H_2-Battery

THE SOLUTION FOR
MULTI-FAMILY HOUSES

ostermeier
H_2YDROGEN SOLUTIONS

Autonomy

Autonomy is the fundamental precondition that enables individuals and their communities to interact with other individuals and communities as equals.

Autonomy permits us to act freely. If we have the resources we need, we can be self-determined. We can freely choose to belong to particular communities and freely define our relationships.

Hydrogen

Hydrogen is the most abundant chemical element in the universe. It is the fuel that powers our sun. It is the foundation of life on Earth.

On our planet, hydrogen is almost exclusively found in bonds with other elements. The most frequent bond is water.

We have known for many years that electrolysis is an efficient way to separate the elements of hydrogen (H_2) and oxygen (O_2) from water (H_2O) simply by using an electric current.

We are most familiar with the gaseous form of hydrogen, a variety of the element that simply teems with energy. It is the perfect energy carrier, one that is capable of storing electricity for long periods of time.

Power to the people

Energy facilitates our autonomy. Independent access to energy is a necessary precondition for autonomous individuals and communities.

Electricity is the most valuable form of energy for human beings. Photovoltaic technology enables every individual to convert solar energy into power – as long as the sun is shining.

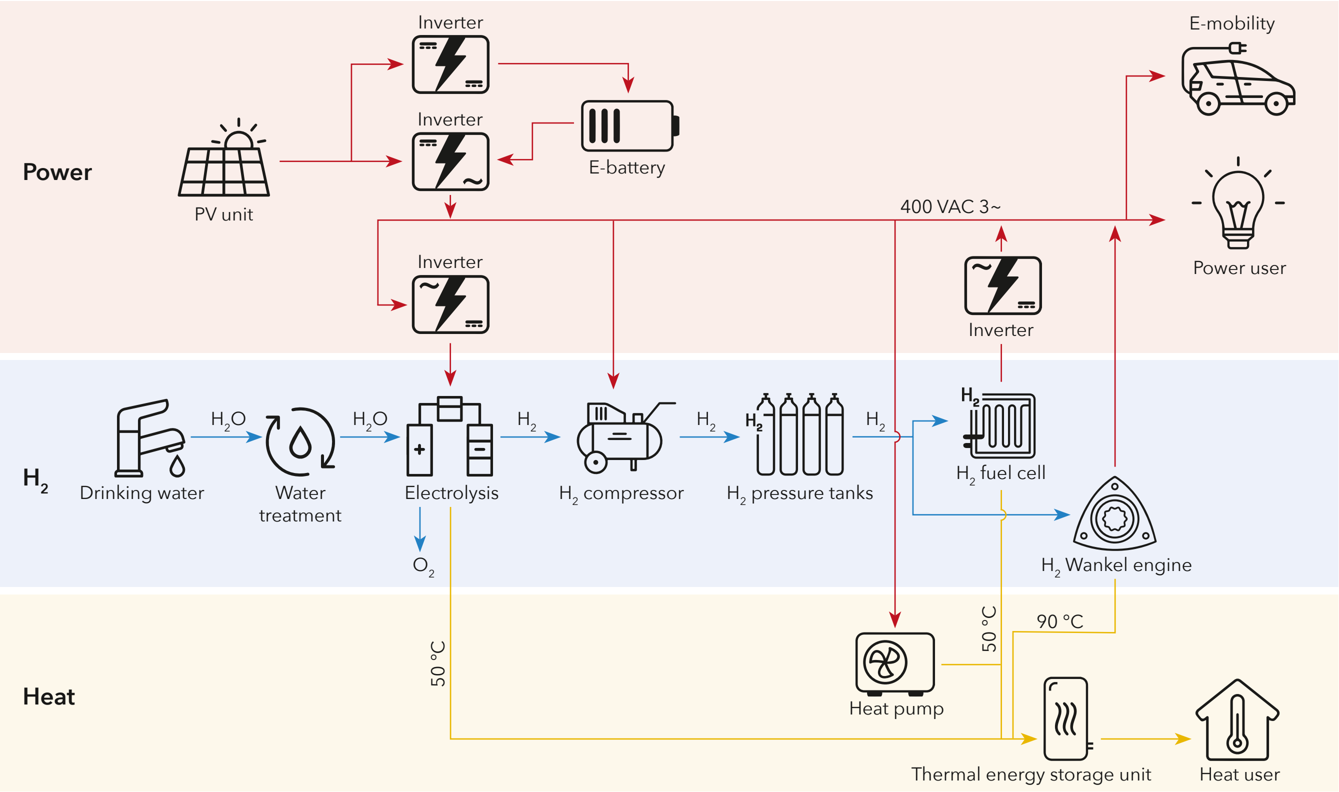
Hydrogen is our answer to the challenge of supplying energy to people whenever and wherever they need it. People can use our hydrogen batteries to conserve solar energy that they can later use on the freezing and dreary days of winter. Hydrogen creates regional energy autonomy.

