



## Electricity for the industry

At what cost price of Offshore Wind does the electrification of the industry accelerate?



# CE Delft

- Independent research and consultancy since 1978
- Transport, energy and resources
- Know-how on economics, technology and policy issues
- 75 employees, based in Delft, the Netherlands
- Not-for-profit



## Clients



Industries  
(Small and medium size enterprises,  
transport, energy and trade  
associations)



Governments  
(European Commission,  
European Parliament,  
regional and local governments)



NGOs

# Content

- At what cost price of Offshore Wind does the electrification of the industry accelerate?
- In other words: electrification potential industry as a function of the cost price of electricity Offshore Wind
  
- Step 1: analysis of the industry's energy demand
- Step 2: price scenarios for natural gas and CO2
- Step 3: calculation alternatives
- Step 4: which alternative is the cheapest?
- Step 5: conclusions



# 1. Analysis energy demand of the Dutch industry

- Analysis per sector and per process
- Steel, chemicals, refining, other
- Demand decreases due to efficiency improvements and drop in demand (refining)
- Cost structure looked at per process:
  - Traditional process
  - Process based on electricity
  - Process based on hydrogen

# 1. Energy demand industry, per proces

- Potential for elektrification:  
About 100 TWh/y

Proces	Potentieel elektrificatie (TWh-e/jaar)			Potentieel groene H <sub>2</sub> (TWh-e/jaar)		
	2030	2040	2050	2030	2040	2050
Staalproductie	0,0	11,1	10,3	9,4	9,2	8,9
Drogen	9,0	8,3	7,7	20,4	18,4	16,6
Scheiden <200°C	1,4	1,2	1,1	10,6	9,6	8,8
Heet water	1,3	1,2	1,1	7,7	7,3	7,0
Warmte voor aandrijving (back-pressure)	1,4	1,1	1,0			
Warmte voor aandrijving (condenserend)	1,4	1,1	1,0			
Productie warmte resterend (stoom)	14,5	13,5	12,4	22,9	20,7	18,7
Productie warmte resterend (verbranding)	56,9	49,1	42,3	89,7	75,6	63,5
Kunstmestproductie				20,1	13,6	8,2
Hydrokraken en hydro-treaten kraakproducten				8,8	6,0	3,2
Methanolproductie				9,4	8,7	8,1

