Hydrogen as seasonal storage for a swiss neighbourhood

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MOTIVATION : PHOTOVOLTAIC FOR NEIGHBOURHOOD 100 INHABITANTS

While in the PV-Community the agreement is overwhelming that the installation rate of 700 MWp per year, which the new Swiss energy law intents to reach are insufficient by more than of a factor of two, it is still a matter of debate how to transfer the overshooting summer PV-generation into the less favourable winter season in central Europe. Therefore we propose here a scalable solution for a neighbourhood in a typical swiss city. Two trials for an appropriate dimensioning of the central components are suggested. In an iterative process we reach to the favourite recommendations for seasonal Hydrogen storage system transferring the summer overproduction into the «dark» winter months.

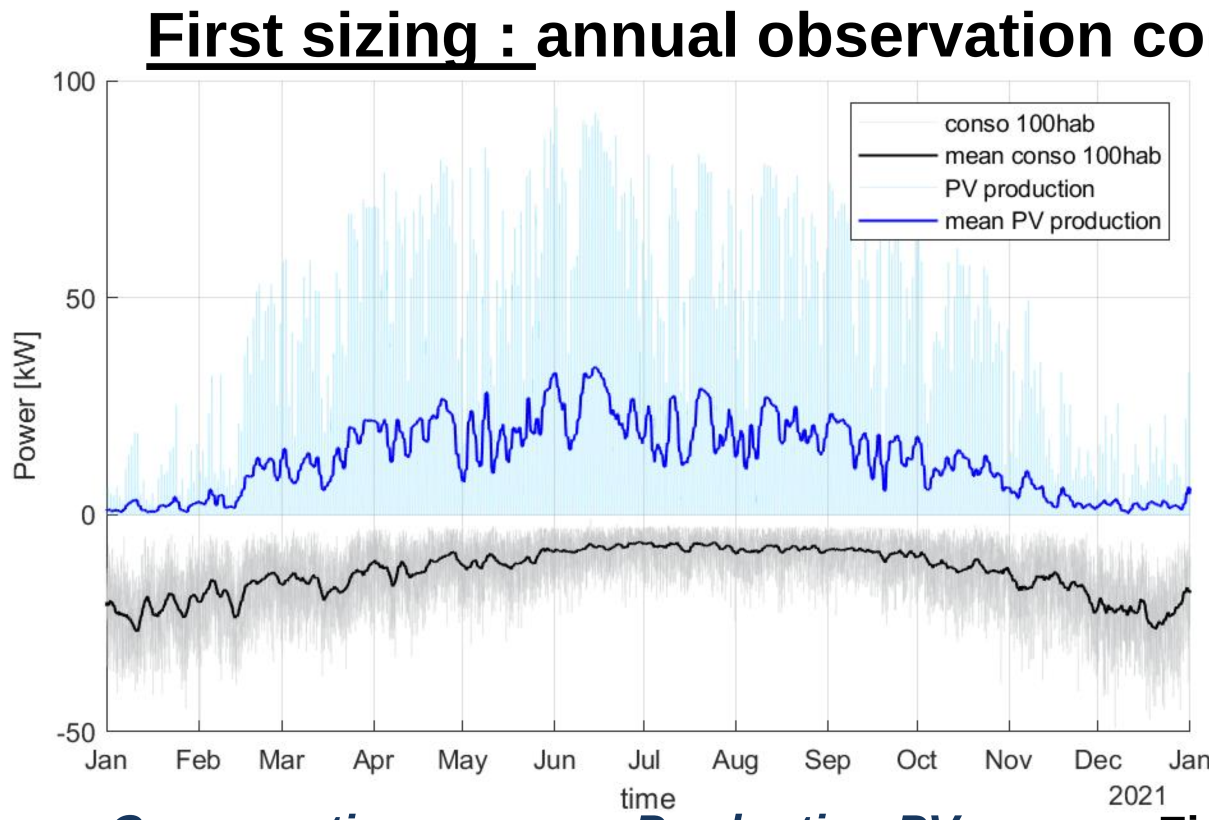
Key data :

3 inhabitants in house
3450 kWh/year

Neighbourhood
100 inhabitants
115 000 kWh/year

Source :
OFEN suisseenergie.ch
fact sheet August 2021,
private communication Oiken

First sizing : annual observation consumption and PV



Consumption energy = Production PV energy **Fig. 1**

Problematic:

Annual imbalance between photovoltaic production (fig.1) and consumption.

