Hoorzitting hernieuwbare energie
maandag 23 januari 2023 14h30

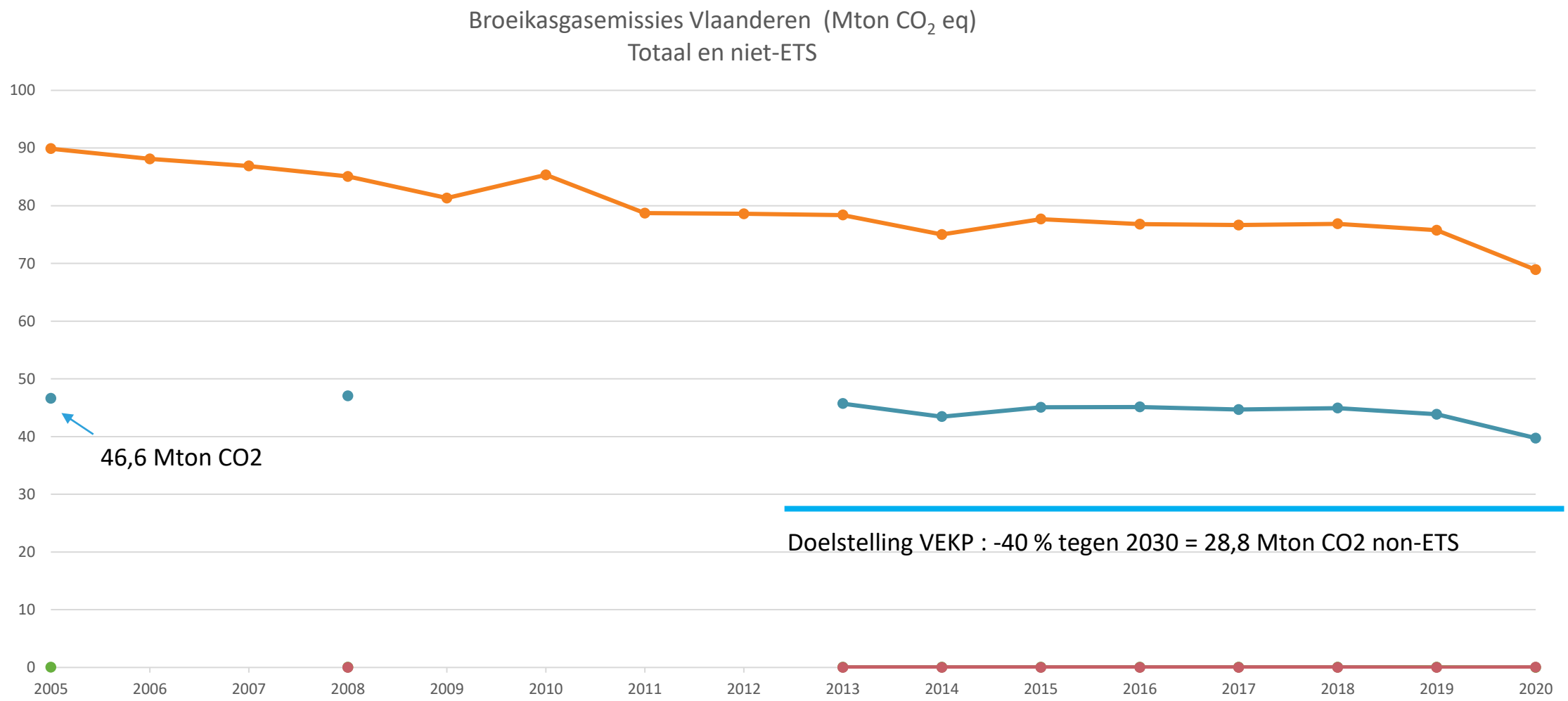
Dirk Fransaer

23 januari 2021

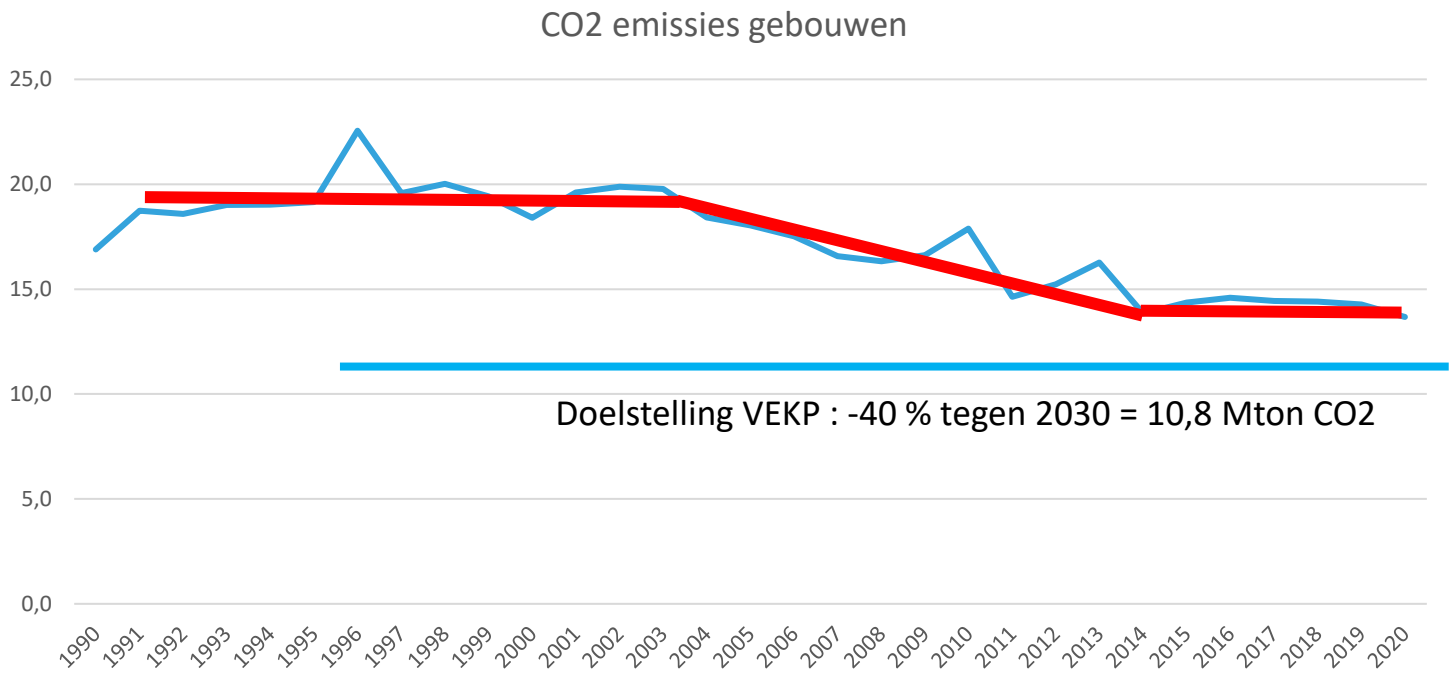
Agenda

- *Evolutie broeikasemissies Vlaanderen*
- *Bebouwing*
- *Hernieuwbare energie Vlaanderen*
  - *Wind*
  - *PV*
  - *Effect op prijs en beschikbaarheid*
- *Invoer groene molecules/"waterstof"*
- *Geothermie*
  - *Ondiepe*
  - *Diepe*
- *Aanbevelingen /Conclusies*

BROEIKASGASEMISSIES VLAANDEREN



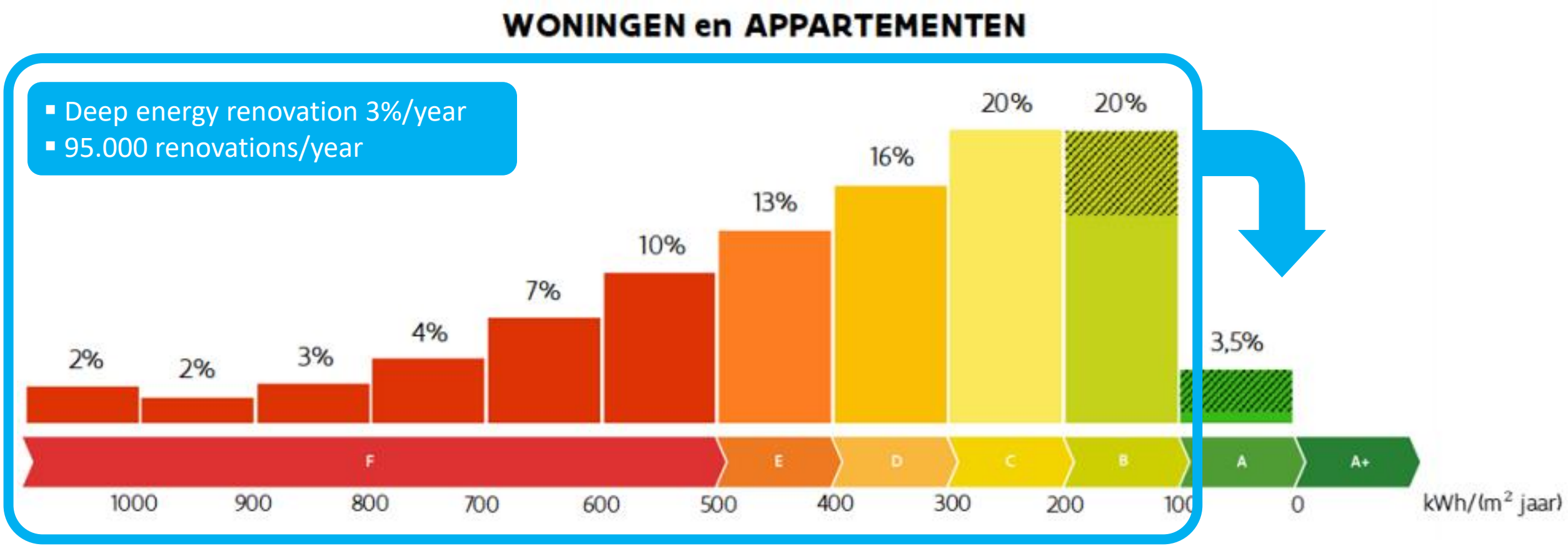
EVOLUTIE EMISSIES HUISHOUDENS - VERWARMING



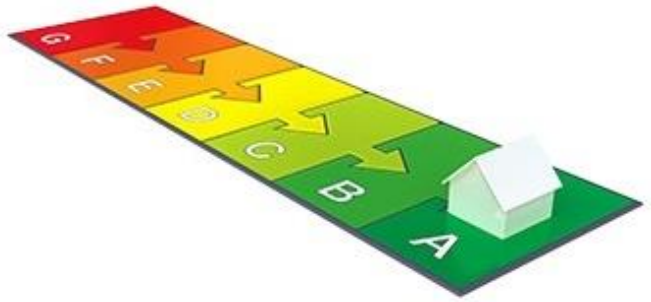
- Warmere winters
- Omschakeling van mazout naar gas (éénmalig)
- Kleinere woningen
- Meer woningen
- En isolatie

- onvoldoende om klimaatdoelstellingen (2050) te realiseren
- Europees klimaatplan
  - Energie efficientie
  - Electrificatie
  - Groene moleculen

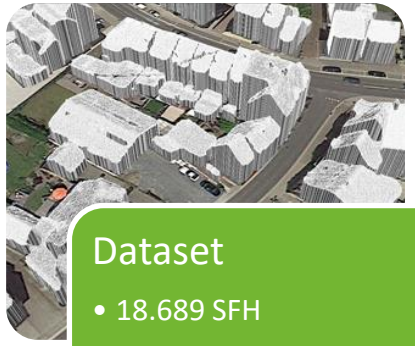
The renovation challenge in Flanders…



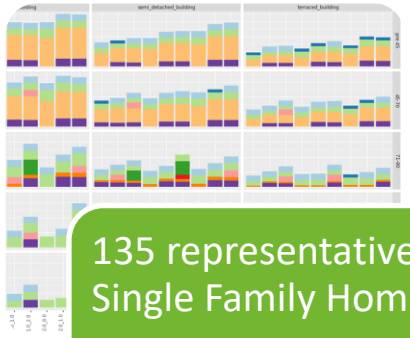
Understanding the Flemish renovation target



- What combinations of renovation measures are most optimal for which single family homes?
- What investment is required?
- Which measures stand out?
- …



Dataset
- 18.689 SFH



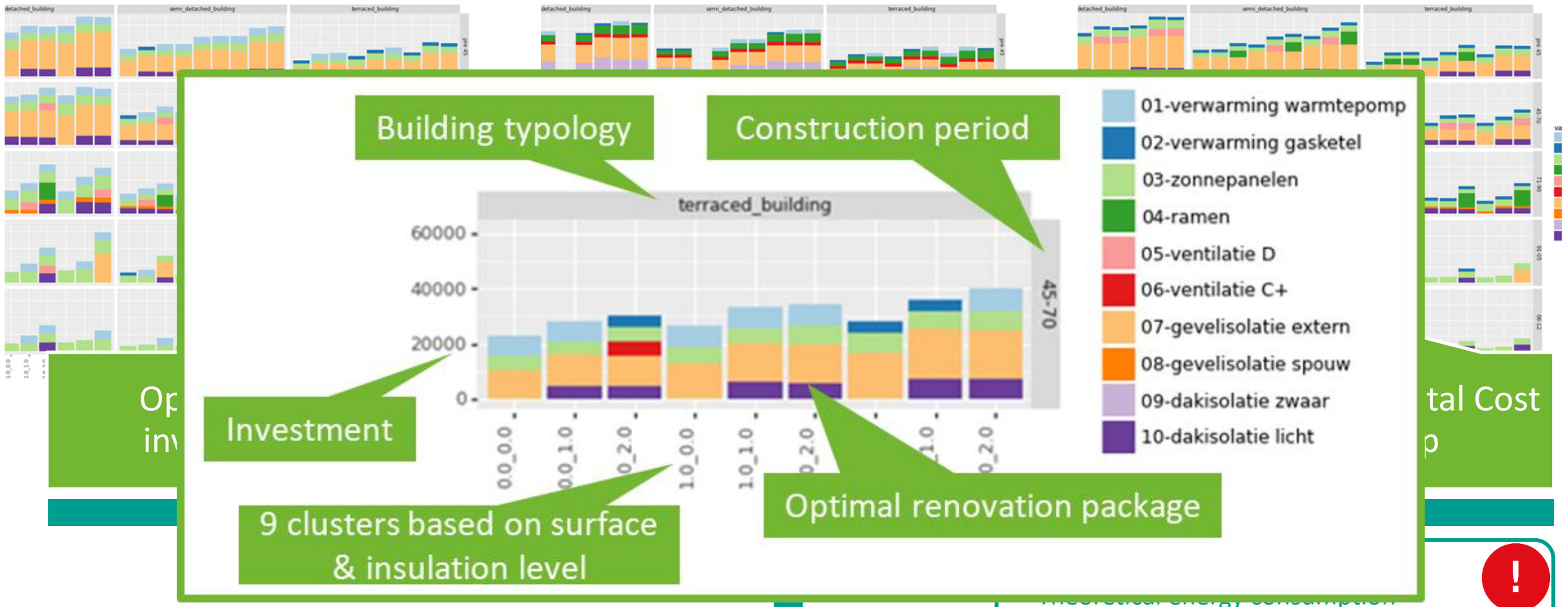
135 representative Single Family Homes
- Construction period
- Building typologies
- Surface & insulation

