

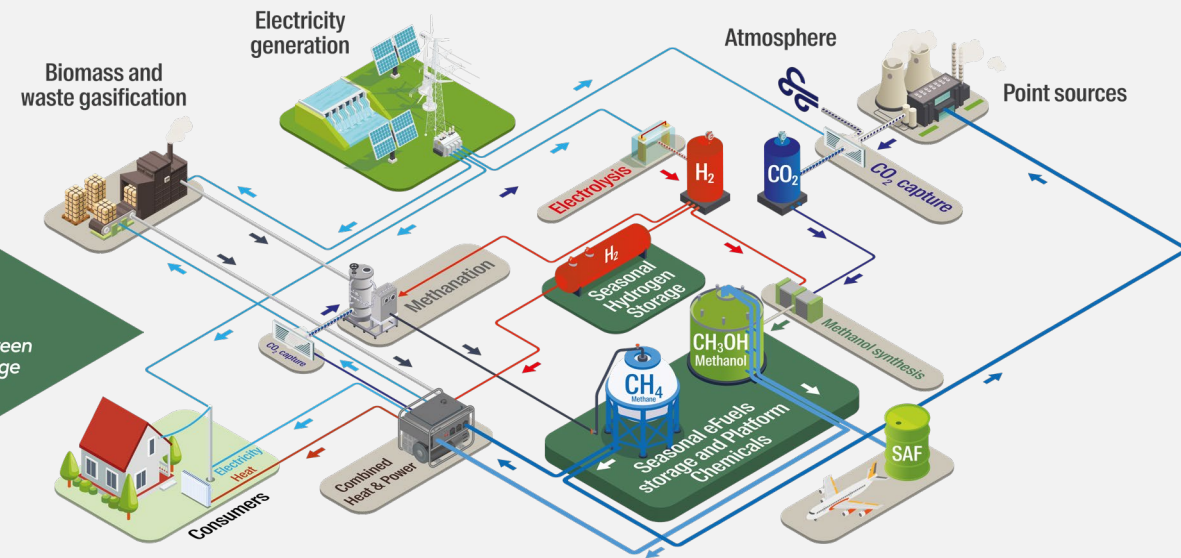
# Coalition for Green Energy and Storage (CGES)

Addressing the climate and energy crises with innovation and technology

Forum InnoClimat 15 novembre 2024



**CGES**  
Coalition for Green  
Energy & Storage



# The challenge: A combined energy and climate crisis!

## Switzerland as a showcase

### Seasonal energy transfer (storage)

- There will be an abundance of “green” energy in summer
- There is a lack of « Swiss » electricity in winter ~ 25 PJ (7 TWh)

⇒ **Need for “green” storage**

**25 PJ (7 TWh) corresponds to:**



**4x**

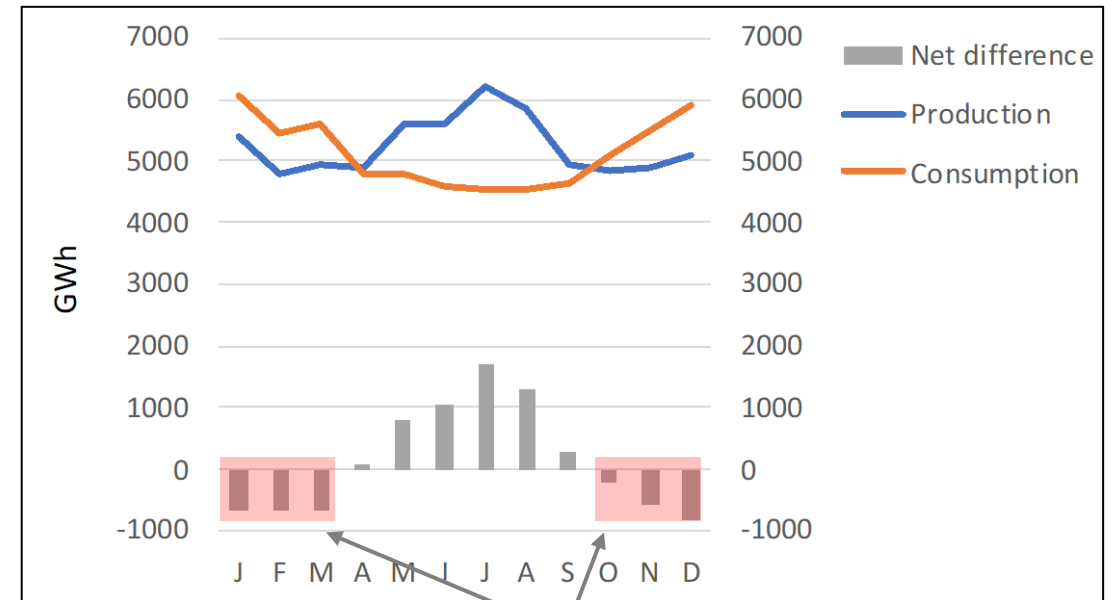
Grand Dixence  
(tallest dam in Europe)



**70 Mio**

Tesla Model S  
(100 kWh battery)

### Electricity production and consumption in Switzerland by month (average 2018-2022)



Winter gap: ~ 25 PJ (7 TWh)

Data Source: OFEN [www.bfe.admin.ch](http://www.bfe.admin.ch)

# The challenge: A combined energy and climate crisis!

## Switzerland as a showcase

### The potential for carbon capture and usage

# 32%

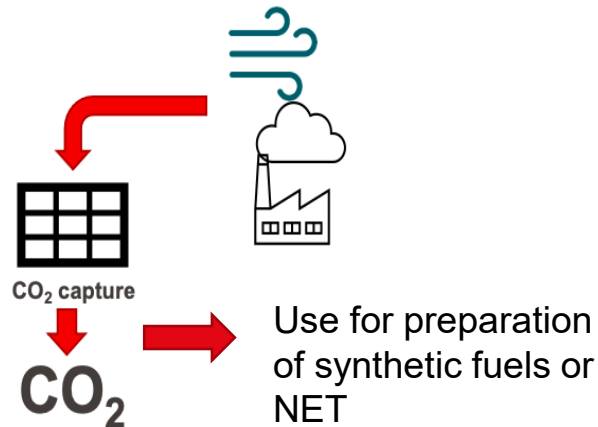
of current CO<sub>2</sub> emissions stem from “hard-to-abate” sectors – (transport, cement, steel)