One year :
PV : +115 000kWh
Cons. : -115 000kWh

Second sizing :

Winter observation consumption and PV

Sizing the photovoltaic power required for the needs of a day in winter (05.01.2021 cons. -23kW)

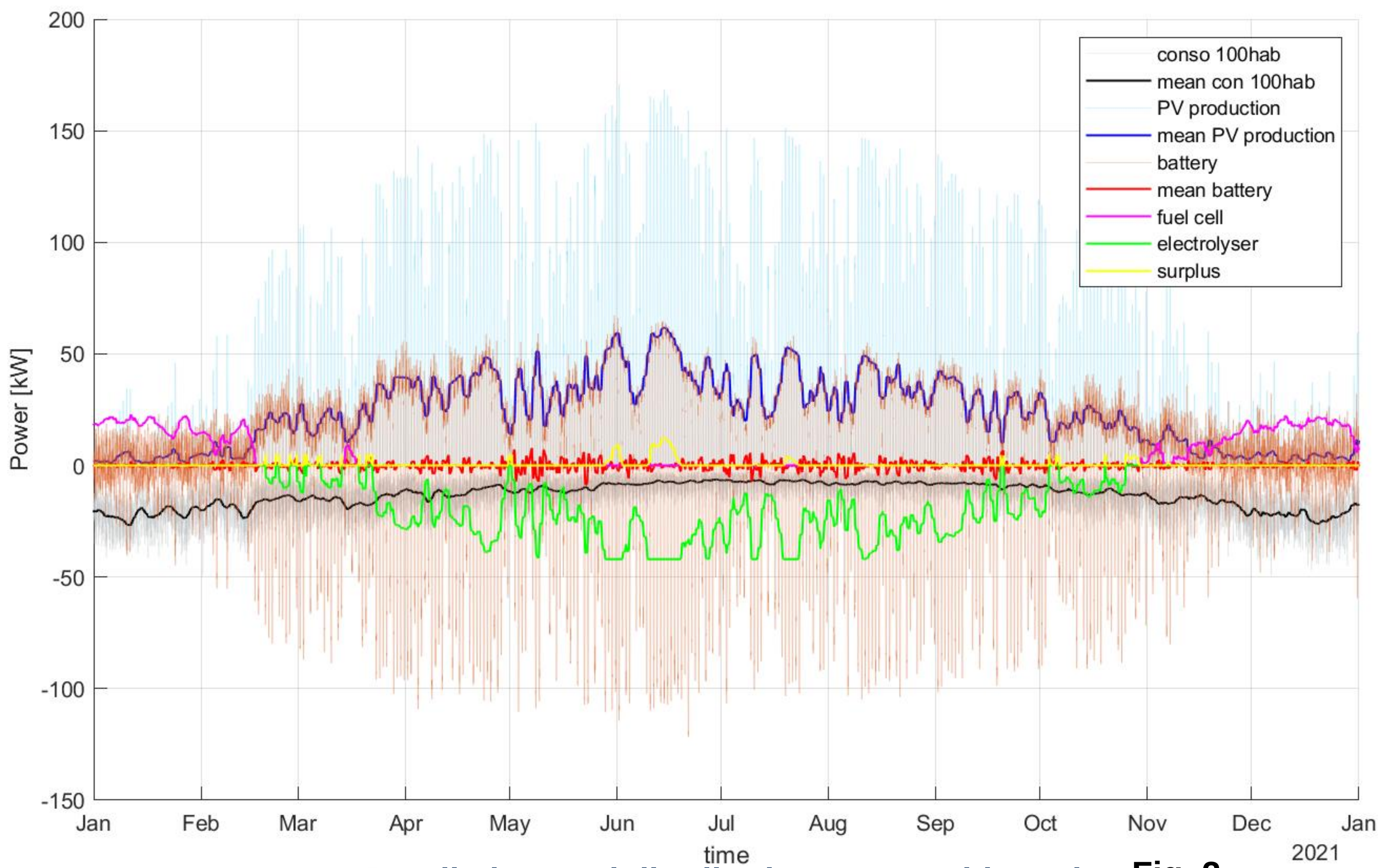
Problematic:

Huge overproduction in summer. Huge over-dimensioning PV (3000kW).

