

Electrification of heating and transport

Implications for the gas and electricity sectors, CO₂ emissions and social costs.

Prof. José L. MORAGA
(VU and RUG)

This presentation is based on the Research Project

Gas and the electrification of heating & transport: scenarios for 2050

By Jose L. Moraga (VU Amsterdam), Chloé le Coq (Stockholm), Machiel Mulder (RUG) and Sebastian Schwenen (München)

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If electrification is the policy choice:

1. What are the consequences for the electricity and gas sectors?

(for electricity demand and the energy mix; for gas demand as input for power generation + for heating and cooking)

2. How are CO₂ emissions affected?

(how much reduction we get compared to business-as-usual?
do we reach the 2050 targets?)

3. What are the net social costs of electrification?

(network costs, investment costs, environmental externalities etc.)

2050 scenario study for AT, BE, DE, FR, and NL.

3 scenarios:

- **Fossil Fuel (FF)** (or *business as usual*): sectors mainly run on fossil fuels and little electrification, even by 2050.
- **Hybrid Scenario (HY)**: intermediate level of electrification by 2050.
- **Full Electrification (FE)**: almost fully electrified housing and transport (specially passenger cars) by 2050.

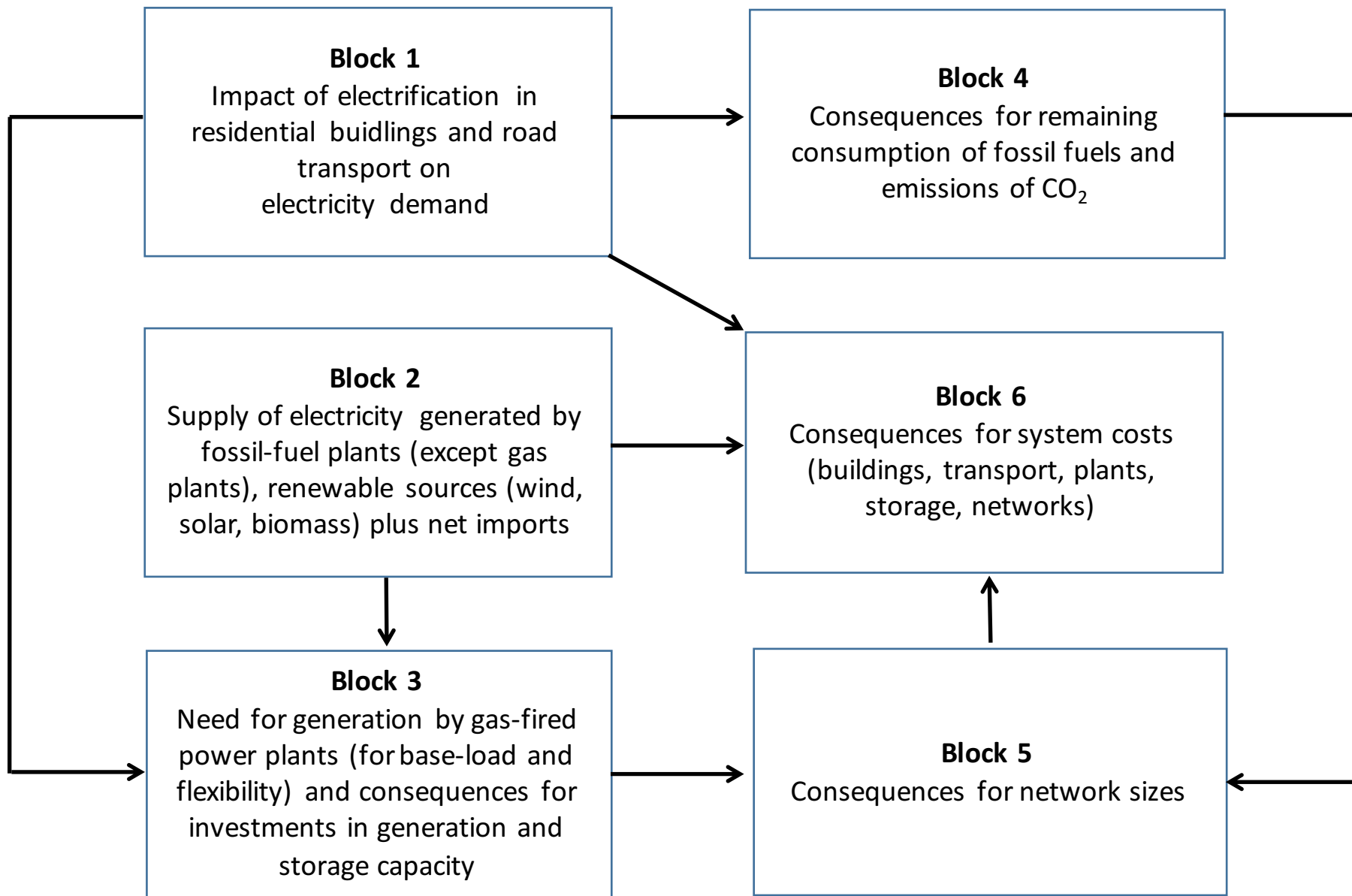
The scenarios should **not** be seen as policy recommendations.

- More modestly, they are meant to shed light on the challenges policymakers and the energy sector might face.

Content

1. Method of analysis
2. Definition of the scenarios
3. Results
 - a) Demand for electricity
 - b) Supply/Production of electricity
 - c) Demand for gas
 - d) Supply of gas
 - e) CO₂ emissions
4. Conclusions

Method



Scenarios

Dutch policy housing and transport

The Regeerakkoord 2017-2021

- About 50.000 fully electric new houses will be built every year
- In between 30.000 and 50.000 existing houses disconnected from gas, renovated and electrified.
- Soon after 2021, this will be 200.000 houses.
- 2050: Fully electrified stock of houses.

If electrification is not possible, district heating should be expanded to its full potential by 2050, which is considered to be 30% of the stock of houses (Ecofys, 2016).

The 2016-2020 Electric Transport Green Deal

- 2020: 10% of all newly sold cars will have an electric powertrain and a plug, and private individuals will own about 75.000 electric cars
- 2025: the ambition is that 50% of the newly sold cars have an electric powertrain and at least 30% are fully electric.
- 2025: all public buses should be electric.

The full electrification (FE) scenario:

	Scenarios		
	Fossil Fuel	Hybrid	Electrification
Annual degree of electrification			
Housing			
New	5%	50%	100%
Existing stock (x1000)	0	100	200
Houses connected to district heating (x 1000)	1	100	1
Transport (% of new cars)			
Passenger cars	5%	40%	80%
Vans	0%	25%	50%
Trucks	0%	5%	10%
Buses	0%	25%	50%
Motorbikes and scooters	0%	50%	80%
Bicycles	35%	35%	35%

The hybrid (HY) scenario:

