

Status quo and perspectives of emissions from upgrading plants in Switzerland

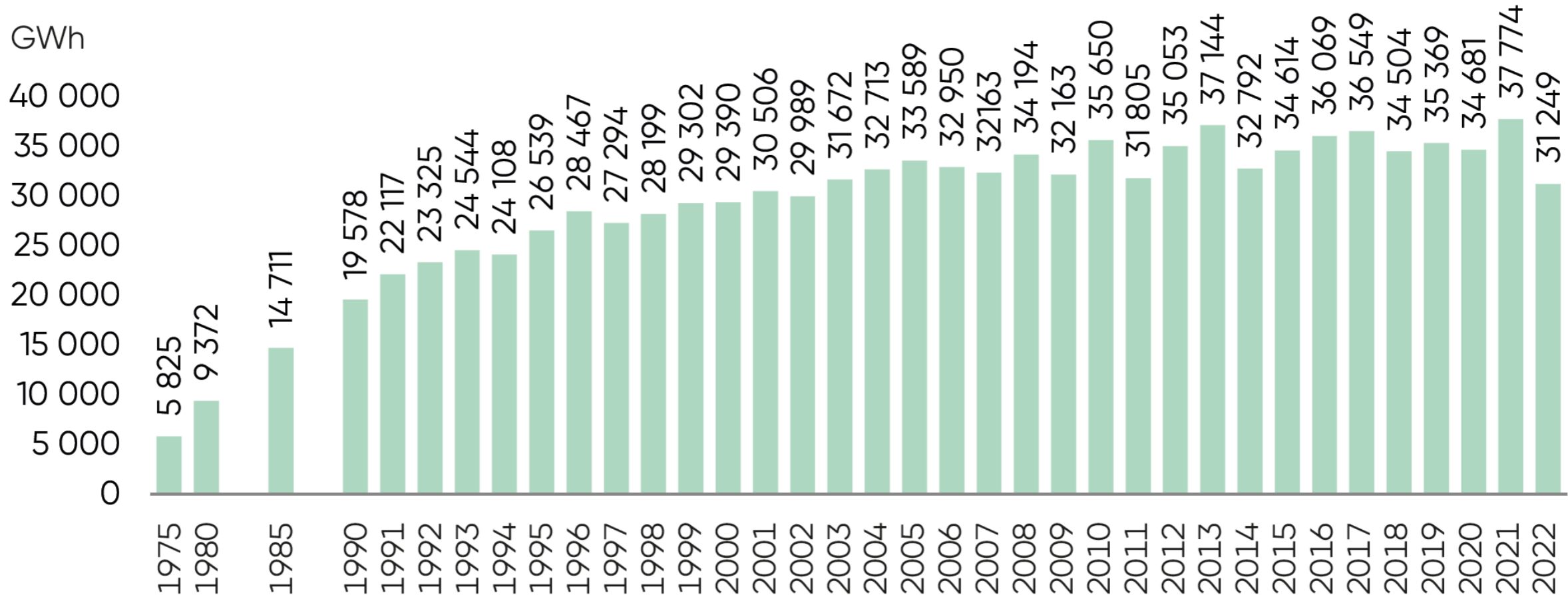


Workshop: Strategies for emission control on biogas upgrading plants – 25.10.2023

Dr. Hajo Nägele, Dr. Wolfgang Merkle
Zurich University of Applied Sciences

Statistics

Gasconsumption in Switzerland



Source: Importers, 2022; Swiss Total Energy Statistics 2022; Transitgas AG, 2022, revised numbers.

■ Yearly gasconsumption in Switzerland between 31.000 and 38.000 GWh

Statistics

Biomethane injection in Switzerland and Liechtenstein

| Heating value | GWh |
|---------------|-----|
| 2010 | 64 |
| 2011 | 91 |
| 2012 | 99 |
| 2013 | 142 |
| 2014 | 213 |
| 2015 | 262 |
| 2016 | 308 |
| 2017 | 341 |
| 2018 | 368 |
| 2019 | 409 |
| 2020 | 418 |
| 2021 | 419 |
| 2022 | 476 |

Source: VSG, 2023.