Renovation measures
- Renovation packages combining 10 measures

Upscaling to Flanders
- 2,03 MIO SFH

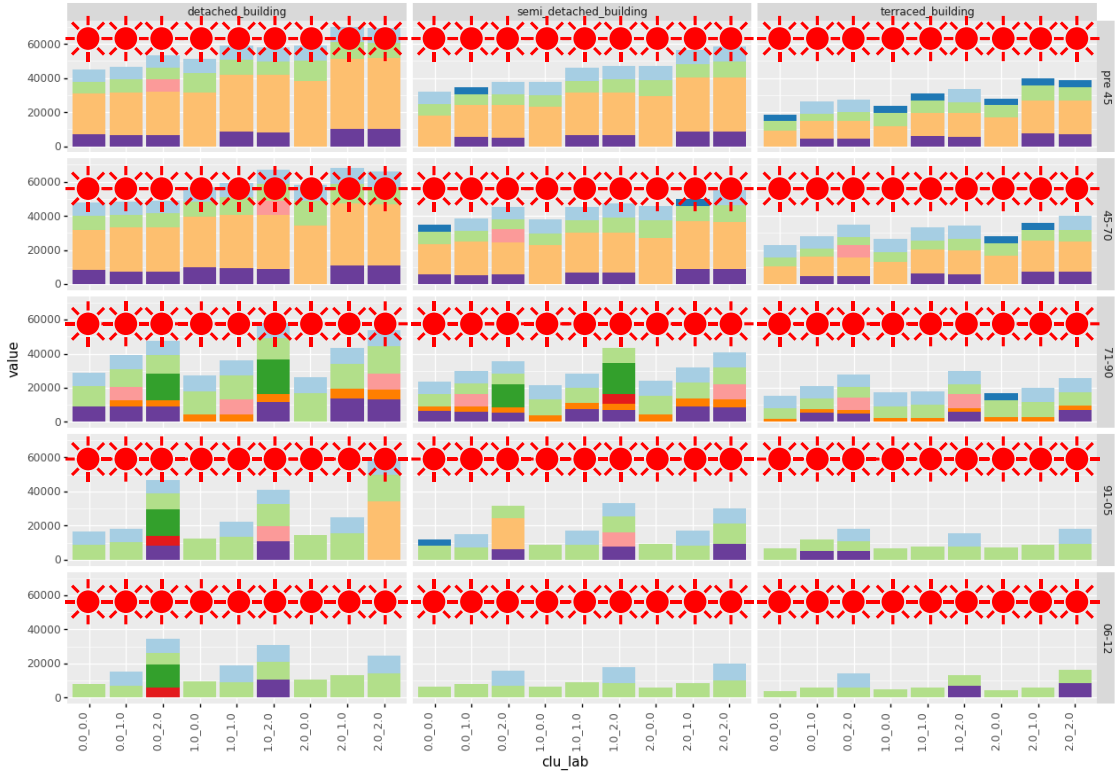
Energy Ville

Analysis over 3 scenarios



- Cultural heritage disregarded
- No apartments
- No co-benefits
- Individual approach, no district heating

Conclusion 1: PV is the dominant measure



- PV installation adopted in all 135 representative SFH
- Enormous impact on average renovation investment
  - **36k€** scenario including PV
  - **66k€** scenario excluding PV as a measure

→ *Result due to large impact of PV on EPC in relation to its investment*

→ *Market conform pricing, and feed-in according new infrastructure tariffs*

Conclusion 2: building envelope measures crucial but expensive

- Building envelope measures (EE) are critical for buildings until ‘90
- Cavity wall insulation for SFH period ‘71-’90 if combined with PV
- Application of PV is determining factor between ‘light’ or ‘deep’ renovation

Incl. PV

Excl. PV

Conclusion 3: Heat pumps market uptake is subject to energy cost

68%

Optimization scenario for investment cost

- HPs applied in 68% of optimal renovation packages
- Until SFH ’90 applied in 84% of optimal renovation packages
- Large contrast with current market practice

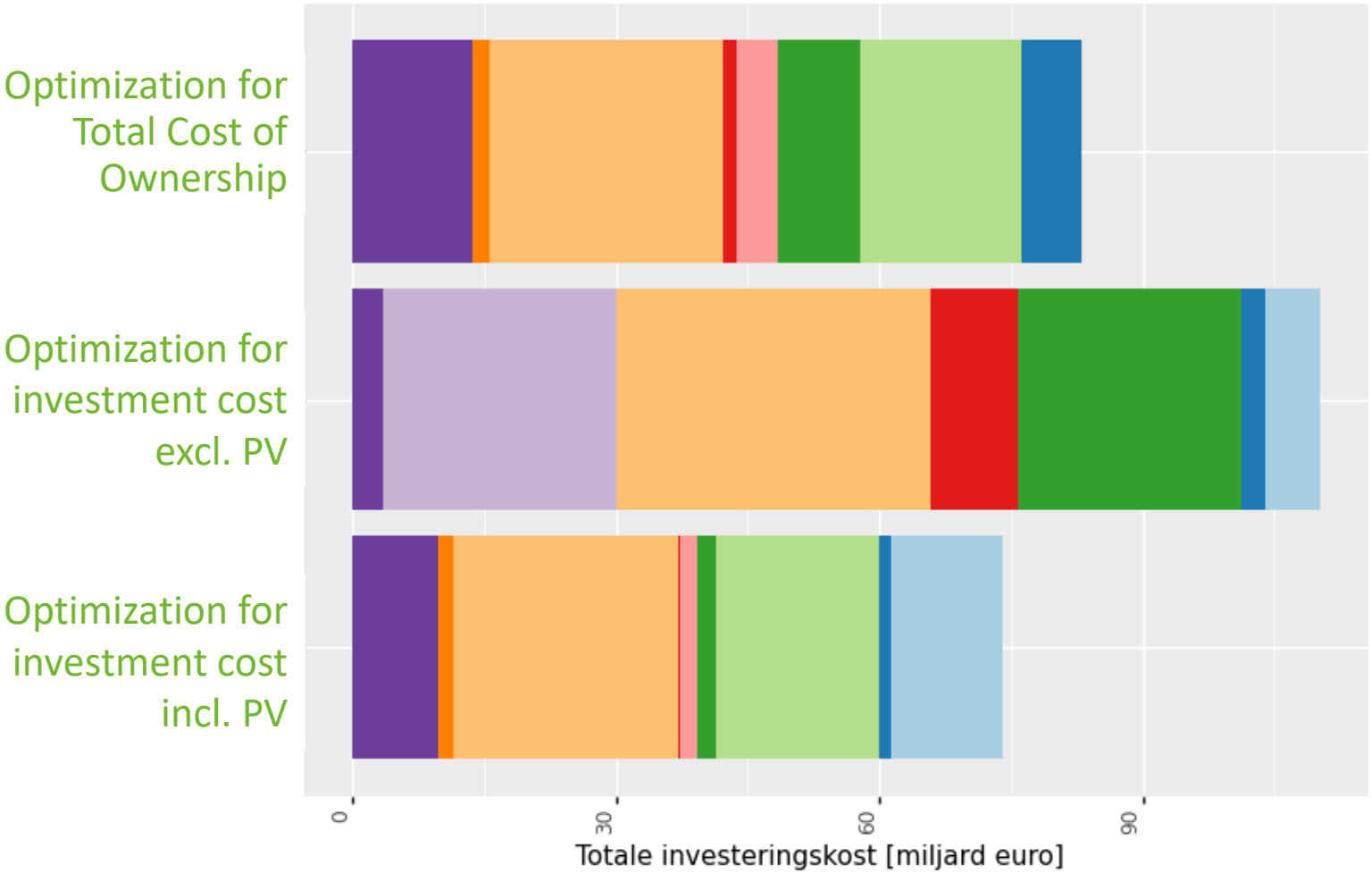
Optimization scenario for Total Cost of Ownership

- 0 optimal renovation packages apply HP
- Includes energy cost for 30y based on theoretical consumption
- Replaced by condensing gas boilers
- Cause = high price ratio electricity/gas

0%

Same scenario, NL energy tariffs → 100% heat pumps

Total investment for Flanders



RENEWABLES IN BELGIUM

Pieter Lodewijks

EnergyVille long-term electricity system scenarios

Capitalizing on insights from multiple stakeholders …

2017 Horizon 2030

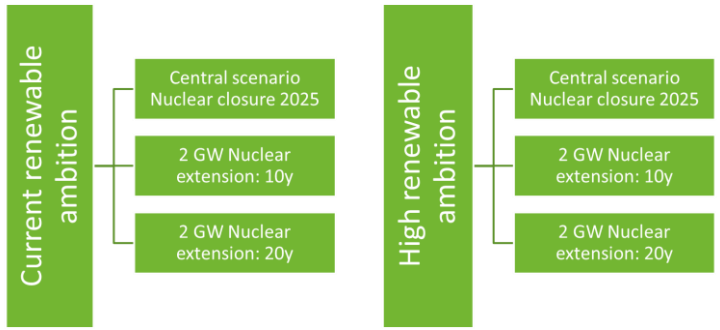
- ‘Energy Transition in Belgium: choices and costs’ ordered by Febeliec
  - Central scenario including nuclear phase-out by 2025
  - High-Low gas price scenario, limited import, 2GW - 10 year nuclear lifetime extension

2018 Horizon 2040

- Updated scenarios post 2030 ordered by Greenpeace, BBL, IEW
  - 2040 outlook including nuclear phase-out by 2025 and with 2GW - 10 year nuclear lifetime extension

2020 Horizon 2050

- 2050 scenarios ordered by Engie
  - ‘Current’ and ‘High’ renewable ambition pathway including 3 scenarios each
    - Central scenario including nuclear phase-out by 2025
    - 2GW - 10 and 20 year nuclear lifetime extension
  - Updated import/export model including cross border impacts
  - CO_2 price up to 84 €/ton by 2030

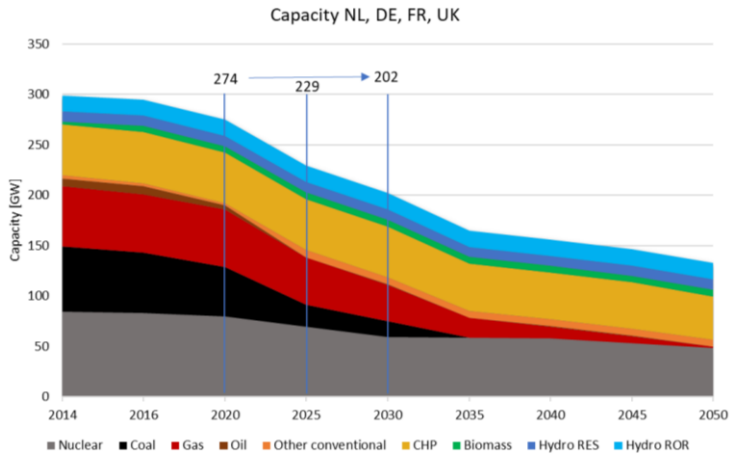


Expected changes in the electricity system

Europe and world

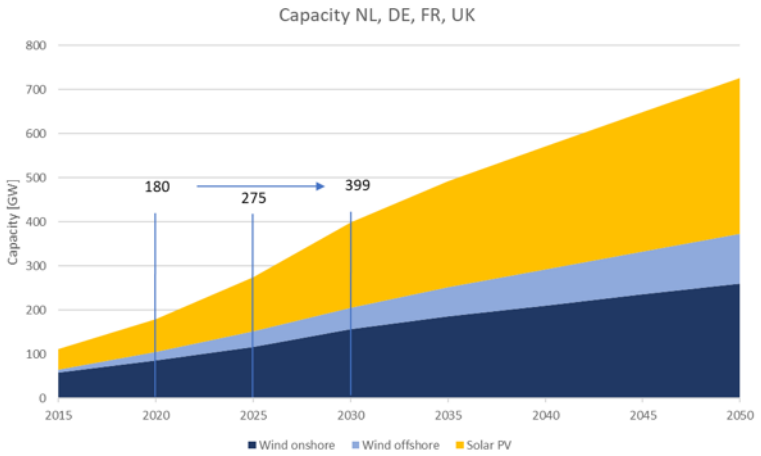
- Renewable investments have proven to be resilient in face of Covid-19 lockdown measures → on track, modest growth in 2020
  - 40% worldwide decline in wind power generation cost over past 10 years
  - 74% worldwide decline in solar PV generation cost from 2010 - 2018
- Europe: electricity systems in neighboring countries (2020-2030) (from National Plans)

Expected **decline in thermal capacity:** -70 GW



2015-2020: Transparancy platform + Eurostat energy balance
2020-2040: TYNDP-DE scenario + EnergyVille assumptions on aging and gradual closure of existing gas units
>2040: extrapolation

Expected **increase in renewable capacity**: +220 GW (PV + 120, onshore wind + 70 GW)



2015-2020: Transparancy platform
2020-2040: DE: Netzentwicklungsplan Strom, UK/FR: TYNDP-DE, NL: TYNDP-NT
>2040: extrapolation

The role of onshore wind in the energy transition

Lowest cost (renewable) electricity generation in Belgium

- Cost decrease
- Efficiency increase
- LCOE (5% discount rate):
  50 €/MWh in 2020
  35 €/MWh in 2030

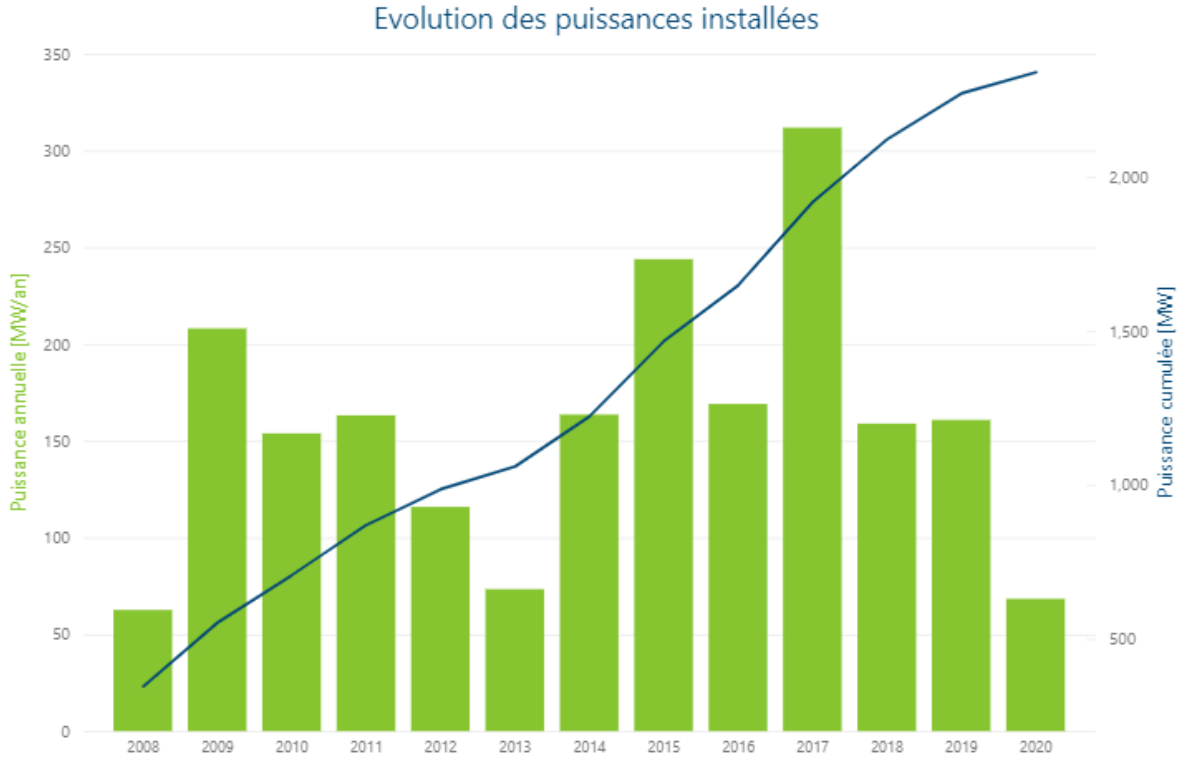
- Location limitation
- NIMBY
- Capacity factor
- Connection to grid

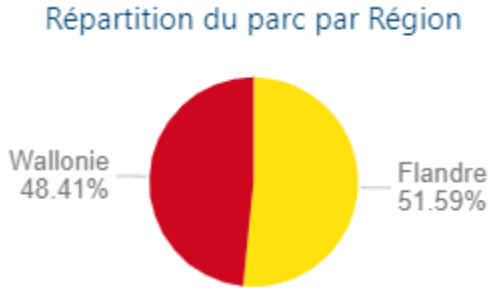
The role of onshore wind in the energy transition

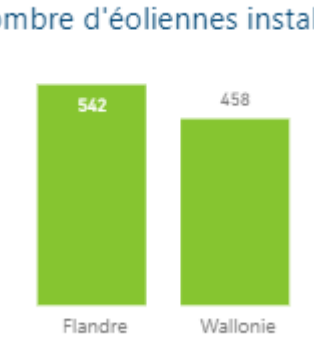
Current onshore wind capacity

- 2019 capacity onshore wind in Belgium (Source: Apere)
  - Flanders 1 242 MW
    + Wallonia 1 036 MW
    = 2 278 MW
- 2017: peak in new investments
  - + 312 MW