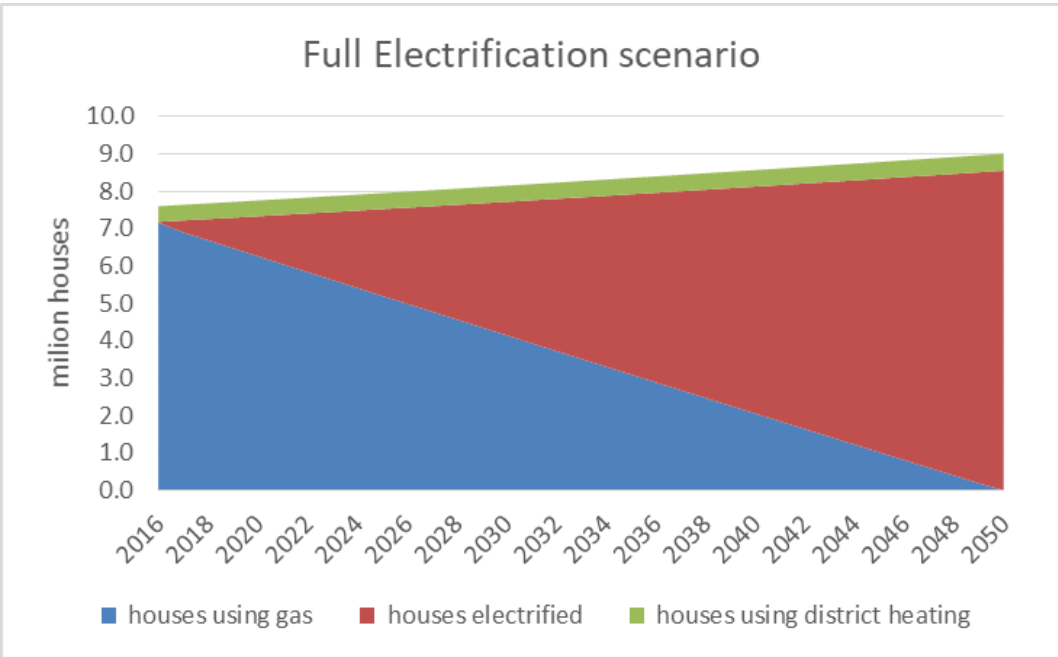
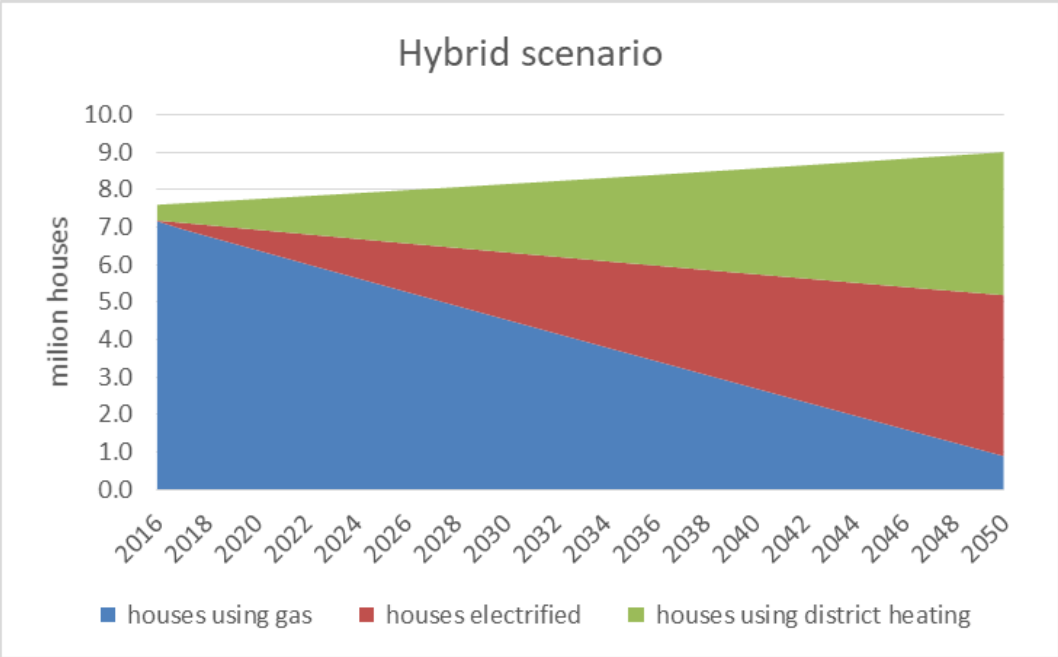
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The Fossil Fuel (FF) scenario

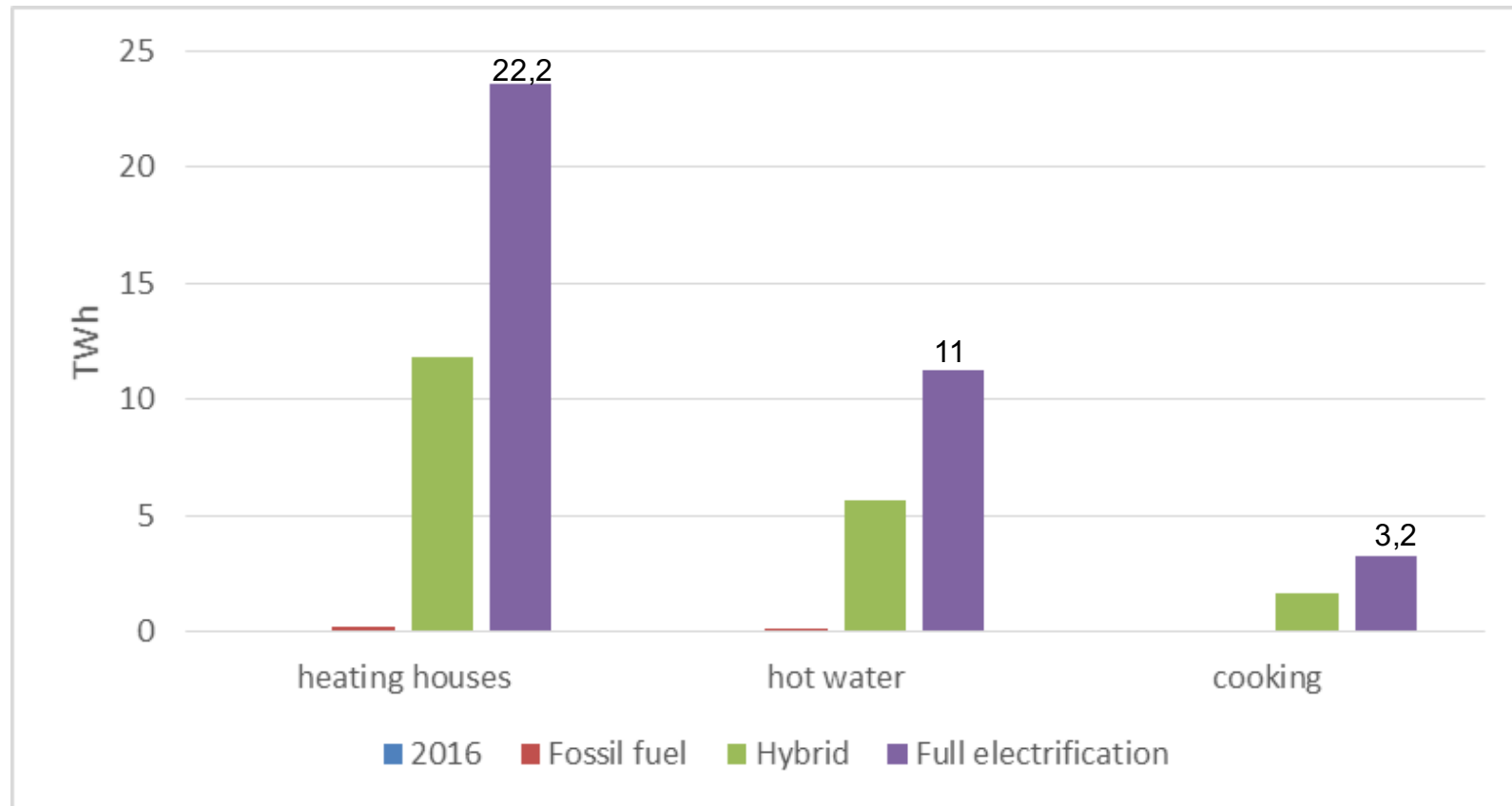
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Results