- Yearly biomethane injection in Switzerland increased up to 476 GWh

Total consumption of natural gas
and renewable gases all sectors

Consumption of renewable
gases incl. foreign certificates

Share of renewable gases
in total gas consumption

Heating value

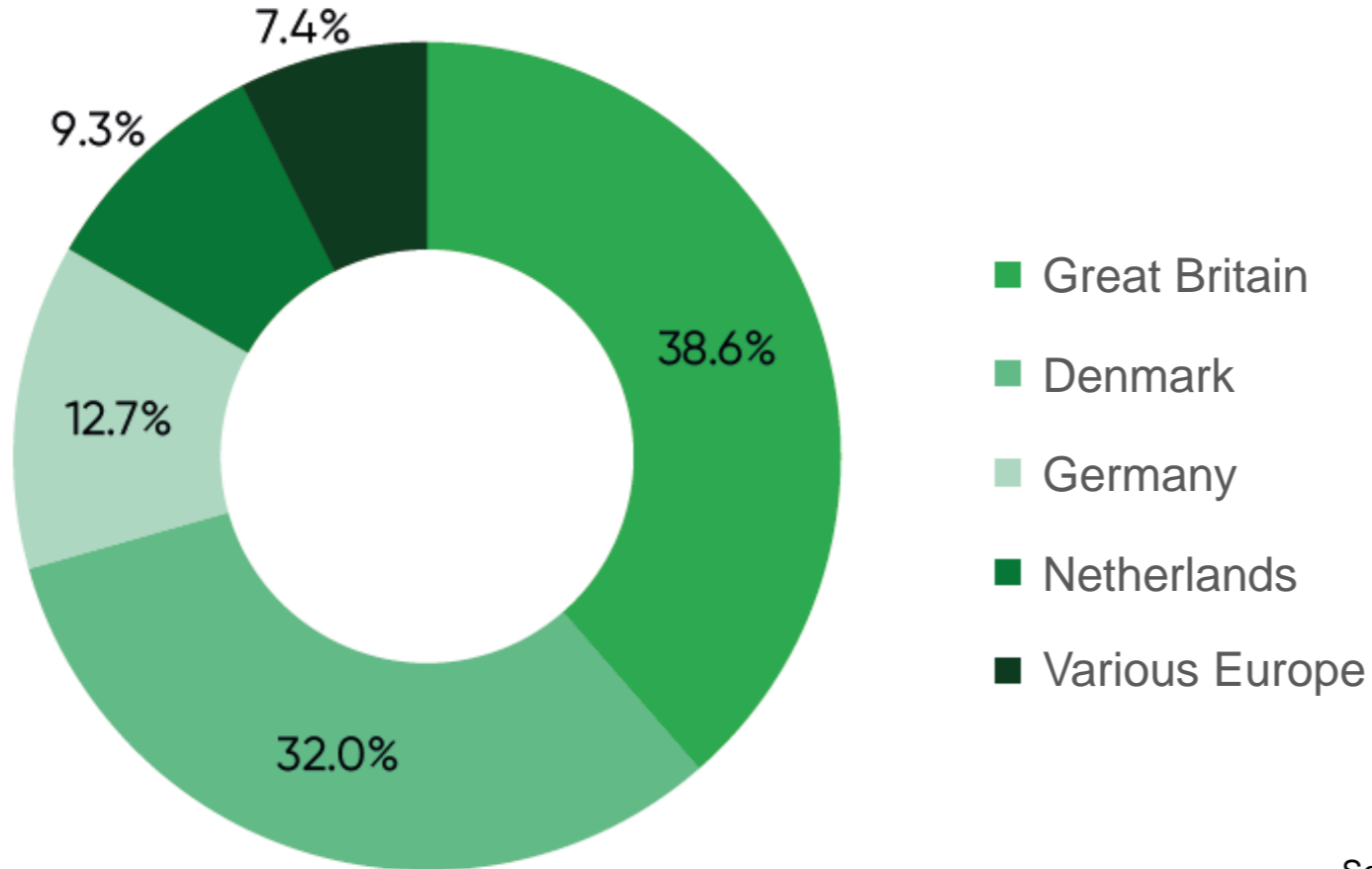
| | GWh | GWh | % |
|------|--------|-------|-----|
| 2020 | 34 846 | 1 456 | 4.2 |
| 2021 | 37 741 | 2 194 | 5.8 |
| 2022 | 31 373 | 2 516 | 8 |

Source: VSG, 2023.

- Share of biomethane consumption around 8 %.