‘Limited’ onshore wind potential in Belgium, (20 GW) but largely untapped







Source: Apere.org

The role of offshore wind in the energy transition

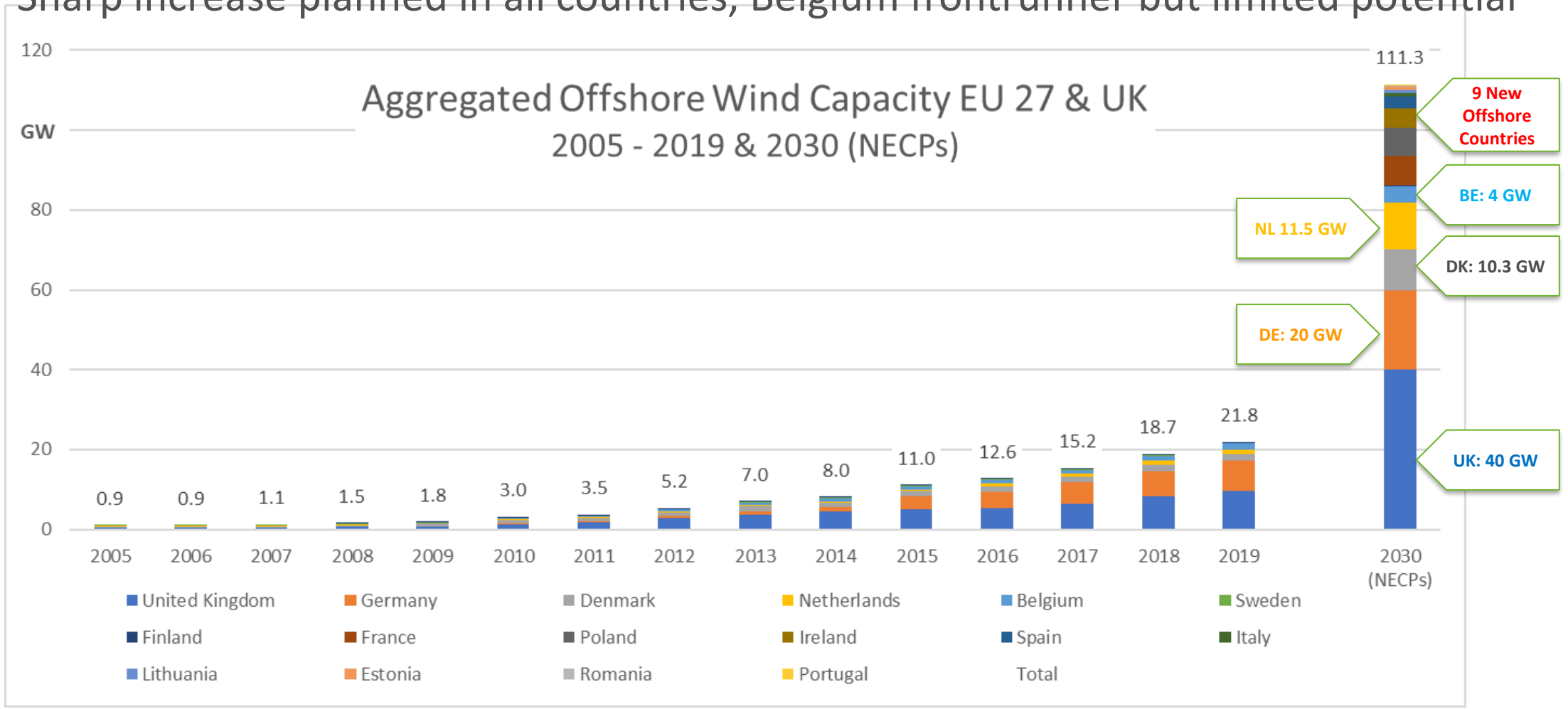
Large capacity growth potential (by 2030)

- Cost decrease
- Auctioning by Member States => lowered bids
- Large spatial potential -> North Sea
- High availability factor 40%

- Large scale investments
- Grid upgrades required: mid-term (e.g. Ventilus), but esp. long-term (DC?)
- Public opposition (grid)
- International cooperation required (takes time)

EU's Offshore growth towards 2020 & 2030 outlook

Sharp increase planned in all countries, Belgium frontrunner but limited potential



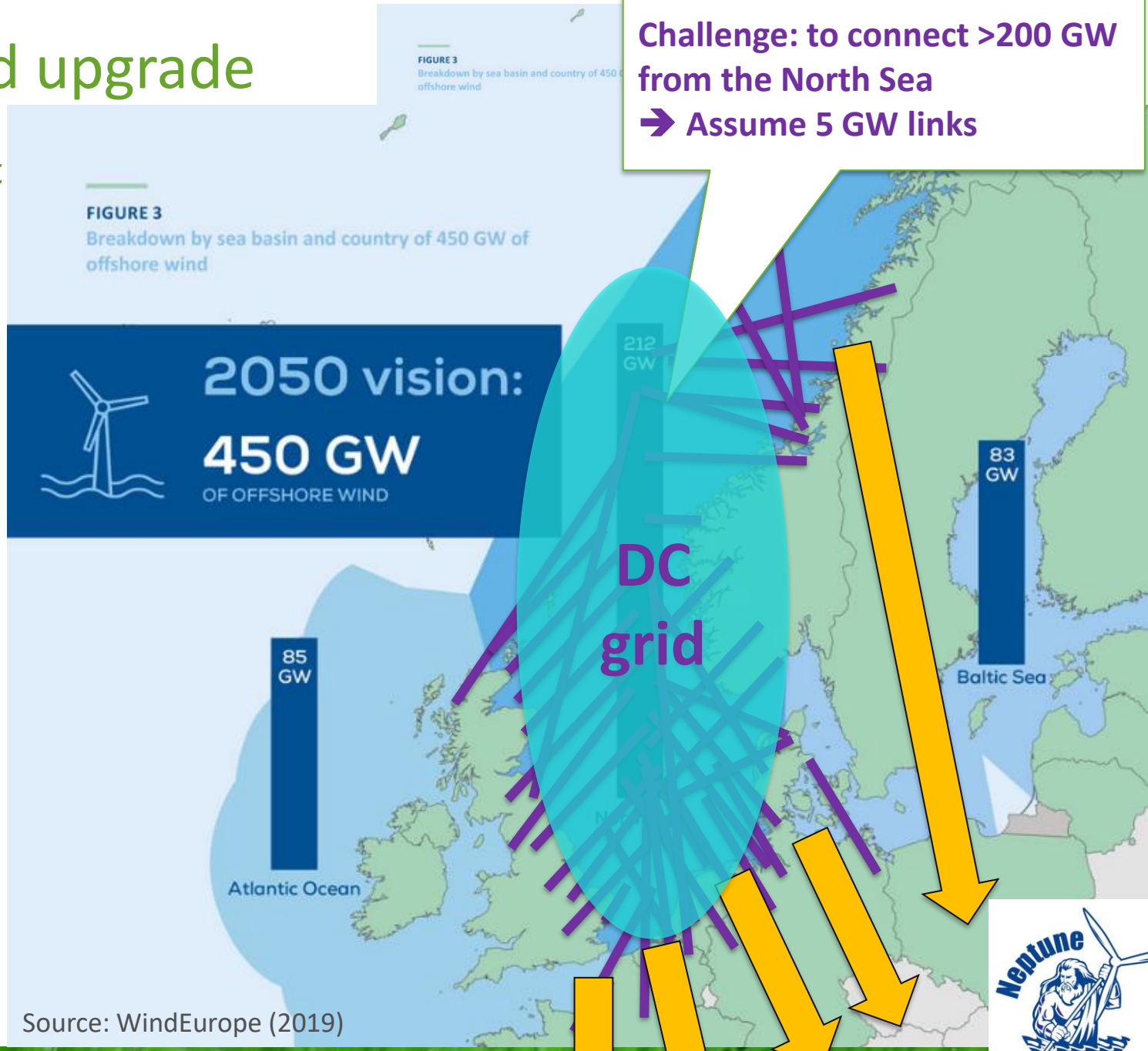
Source: own iteration, based on EurObserv'ER 2020 & WindEurope (NECPs 2030)

Offshore wind requires grid upgrade

- By 2050, large-scale offshore deployment
  - >100 GW by 2030
  - ~450 GW by 2050 (WindEurope, 2019) of which, >200 GW in the North Sea
  - EC EU-target: ~300 GW
- Massive connections are increasingly further from shore:
  - HVDC is only realistic option
  - Meshing is needed
  - Needs to be integrated in the existing system (hybrid AC/DC)
- Onshore upgrade requires also new backbone system for Europe

➢ **Investigated in Neptune project**

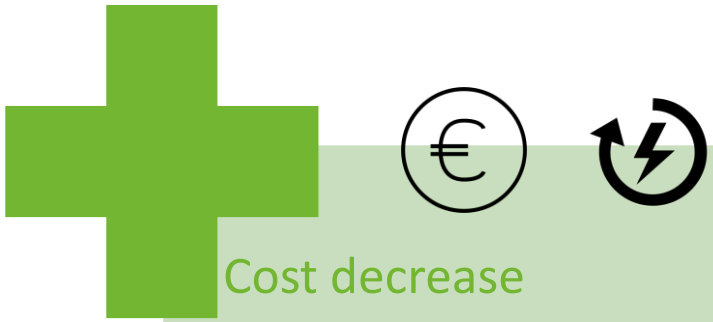
Coordinator Neptune Project:
Prof. Dirk Van Hertem <dirk.vanhertem@esat.kuleuven.be>



Source: WindEurope (2019)

The role of PV in the energy transition

Largest capacity growth potential (2030) of all renewables



Cost decrease

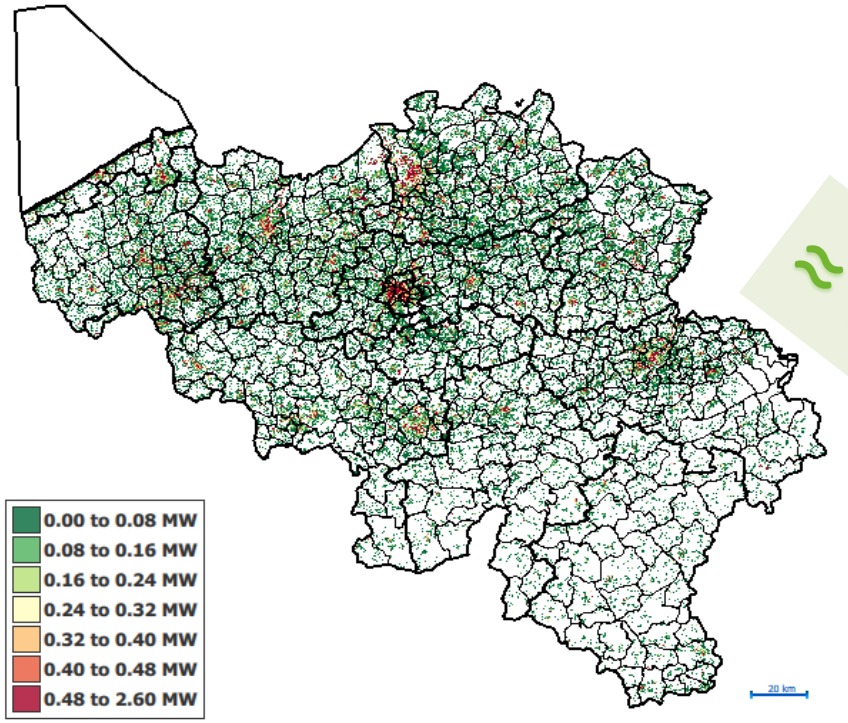
- Large spatial potential -> roofs
- Integration potential with local energy systems (e.g. heat pumps, charging EV)

- Distributed investors & investments
- Regulation & policy sensitive
- Capacity factor (~12%)
- Connection to grid can cause local challenges

The role of PV in the energy transition

PV – potential in Belgium

- Increased efficiency (generation/m^2) for new techs
- PV installations (285Wp)
  - Residential: < 10kW, 40% of roof area as suitable assumed
  - Commercial/Ind.: > 10kW, 80% of roof area as suitable assumed
  - Based on detailed studies in-situ case studies in Flanders
  - No ground mounted installations taken into account



≈ 84 GW

Figure: Potential of additional PV rooftop installation in Belgium (MW per ha)

Technology	Source	Flemish region	Brussels Capital Region	Walloon region	Belgium Offshore	Belgium
Capacity (GW)						
PV Current[1] (2018!)	Commercial&Industry	1.02	0.05	0.55	0.00	1.62
	Residential	1.44	0.01	1.05	0.00	2.51
	Subtotaal	*2.46*	*0.05*	*1.61*	*0.00*	*4.12*
PV Potential[4]	Commercial&Industry	25.71	1.70	14.44	0.00	41.85
	Residential	24.37	1.50	15.89	0.00	41.76
	Subtotaal	*50.07*	*3.21*	*30.33*	*0.00*	*83.61*

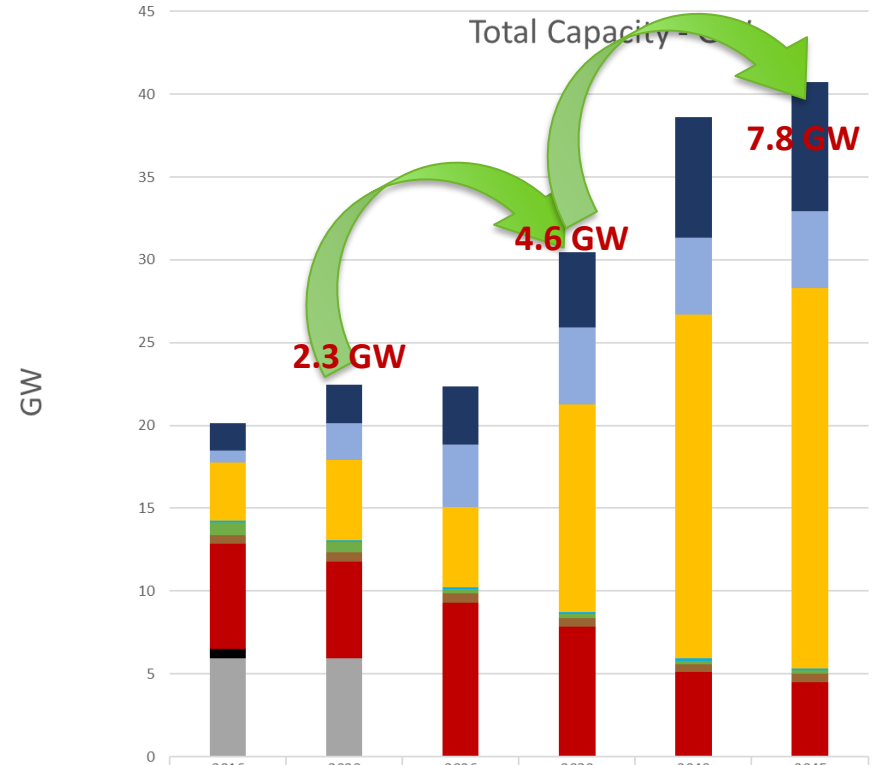
NECP 2030 (WAM): ~11 GW

Source: VITO/EnergyVille, ETF BREGILAB project

Scenario results – Current renewable ambitions

Speeding up onshore wind investments is cost effective

- Assumption social acceptance prevents societal cost optimization
- Limiting new investments to +250 MW/y from 2020-2030
- New investments limited to +450 MW/y >2030 to compensate for substitution of ageing turbines
- Result:
  - double the capacity to 4,5 GW from now to 2030
  - Would be cost effective to do more

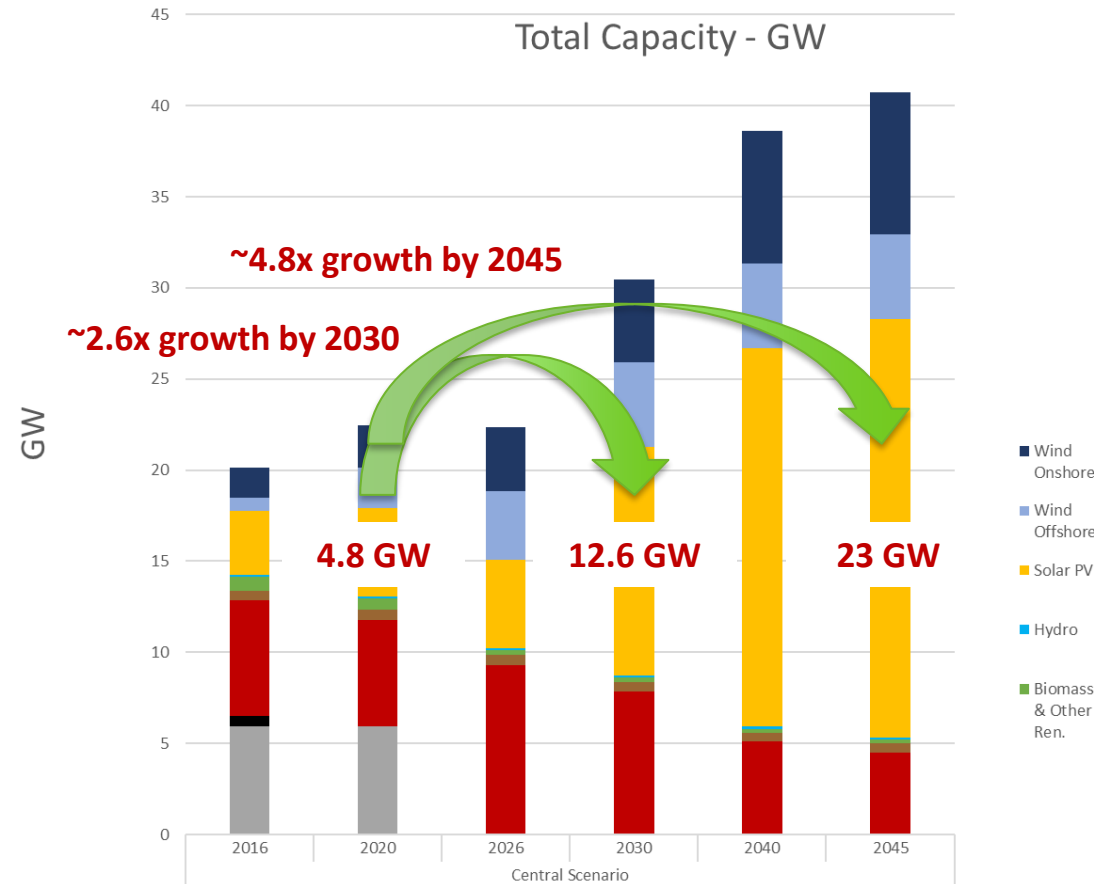


Central Scenario	2016	2020	2026	2030	2040	2045
Wind Onshore	1,66	2,28	3,53	4,55	7,28	7,80
Wind Offshore	0,71	2,26	3,76	4,63	4,60	4,60
Solar PV	3,54	4,83	4,83	12,57	20,77	22,97
Hydro	0,10	0,11	0,12	0,12	0,14	0,15
Biomass & Other Ren.	0,75	0,62	0,27	0,22	0,21	0,20
Other Fossil	0,56	0,55	0,55	0,55	0,49	0,50
Natural Gas	6,35	5,86	9,31	7,84	5,10	4,49
Coal	0,56					
Nuclear	5,93					