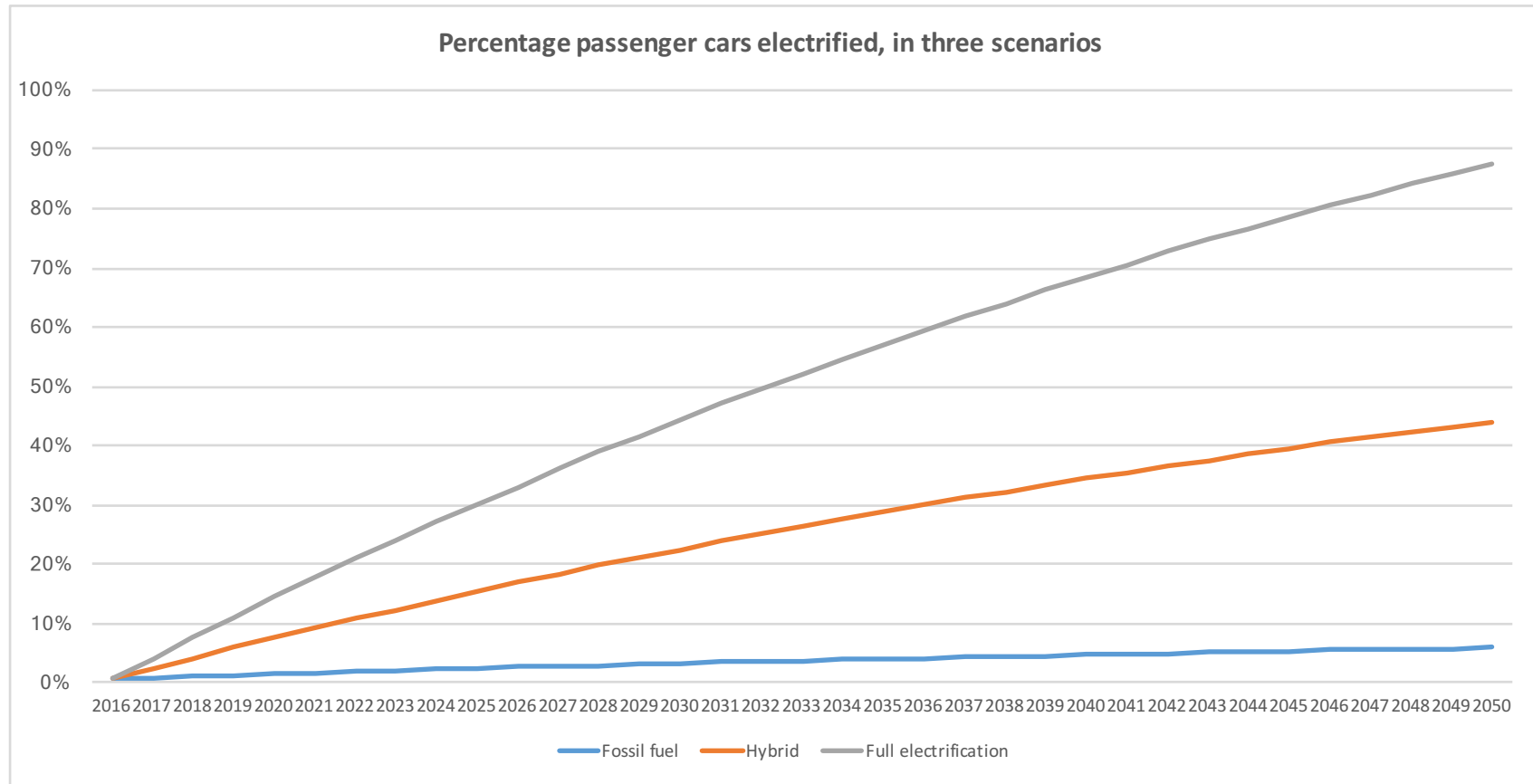
Electrification houses, in 2 scenario's



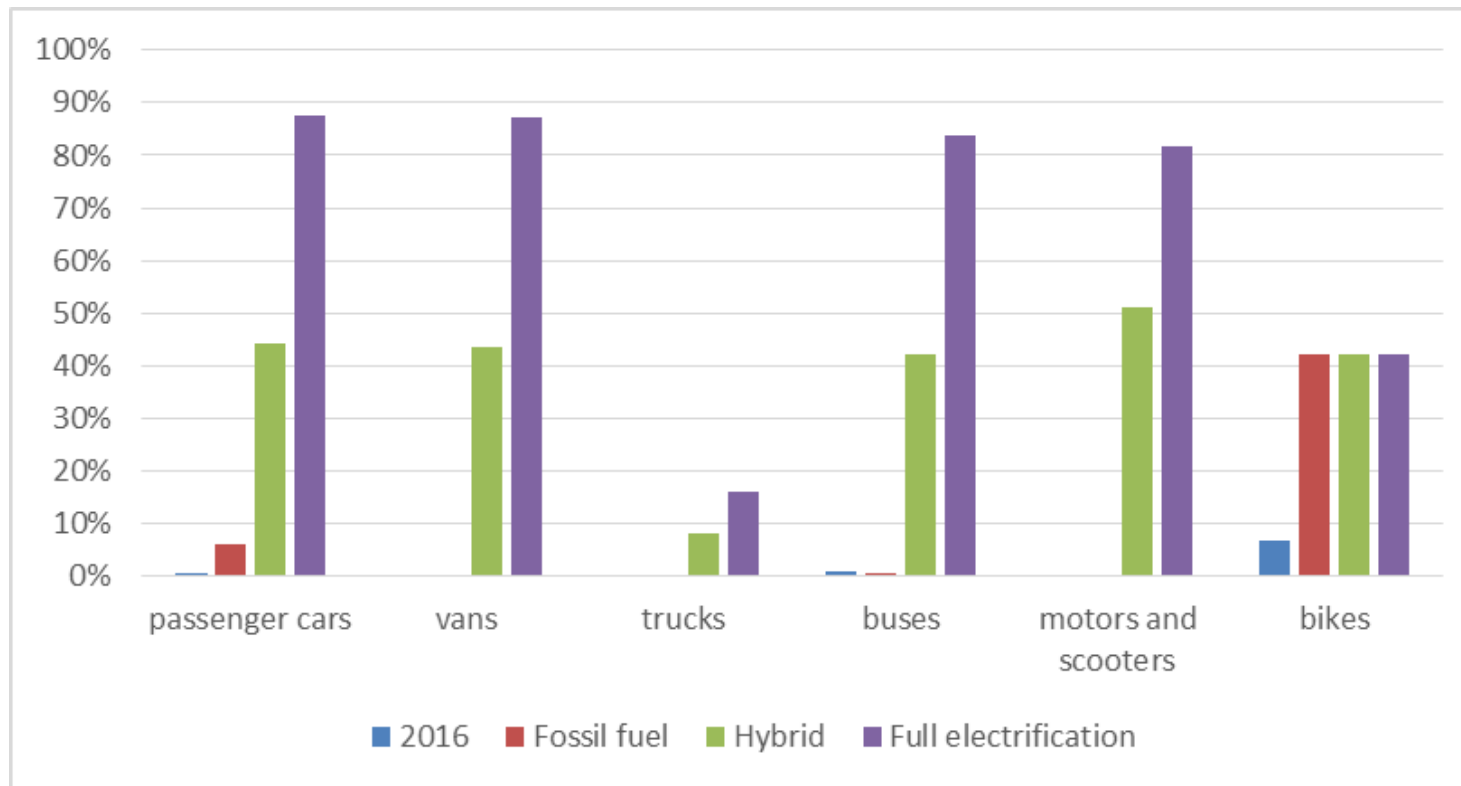
Electricity demand from **houses**, for space heating, water heating and cooking, in 2050 = 36,4 TWh