# 20%

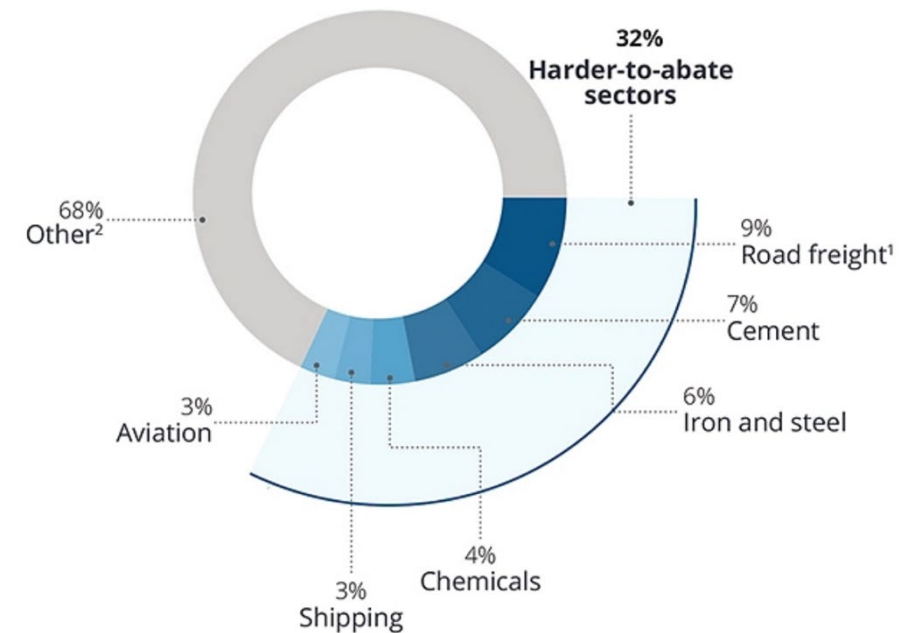
of current emissions are expected in Switzerland in 2050 (11.8 Mio tonCO<sub>2</sub>)

Carbon capture at the source is on the verge of economic feasibility

CO<sub>2</sub> can be reused:  
**Virtuous carbon cycle, including needs to be stored (NET)**

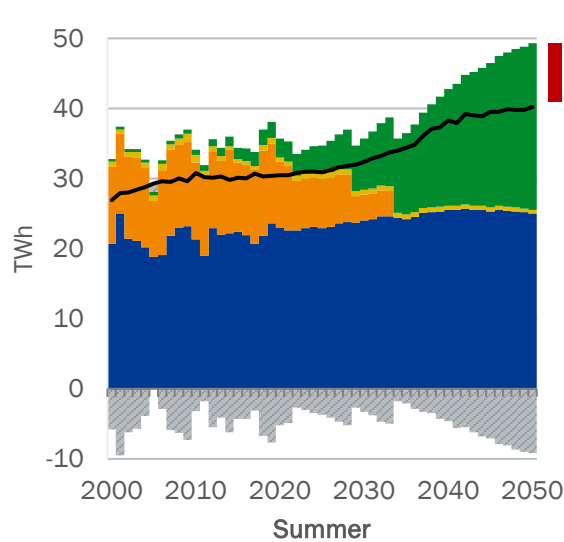


Global carbon dioxide emissions by sector in 2018



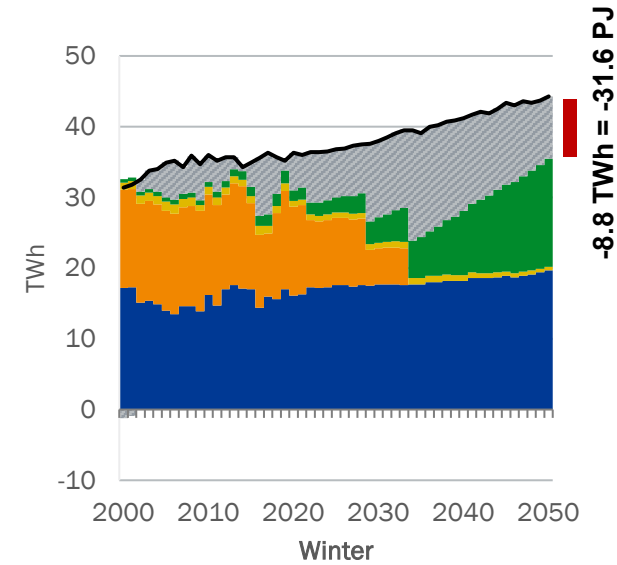
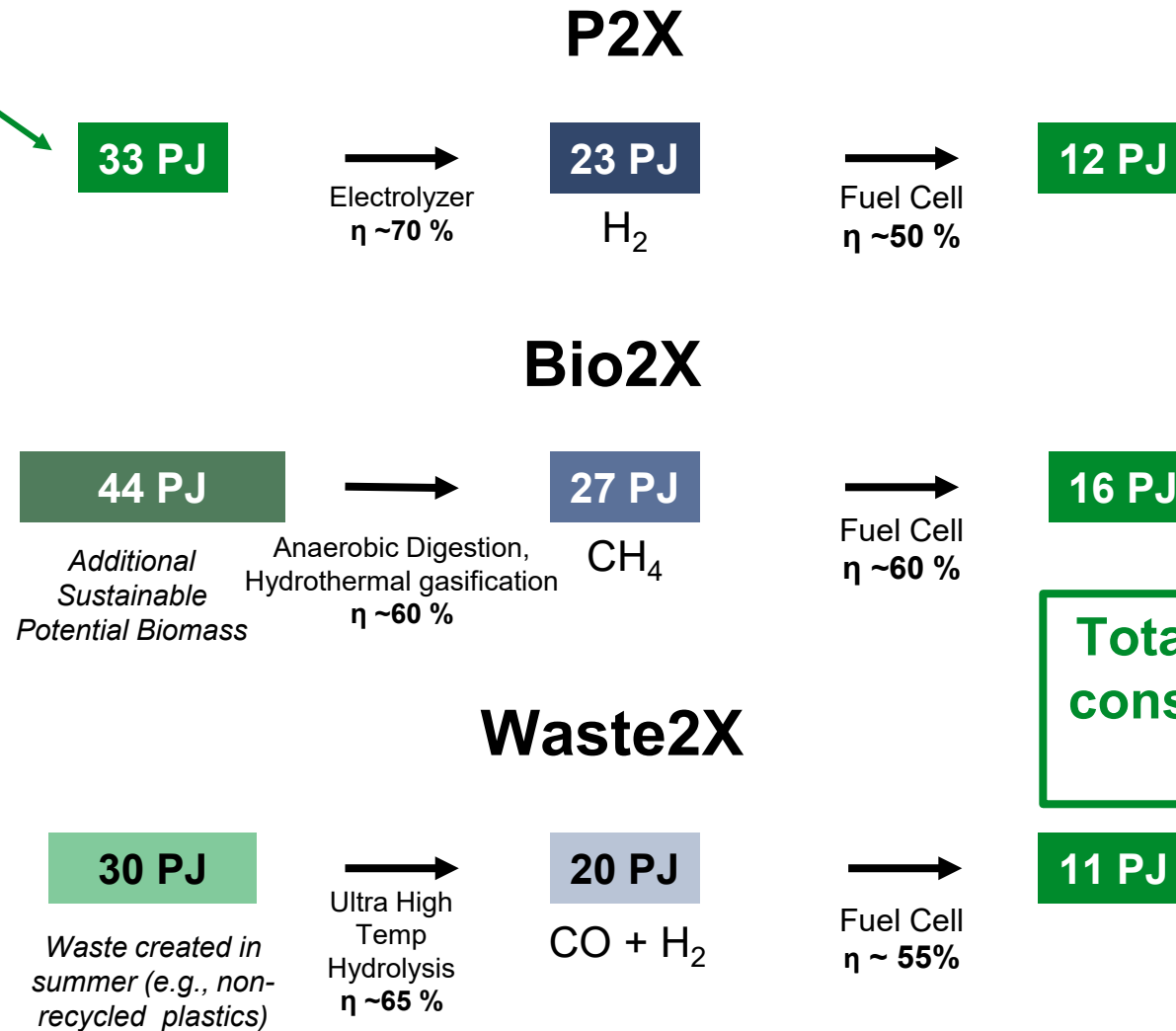
In Switzerland in 2050, harder-to-abate emission estimated to **11.8 Mio ton CO<sub>2</sub> / year**