Source: Central Scenario - EnergyVille (2020)

Scenario results – Current renewable ambitions

- PV growth not limited
  - energy system cost optimisation
  - Grid integration + battery storage needs
- Subsidies and regularity ‘barriers’ not taken into account
- PV cost efficiency drives investments
  - 2020 - 2030: **+ 7.8 GW**
  - 2030 - 2045: **+ 10.4 GW**
- **Result viewer:** https://www.energyville.be/belgian-long-term-electricity-system-scenarios



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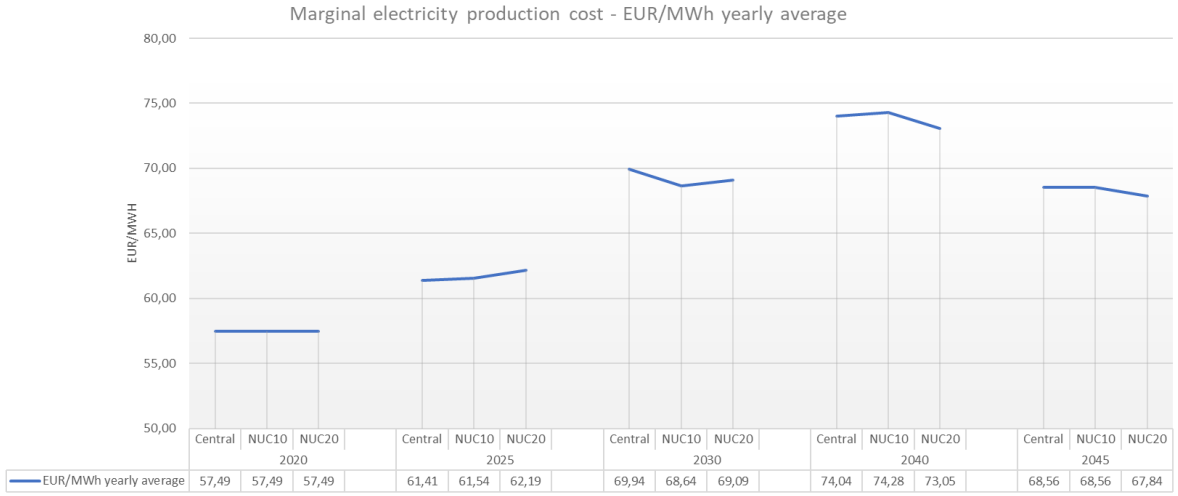
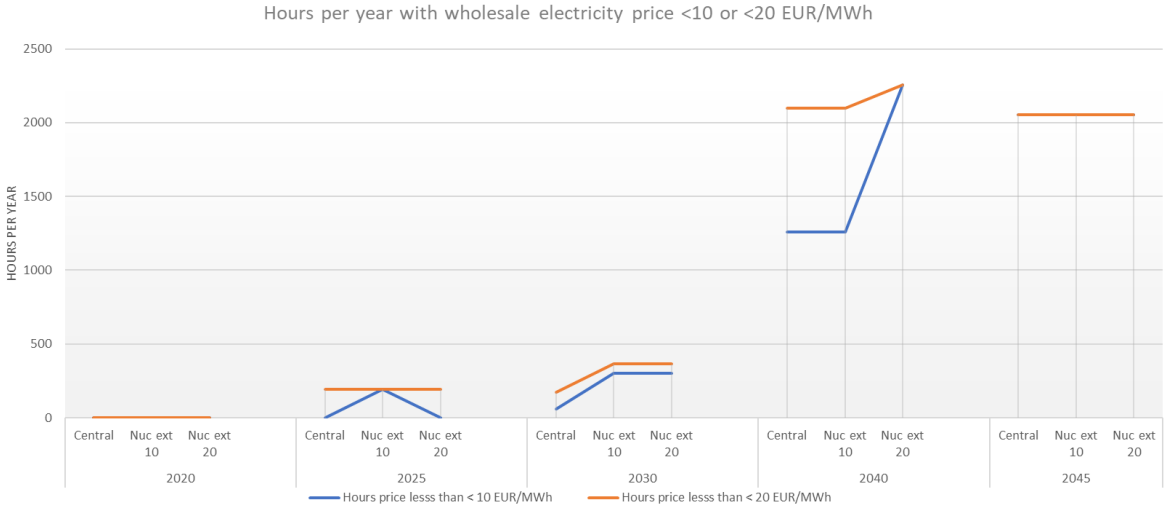
Coal	0,56					
Nuclear	5,93	5,93				

Source: Central Scenario - EnergyVille (2020)

Marginal electricity production cost – wholesale price

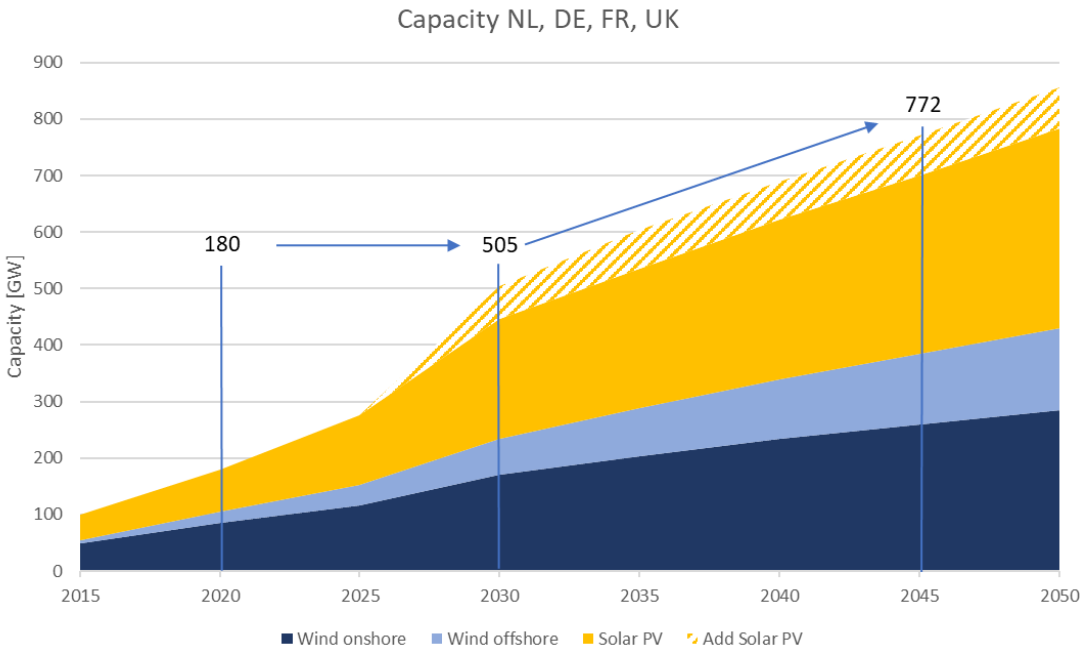
- Nuclear extension has a limited impact on the wholesale price of electricity in Belgium
  - Wholesale price determined by gas units, gas price and ETS price
  - 2030:
    - Central: almost 70 EUR/MWh
    - 10y LTO: - 1,3 EUR/MWh compared to Central
    - 20y LTO: - 0,9 EUR/MWh compared to Central
  - 2040: - 1,0 EUR/MWh in 20y extension scenario
- Number of hours per year with low wholesale price, <10 or <20 EUR/MWh
  - 2030, <10 EUR/MWh: 300 h/y in nuclear extension vs. 58 h/y in central scenario
  - Sharp increase from 2040 onwards, 2100 h/y with wholesale price <20 EUR/MWh and 2260 h/y in 20y nuclear extension scenario





High RES - Changes in assumptions

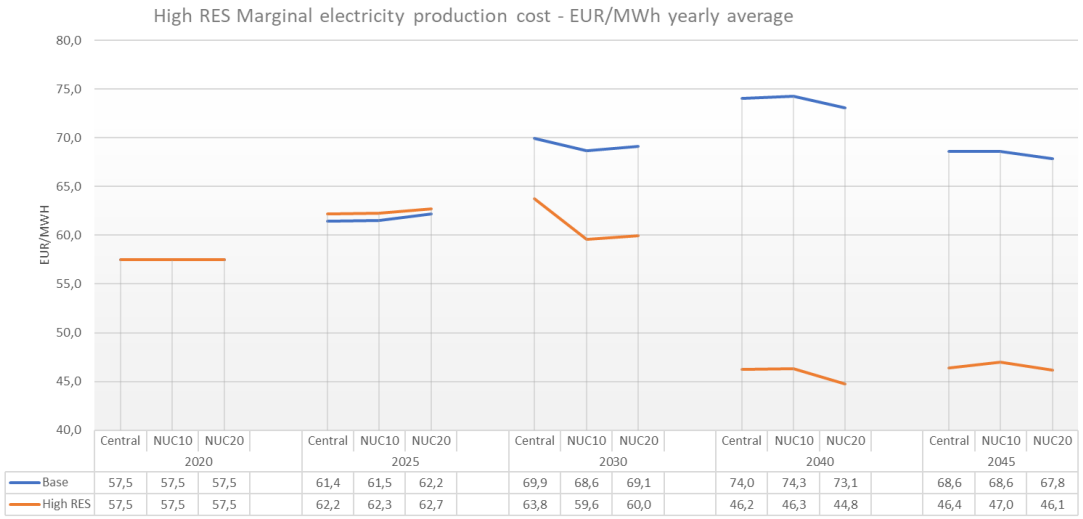
- Exogenous renewable capacity neighbouring countries
  - Highest available TYNDP scenario results
  - Additional 266 GW renewables from 2020-2030 = solid area in graph
- Endogenous changes
  - PV
    - Investment cost PV: lower estimate IRENA projections
      - 2030: 306 €/kW (vs 540 €/kW)
      - 2050: 148,5 €/kW (vs 324 €/kW)
    - Allow investments in all countries, in neighbouring countries on top of exogenous capacity = 'Add solar PV" in graph (result from model)
  - Batteries
    - Lifetime extension from 10 to 20y starting from 2035
    - Allow investments in all countries
  - Onshore wind Belgium
    - Post 2030 annual capacity *increase* max. 500 MW/y → maximum capacity 12,5 GW by 2050
  - Offshore wind Belgium
    - Maximum potential implemented: 6 GW from 2040 onwards



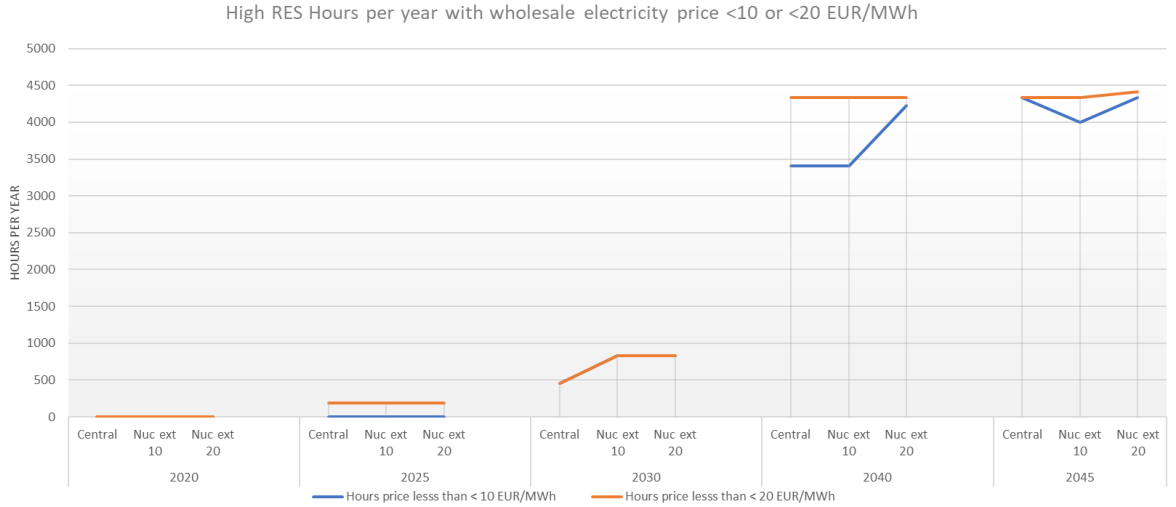
Marginal electricity production cost – wholesale price

- High RES scenarios lead to much lower wholesale electricity prices from 2030 onwards
  - 2030:
    - High RES scenarios are well below Current renewable ambition scenarios: 6,1 – 9,1 €/MWh lower
  - 2040:
    - High RES scenarios difference with Base scenarios increases to almost 30 €/MWh

- Number of hours per year with low wholesale price, <10 or <20 EUR/MWh
  - 2030, <10 EUR/MWh: 800 h/y in nuclear extension vs. 450 h/y in High RES central scenario
  - Sharp increase from 2040 onwards, 3400 h/y with wholesale price <10 EUR/MWh and 4300 h/y in 20y nuclear extension scenario



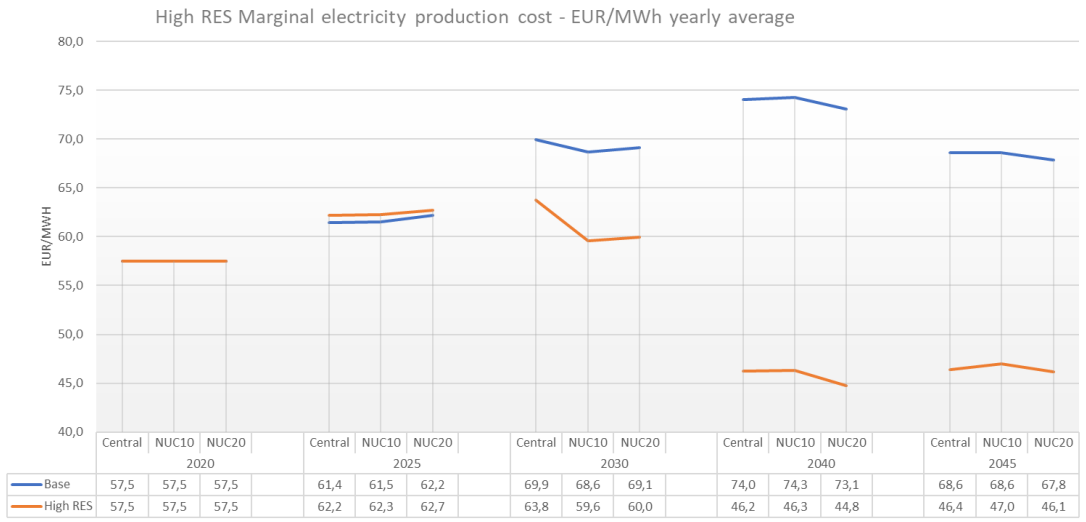
	Central	NUC10	NUC20	Central	NUC10	NUC20	Central	NUC10	NUC20	Central	NUC10	NUC20	Central	NUC10	NUC20
	2020			2025			2030			2040			2045		
Base	57,5	57,5	57,5	61,4	61,5	62,2	69,9	68,6	69,1	74,0	74,3	73,1	68,6	68,6	67,8
High RES	57,5	57,5	57,5	62,2	62,3	62,7	63,8	59,6	60,0	46,2	46,3	44,8	46,4	47,0	46,1