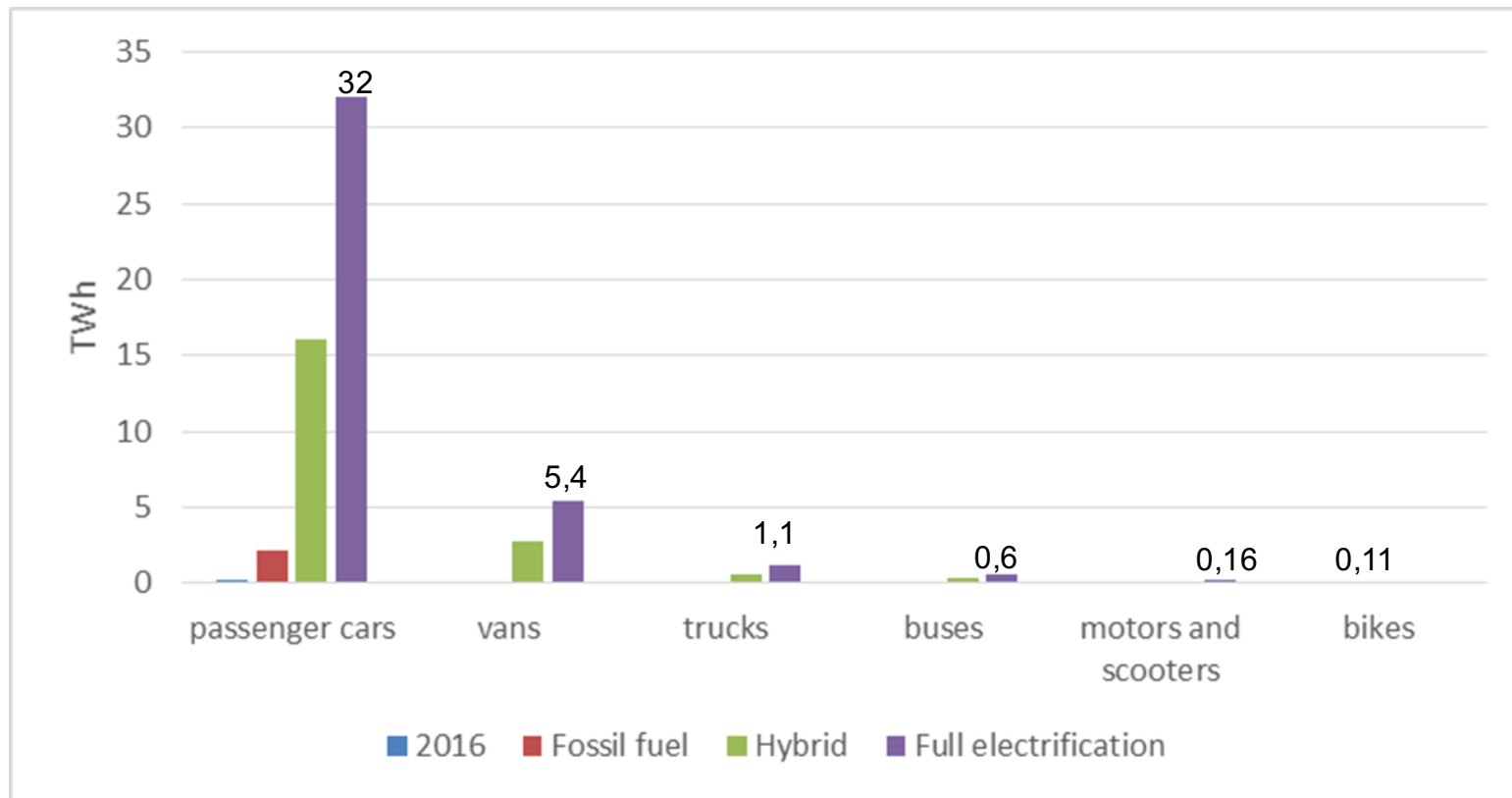
Electrification of transport (passenger cars)



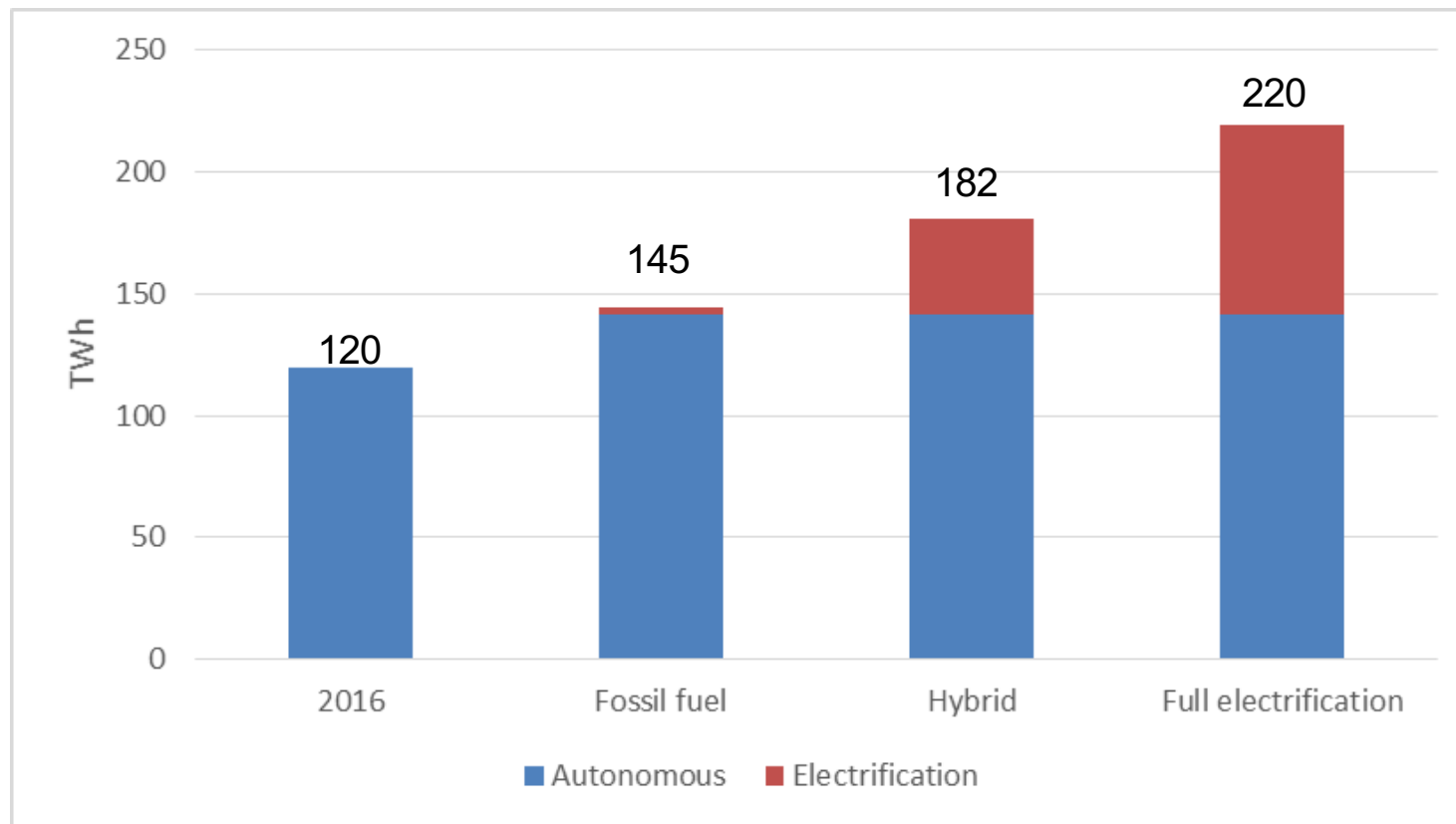
Electrification of transport, by 2050



Electricity demand from the **transport sector**, in 2050 = 39,6 TWh



Total electricity demand Nederland, autonomous + electrification, in 2050



How will all that amount of electricity be generated?