# Summer/winter electricity balance, scenario ZERO basis 2050



Net import/export  
 Renewable energy  
 Hydro  
 Fossil fuels  
 Nuclear  
 Gross consumption

Prognos AG, 2020, Perspectives énergétiques 2050+  
 Rapport succinct, Office fédéral de l'énergie OFEN..  
 V. Burg, et. al 2018, Analyzing the potential of domestic  
 biomass resources for the energy transition in  
 Switzerland, Biomass and Bioenergy, 111, 60-69.  
 SFOE Energy Statistics



**Total potential > 39 PJ if we consider PtX + biomass and waste gasification**

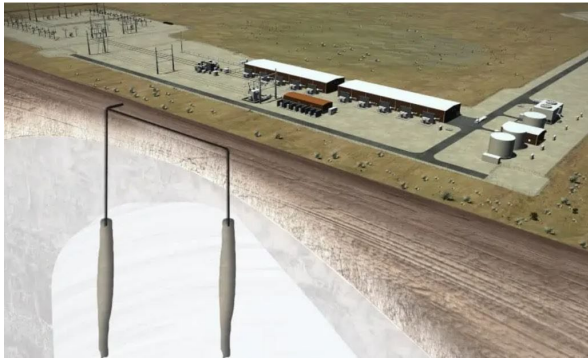


# Estimation of the Chemical Energy Storage Cost

## Hydrogen

50 PJ → 25 PJ  
Fuel Cell  
 $\eta \sim 50\%$

35 million m<sup>3</sup> @150 bar



~ **46x** “ACES Delta”

Current world's largest H<sub>2</sub> storage site in Utah (1.1 PJ/ 300 GWh)

→ **11 billion** CHF CAPEX  
(salt storage)

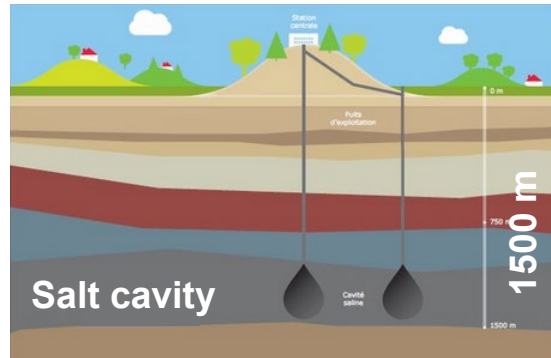
→ **153 billion** CHF CAPEX  
(tube storage)

Coalition for Green Energy and Storage

## Methane

42 PJ → 25 PJ  
Fuel Cell  
 $\eta \sim 60\%$

5 million m<sup>3</sup> @250 bar



~ **40%** of current Swiss annual gas consumption

~ **10x** “Lined Rock Cavern” potential Oberwald project of Gaznat (4.3 PJ, 400 Mio CHF)

→ **3.9 billion** CHF CAPEX (lined rock storage)

→ **4.4 billion** CHF CAPEX (LNG plant + storage)

## Methanol

45 PJ → 25 PJ  
Fuel Cell  
 $\eta \sim 55\%$

3 million m<sup>3</sup> liquid



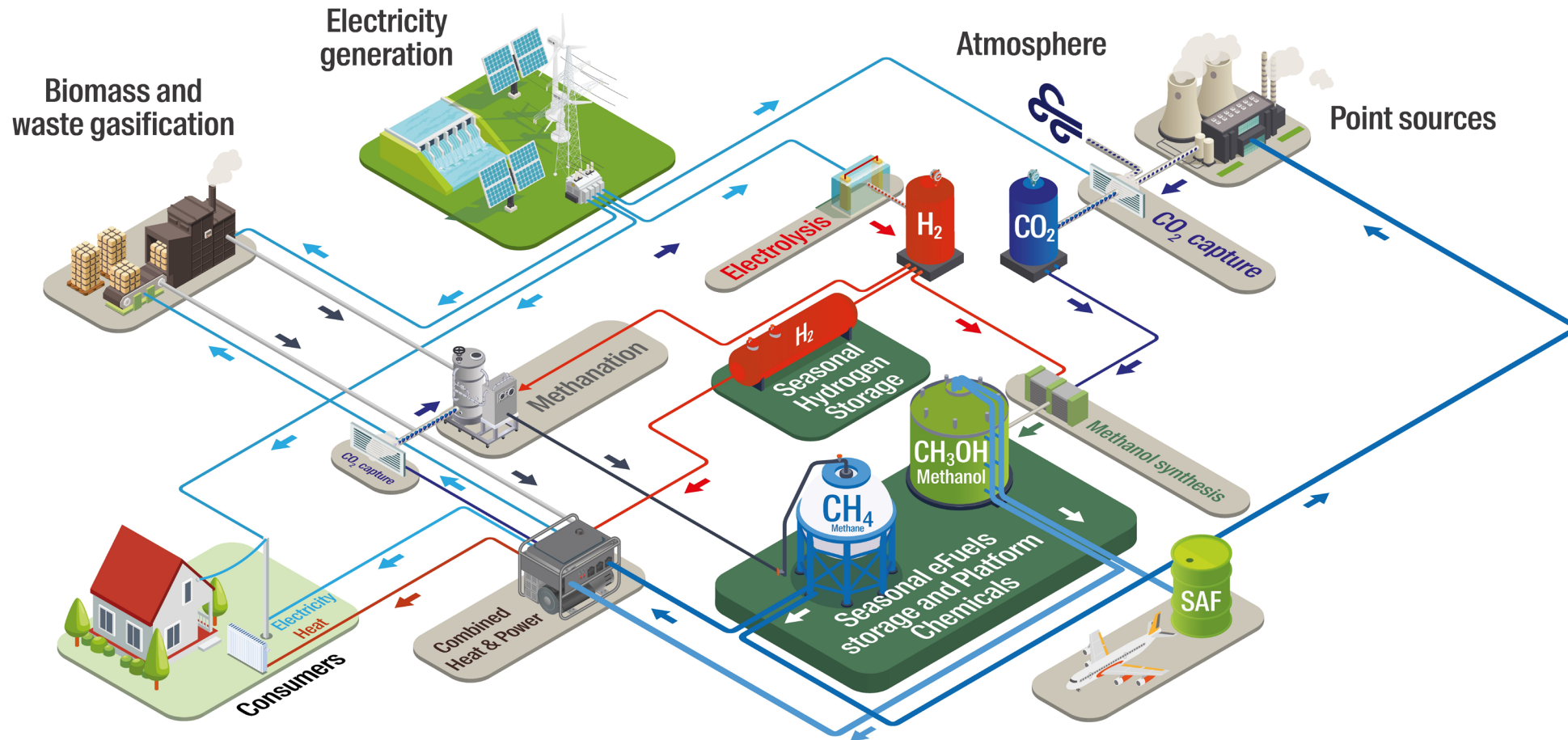
Large-scale or distributed storage possible