Goal

The aim of the hydrogen-based seasonal thermal energy storage solutions offered by ostermeier H2ydrogen Solutions (OHS) is to create a largely autonomous energy supply system for such buildings as multi-family houses, hotels, industrial companies and schools. In this system, renewable power generated by photovoltaic technology and the wind is converted into hydrogen during periods of excessive power production, stored and converted back into power and heat when needed.

Schematic overview of the entire system

The figure that you see below outlines the conceptual structure of OHS's seasonal thermal energy storage solutions. The power quantity of the individual components is based on the type and size of the structure involved in a project. It is determined during a simulation that weighs each of these factors.



How a seasonal thermal energy storage solution works

The chart that you see below outlines the principles on which the season thermal energy storage unit is based. An energy management system (EMS) installed in the building controls the operation of individual building-engineering components and optimises this process. Our systems are designed to work with a range of energy management systems made by various manufacturers.

PRIORITY 1

Direct usage for things like lighting and household appliances and subsequently for the production of heat with a heat pump or heating element in a buffer storage unit

PRIORITY 2

Short-term storage in a stationary battery or for use in charging an e-vehicle

PRIORITY 3

Conversion into hydrogen and long-term storage in a low-pressure tank (20 bar) and subsequently in a high-pressure tank (300 bar)

PRIORITY 4

Export of residual power into the grid

Model project multi-family house

Individual project optimisation

The model project shown here provides an overview of the energy and financial aspects of a multi-family house. We provide customised simulations to address the special requirements of each individual property. These simulations are based on data provided to us by our clients. You can download the survey we use for this purpose from our website. The aim of our standard simulations is to find the optimal balance between the maximum degree of autonomy and the lowest-possible investment costs.

Marginal data of the model project

The data of the property shown here:

- A residential building with four apartments and 450 square metres of net dwelling area
- A 200 square-metre roof for 40 kWp installed PV output, pointing to the south with a 30° roof slope
- Energy standard of the building: KfW 40
- Standard load profiles for power and heat consumption for a three-member family per apartment

Results of the model project

The optimal solution was calculated on the basis of the data shown above. The following components were identified on the basis of this information:

- A 40 kWp PV system
- A 40 kWh storage battery and 20 kW injection and withdrawal capacity
- Heat pump with 20 kW electrical capacity (seasonal co-efficient: 4)
- Heat buffer storage unit with 2,000 litres of water capacity
- Electrolysis with a nominal electrical output of 10 kW
- 288 high-pressure cylinders (=18 bundles consisting of 16 cylinders each) at 300 bar that serve as hydrogen storage units
- Fuel cells with electrical output power of 8.4 kW

The figures that you see below show the results of the calculation for an exemplary year. In particular, weather data can vary significantly from year to year and yield different results. In principle, though, individual years are comparable.