Statistics

Biomethane import (certificates) to Switzerland



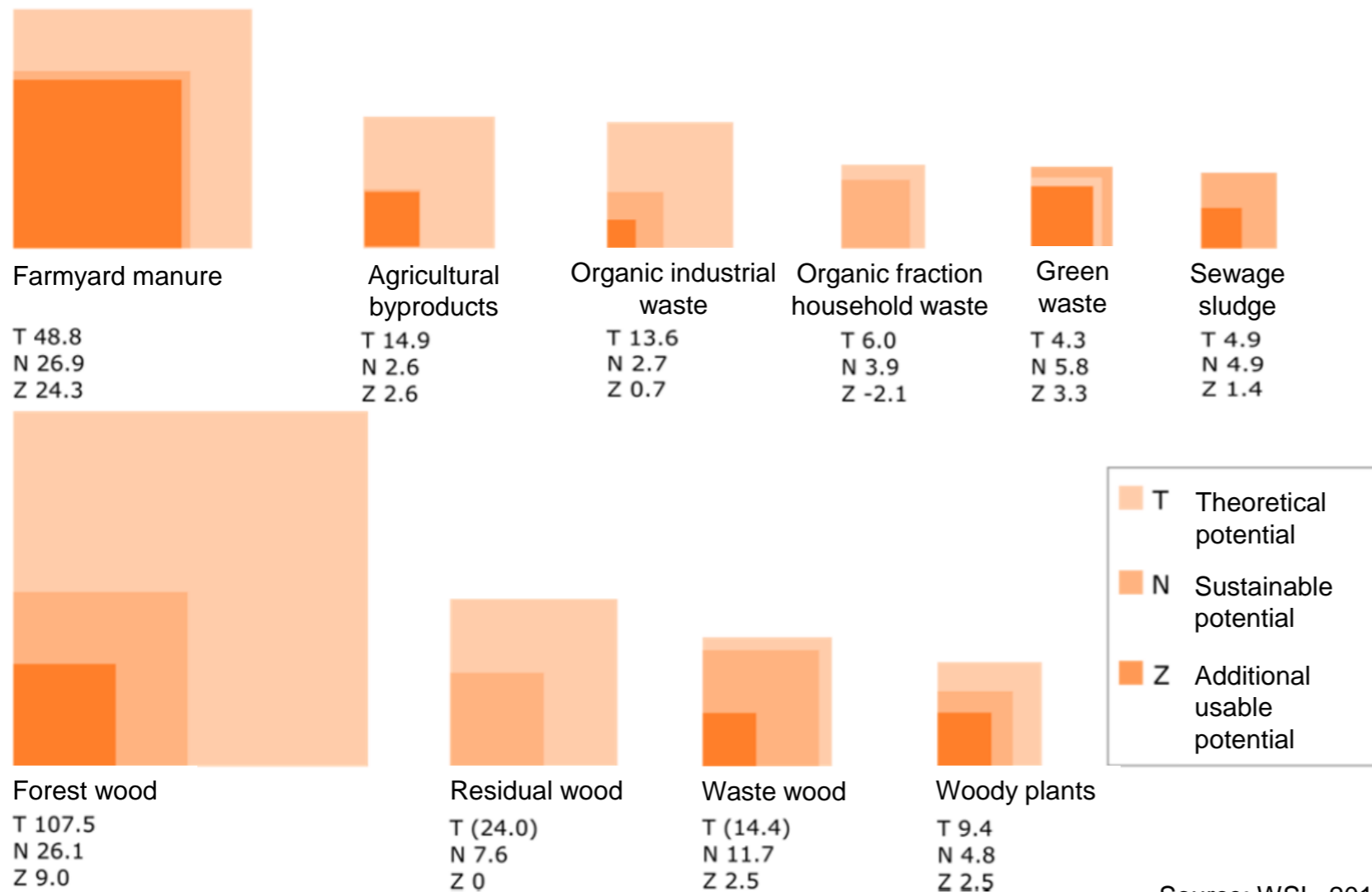
Source: VSG, 2023.

■ Most certificates (2306 GWh) from four European countries.