~ **6k** 500 m<sup>3</sup> tanks

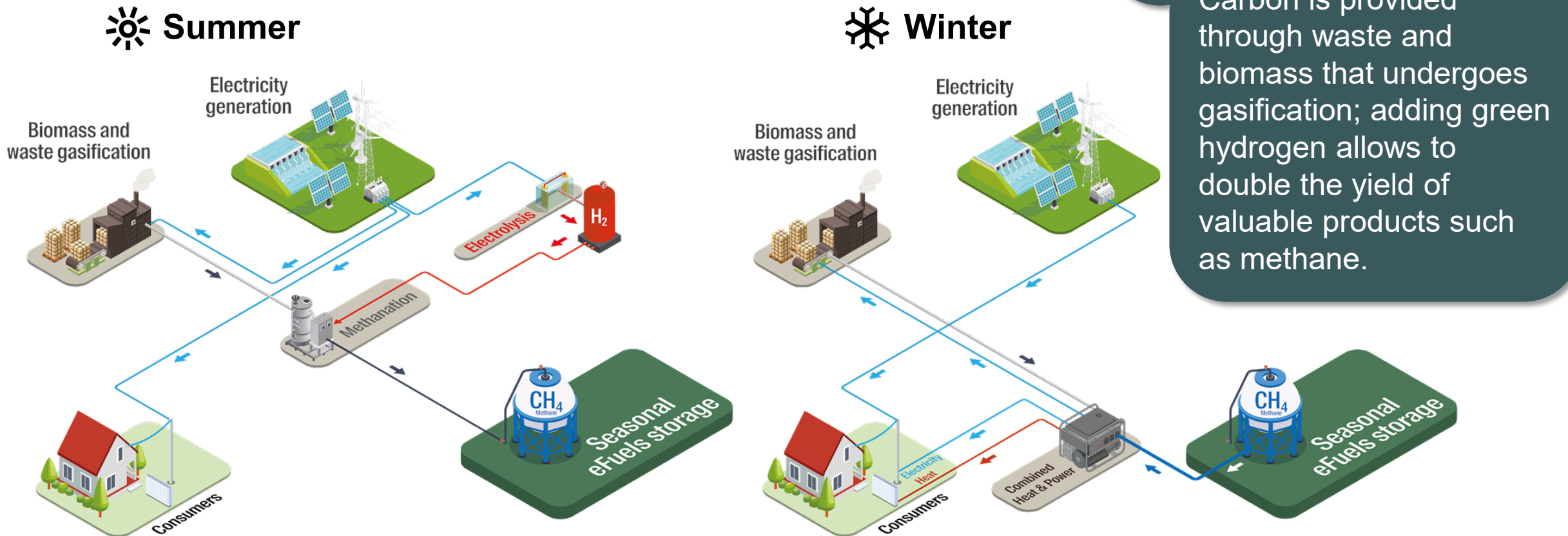
→ **1.1 billion** CHF CAPEX

Sources: [Hissel, D., et al., ACES Delta](#), [Hyuspre](#), SFOE, [Gaznat](#), [Alibaba](#) (methanol), [Ohgishima tank](#) (methane), [Advances in Chemical Engineering](#), [Ludwig- Bolkow-Systemtechnik GmbH \(LBST\)](#), [Oxford Institute for Energy Studies](#)

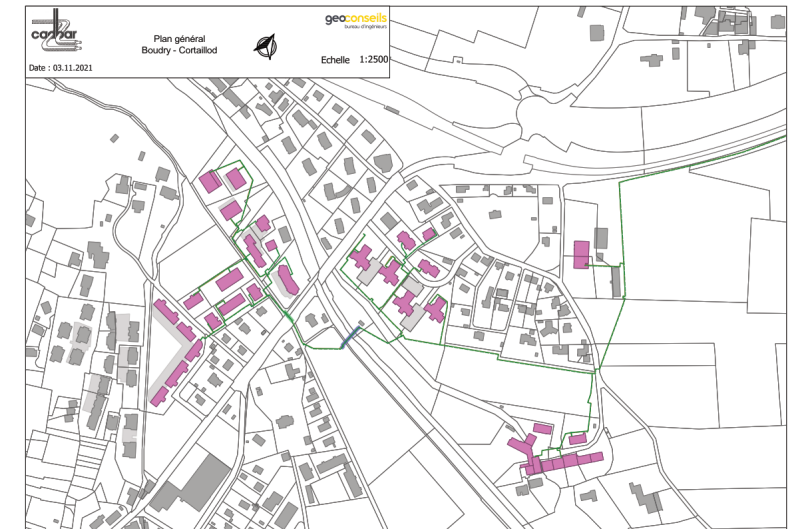
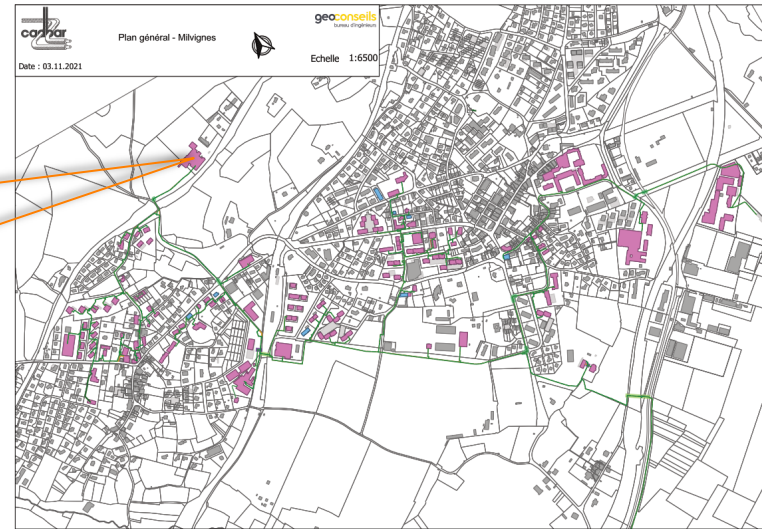
# CGES: the full picture of green energy & storage with CO<sub>2</sub> virtuous cycle