Power generation and consumption (power balance)
Figure 1 (daily breakdown) and Figure 2 (weekly breakdown) show the power produced by a photovoltaic unit (yellow) and power consumed. Power consumption is broken down by power used by the apartments (blue), the power used by the H_2 compressor (orange) and the power used by the heat pump (red).

Annual overview (days)

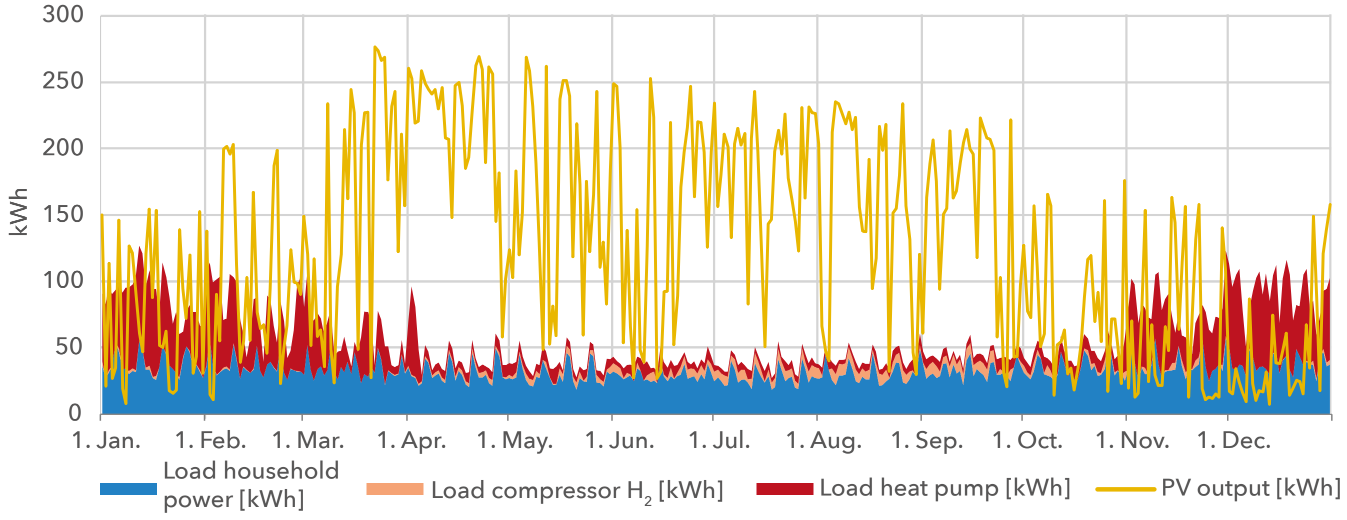


Figure 1.: The power generated by the photovoltaic unit (yellow), household power (blue), the power used by the H_2 compressor (orange) and the power used by the heat pump (red).