Lower wholesale prices – increased electricity demand

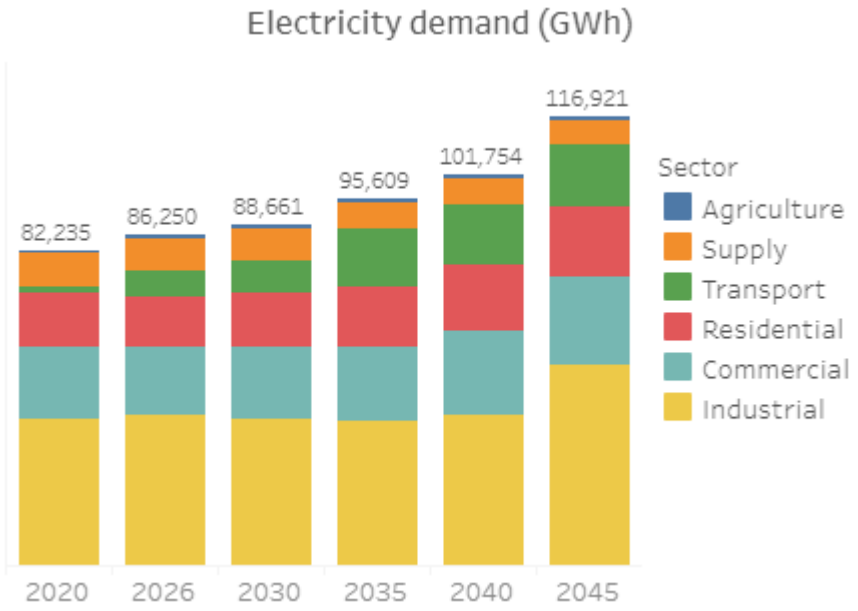
Lower wholesale prices lead to further electrification of demand sectors

- Number of hours per year with low wholesale price, <10 or <20 EUR/MWh
  - Sharp increase from 2040 onwards, 3400 h/y with wholesale price <10 EUR/MWh and 4300 h/y in 20y nuclear extension scenario

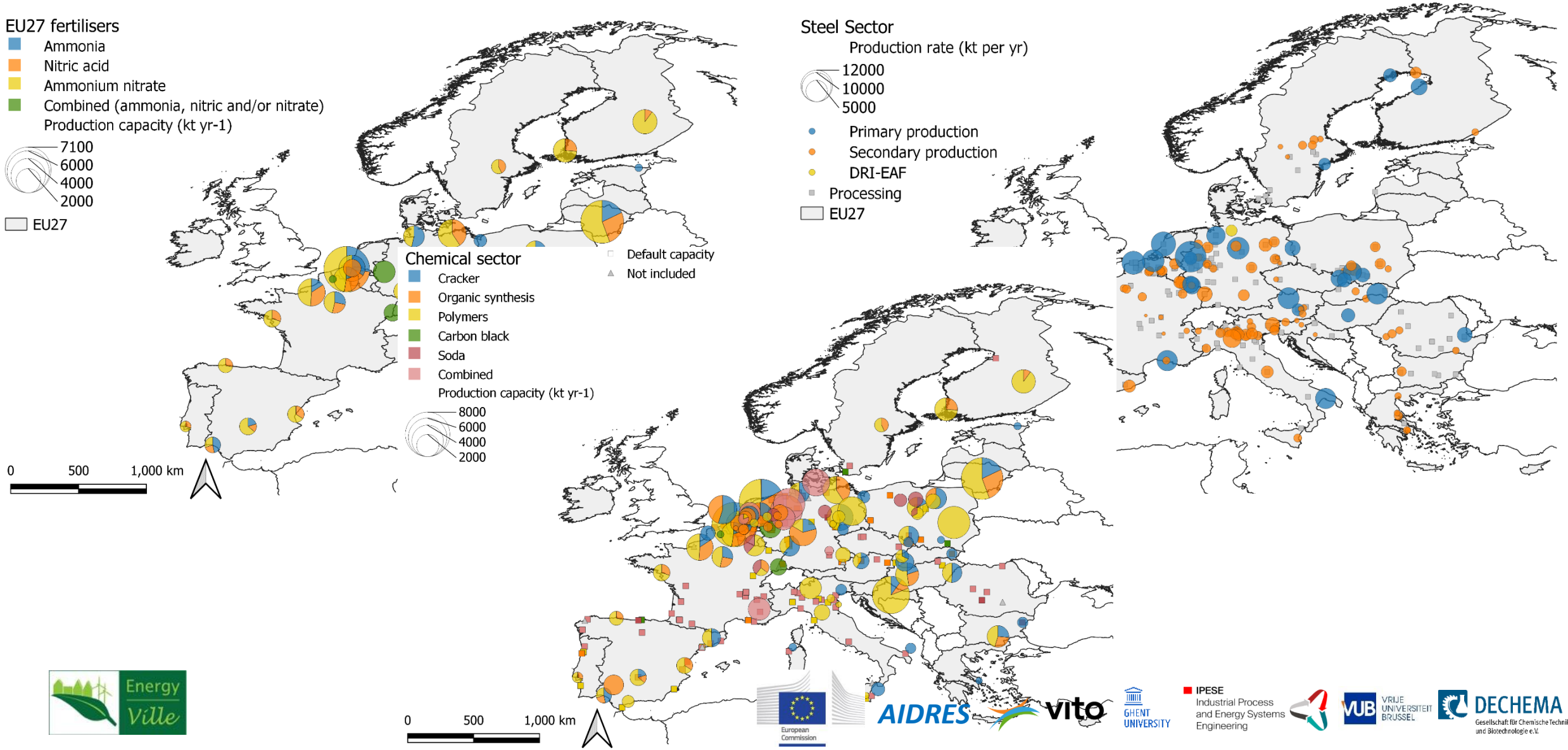


	Central	NUC10	NUC20	Central	NUC10	NUC20	Central	NUC10	NUC20	Central	NUC10	NUC20	Central	NUC10	NUC20
	2020			2025			2030			2040			2045		
Base	57,5	57,5	57,5	61,4	61,5	62,2	69,9	68,6	69,1	74,0	74,3	73,1	68,6	68,6	67,8
High RES	57,5	57,5	57,5	62,2	62,3	62,7	63,8	59,6	60,0	46,2	46,3	44,8	46,4	47,0	46,1

- Electrification of transport sector, residential and industrial processes
- No full decarbonization reached



Belgium – Netherlands – Germany: industrial hotspot



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DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e.V.

Direct/indirect electrification essential for transition

Energy system approach needed: cross-vector/sector/border

- Renewable electricity scarce in the Be-Nl-De region: negative balance electricity demand vs. renewable generation potential
- Cross-border collaboration needed
- Infrastructure needed
  - Electricity transmission
  - Gas grids
  - CO_2 pipelines

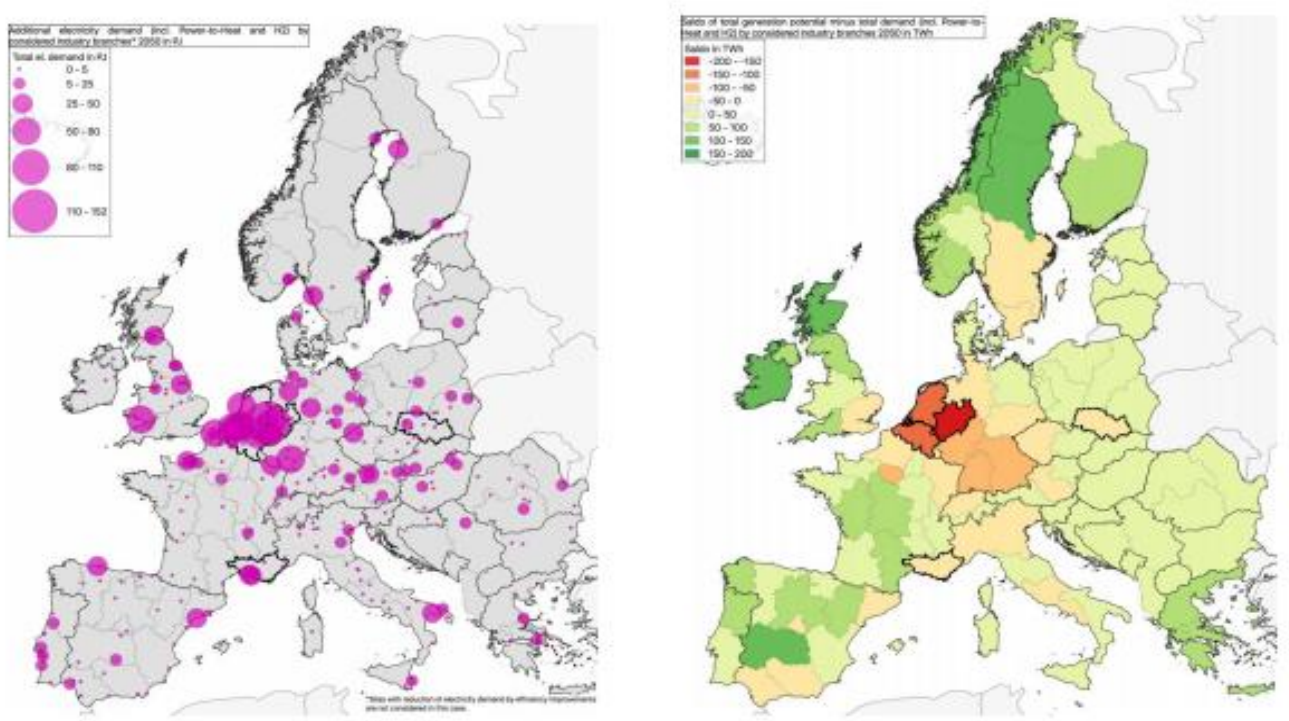


Figure 1: Regional distribution of electricity demand 2050 of three decarbonised core industries (left) and resulting electricity balances by considering electrifiation of other sectors

Source: Wuppertal Institut based on Material Economics 2019, e-Highway 2050, 2014)

CO_2 emissions to be captured & stored

- Trilateral region potential hotspot for CCS/CCU but depending on the (in)direct electrification

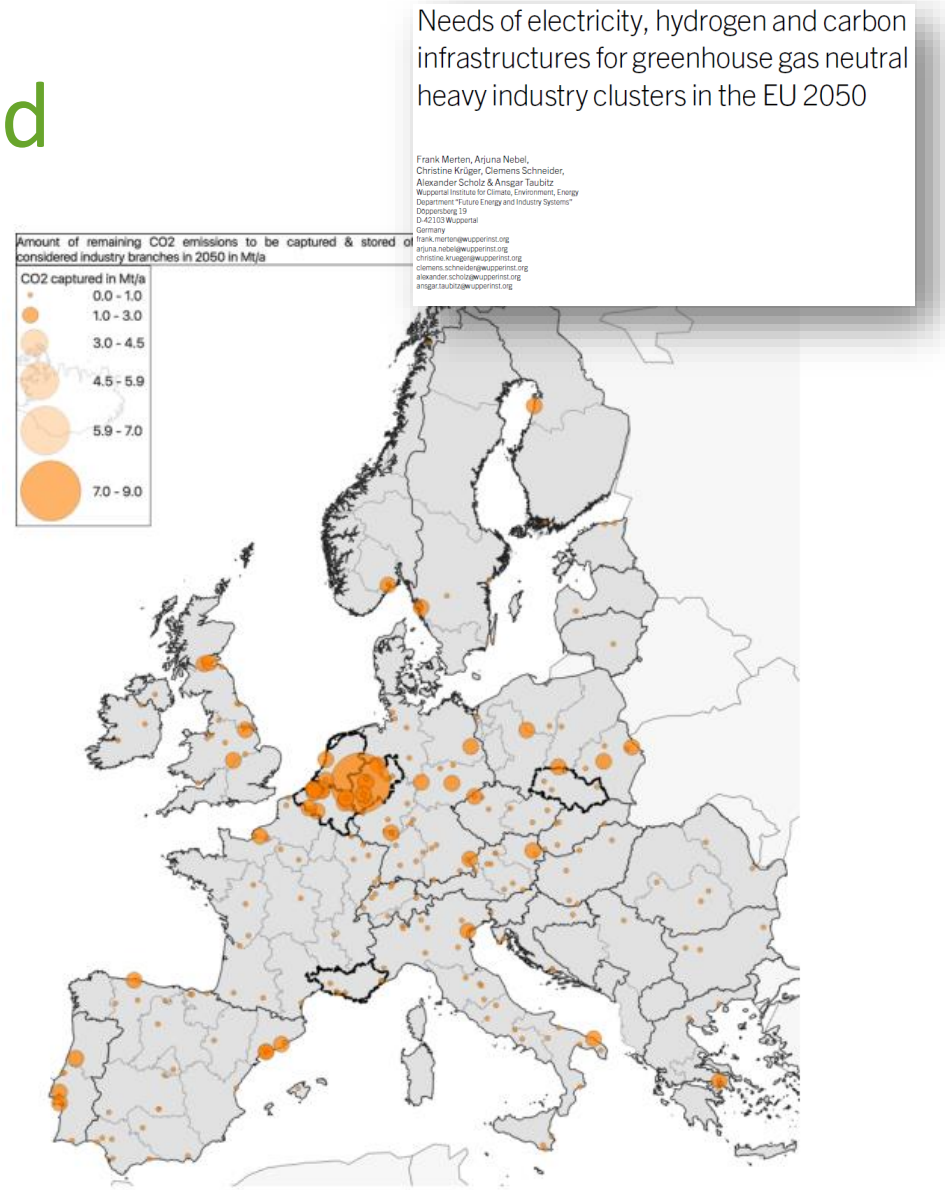
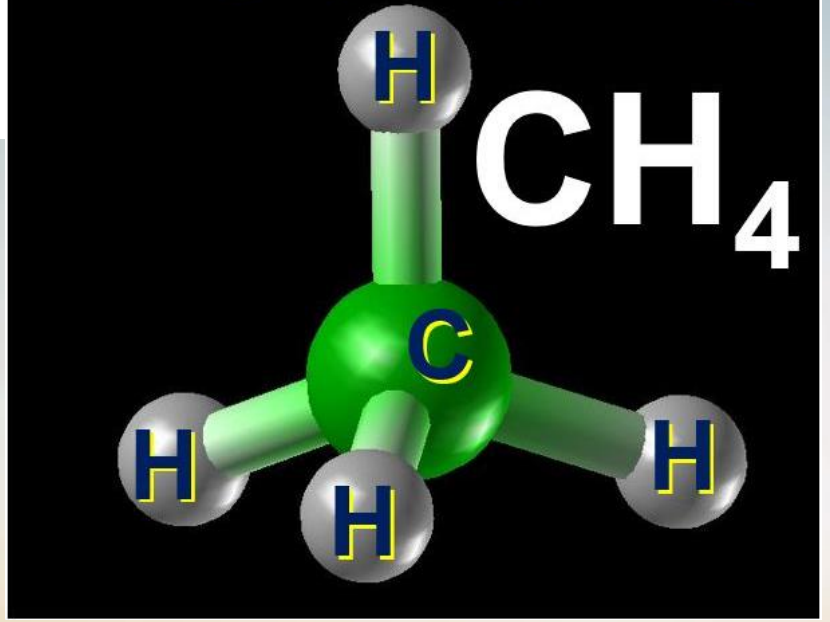


Figure 3. Regional distribution of the remaining CO_2 emissions in 2050 after the ME-Scenario "CCS".



Green Methane – recycled gas – renewable molecule

GERECYCLEERD GAS (WATERSTOF ?)