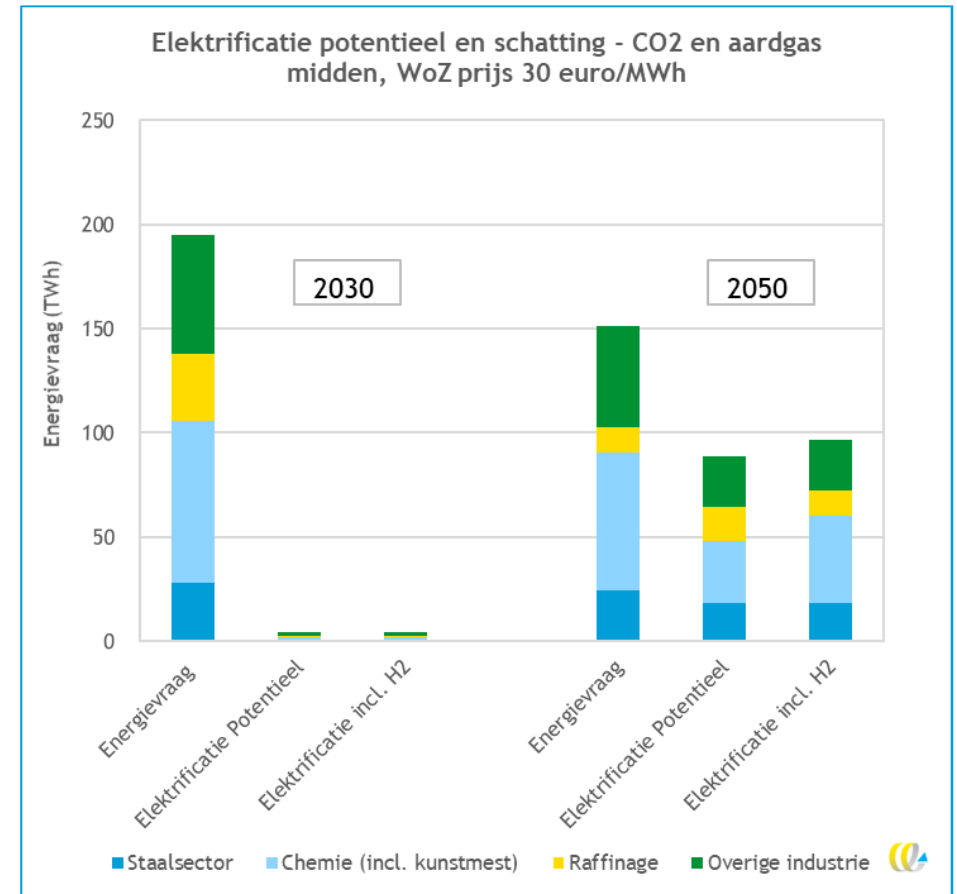
## 2. Price scenarios

- Natural gas is now the reference
  - Price depends on market demand
  - Correlated to CO<sub>2</sub> price
- CO<sub>2</sub> price depends on political goals
  - EU Greenddeal will lead to a higher ETS price
- 3 price scenarios
- Electricity price is determined by
  - Cost price Offshore Wind (60%)
  - Production costs of adjustable power (40%)
  - Extra network costs

Scenario	Prijs	Eenheid	2030	2040	2050	Bron 2030	Bron 2040	Bron 2050
Laag	Aardgas	€/m <sup>3</sup>	€ 0,28	€ 0,35	€ 0,42	Huidige prijs	Interpolatie	I13050 min
	CO <sub>2</sub>	€/ton	€ 38	€ 118	€ 200	KEV -20%	Interpolatie	Milieuprijzen (2°C - onder)
Midden	Aardgas	€/m <sup>3</sup>	€ 0,23	€ 0,22	€ 0,21	KEV	Interpolatie	I13050 midden
	CO <sub>2</sub>	€/ton	€ 46	€ 153	€ 260	KEV	Interpolatie	Milieuprijzen (2°C - midden)
Hoog	Aardgas	€/m <sup>3</sup>	€ 0,16	€ 0,13	€ 0,11	KEV +20%	Interpolatie	I13050 hoog
	CO <sub>2</sub>	€/ton	€ 55	€ 259	€ 462	KEV +20%	Interpolatie	Milieuprijzen (2°C - Analyse Cuijk Bovengrens)

