



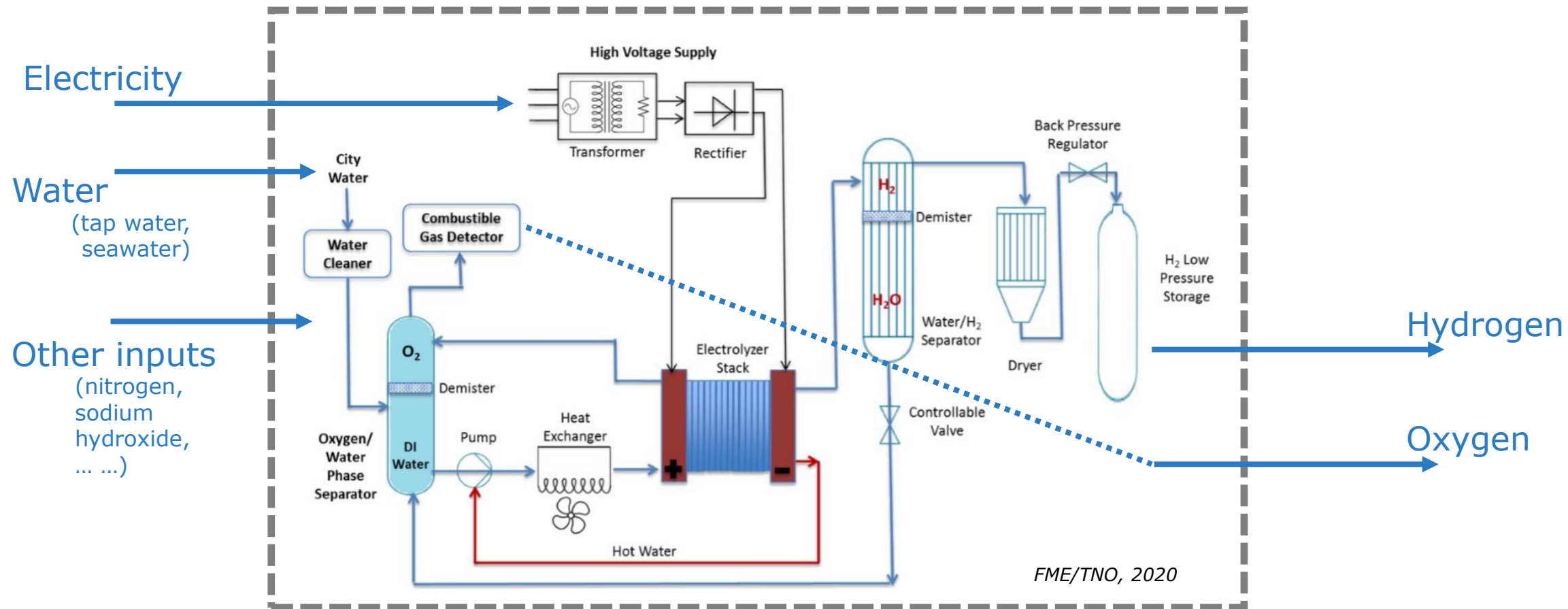
Greenhouse gas emission calculations

–
relation between 70% GHG
reduction and number of
“additional” and “grey” full
load hours

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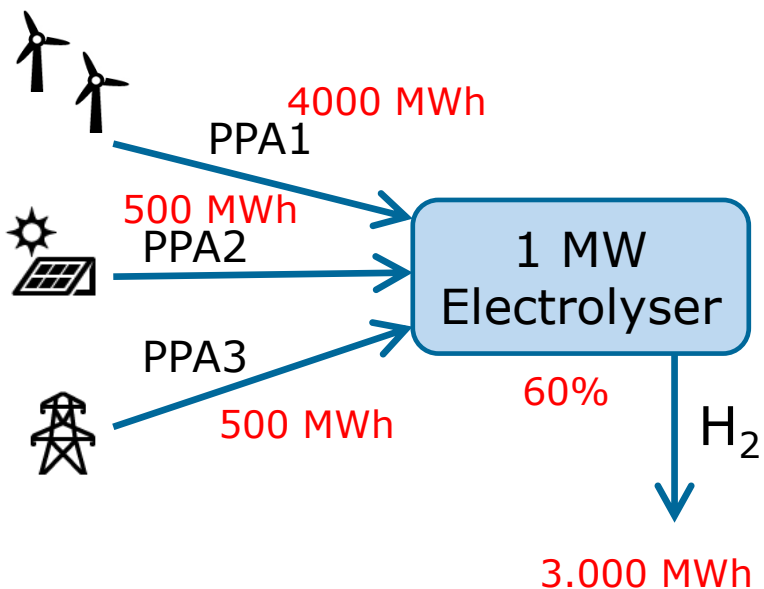


Example GHG calculations





Example for making a calculation



Two important methodological notes:

1. If the 4500 MWh electricity all comply with DA 27.3, then the renewable fraction of the H₂ output is $4500/5000 = 90\%$. Then 2700 MWh hydrogen is classified as renewable hydrogen (and RFNBO if the 70% requirement is met) and 300 MWh hydrogen is classified "non-renewable". [draft DA 28.5 Annex A article 3.a]
2. < according to the current draft DA 28.5 > The GHG calculation has to be made over the process (the electrolyser) so with the renewable and the non-renewable electricity input and hydrogen output combined. [draft DA 28.5 Annex A article 1 last paragraph]