VOORDELEN GROEN METHAAN

- Hergebruik **bestaande gasnetten** – bestaande markt
- Vergelijkbaar met levering “**groene elektriciteit**”
- Duurder dan gewoon aardgas vroeger
- Gekend productieproces : Sabatier-reactie
- **goedkoper én enig alternatief** voor aanzienlijk gedeelte van de woningen en industrie
- Is compatible met **Europese “green deal”** (hernieuwbare molecule)

- **Geopolitiek:**
  - Meer landen kunnen groen methaan leveren dan OPEC (Marokko, Zuid-Afrika, Chili, India, …) => max. productieprijs
  - Rusland komt economisch buiten spel

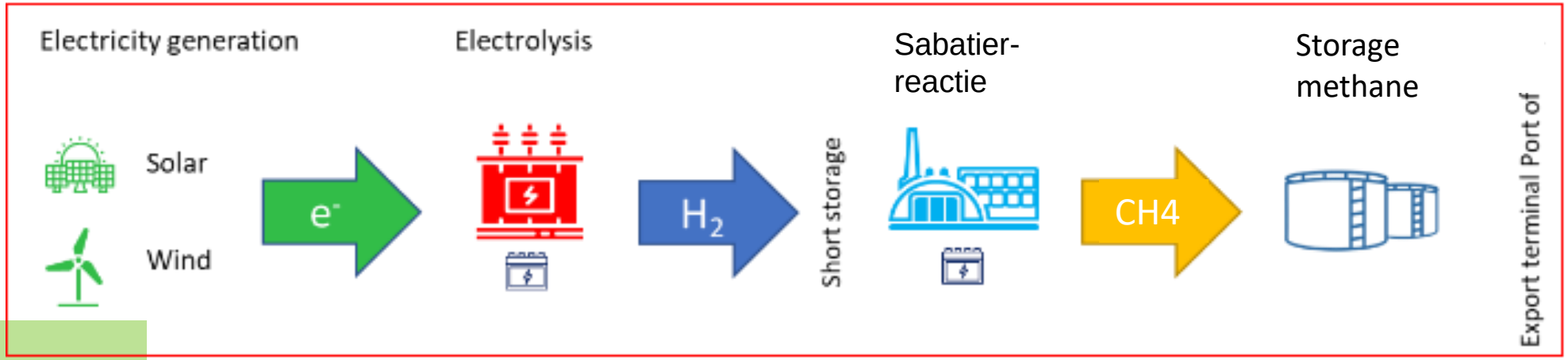
- Ideaal “**CO2 certifiëring**” en toewijzing CO2 credits aan landen
- Duidelijke **communicatie** door (Vlaamse) overheid

PRODUCTIE GROEN METHAAN

COMPONENTEN EN PROCÉDÉ

- CO_2
  - Captatie Vlaanderen Chemie
  - Captatie UAE
  - DAC
- H_2
  - Midden-Oosten – India – Chili, Marokko

  Lage hernieuwbare energiekost
- Gekend productieprocédé
  - Sabatier-reactie (1912)



VITO & IMEC PARTNERS IN POWER TO MOLECULES

Joint development

of electrolysis technology blocks

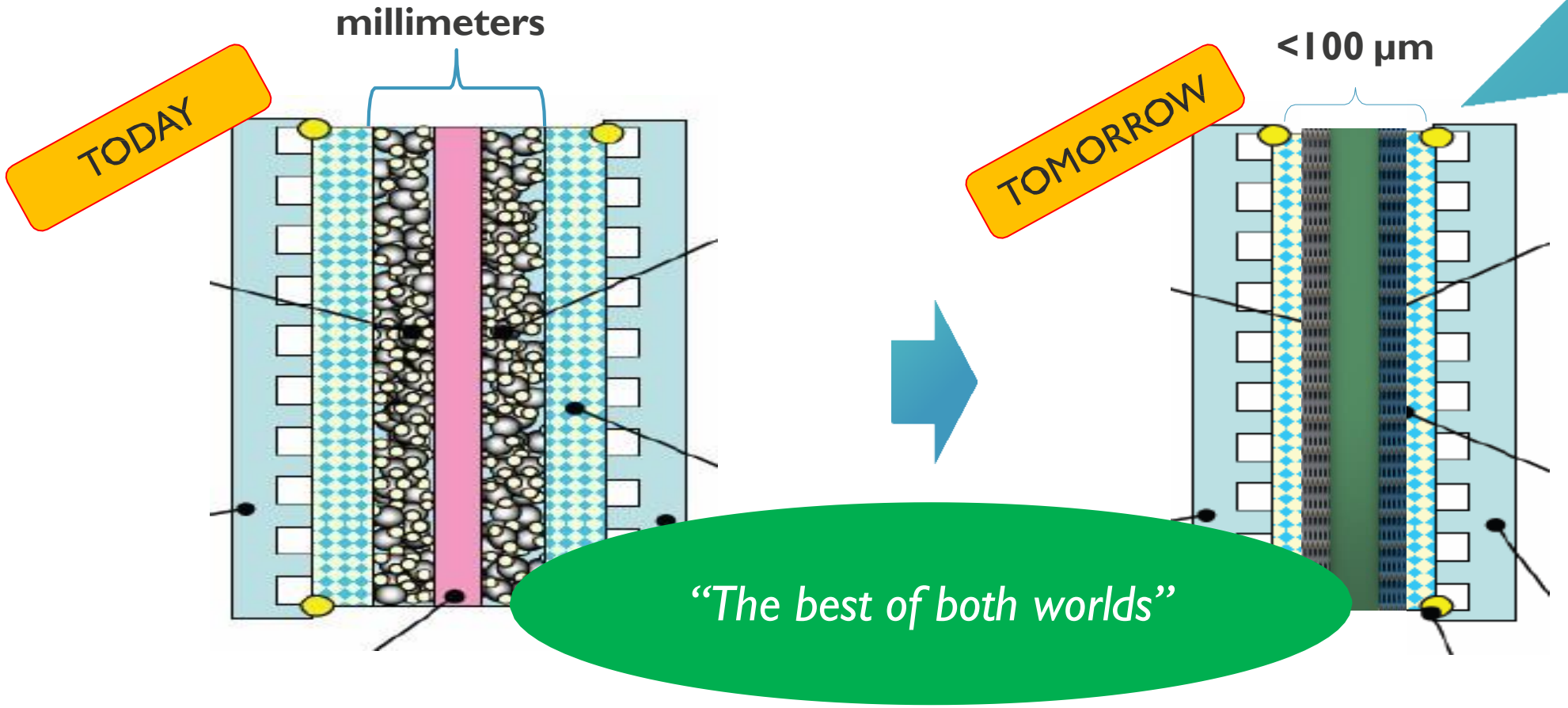
- nanomesh electrodes
- thin film deposition technology,
- catalyst material
- solid electrolyte membranes
- Masters of interfaces

- cast polymer ceramic composite membranes
- catalyst development
- electrolyser cell & stack design
- pressurized electrolyser stacks & systems
- operational testing of cells & stacks

VITO / imec bilateral agreement underway: joint development and joint valorization (strategy)