### 3. Potential for electrification per sector

- 2030
  - Hardly any potential
- 2050
  - Potential about 100 TWh/y



## 4a. Calculations > cheapest?

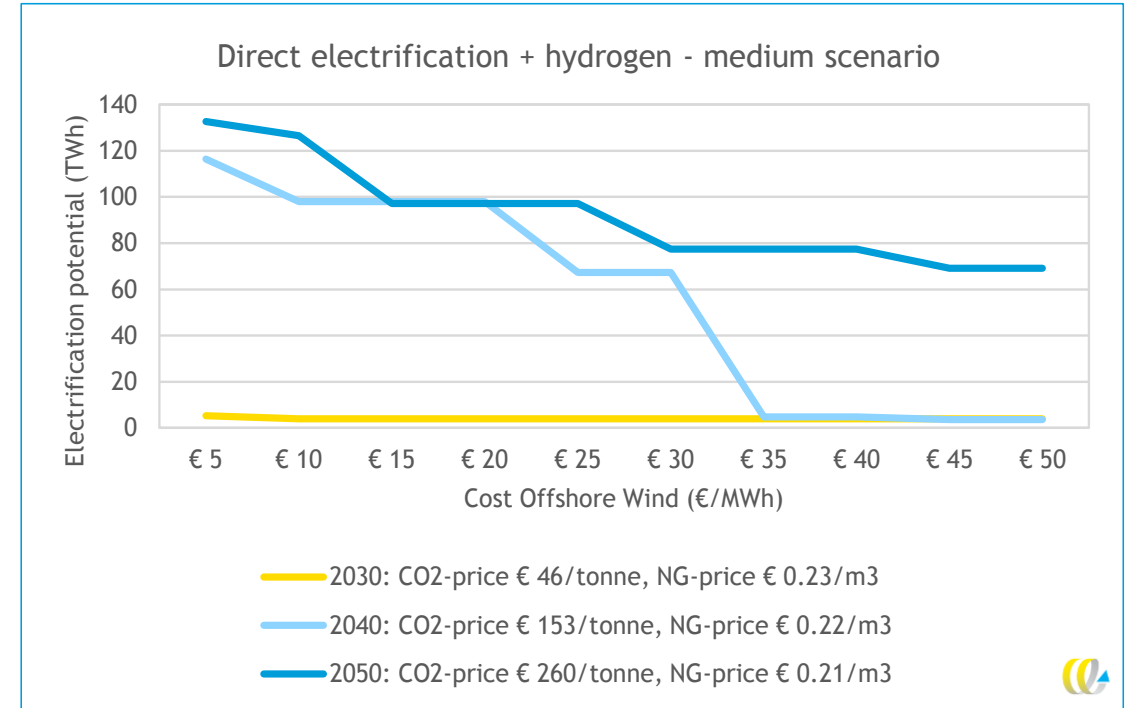
- Analysis per sector and per process
- Which technique is the cheapest?
  - Traditional natural gas
  - Hydrogen
  - Electricity

Electrification potential 2040 - Medium Scenario CO <sub>2</sub> € 153/tonne, natural gas € 0,22/m <sup>3</sup>		Technology	Potential (TWh-e/year)	Cost offshore wind (€/MWh)										
				5	10	15	20	25	30	35	40	45	50	
Steel production	Electrowinning	11,1												
Drying	Electric drying	8,3												
Seperation <200° C	Heatpump	1,2												
Hot water	Heatpump	1,2												
Heat for propulsion (backpressure)	Electric motor	1,1												
Heat for propulsion (condenserend)	Electric motor	1,1												
Pruduction heat - other (steam)	E-boiler	13,5												
Pruduction heat - other (combustion)	Electric furnace	49,1												
Manure production	Green hydrogen as raw material	13,6												
Methanol production	Green hydrogen as raw material	6,0												
Hydrocracking and hydro-treaten cracking products	Green hydrogen as raw material	8,7												
Totals (TWh-e/year)		Conventional	0	8	8	14	48	48	48	48	110	110		
		Electrification	67	67	67	67	67	67	5	5	4	4		
		Hydrogen	48	39	39	34	0	0	0	0	0	0	0	