Example GHG calculations

Numbers needed for a basic calculation:

- Fossil fuel comparator (FFC): $94 \text{ g CO}_{2,\text{eq}}/\text{MJ}_{\text{fuel}}$
- 4500 MWh electricity complying to DA 27.3 requirements
- 500 MWh electricity not complying to DA 27.3 requirements
- GHG intensity of electricity not complying to DA 27.3

The Netherlands: $132 \text{ g CO}_{2,\text{eq}}/\text{MJ}_{\text{electricity}}$

(Source: DA 28.5, Annex C, Table A)

Example:

- 1 $\text{MW}_{\text{e,input}}$ electrolyser, located in The Netherlands
- 5000 full load hours per year
- 10,0% of which is grey (not complying to DA 27.3)
- Efficiency: 1 kg H_2 / 55,56 kWh 60,0% (LHV)

Calculation:

- Yearly emissions: $500 \text{ MWh}_e * 1000 * 3,6 \text{ MJ} / \text{MWh} * 132 \text{ g CO}_{2,\text{eq}}/\text{MJ}_e = 237,6 \text{ Mg CO}_2$
- Yearly amount of hydrogen: $5000 \text{ MWh} * 60\% * 1000 * 3,6 \text{ MJ} / \text{MWh} = 10,8 \text{ million MJ}$
- Emission Intensity (EI) of hydrogen: $237,6 / 10,8 = 22,0 \text{ g CO}_{2,\text{eq}}/\text{MJ}_{\text{H}_2}$

<p><u>GHG reduction %</u> (FFC – EI) / FFC = 77,6%</p>
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Example GHG calculations

Numbers needed for a basic calculation:

- Fossil fuel comparator (FFC): $94 \text{ g CO}_{2,\text{eq}}/\text{MJ}_{\text{fuel}}$
- **4360** MWh electricity complying to DA 27.3 requirements
- **640** MWh electricity not complying to DA 27.3 requirements
- GHG intensity of electricity not complying to DA 27.3

The Netherlands: $132 \text{ g CO}_{2,\text{eq}}/\text{MJ}_{\text{electricity}}$

(Source: Annex C, Table A, DA 28.5)

Example:

- $1 \text{ MW}_{\text{e,input}}$ electrolyser, located in The Netherlands
- 5000 full load hours per year
- **12,8%** of which is grey (not complying to DA 27.3)
- Efficiency: $1 \text{ kg H}_2 / 55,56 \text{ kWh}$
 $60,0\%$ (LHV)

Calculation:

- Yearly emissions: $640 \text{ MWh}_e * 1000 * 3,6 \text{ MJ} / \text{MWh} * 132 \text{ g CO}_{2,\text{eq}}/\text{MJ}_e = 304,1 \text{ Mg CO}_2$
- Yearly amount of hydrogen: $5000 \text{ MWh} * 60\% * 1000 * 3,6 \text{ MJ} / \text{MWh} = 10,8 \text{ million MJ}$
- Emission Intensity (EI) of hydrogen: $304,1 / 10,8 = 28,2 \text{ g CO}_{2,\text{eq}}/\text{MJ}_{\text{H}_2}$

<p><u>GHG reduction %</u> (FFC – EI) / FFC = 70,0%</p>



Table A: Emission intensity of electricity in the European Union 2018

Country code	Country	Emission intensity of generated electricity (g CO ₂ eq/MJ)
AT	Austria	46
BE	Belgium	68
BG	Bulgaria	141
HR	Croatia	47
CY	Cyprus	218
CZ	Czech Republic	148
DK	Denmark	54
EE	Estonia	223
FI	Finland	37
FR	France	20
DE	Germany	124
EL	Greece	171
HU	Hungary	85
IE	Ireland	108
IT	Italy	103
LV	Latvia	52
LT	Lithuania	22
LU	Luxembourg	22
MT	Malta	126
NL	Netherlands	132
PL	Poland	221
PT	Portugal	91
RO	Romania	105
SK	Slovak Republic	54
SI	Slovenia	77
ES	Spain	85
SE	Sweden	6

GHG intensity of grid-electricity

Country code	Country	Emission intensity of generated electricity (g CO ₂ ,eq/MJ)		
		2018 (Table A DA 28.5)	2018 calculated	2020 calculated
AT	Austria	46	49	39
BE	Belgium	68	67	56
BG	Bulgaria	141	140	119
HR	Croatia	47	50	59
CY	Cyprus	218	218	204
CZ	Czechia	148	156	131
DK	Denmark	54	53	29
EE	Estonia	223	212	129
FI	Finland	37	38	23
FR	France	20	21	20
DE	Germany	124	129	101
EL	Greece	171	175	125
HU	Hungary	85	85	74
IE	Ireland	108	112	91
IT	Italy	103	107	94
LV	Latvia	52	49	35
LT	Lithuania	22	20	56
LU	Luxembourg	22	102	53
MT	Malta	126	125	134
NL	Netherlands	132	139	101
PL	Poland	221	238	211
PT	Portugal	91	101	63
RO	Romania	105	105	86
SK	Slovak Republic	54	56	46
SI	Slovenia	77	78	71
ES	Spain	85	91	55
SE	Sweden	6	6	4



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Questions?