Statistics

Biomass potential in Switzerland

Primary energy (PJ per year)



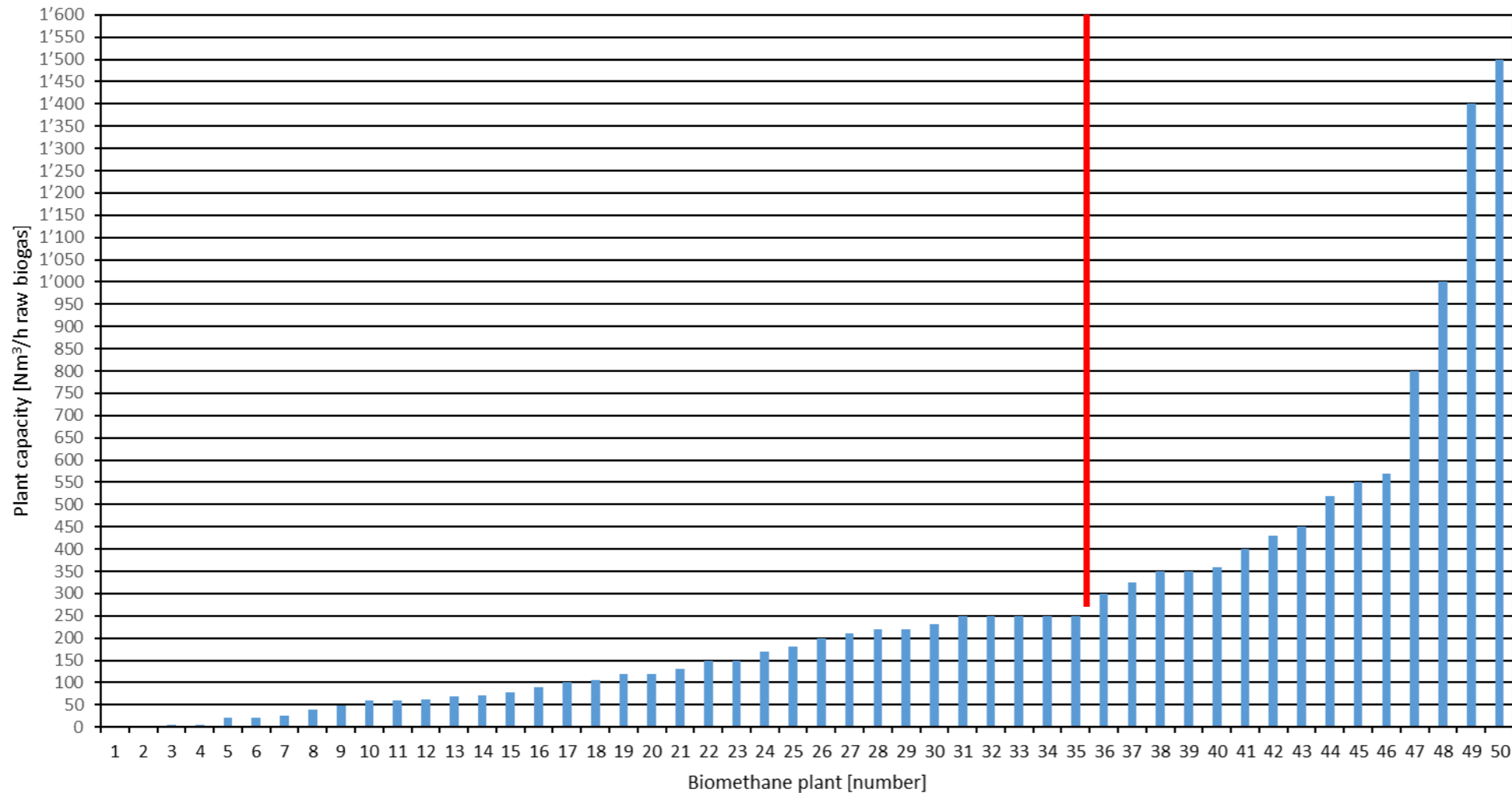
Source: WSL, 2017.

■ Biggest biomethane potential from farmyard manure

Biomethane in Switzerland

Biomethane plants – Installed capacity

- 50 biomethane plants (42 upgrading, 3 direct injection and 5 vehicle fuel)
- Installed biomethane capacity: 7,736 Nm³/h biomethane; 67,764,382 Nm³/a