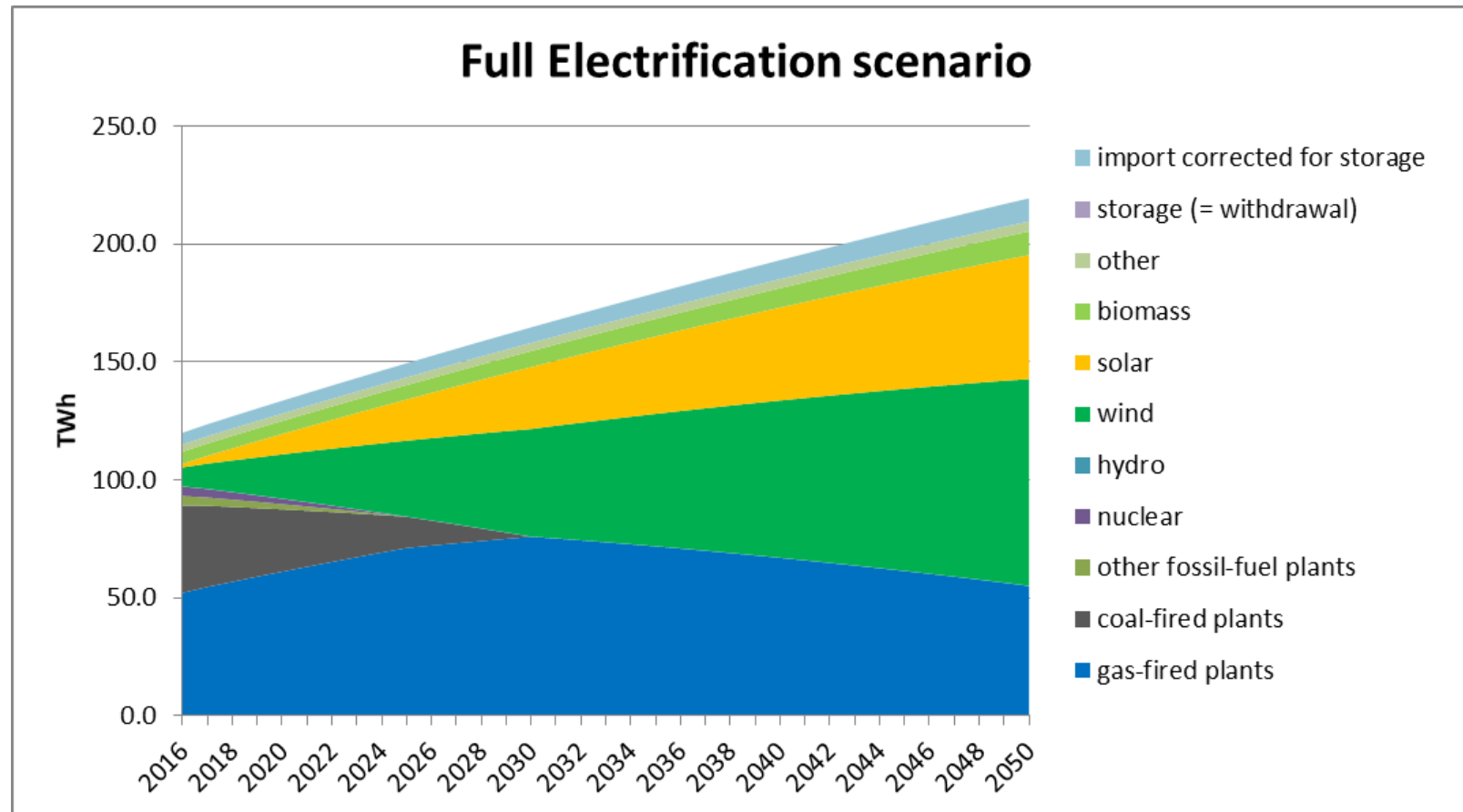


Dutch policy electricity sector

Variable	Assumption	Background		
coal-fired plants	-7%	facing out in	2030	
other fossil fuel plants	-11%	facing out in	2025	
nuclear plants	-11%	facing out in	2025	
hydro plants	0%	remains constant		
wind (annual increase in TWh)	2.7	policy target in 2030 is	13000	MW
wind in period after policy target (increase in TWh)	2.1	annual investments after 2030	600	MW
solar (annual increase in TWh)	1.8	policy target in 2030 is	12000	MW
solar in period after policy target (annual increase in TWh)	1.3	annual investments after 2030	600	MW
biomass	2%	gradual increase based on past		
other	1%	gradual increase based on past		
net import (if negative, this refers to export)	2%	increase in cross-border capacity		

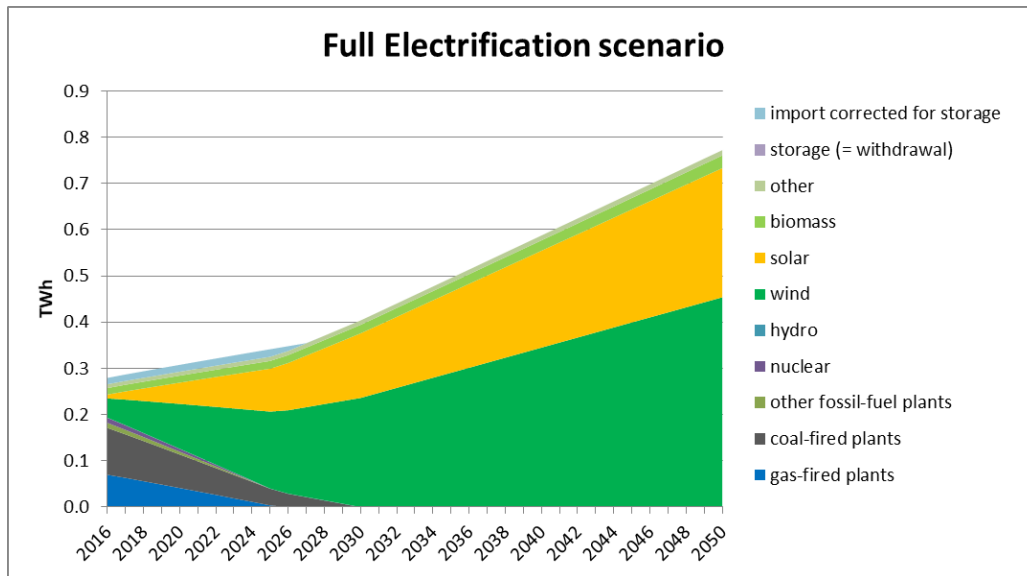
Capacity factors: wind: 40%, solar: 25%
 (higher than in working paper, wind: 30%, solar: 10%)