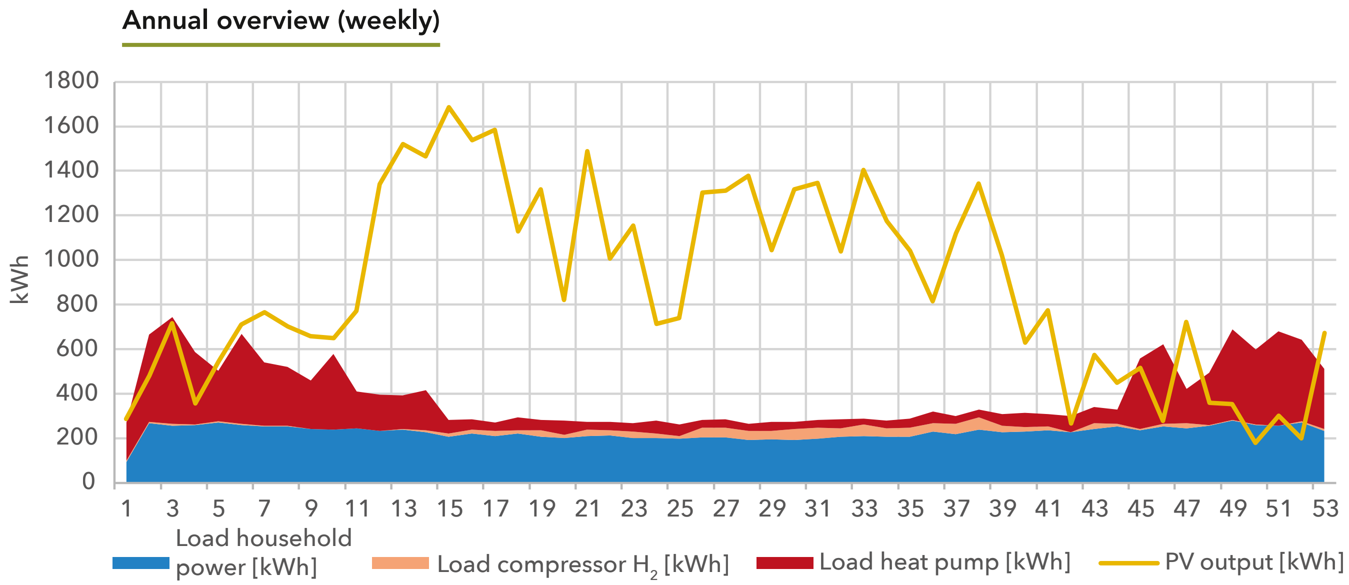


Figure 2.: The power generated by the photovoltaic unit (yellow), household power (blue), the power used by the H_2 compressor (orange) and the power used by the heat pump (red).

Monthly power consumption is shown once again in Table 1.
But an hourly breakdown of the data is necessary for the simulation.

Table 1.: *Monthly power breakdown*

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Σ
Power generation (kWh)	2,382	2,925	4,925	6,547	5,023	4,384	5,656	4,852	4,529	2,442	1,962	1,442	47,069
Σ Power consumption* (kWh)	2,770	2,292	1,838	1,340	1,222	1,179	1,195	1,291	1,348	1,420	2,317	2,858	21,070
Household power (kWh)	1,145	1,035	1,055	922	911	866	848	936	976	1,042	1,092	1,177	12,005
Compressor (kWh)	29	12	6	73	106	118	197	183	179	73	47	17	1,040
Heat pump (kWh)	1,596	1,245	777	345	205	195	150	172	193	305	1,178	1,664	8,025
Δ	**-388**	**633**	**3,087**	**5,207**	**3,801**	**3,205**	**4,461**	**3,561**	**3,181**	**1,022**	**-355**	**-1,416**	**25,999**

** Power consumption is composed of the total amount used for household power and by the compressor + heat pump*

Electrolysis module ELM

Heat production and consumption (heat balance)

The heating needs of buildings consist of hot water and heat requirements. Hot water needs remain fairly constant throughout the year. Heat, on the other hand, is primarily used on the cold days of spring, autumn and winter. Both electrolysis (in the summer) and, in particular, the fuel cell or Wankel engine (in the winter) produce usable heat. The remaining heat needs are met with a heat pump. Figure 3 that you see below shows the heat balance for every week of the year. The high need for heat during the weeks of winter can be clearly seen.