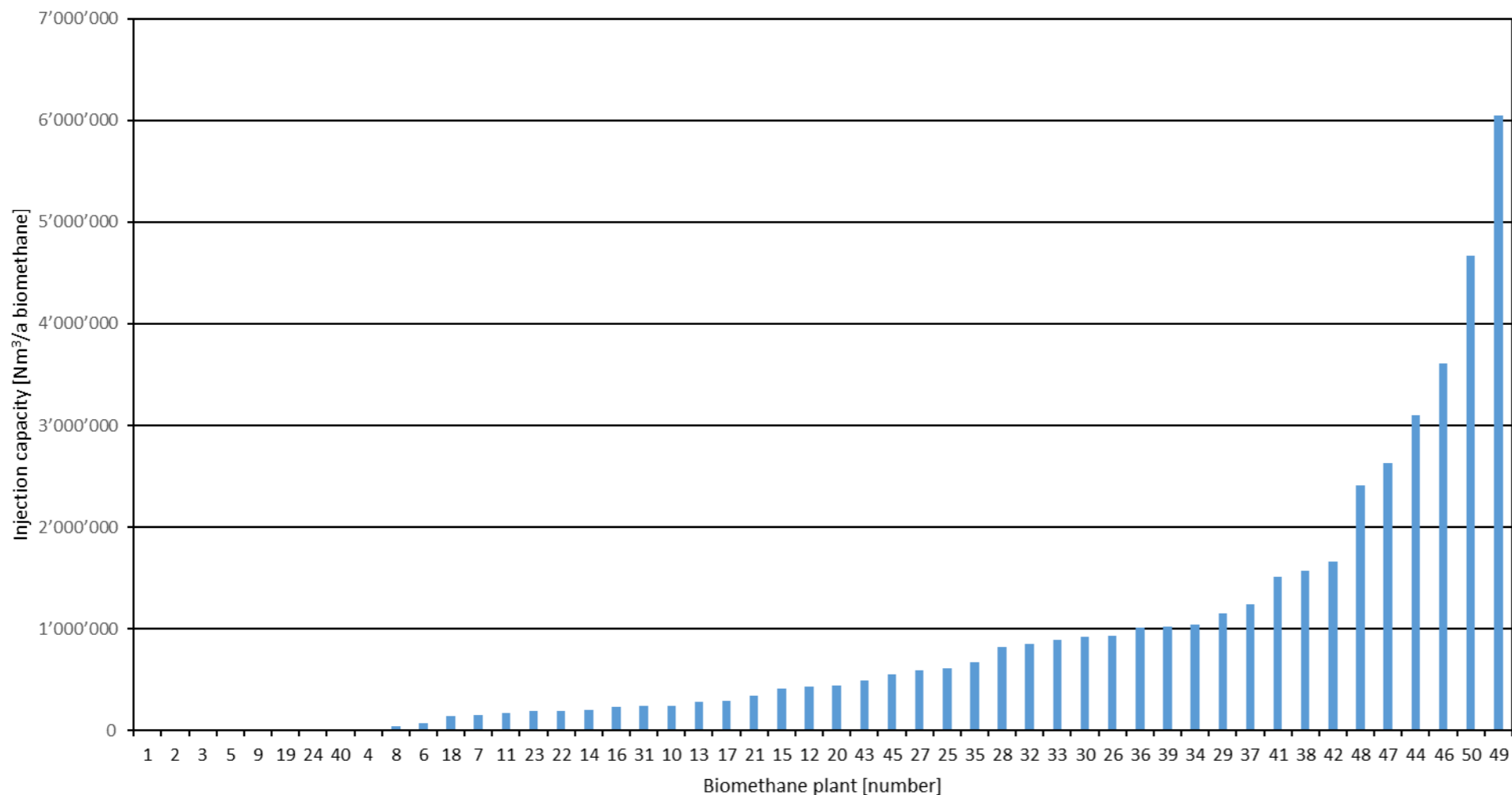


- Mean installed biomethane capacity per plant:
 - 158 Nm³/h biomethane;
 - 276 Nm³/h biogas

Biomethane in Switzerland

Biomethane plants – Injected capacity

- Injected biomethane capacity (2022): 44,073,054 Nm³/a
- Five vehicle fuel plants, one plant from Liechtenstein and two new plants from 2023 are not included (0)