Production of electricity



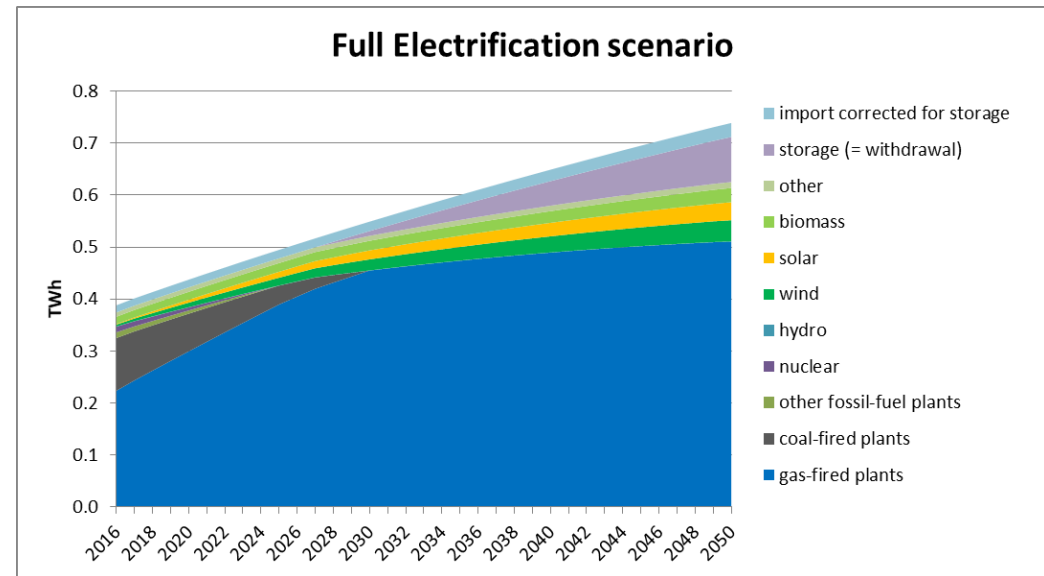
Electricity supply under extreme weather conditions

“Summerday”: plenty of wind and sun, no heating, weekend day



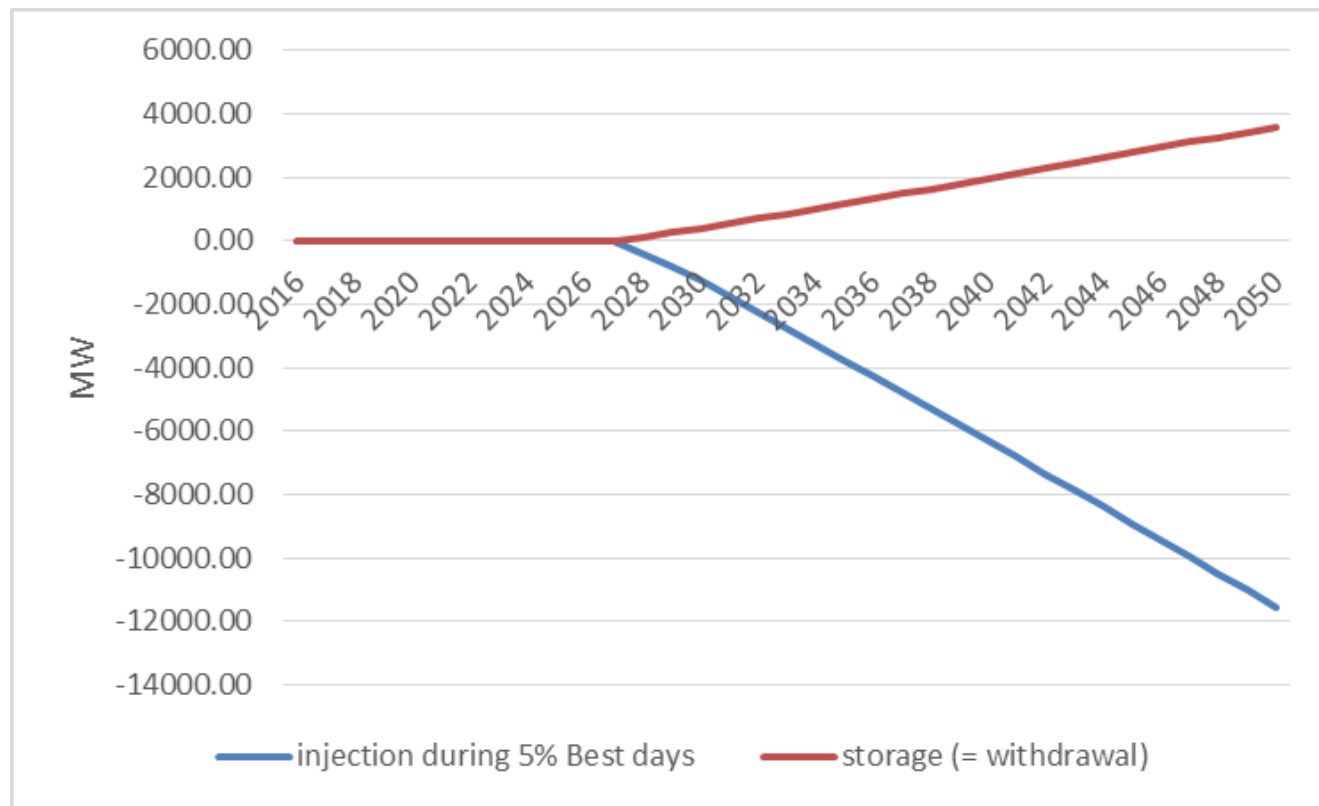
Sun, wind and biomass produce more than necessary. Excess production converted into hydrogen (PtG) and stored.

Winterday: Little wind and sun, high heating demand, working day



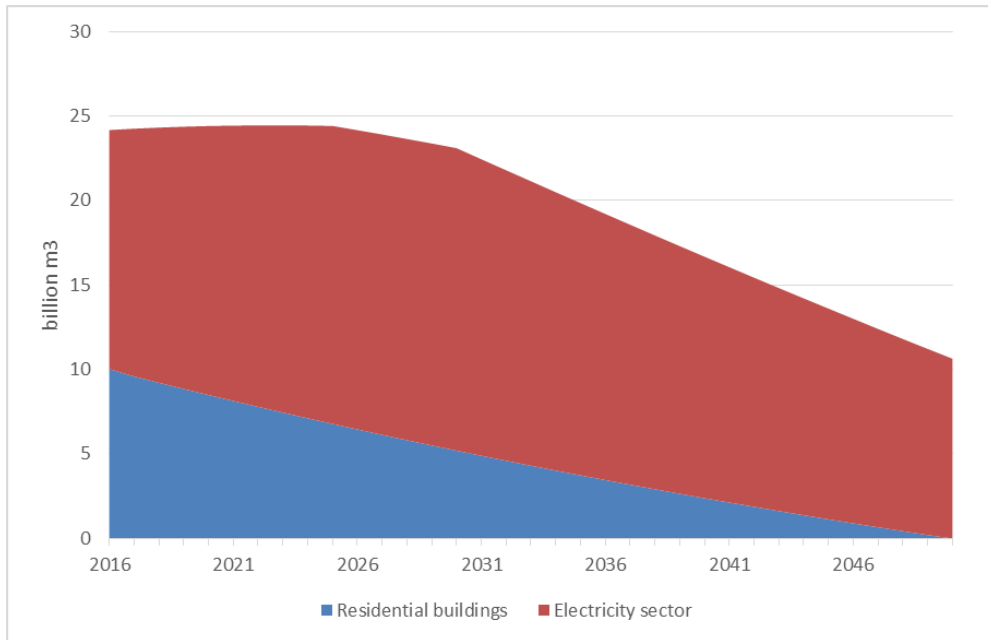
Electricity produced from hydrogen stores, plus wind, sun, biomass and imports not sufficient: gas-fired power plants necessary

'Storage' of electricity for seasonal flexibility (hydrogen)