# Catapult Candidate CC2: Solid Waste Energy Storage Solutions (SWESS)

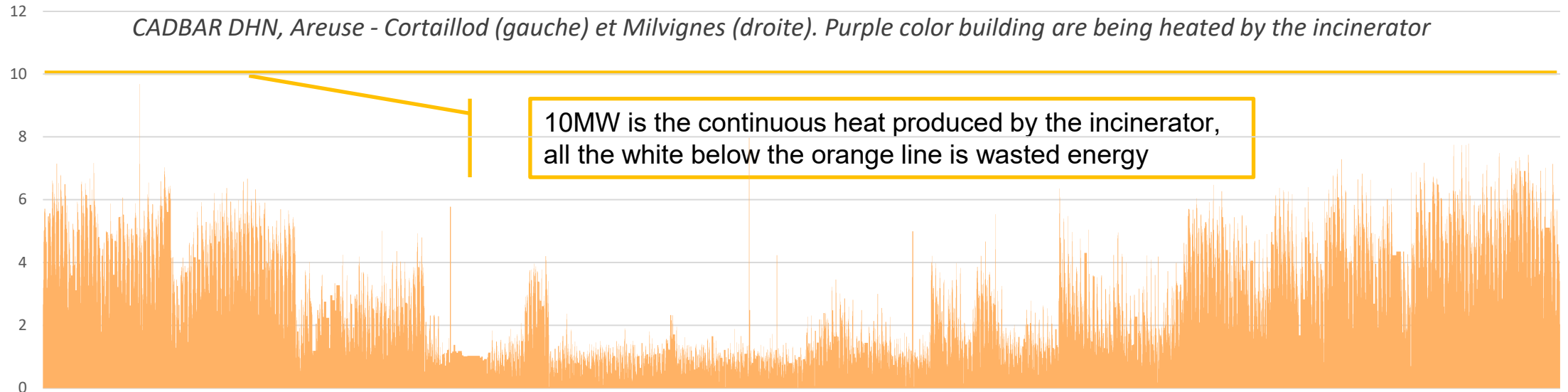


# Example of Cottendart-Colombier (NE) incinerator and local district heating network (DHN)



CADBAR DHN, Areuse - Cortailod (gauche) et Milvignes (droite). Purple color building are being heated by the incinerator

MW



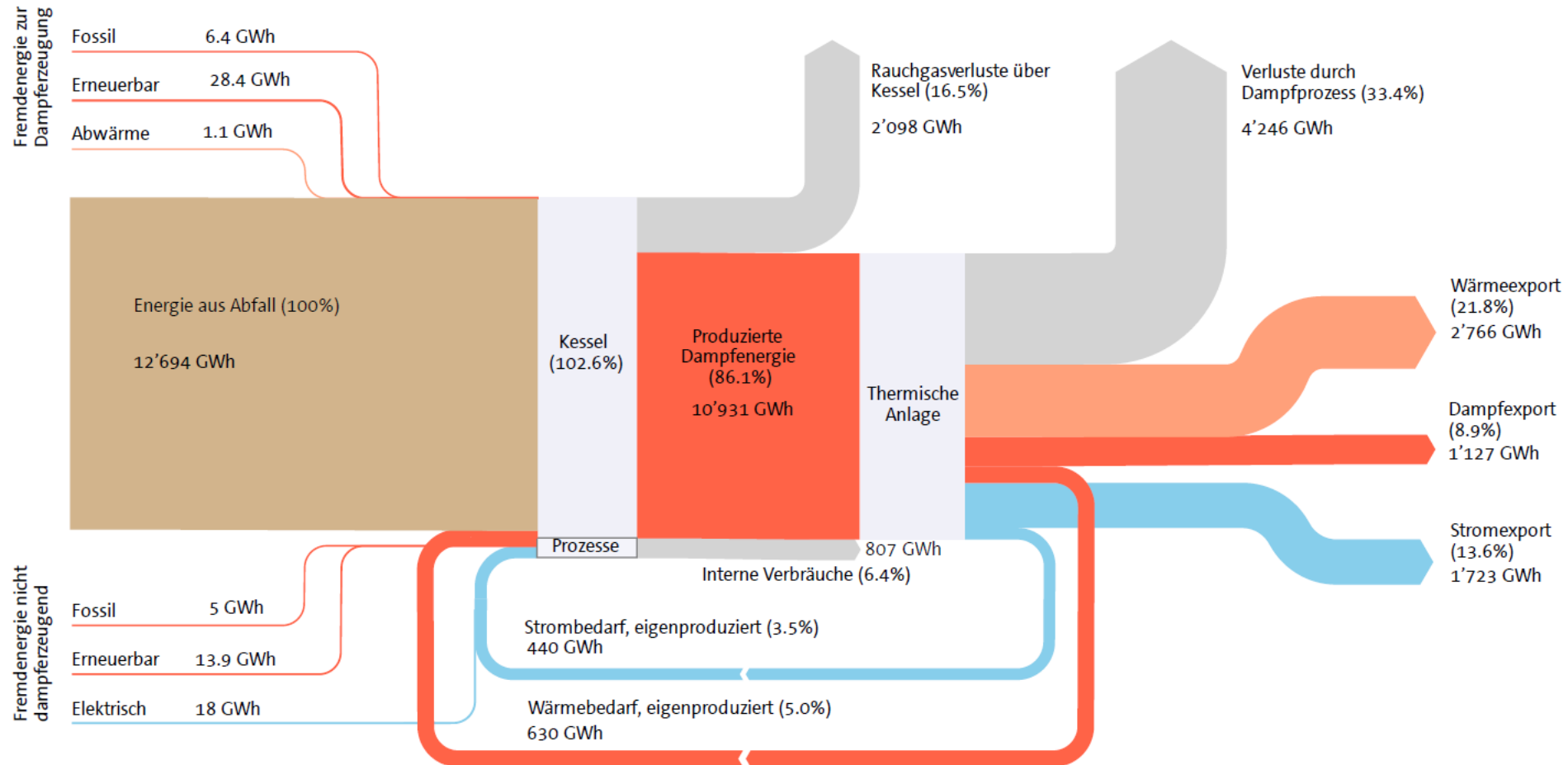
10MW is the continuous heat produced by the incinerator,  
all the white below the orange line is wasted energy