One year :
Surplus : 3 651 000kWh

HYDROGEN STORAGE

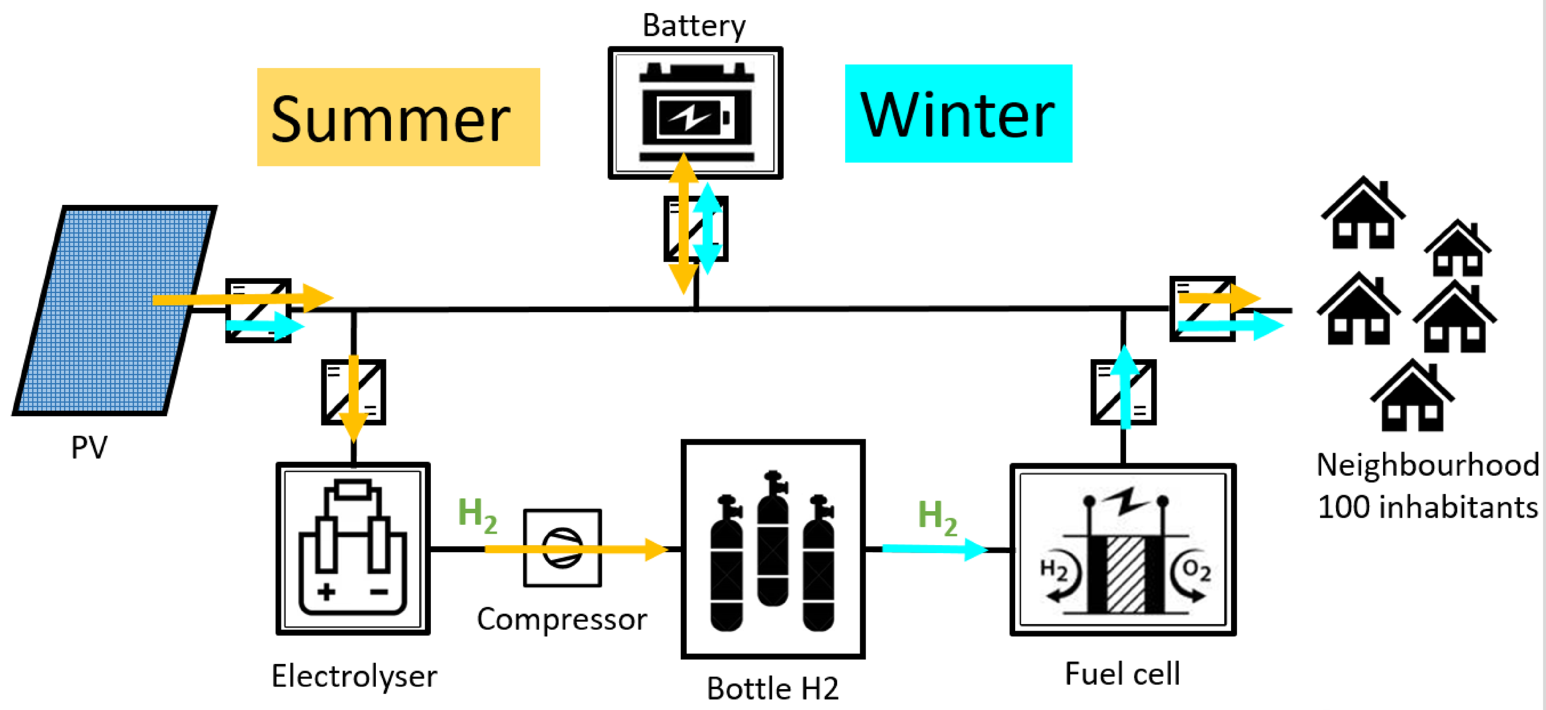
Annual distribution of hydrogen storage



Detailed annual distribution power with peak **Fig. 2**

For ease of reading, there are moving means with a 2-day window (fig.2). High power is exchanged with PV and batteries. To reduce costs, the electrolyser is limited to -45 kW. A minimum power of -5 kW is required to switch it on and thus avoid deterioration at low power.