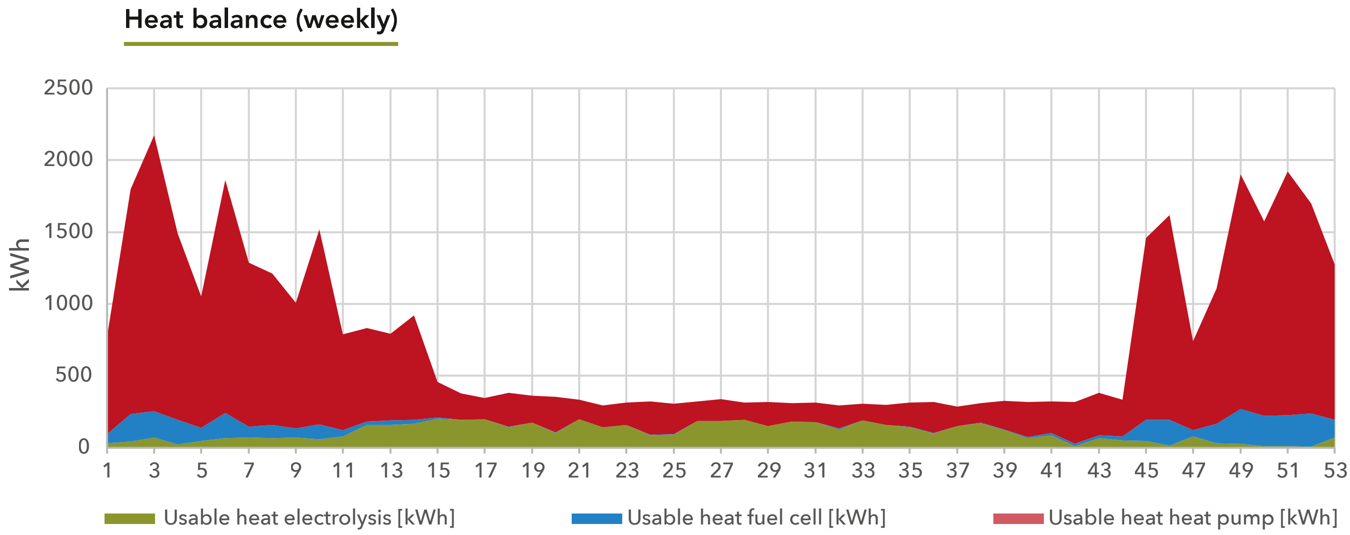

Heat balance (weekly)

Figure 3.: Heat balance of the building. Hot-water and heating needs are met by electrolysis, the fuel cell and the heat pump.

Electrolysis, fuel cell and hydrogen storage units (hydrogen balance)

Figure 4 that you see below shows the point at which hydrogen is produced from excessive PV power by electrolysis and stored (green bar) and the point at which the fuel cell uses hydrogen (blue bar) to produce power and heat. The figure corresponds with the previous figures. The level of the hydrogen storage unit (light green area) is also shown.