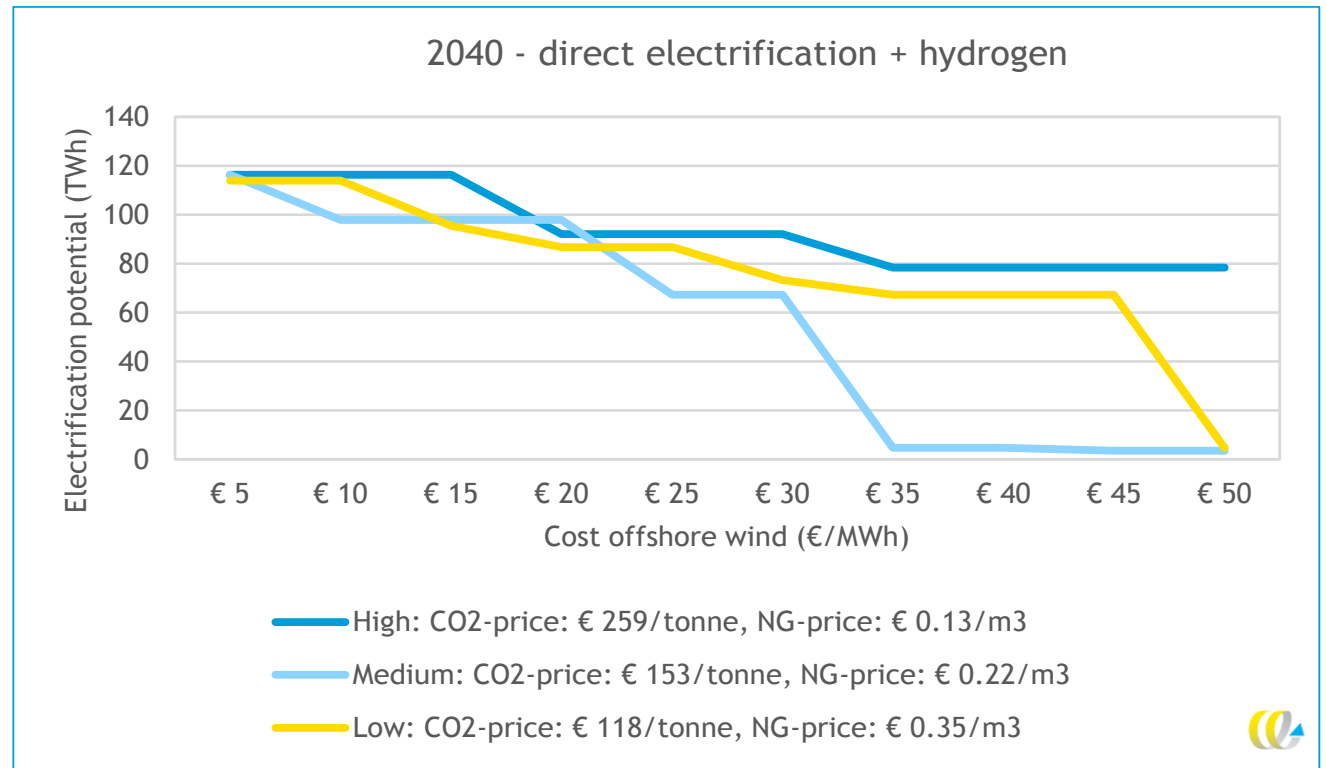
## 4b. Electrification - 2030-2040-2050

- 2030
  - Hardly any electrification
  - CO2 price is too low
  - Only grants help
- 2040
  - CO2 price high enough to convert natural gas > electricity
  - Speed of electrification depends on the price of WoZ
  - The potential for additional offshore wind is 0 - 11 GW
- 2050
  - Electrification often the cheapest solution
  - Some processes are not suitable for electricity and use hydrogen
  - Potential for additional offshore wind is 8 - 15 GW



## 4. Speed up period 2030-2040

- Interesting period
- Ambitions EU Greenddeal
- CO2 price will be higher
- Cost price for offshore wind, most decisive for speed



## 5. Conclusions

- CO2 price + natural gas price is the most determining factor for the industrial electrification
  - Processes with high uptime
  - Variable costs are the greatest, fixed costs hardly
- Until 2030 CO2 price too low for switch to electrification
  - Cost price Wind op Zee determines subsidy volume
- Offshore wind can increase speed in the period 2030-2040
  - Cost price Wind op Zee can accelerate electrification
- Electrification will be dominant in the period up to 2050
  - Hydrogen is more expensive per GJ than electricity, natural gas + CO2 price even more expensive
  - Some processes cannot (yet?) be electric
- Cost price for offshore wind determines the cost price of industrial products

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