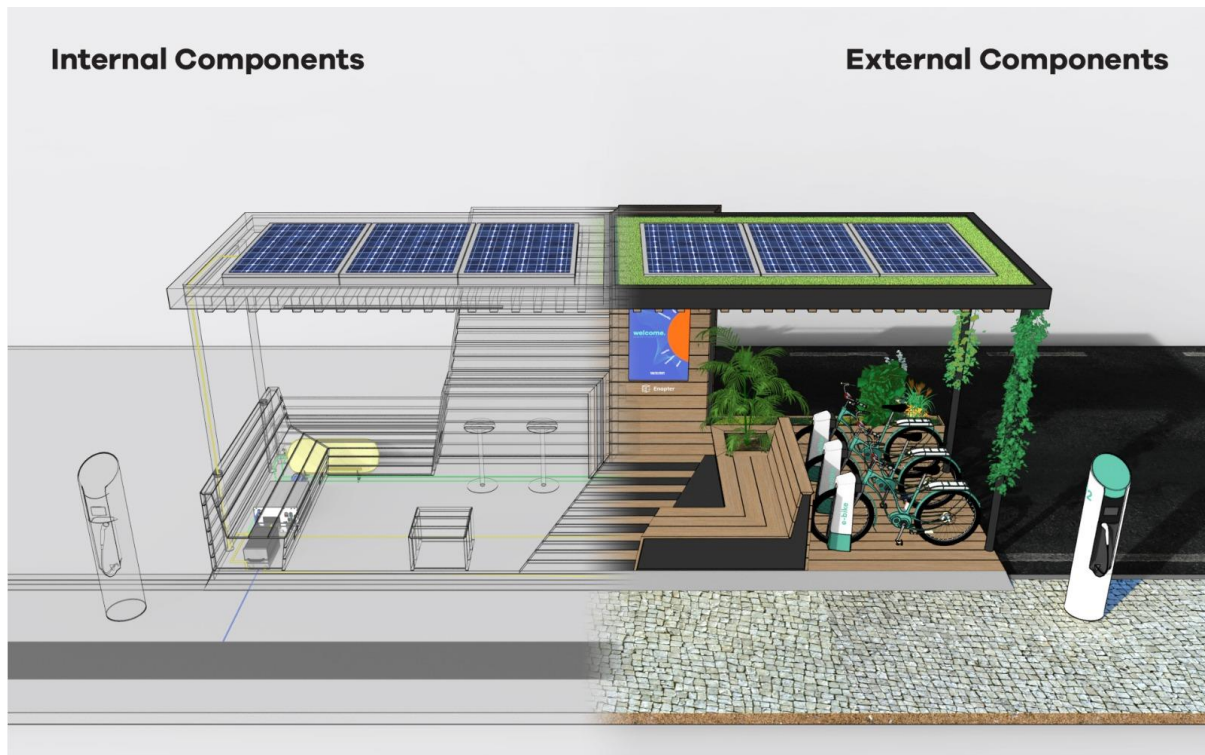


H2ZERØ PARKLET



The H2ZERØ parklet is an innovative solution that unites intelligent design to a hydrogen system in a business model that can enable smart cities to fight back against cars for city space.

H2ZERØ occupies one or two regular parking spots adding value to people's quality of life by providing a space where people can interact with each other, relax, and get information about the city, instead of using valuable space with idle cars.

So why a parklet? These are relatively cheap ways to provide more open space for the public in urban areas where this has become rare. In a parklet, parking spots which are exclusive spaces dedicated to polluting cars, are transformed in quality of life for citizens. Research has proved that parklets help increase economic activity in their areas by fomenting foot traffic, especially in commercial spaces. The additional movement helps reduce car travel speeds, increasing safety for both pedestrians and drivers. The micro-mobility trend seen in modern cities can be incorporated into parklets, providing parking and charging to service providers. Parklets offer an attractive solution for encouraging orderly parking of e-scooters, bikes, and other modes.¹

H2ZERØ is also a canvas for the public and private sector to reach their public creatively. By enabling a few tailored features in a pre-assembled and pre-designed structure, companies can share the installation and advertising costs while reducing local emissions by using renewable energy and fomenting clean energy vehicles.