IMPROVING THE MEMBRANE ELECTRODE ASSEMBLY

THE HEART OF THE ELECTROLYSER



Inefficient electrolyser architecture with large ohmic losses at high currents

>10x smaller Membrane Electrode Assembly

100-1000 times larger throughput

FROM RESEARCH TO MARKET: THE **HEMEL PROJECT**

HEMEL BG/SG

imec

Research partners

vito

Components

BEKAERT better together

Electrolyser

John Cockerill

Development of hydrogen projects

COLRUYT GROUP

DEME

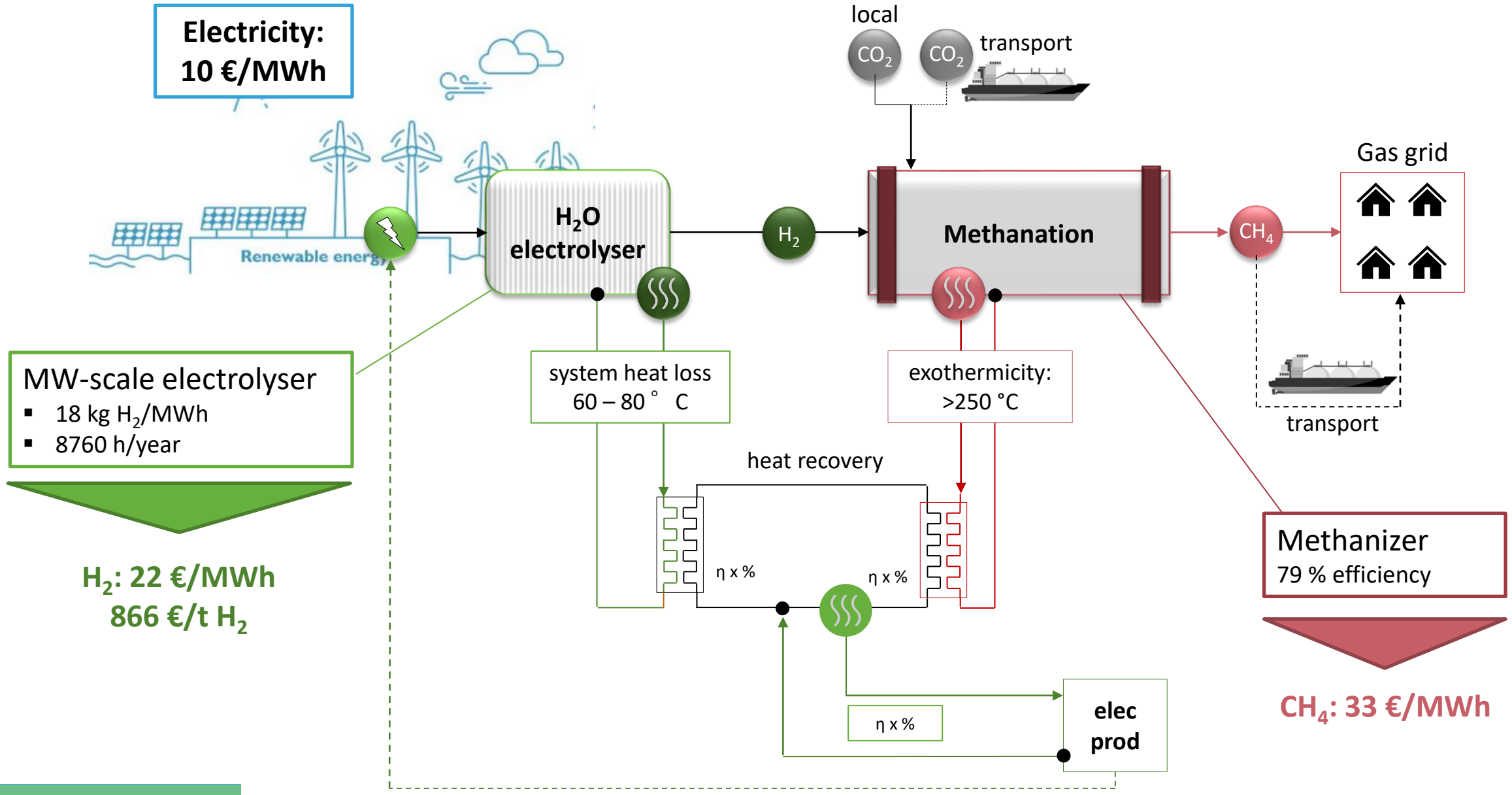
HEMEL-FG
Exploitation in H_2

HEMEL:
Hydroxyl Exchange Membrane ELectrolyser

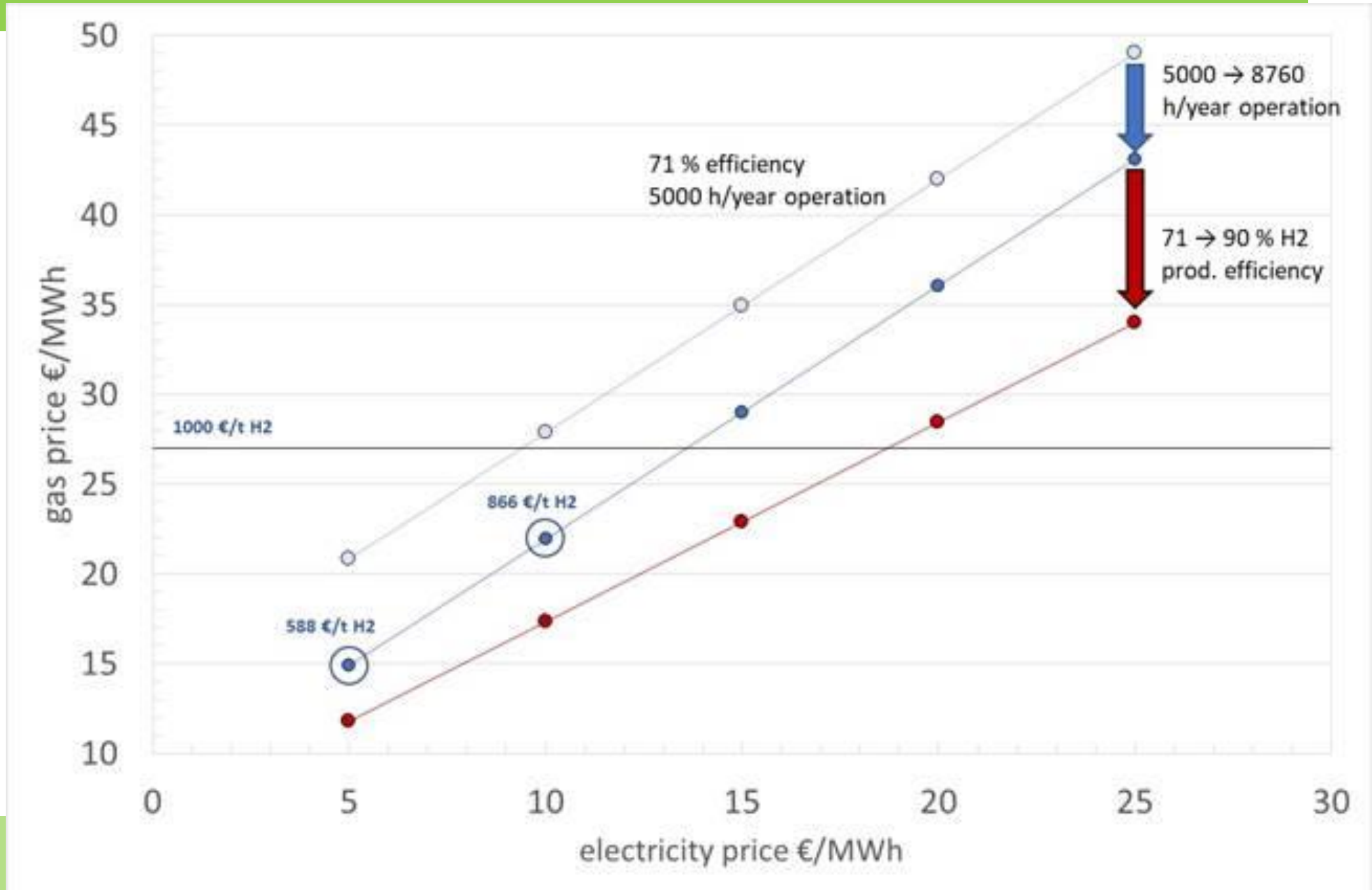
JointValorization
JointVenture

IP Company in the Field of green Hydrogen and Product Company

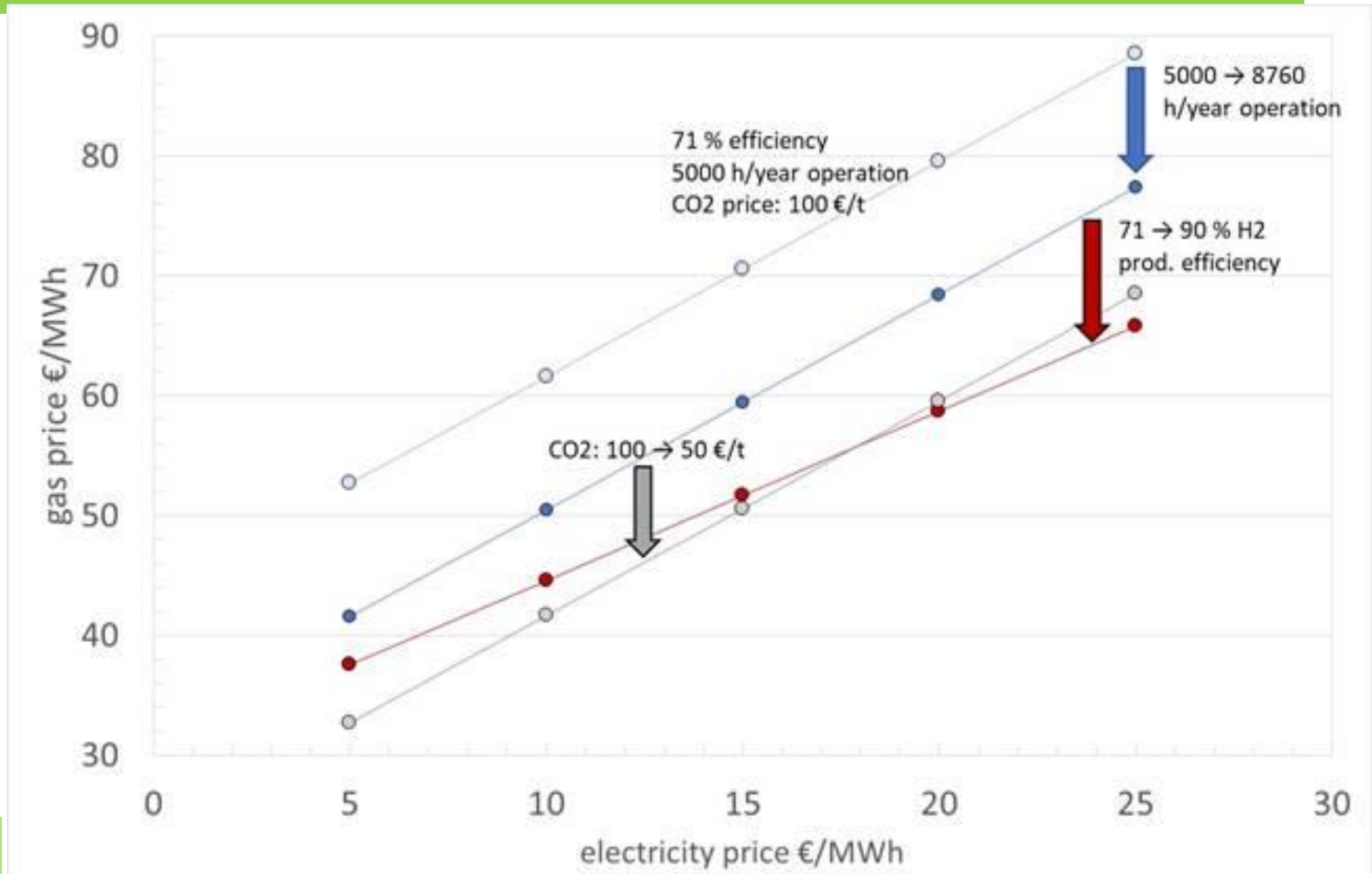
Businessplan - component



H2 PRICE

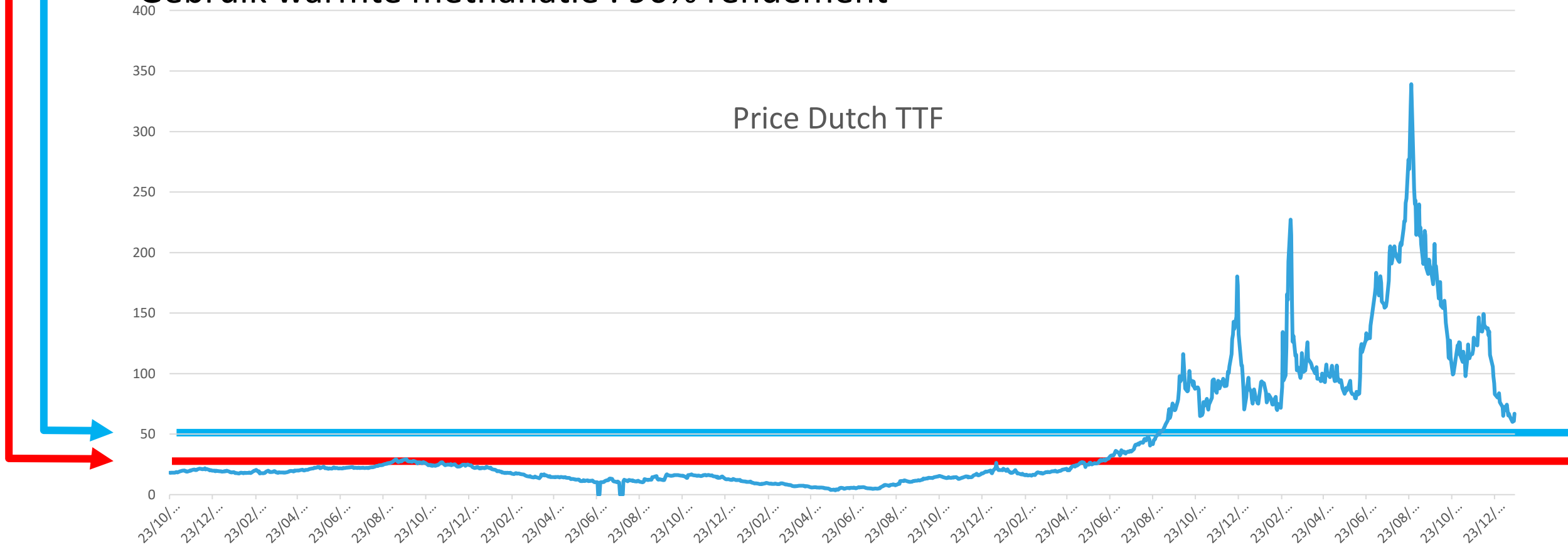


CH4 PRICE



COMPARISON GASPRICE VERSUS COSTPRICE

- Kostprijs : 33 €/MWh bij 8760 u/jaar (71 % rendement of 7800 u à 90 % rendement)
- Duqm - aanname 5800 u/jaar => 50 €/MWh
- Gebruik warmte methanatie : 90% rendement



INVESTERINGEN VOOR VLAANDEREN BEBOUWING – CA. 8 MT CO2

- Dit vereist een 9.23 GW electrolyser en 6.6 GW methaniser, voor full-load production;
- Komt overeen met 81 TWh omzetting van hernieuwbare elektriciteit tot 45 TWh methaan;
- 8.3 TWh exotherme warmtevrijzetting => verhoging efficiëntie proces
- CAPEX: 10 393 M€ (excl. PV en/of wind – afweging CAPEX versus OPEX)
- OPEX : 1 000 M€ per jaar (hernieuwbare elektriciteit)

- Omzet : 45 TWh à 60 €/MWh = 2 700 M€/jaar

HYPORT® Duqm, Phase 1 of a 1,5 GW electrolyser complex

DEME OQ

Electrolyzer	500 MW
Full Load Hours	5800 hrs/yr
Onshore windpark	620 MW
Solar PV park	690 MW
Green H2	59,000 mt/yr
Green NH_3	332,000 mt/yr

ADDITIONELE THEMA'S

SEIZOENSFLUCTUATIES

- Sterke vraag in December nood aan (ondergrondse) opslag – spreiding over het jaar
  - Loenhout : 1 miljard m3 gasopslag
  - Bree : potentieel voor 6 à 10 miljard m3 gasopslag

CO2 CERTIFICAAT

- CO2 certificaat – herkomst CO2
  - Vlaamse chemie rechtstreeks afgevangen : 50 % CO2 reductie
    - Kwaliteit CO2
  - UAE rechtstreeks afgevangen : 50 % CO2 reductie wereldwijd : credits ?
  - Vlaanderen (of UAE/Oman) DAC : 100 % CO2 reductie

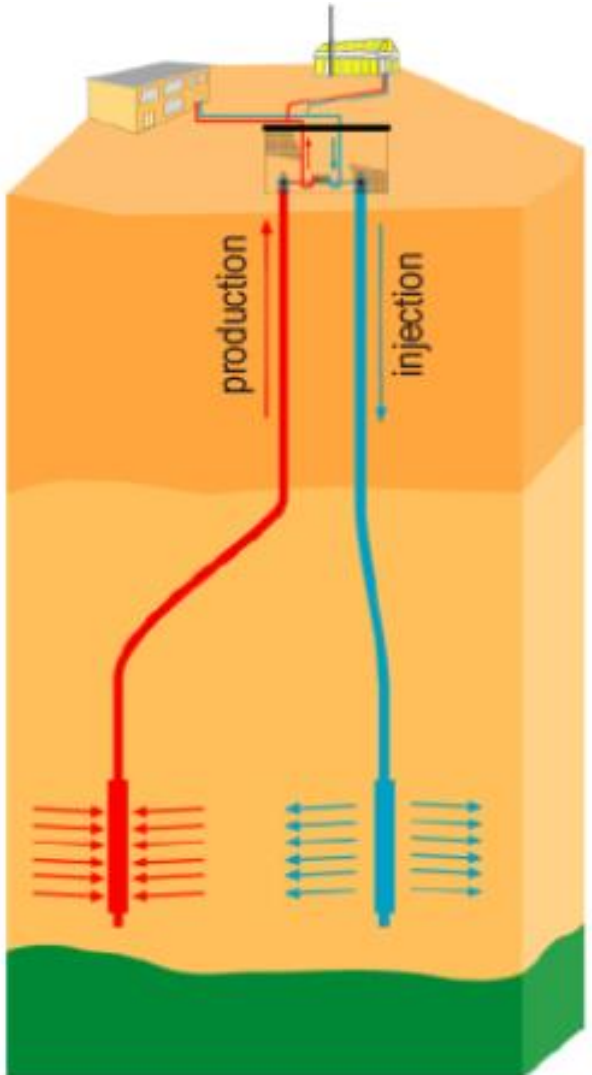
GEBRUIK ONDERGROND

- Ondiepe ondergrond (tot 100 m) :
  - BTES/ATES - geothermische warmtepomp
- Diepe ondergrond :
  - Kolenkalksteen
    - Janssen Pharmaceutica – Beerse
    - Turnhout – Lommel (Hyta)
    - VITO – Mol : doublet – warmte + elektriciteit
  - Brabants massief