Heat request from the district heat network (DHN) CADBAR from October 2019 (left) to September 2020 (right) in MW



# Running 24/7 every day of the year, incinerators waste about 50% of the primary energy

## Energiefluss CH-KVA 2022





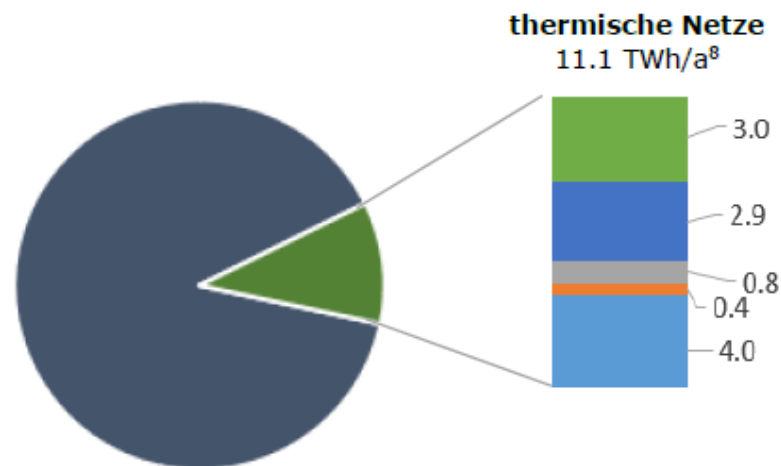
# While actual thermal networks still burn 30% of fossil gas with the objective to double the capacity and be 100% renewable by 2050