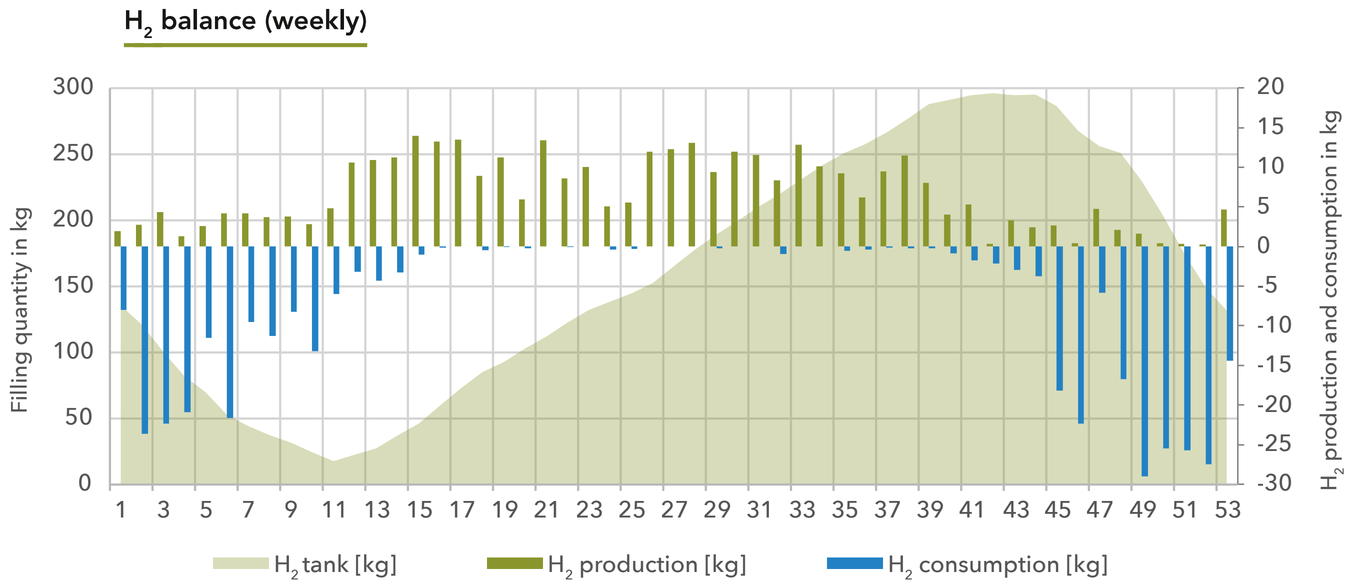

H_2 balance (weekly)

Figure 4.: A weekly breakdown of the times when hydrogen is produced (green) and is used (dark blue) as well as the level of the hydrogen storage unit are shown throughout the year. (Note: About 1kg of hydrogen can be stored in a 50 l pressure cylinder at 300 bar.)

Cost-related data of the model project

The simulation calculates the power quantities of the necessary components. Table 2 lists the investment costs and annual maintenance costs for each component. Maintenance costs that occur at greater intervals were converted into annual maintenance costs for the purpose of clarity.

Table 2.: *Investment and maintenance costs for individual components used in a seasonal storage solution.*
Costs will vary for individual projects.

Components	Most important parameter	Investment costs (net)	% of the whole	Deprec.	Annual maintenance costs
Photovoltaic system	40 kWp	€32,000	7 %	20 years	€100
Electric battery	40 kWh	€25,000	6 %	15 years	€0
Heat pump	20 kW	€15,000	3 %	20 years	€100
Heat buffer storage unit	2,000 l	€3,000	1 %	30 years	€0
Electrolysis	10 kW$_{el}$ & 1 kW$_{th}$ @ 50°C	€80,000	18 %	20 years	€500
H_2 low-pressure tank	16 cylinders (= 1 bundle)	€10,000	2 %	20 years	€80
H_2 compressor	2 Nm^3/h output volume	€40,000	9 %	20 years	€200
H_2 high-pressure tank	18 x 16 cylinders (= 18 bundles)	€180,000	41 %	20 years	€1,440
H_2 fuel cell	1.6-8.4 kW$_{el}$ & 4 kW$_{th}$ @ 50 °C	€45,000	10 %	20 years	€200
Alternative: H_2 Wankel engine	2-10 kW$_{el}$ & 20 kW$_{th}$ @ 90 °C	(€30,000)	(7 %)	20 years	€150
Installation (H_2 sensor, piping, connections)		€5,000	1 %	20 years	€100
Total	-	**€435,000**			**€2,720**

Total

The system layout selected for this model project results in a self-sufficiency level of more than 98 % for all energy used by the building (both household power and heat). The use of an energy-management system will create an even higher level of self-sufficiency.

Self-sufficiency level for power and heat: > 98 %
Grid supply: 355 kWh
Grid feed-in: 8,732 kWh

Government incentives

European and national funding opportunities must be examined locally.

Power to the People

Ubique Terrarum

Our modular hydrogen solutions
empower local communities to gain energy
independence and become energy producers.
Worldwide.

ostermeier
H_2YDROGEN SOLUTIONS

ostermeier H2ydrogen Solutions GmbH
Dieselstraße 1 | 85301 Schweitenkirchen, Germany
Phone +49 8444 924 90 -0 | Fax +49 8444 924 90 -29
info@ohs.energy | **www.ohs.energy**

Version 1.0 | last updated: June 2022

Your partner:

Klimaneutral
Druckprodukt
ClimatePartner.com/53093-2108-1002