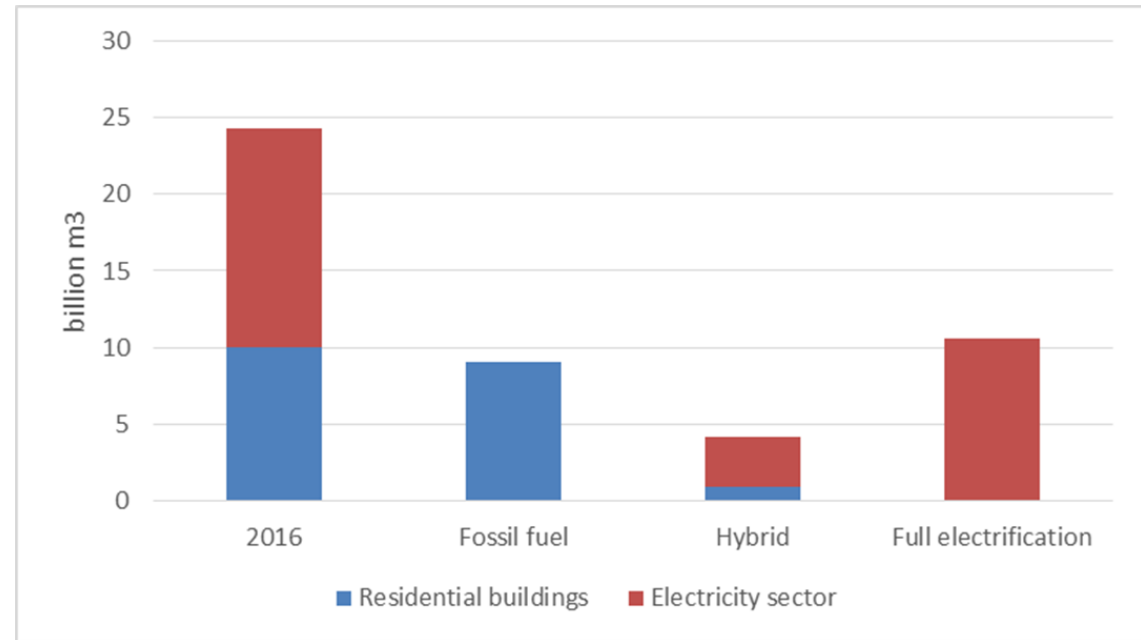


Gas demand from housing and electricity sectors

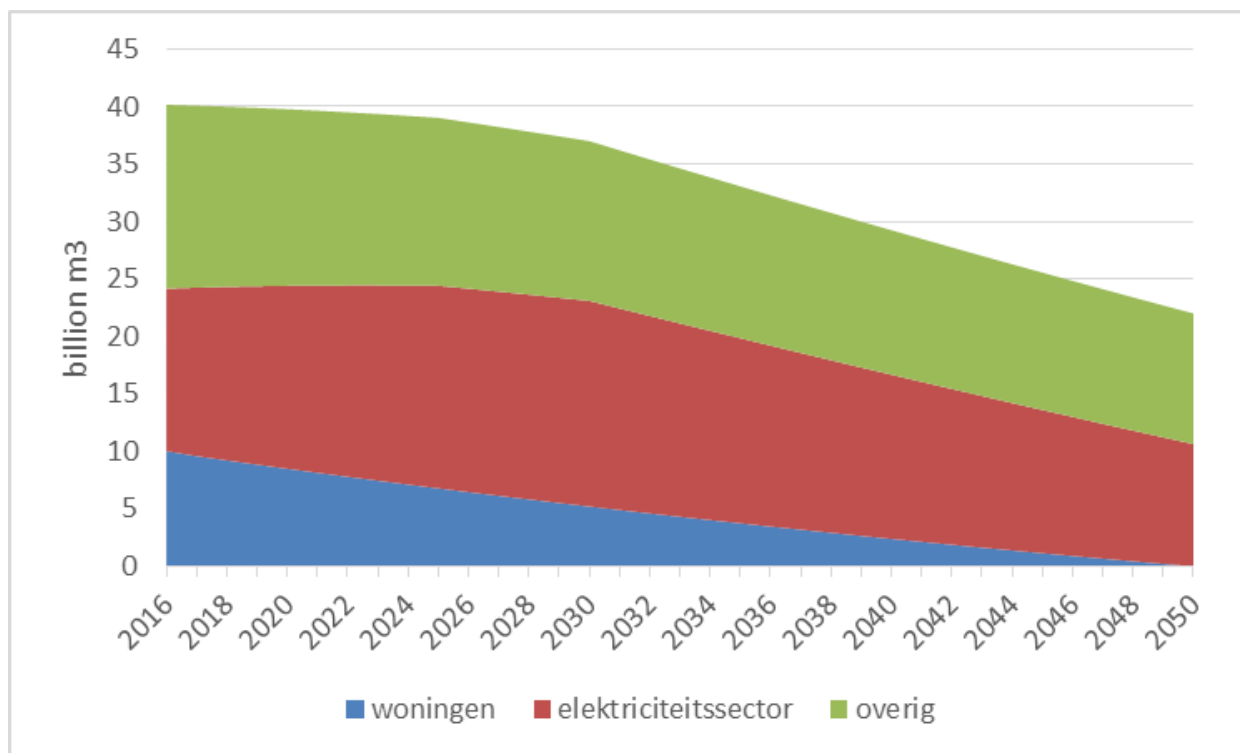
Full electrification scenario



All scenarios in 2050



Total gas demand in Nederland



Assumption: efficiency gains in industry is 1% per year (no hydrogen, no electrification)

