

### Biogas from Swiss farms

Switzerland has 57'617 farm sites, of a mean size of 20 ha per farm, spread between 1 and 50 ha for >92% of them.

40'309 farms breed cows (1'545'600 cows, 38 cows per farm on average),

8'234 breed pigs (1'584'400 pigs, 192 pigs per farms on average)

and the country has 10'519 km<sup>2</sup> of agricultural surface (25.5% of the total country surface) from which also straw and other residues are recoverable.

Recoverable power:

205 W per cow from cow manure

40 W per pig from pig manure

120.5 W from 1 ha of agro-waste

a) What is the recoverable yearly Swiss agro-biogas potential from manure and other biowaste (in PJ)?

b) How does this relate to the total final Swiss energy consumption (of ≈800 PJ)?

c) What is the average potential power-size per farm: in kW? In biogas flow (m<sup>3</sup>/h)?  
(Assume 66% CH<sub>4</sub> in the biogas and 11 kWh per m<sup>3</sup> CH<sub>4</sub>)

The reality of Swiss agricultural biogas exploitation in 2021 is a production of 150 GWh in 110 installations in ICE CHP with 36% electric efficiency.

d) How does this compare to the theoretical energy potential ?

e) What is the average engine power size per site? (Assume 7000h load per year)

f) What do you conclude from this ? How could the biogas potential be better used ?

### Gasoline / Diesel replacement by inland bioethanol / biodiesel production

Inland mobility fuel in Switzerland is ~5.1 Mtoe gasoline and ~2 Mtoe diesel per year.

(1 Mtoe = 42 PJ)

Assume we want to replace part of it by inland biofuel production and that we can dedicate 1000 km<sup>2</sup> of the Swiss territory (total: 41'000 km<sup>2</sup>) to sugar beet plantation and 1000 km<sup>2</sup> to rapeseed plantation.

Bioethanol (21.3 MJ / L) from sugar beet : yield 2500 L / ha

Biodiesel (33 MJ / L) from rapeseed : yield 700 L / ha

a) How much (%) of imported gasoline and diesel fuel consumption could we replace this way ?

b) If we were to dedicate instead 1000 km<sup>2</sup> of forest land (there is ~11'000 km<sup>2</sup> of forest) to bioethanol production (renewable dry wood production of 20 tonne / ha.yr, converting 3 kg wood to 1 kg ethanol), how much gasoline could we replace ? (ethanol density: 0.8 kg/L)

c) If we would instead convert this yearly available wood quantity into methane (wood-to-methane = 70% energy efficiency yield) for mobility (gas vehicles) ? (Assume 16.7 MJ/kg dry wood)

Comment the results.