## FAKTENBLATT Thermische Netze

InfraWatt - Thermische Netze Schweiz - VBSA

### Wärmebedarf 2021

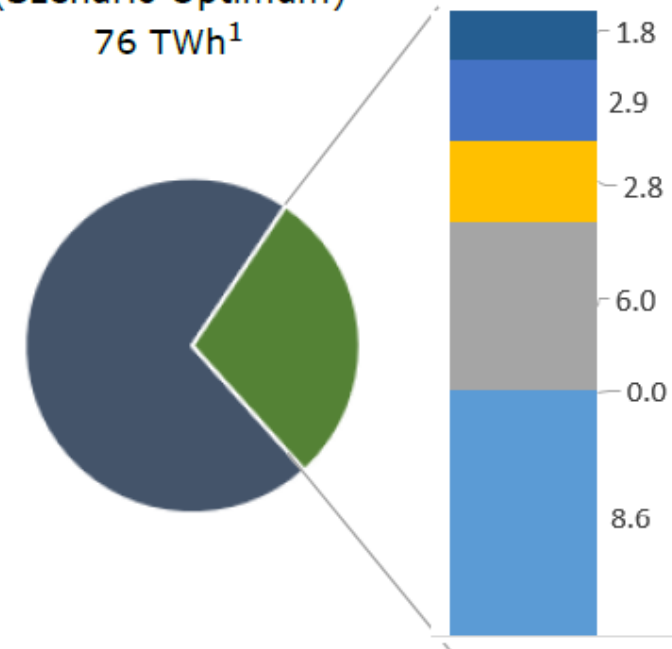
104 TWh/<sup>1</sup>



### Wärmebedarf 2050

(Szenario Optimum)  
76 TWh<sup>1</sup>

thermische Netze  
22 TWh/a<sup>1 und 5</sup>

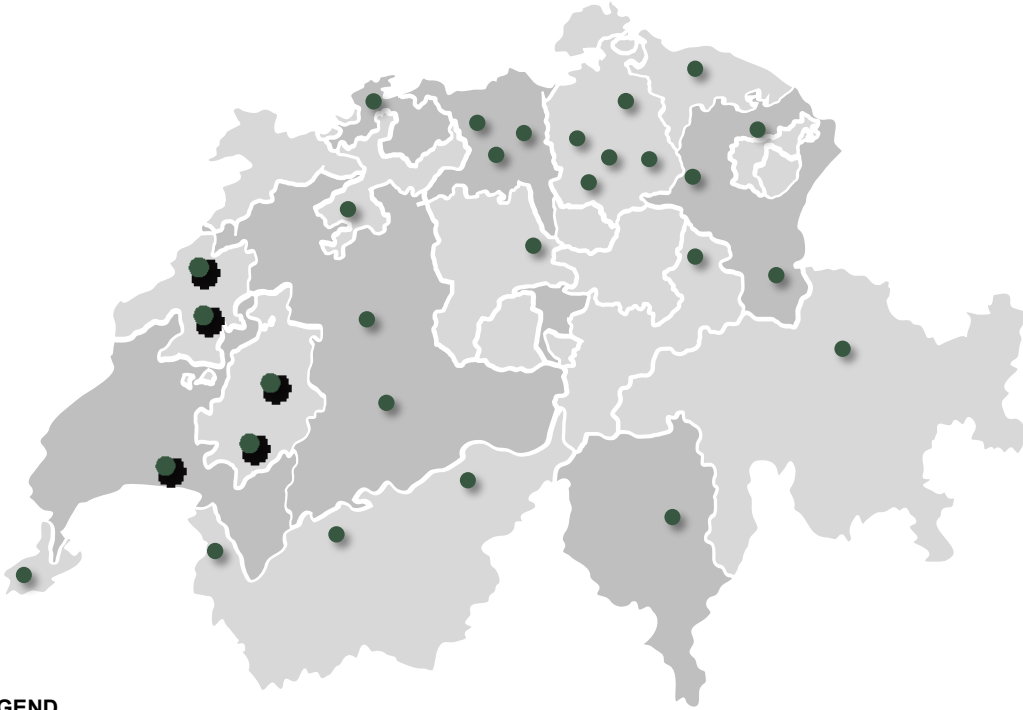


■ KVA ■ Sonstige ■ WP ■ Geothermie ■ Feste Biomasse ■ Erdgas ■ Biogas

## Waste incinerators are centralized while district heating are decentralized, closed to dynamic heat consumers

### Map of Incinerators

29 incinerators burning 12.7 TWh/y of waste



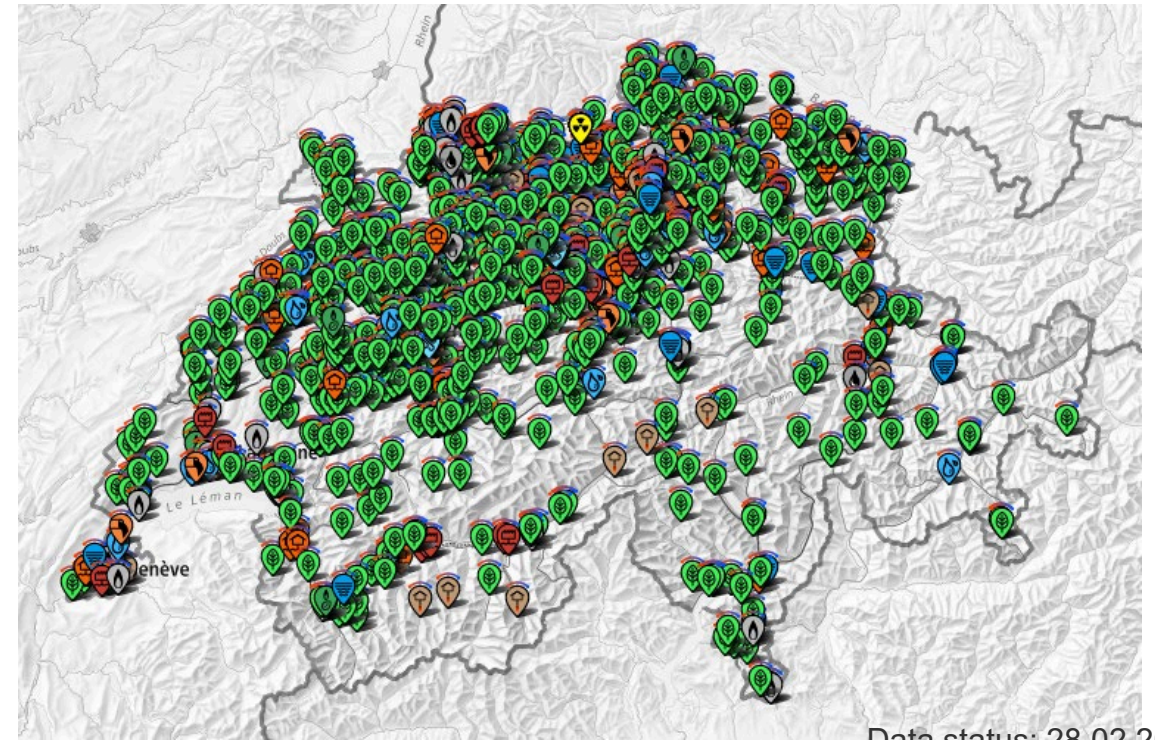
LEGEND

- Location of the 29 incinerator in Switzerland which could be replaced by ~ 750 gasification systems

Data status: 07.09.2023

### Map of thermal networks

Thermal networks by source (top 3: biomass, surface water, municipal incinerator) ~ 1070 networks consuming 11.1TWh/y



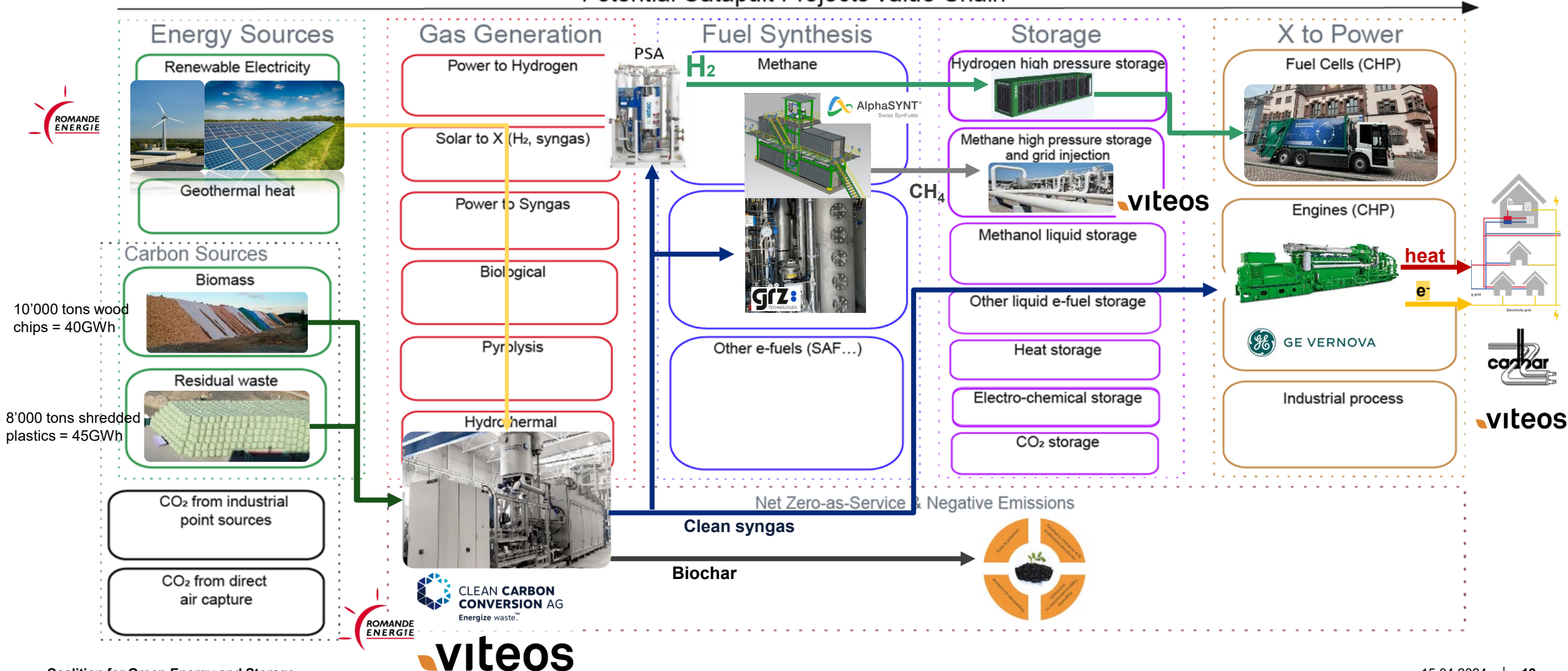
Data status: 28.02.2024

LEGEND

- |               |         |                   |                                       |
|---------------|---------|-------------------|---------------------------------------|
| Surface water | Air     | Geothermal energy | Natural gas                           |
| Groundwater   | Biomass | Nuclear energy    | Wastewater                            |
| Solar thermal | Biogas  | Heating oil       | Waste heat from municipal incinerator |
|               |         |                   | Industrial and commercial waste heat  |

