijkervaring opdoen



Gewoon uitrollen





# › HYDROGEN: WHERE ARE WE, AND WHAT'S NEXT?

## › Sketch of the situation:

- › The importance of "hydrogen" is increasingly recognized
- › Technology is basically available
- › Large capacity wind at sea (our "new natural gas")
- › Extensive gas infrastructure already present
- › Opportunities for new high-quality industrial activities

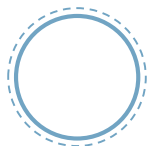
} Favorable starting position

## › Challenges ahead:

- › Development of sustainable energy (sources) and CO<sub>2</sub> storage
- › Scaling up electrolysis
- › Adjusting natural gas infrastructure
- › Gain practical experience (production/infrastructure/applications)
- › Activate the market and develop revenue models
- › Developing (appropriate) legislation and regulations

} Programmatic approach

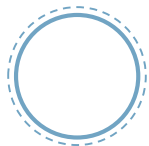
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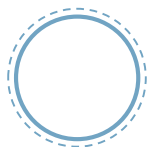
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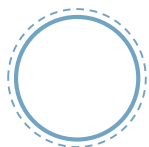
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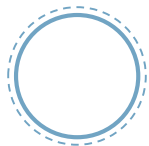
## › GOOD TO REMEMBER ...

- › **Hydrogen increases the possibilities to use wind and solar energy**
  - › Availability of renewable energy (electricity) is an essential precondition
  - › Hydrogen is not about using “surpluses”; it is not a byproduct of renewable electricity
- › **Hydrogen provides great flexibility for the energy system**
  - › Controllable deployment of renewable energy: time, location, application
  - › As a fuel or a feedstock/industrial gas
- › **Water-electrolysis and fuel cells are key technologies**
  - › Controllability of water-electrolysis; grid services as a “bonus”
- › **Natural gas/CCS with deployment of hydrogen as fuel**
  - › Significant contribution possible to 2030 CO<sub>2</sub> emission reduction goals
  - › Stepping stone for the transition to green hydrogen
- › **Hydrogen is no longer a distant future: technology and infrastructure is available**
- › **Next: gaining experience; market activation; adapting legislation and regulation; further RD&D**

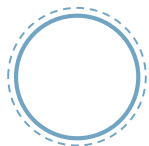
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Kennis over de rol van waterstof in de energietransitie



Kennis over wat er allemaal mogelijk is met waterstof



Niet specifiek iets halen, ik neem deel vanuit interesse



## › WATERSTOF

- › Bedankt voor uw deelname en vul de evaluatie in die u nu op het scherm ziet
- › Vragen worden later beantwoord. Webinars kijkt u terug via [www.tno.nl/waterstof](http://www.tno.nl/waterstof)
- › Schrijf u in voor de volgende webinars: <https://www.tno.nl/waterstof>
- › 28 november 11.00 (Engels): Vier toepassingen van waterstof: wat kan er al en wat zijn de risico's? Sprekers: Lennart van der Burg en Roel Natris (TNO)
- › 9 december 15.00 (Engels): Nederland als internationale waterstof-hub: welke (internationale) waterstofprojecten zijn er en welke positie neemt Nederland daarin? Sprekers: Noé van Hulst (waterstofgezant EZK), René Schutte (Gasunie), René Peters (TNO)

**BEDANKT VOOR  
UW AANDACHT**