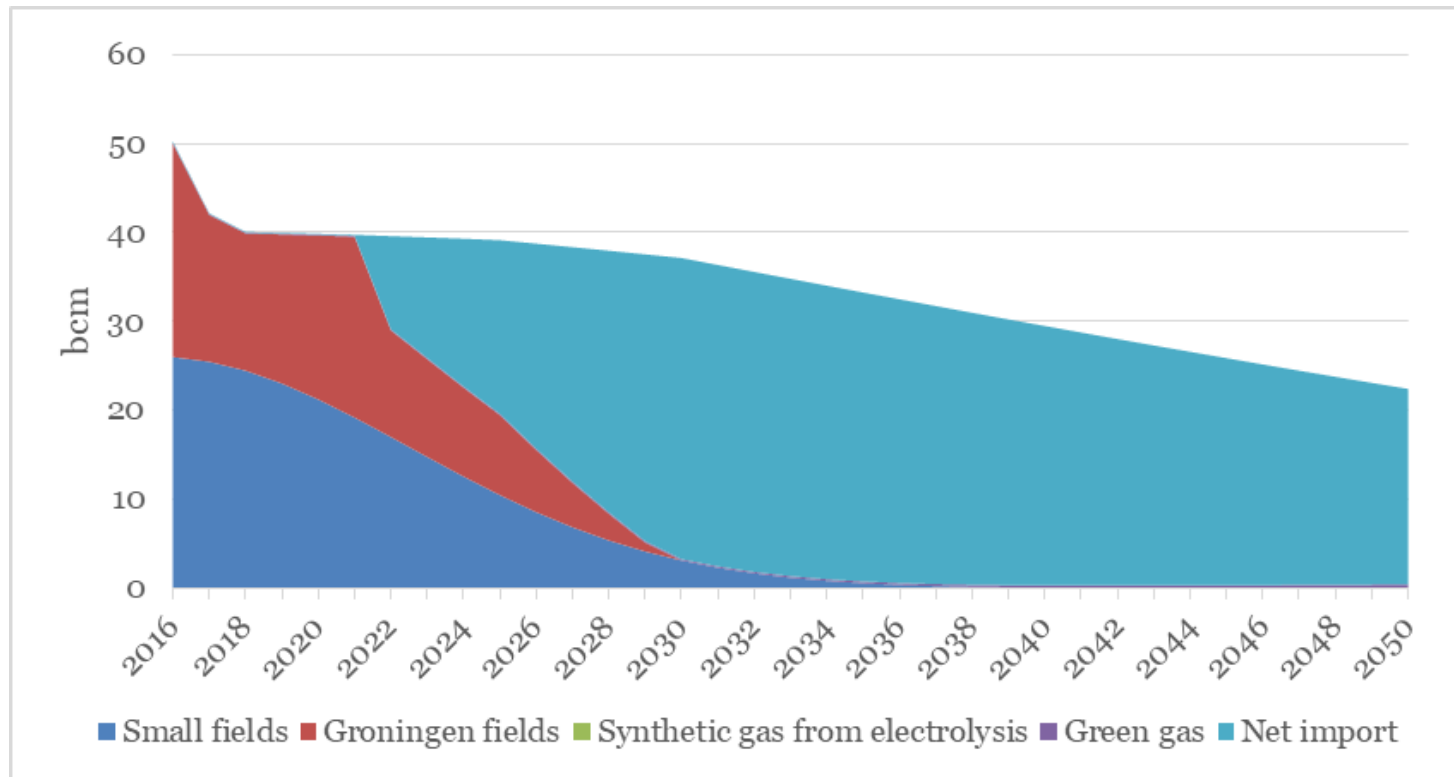
Supply of gas, Dutch policy

Table 9.2. Assumptions on future supply of gas

Variable	Value
production cap Groningen gas field (bcm):	
- 2017 - 2021	21.6
- 2022	12
	gradual decline to 0
2023-2030	bcm in 2030
annual reduction in production small fields	2%
annual increase in production of green gas	5%

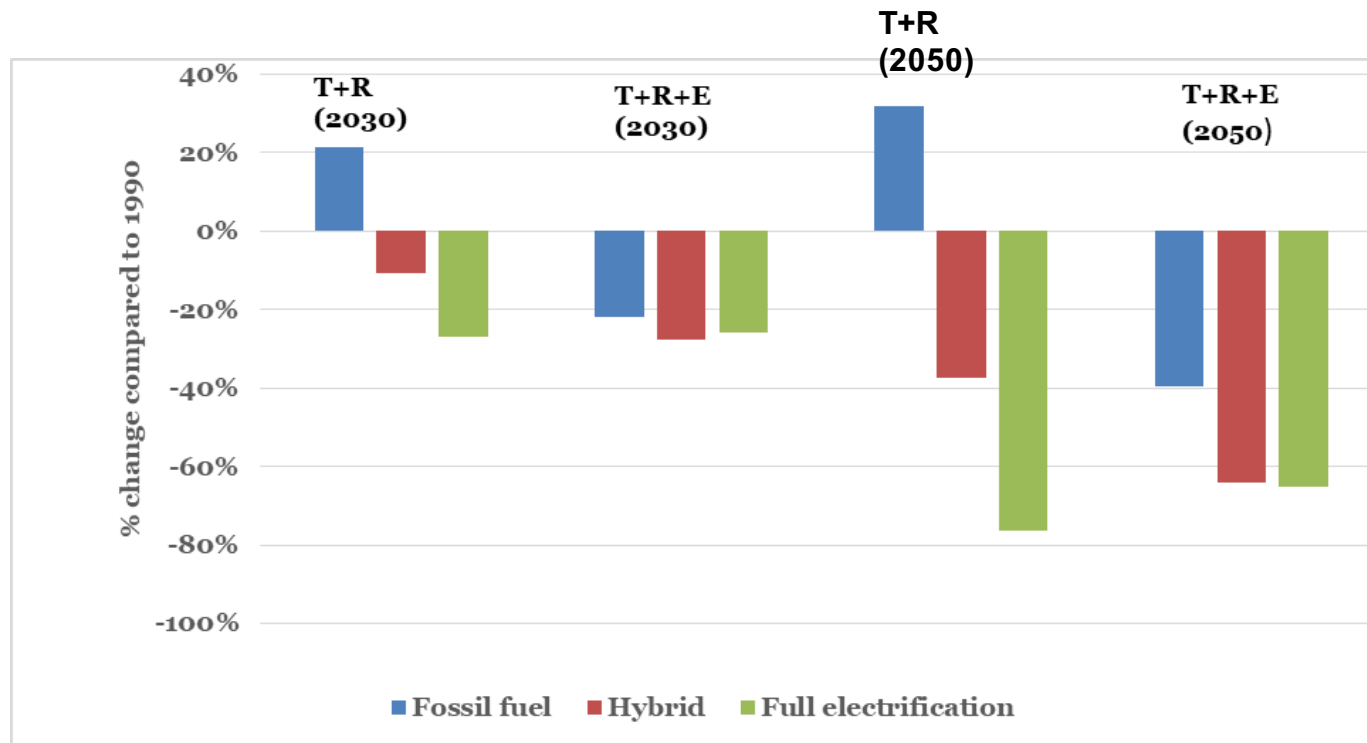
Supply of gas

Full electrification scenario



Significant increase in import dependence

Reduction CO₂ emissions relative to 1990 levels



T=Transport
R=Residential sector
E=Electricity sector

Conclusions

Conclusions

- Electrification of heating and transport leads to a substantial increase in the demand for electricity.
- Planned growth in renewable sources of electricity is insufficient to prescind from the use of natural gas because of:
 - closure of the coal-fired power plants
 - autonomous increase in the demand for electricity
 - extra demand for electricity for heating and transport purposes
- With more renewable generation, electricity supply will be more volatile.
 - strong increase in electricity demand makes the excess production under very favorable weather conditions too small (limited PtG).
 - gas-fired power plant capacity needs to expand
- CO₂ emissions will fall but target of a 80% cut below the 1990 levels not reached
- Current governmental plans for RES capacity too limited for electrification.

Other countries

Other countries

Additional electricity load in 2050

		AT	BE	FR	DE	NL
% increase over current (2016) load*	BAU	21%	13%	34%	20%	20%
	HY	44%	52%	40%	47%	51%
	FE	63%	91%	62%	64%	83%
Share of Gas	2016	12%	26%	4%	12%	43%
	BAU	0%	50%	0%	9%	23%
	HY	5%	63%	4%	26%	39%
	FE	15%	70%	18%	33%	50%
Share of RES	2016	73%	15%	17%	28%	12%
	BAU	100%	32%	57%	85%	67%
	HY	88%	24%	54%	69%	53%
	FE	78%	19%	47%	62%	44%

* The bulk of the increase in BAU is due to autonomous increase in power demand

Additional grid/gas network capacity in 2050

		AT	BE	FR	DE	NL
Electricity grid	2016	83	89	84	84	83
	BAU (=100)	100	100	100	100	100
	HY	119	135	117	124	125
	FE	133	170	136	138	152
Gas network **	2016	170	76	99	75	
	BAU (=100)	100	100	100	100	100
	HY	134	118	115	113	93*
	FE	159	137	133	120	120

*: due to district heating in NL

** : gas network need not be expanded because of existing over capacity

CO2 emissions reductions by 2050 relative to 1990

		AT	BE	FR	DE	NL
Housing and Transport	BAU	+12%	+11%	+18%	-11%	+33%
	HY	-38%	-31%	-20%	-57%	-37%
	FE	-80%	-81%	-71%	-84%	-76%
Housing, transport and electricity	BAU	-14%	+10%	-6%	-56%	24%
	HY	-46%	+3%	-31%	-65%	-40%
	FE	-62%	-11%	-48%	-70%	-41%

References

CERRE, [Gas and electrification of heating & transport, scenarios for 2050](#)
(full report: studies for Austria, Belgium, France, Germany, and the NLs)



For the Dutch study (extract of CERRE report):

Moraga en Mulder, [Electrification of heating and transport: a scenario analysis of the Netherlands up to 2050](#),
CEER policy papers, 2, May 2018.



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