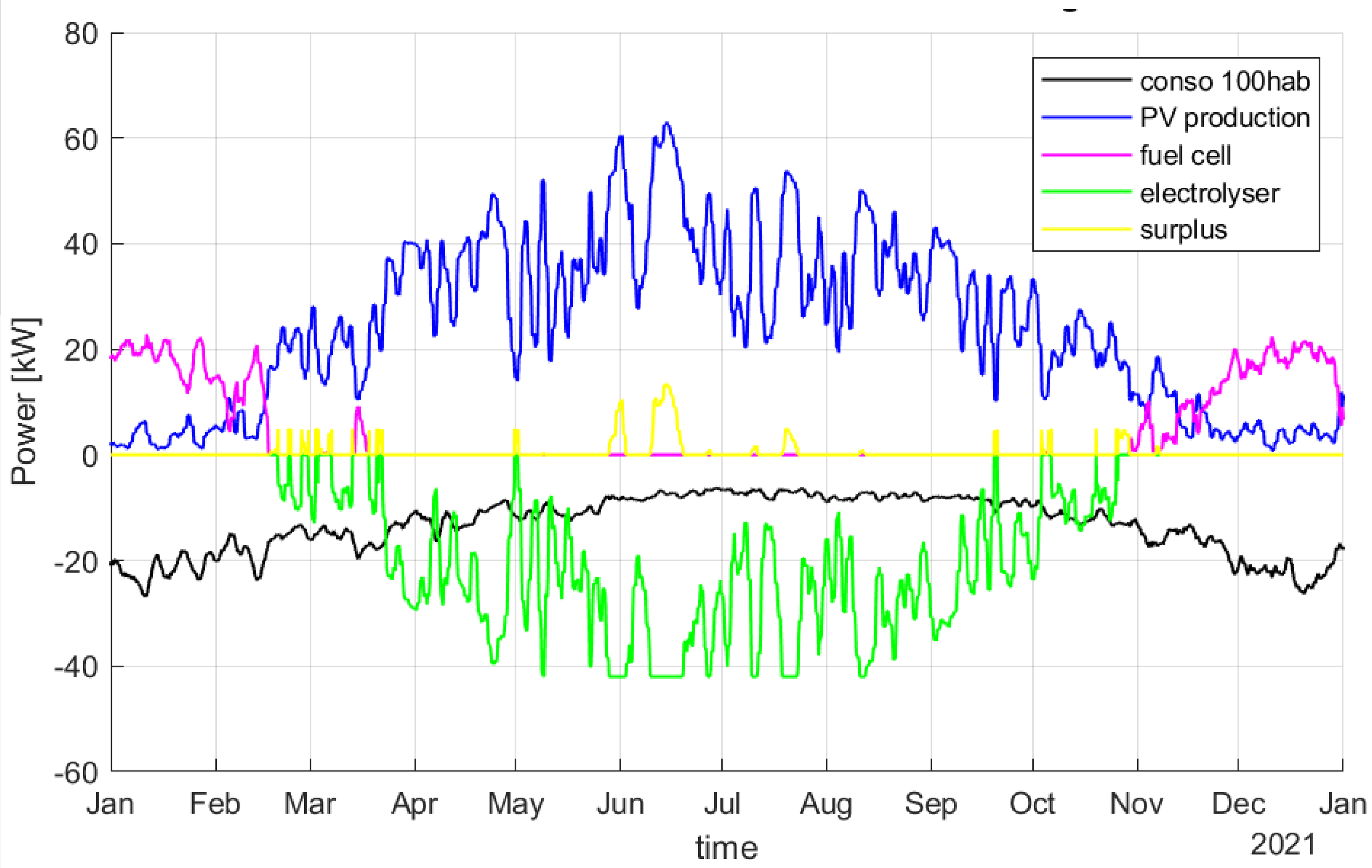
Main components



Components for seasonal hydrogen storage **Fig. 3**

Hydrogen devices are added to the existing ones (fig.3). Then 2 flow paths are possible to store or use H2.

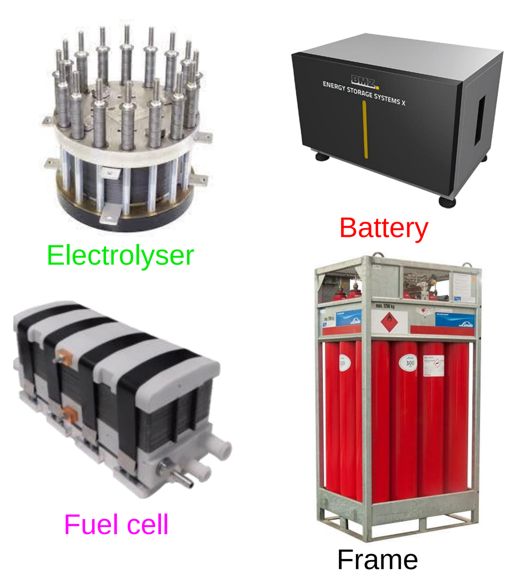
The power of the electrolyser follows the moving average of the PV production (fig.4). Fuel cells fill the gap in the winter months. A small surplus of 4230 kWh is not valorized



Mean power with the influence of electrolysis and fuel cells **Fig. 4**

RESULTS

PV	145kW	+216 000 kWh	365 day
Electrolyser	-45kW	-132 000 kWh	230 day
Fuel cell	23kW	+38 300 kWh	116 day
Battery	110kW	800 kWh	11m³
Hydrogen	2324kg	76 680 kWh	200 bar
Storage H2	131 m³	Area 164 m²	218 frame



CONCLUSION

Important sizing factor :

The photovoltaic production needs to be **1.85x** higher (216 MWh) than the energy consumed during the year (115 MWh).

1. Hydrogen as transfer medium from summer to winter seems technically feasible, with reasonable size of the storage volume, based on industrial standard 200 bar H2-bottles.

2. The cost considerations for such as seasonal storage solution need to consider the heavy impact that a significant overproduction of PV-power in summer will have on the kWh-market prize.