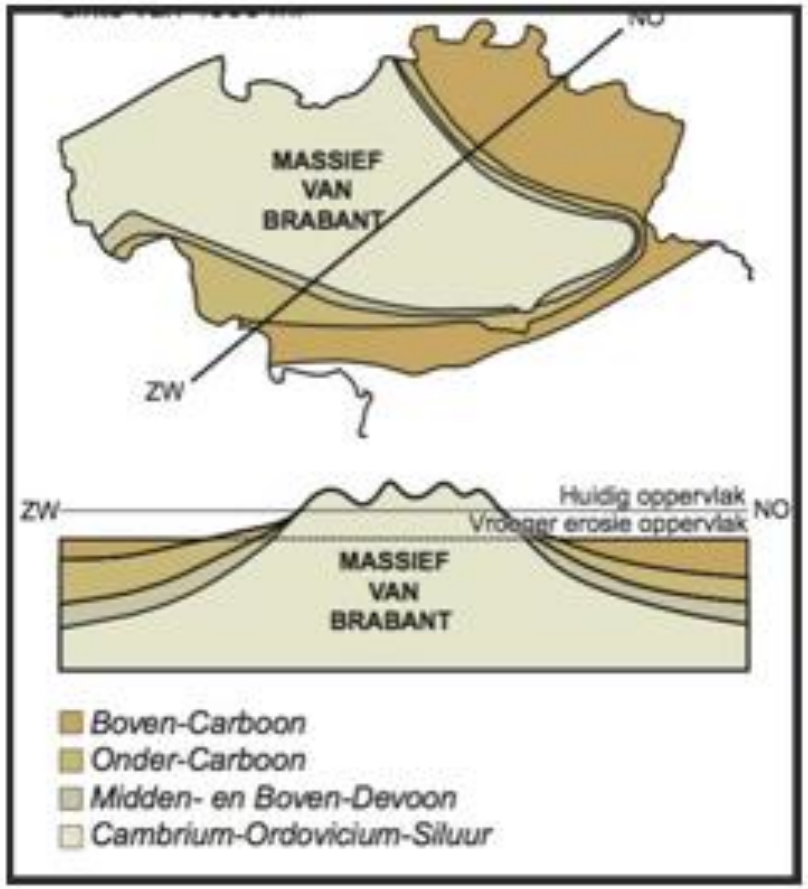
900 kW heating + 560 kW cooling

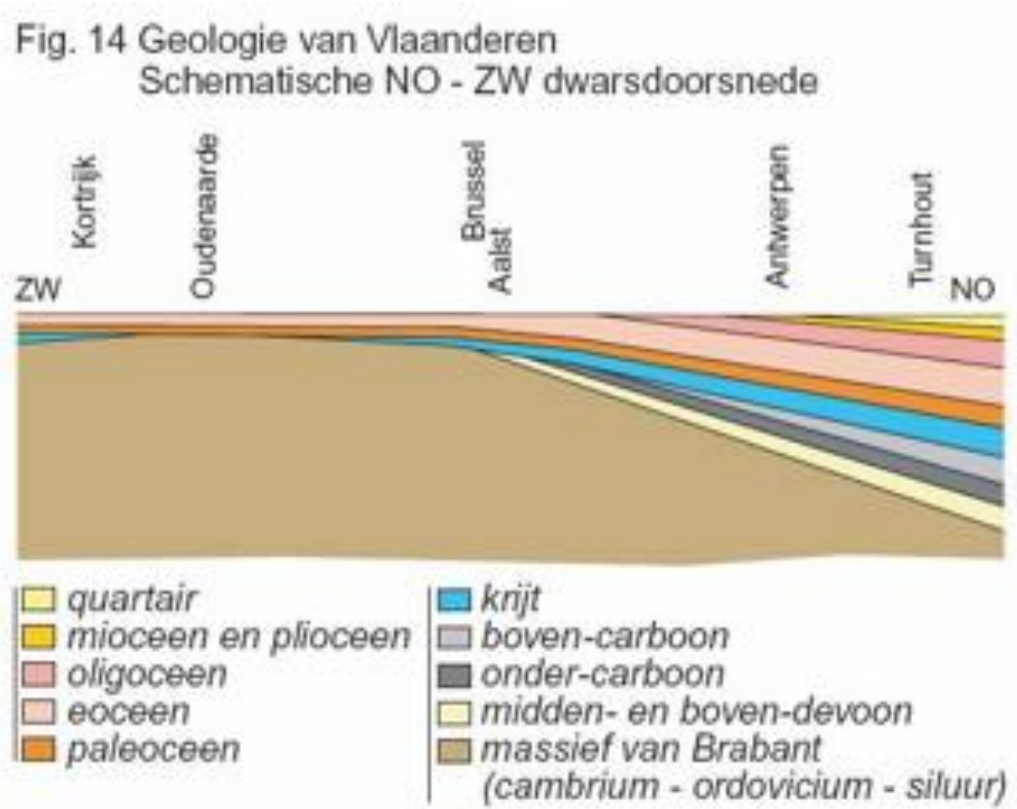

Daldrup
Daldru
&Söhne

Principe van aardwarmtewinning d.m.v. een geothermisch doublet

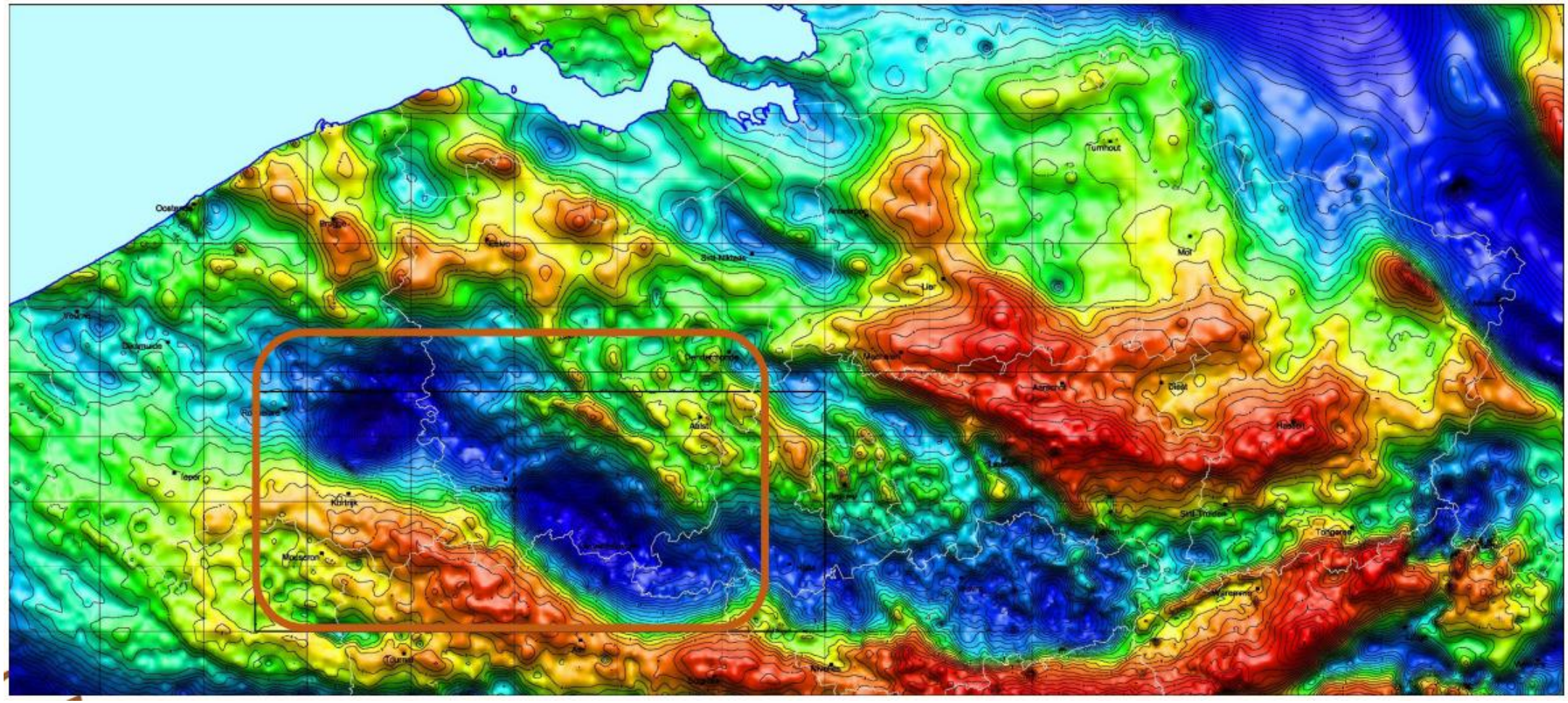


Schematische voorstelling van het Massief van Brabant

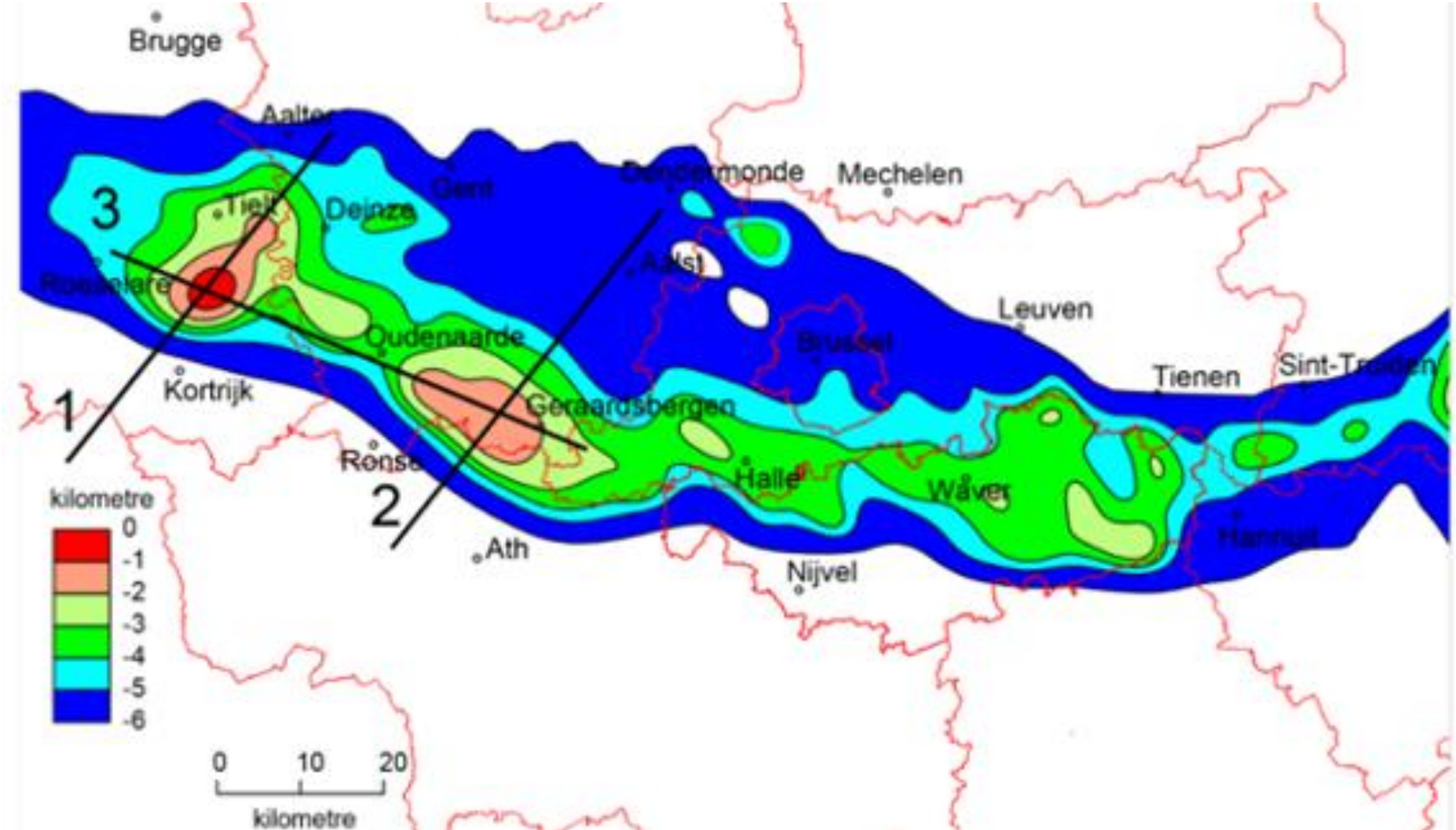




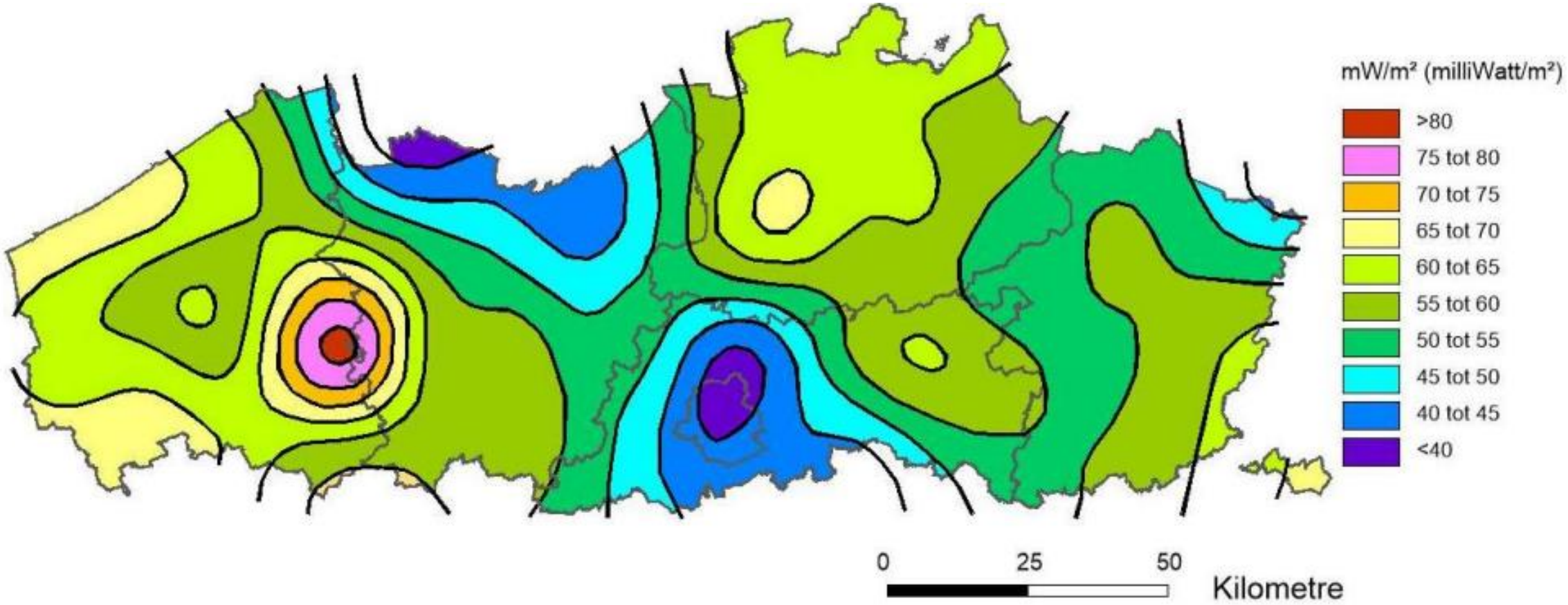
Een gordel van negatieve gravimetrische anomalieën (blauw) van de kust tot in Maastricht
(wijst op de aanwezigheid van lichte gesteenten, o.a. granietlichamen)
Koninklijke Sterrenwacht van België



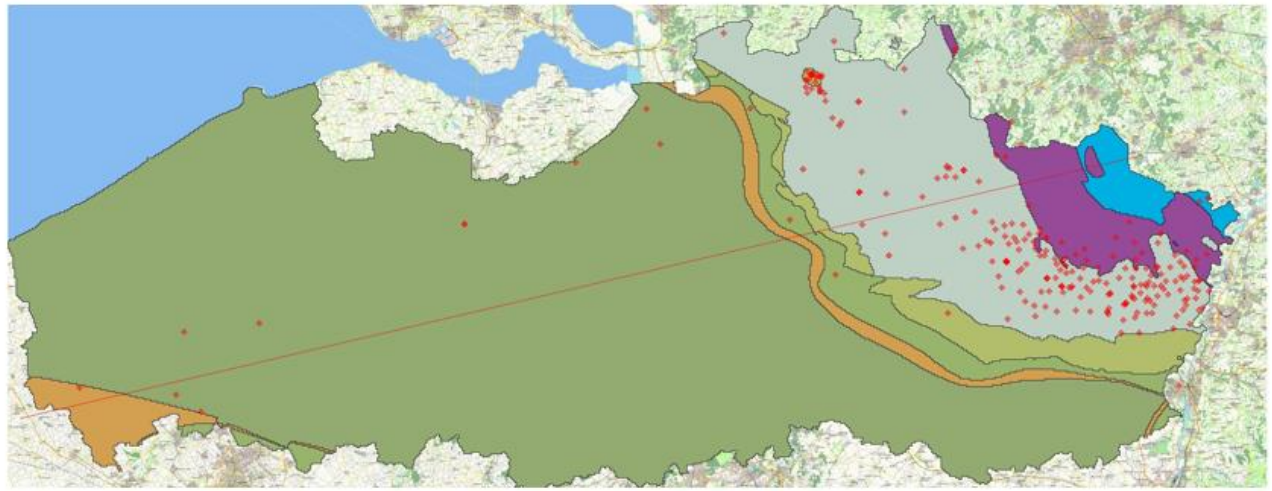
Herinterpretatie door British Geological Survey (BGS) i.o.v. ANRE, 2003
Diepte van de top van de lichte gesteentelichamen
Mogelijk granietlichamen met geothermische mogelijkheden

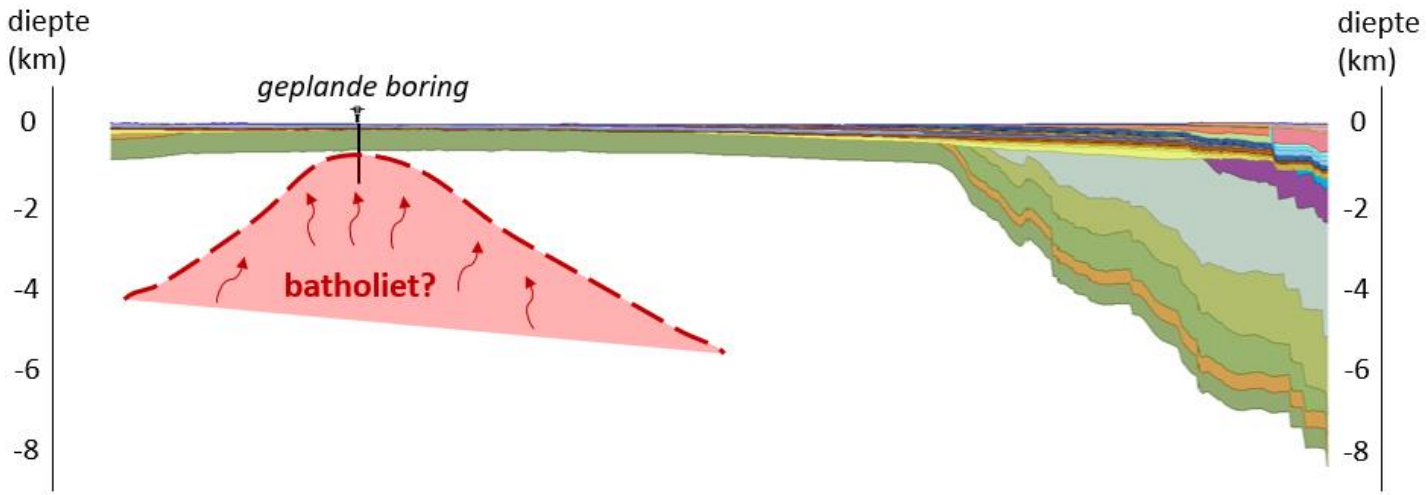


Warmtefluxkaart (VITO 2020 in opdracht van VPO)
De hoge piek in de streek van Waregem valt op



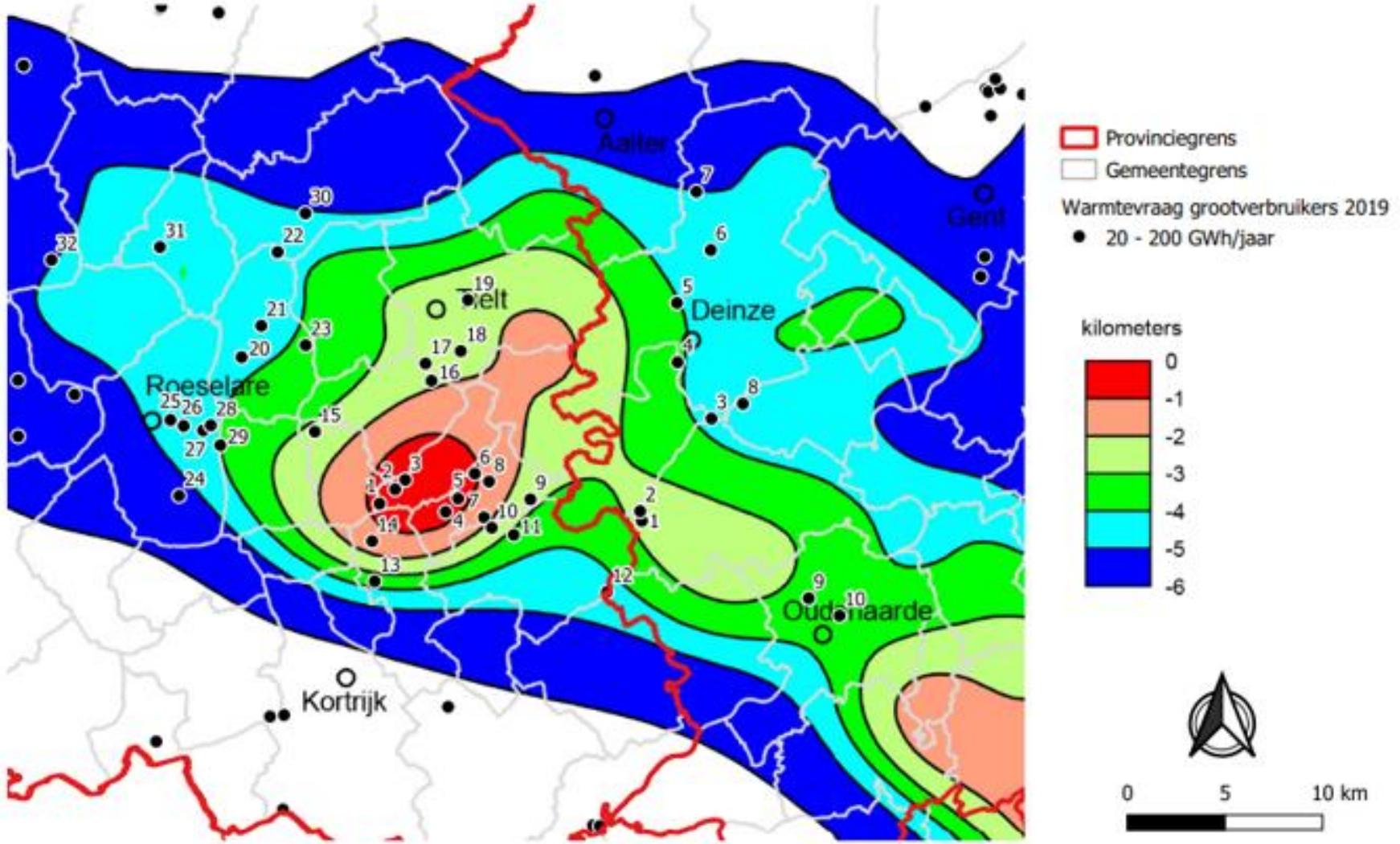
Gepland onderzoek in Wielsbeke-Oostrozebeke





G3Dv3 model gevisualiseerd met Subsurfaceviewer®; Team VPO - ondergrond

40 bedrijven met een grote warmtevraag boven de batholiet



Conclusies/aanbevelingen

- *Vervanging EPC door 3 “labels”*
  - *CO2 neutraal*
  - *Opwekken hernieuwbare energie*
  - *Energie-efficientie*
- *Oog voor Total cost of ownership – ogenblikkelijke betaalbaarheid (duurzaamheid)*
  - *Prijseffecten (Europees)*
  - *Promotie geothermische warmtepomp en gebruik ondiepe geothermie*
- *Rol diepe geothermie : verder onderzoek*

Bedankt !