# Catapult II – Solid Waste Storage – Canton Neuchâtel

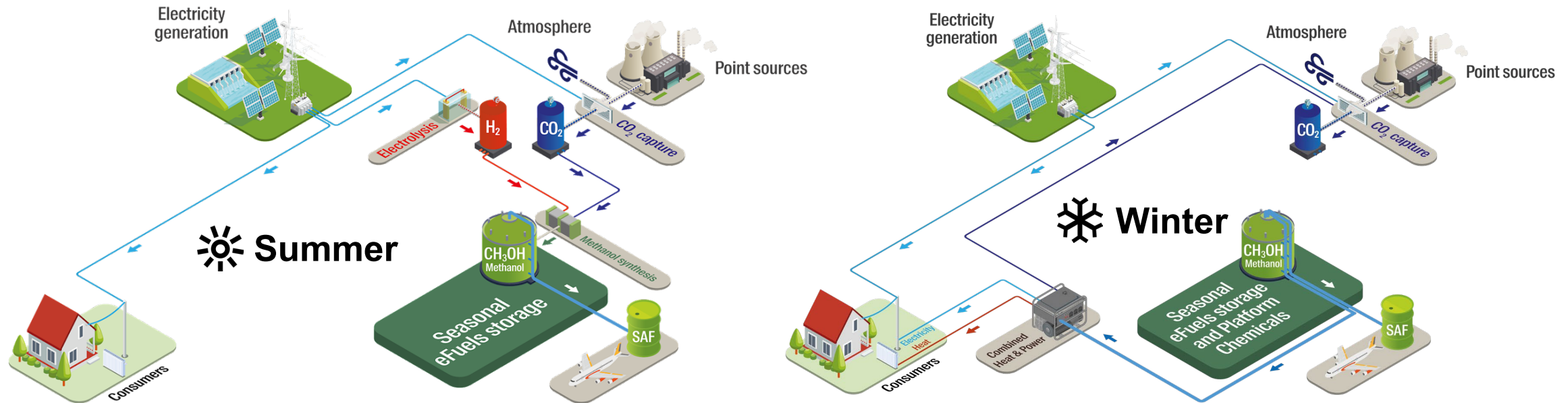
## Potential Catapult Projects Value Chain





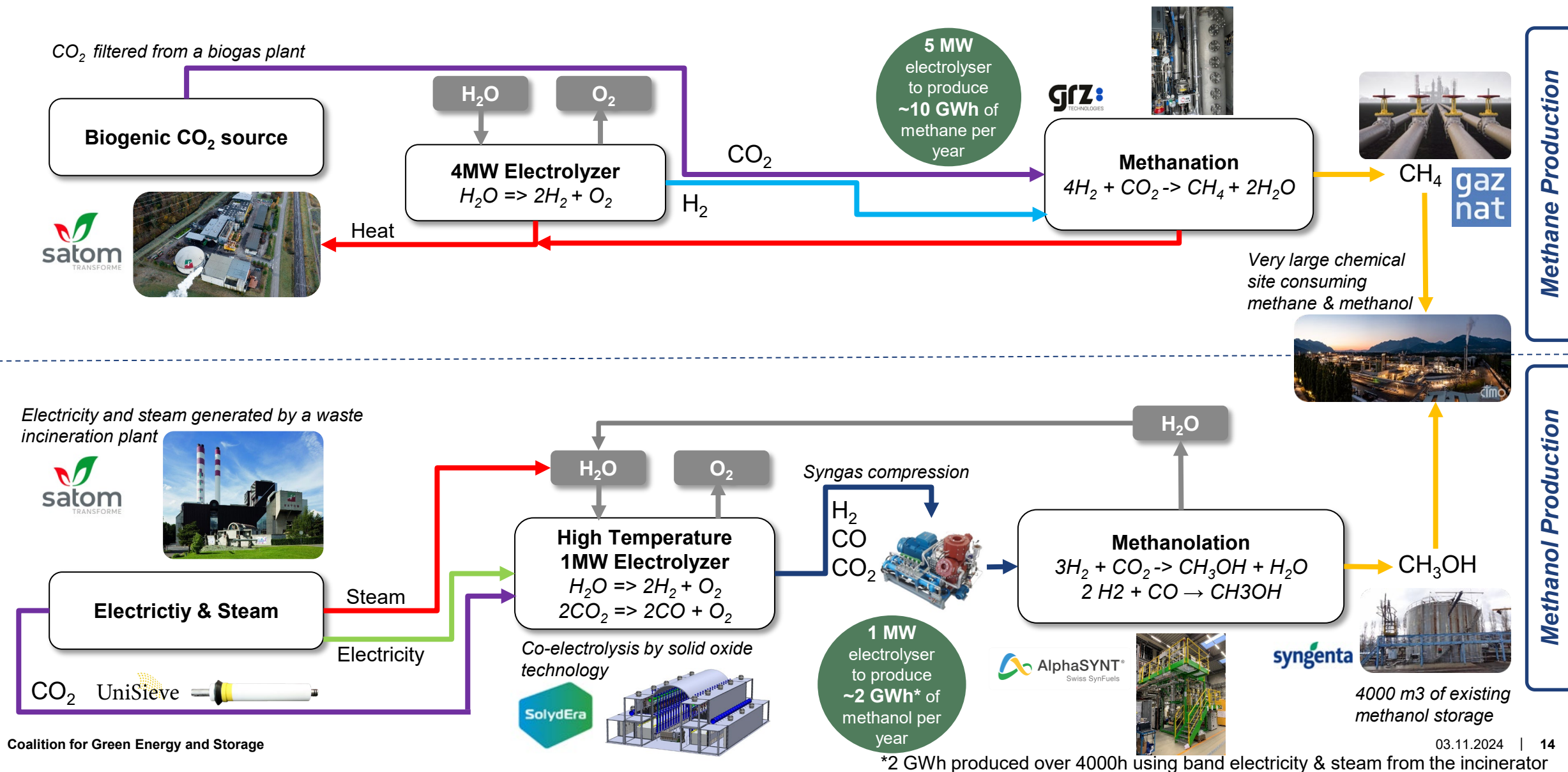
# Catapult 3: Synthetic fuels production with CO<sub>2</sub> virtuous cycle

## Example 2: e-methanol production

**CC3**

Carbon is provided as CO<sub>2</sub> from point sources. Adding green hydrogen allows to produce storable energy such as synthetic methanol.

# Green Methane & Methanol Demonstrator in Chablais







# Thank you

Alexandre Closset