- 65% of installed biomethane capacity is reached

Biomethane in Switzerland

Upgrading technology

- Injection: Membrane, Chemical scrubber, PSA, Biological methanation
- Vehicle fuel: Membrane, Catalytic methanation
- Direct injection: no upgrading

| Technology | Number of plants | Share on biomethane injection in Switzerland (2022) |
|---|------------------|---|
| | (-) | (%) |
| Water scrubber | 0 | 0 |
| Chemical scrubber | 9 | 44.1 |
| Membrane | 30 | 40.2 |
| PSA | 5 | 12.4 |
| Organic physical scrubber | 0 | 0 |
| Direct injection | 3 | 2.7 |
| Catalytic methanation | 1 | 0 |
| Biological methanation* | 2 | 0.5 |
| Other+unknown | 0 | 0 |
| *sometimes in combination with membrane | 50 | 100 |

Biomethane in Switzerland

Methane slip limits

- Methane slip limit value of **2.5 %** on methane in the raw gas entering the biogas upgrading unit (SVGW guideline G13)

- State of the art technologies reach lower methane emissions:
 - Chemical scrubber: < 0.1 %
 - Membrane: ~ 0.5 %
 - PSA: ~ 2.0 %

- **Goal: Make recommendations for new limit value(s), evaluating the effects of avoided methane emissions**

Biomethane in Switzerland

Methane emissions depending on methane slip limit value

- Direct injection plants counted without methane slip

| | Yearly injected biomethane capacity (Nm ³ /a Biomethane) | Yearly produced biomethane* (Nm ³ /a Biomethane) | Yearly biomethane emissions (Status Quo 2.5 %) (Nm ³ /a Biomethane) | Yearly biomethane emissions (1 %) (Nm ³ /a Biomethane) | Yearly biomethane emissions (0.5 %) (Nm ³ /a Biomethane) | Yearly biomethane emissions (0.2 %) (Nm ³ /a Biomethane) |
|--------------------------------------|--|---|---|--|--|--|
| Mean: | 881,479 | 903,474 | 21,995 | 8,798 | 4,399 | 1,760 |
| Sum: | 44,073,954 | 45,173,687 | 1,099,733 | 439,893 | 219,947 | 87,979 |
| Methane slip (%): | | | 2.43 | 0.97 | 0.49 | 0.19 |
| CH ₄ emissions (t/a): | | | 790 | 316 | 158 | 63 |
| CO ₂ equivalents** (t/a): | | | 19,740 | 7,896 | 3,948 | 1,597 |

*2.5% losses assumed

** factor 25

- Depending on methane slip limit value, the methane emissions could be reduced from **790 t/a** to **63 t/a**.

Biomethane in Switzerland

Scenarios for methane slip limit value(s)

- Scenario 1 (plants < 100 m³/h biogas: 1 %; plants > 100 m³/h biogas: 0.5 %)
- Scenario 2 (plants < 100 m³/h biogas: 1 %; plants > 100 < 400 m³/h biogas: 0.5 %; plants > 400 m³/h biogas: 0.2 %)
- Scenario 3 (plants < 100 m³/h biogas: 1 %; plants > 100 < 200 m³/h biogas: 0.5 %; plants > 200 m³/h biogas: 0.2 %)

| | Yearly injected biomethane capacity (Nm ³ /a Biomethane) | Yearly produced biomethane* (Nm ³ /a Biomethane) | Yearly biomethane emissions (Status Quo 2.5 %) (Nm ³ /a Biomethane) | Yearly biomethane emissions (Scenario 1) (Nm ³ /a Biomethane) | Yearly biomethane emissions (Scenario 2) (Nm ³ /a Biomethane) | Yearly biomethane emissions (Scenario 3) (Nm ³ /a Biomethane) |
|--------------------------------------|--|---|---|---|---|---|
| Mean: | 881,479 | 903,474 | 21,995 | 4,545 | 2,921 | 2,204 |
| Sum: | 44,073,954 | 45,173,687 | 1,099,733 | 232,850 | 157,385 | 114,687 |
| Methane slip (%): | | | 2.43 | 0.52 | 0.35 | 0.25 |
| CH ₄ emissions (t/a): | | | 790 | 167 | 113 | 82 |
| CO ₂ equivalents** (t/a): | | | 19,740 | 4,180 | 2,825 | 2,059 |

*2.5% losses assumed

** factor 25

- Depending on Scenario, the methane emissions could be reduced from **790 t/a** to **82 t/a**.

Outlook

Development and challenges in future

- Depending on methane slip limit value further development in this sector will be influenced
- Also the costs for the technologies to avoid methane slip are still high in smaller scales
- Easy available biomass potentials in Switzerland are already exhausted
- Biggest biomass potential for smaller plants treating farmyard manure



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