¹ <https://www.spin.app/parklets>

By crafting partnerships between local companies and municipalities, H2ZERØ is a way for brands to get closer to customers while reducing their environmental footprint. Limitless possibilities of additional interactive features can be implemented in the parklet using the parklet's interactive screen and hotspot network. H2ZERØ achieves close contact with the public that can boost marketing campaigns, result in lower costs of customer acquisition and outreach for partner brands.

Technical description

The system's energy management follows the availability of renewable energy supply, most notably solar photovoltaic. When solar energy is available, clean electricity directly powers the devices in the parklet. Excess electrical energy can be stored in a small battery for short-term storage, turned into clean hydrogen for long-term storage, and supply hydrogen fuel for fuel cell cars, motorcycles, and bikes as an additional feature.

For hydrogen-optimized parklets aiming to monetize hydrogen fuel sales, energy can also be supplied from the grid, targeting periods when the renewable energy share is maximum. H2ZERØ acts both as distributed generation and as a "load sink" to help regional governments avoid curtailment in peak wind and solar generating regions. As this approach may lead to stricter legislation, ideal partners would be companies already invested in the market of hydrogen refueling stations.

When electricity demand is higher than the panels' generation, hydrogen is consumed on a PEM fuel cell to generate green electricity, with water as the only emission. The system can also be connected to local commerce as a way to "expand" their area for clean energy generation, reduce emissions and electricity costs over seasons.

System Architecture

The system can be managed by Enapter's Energy Management System (EMS) to achieve a smart integration of the following components:

- Solar panels for renewable energy generation (possible to expand to other technologies if conditions allow),
- Enapter's electrolyzer for the conversion of green electricity to green hydrogen,
- A battery pack for short-term electricity demand,
- Hydrogen tanks, sizeable according to available energy generation and desired storage,
- A compressor for hydrogen pressure regulation
- Power electronics

Additional features for the parklet:

- Interactive screen
- Wi-fi hotspot
- Electrical plugs
- Electrical bike dock (optional)
- Hydrogen fuel filling outlet (optional)
- Additional features can be added according to the client's needs.

Techno-economic analysis

The system architecture suggested in this application was simulated with the support of HOMER PRO® software as a preliminary feasibility and cost analysis. **A viable system was achieved with the complete disconnection from the grid**, with a more expensive but non-prohibitive Net Present Value. An initial capital investment of 19,7 thousand euros is expected, approximately nine thousand euros more expensive than using a grid connection solely, at current German electricity prices.

The electrical consumption was estimated by the parklet's features, considering the daily usage of all the appliances. The electrical plugs are supposed to provide enough electricity to day-to-day power electronics, such as computers and phones. An additional demand can be planned to recharge electric city bikes, and possibly electric cars, or other applications partner companies may be interested in adding.

Starting from the available solar resource, limited by the parklet's roof area, the system was sized to supply the considered electrical loads. Six solar panels fit H2ZERØ's roof, accounting for an **annual production of 3MWh of renewable energy per parklet every year**.

Due to its high-rated power, one of Enapter's EL2.1 is sufficient to store the excess solar energy generation as hydrogen. A reliable system can be achieved to supply energy year-round to the parklet appliances with Enapter's EL2.1, a tank of 0.5kg capacity of stored hydrogen, a fuel cell system of approximately 3kW, and the corresponding power electronics. Li-ion batteries can be used if peak power demands are expected, but this technology was not considered in our base case.

While a cheaper CAPEX could be achieved by having a simple connection to the grid, H2ZERØ's benefits go beyond a capital cost. H2ZERØ is an emission-free canvas for creativity and green marketing. By our estimations, by sharing the parklet's CAPEX with a partner interested in profiting from its marketing potential, **our system can achieve cost parity with grid-connected alternatives** and even become a profitable asset. Additional regional subsidies can be applied, further reducing the unit cost.

Extra services can be provided, such as EV and FCEV-charging, and grid-balancing services, with a simple grid connection. This unique feature of H2ZERØ can give utility companies a flexible IoT-like service to balance urban grids and market penetration for hydrogen companies expanding their refueling station networks, opening new doors to profitable business models.

Saving the planet

One evident impact of H2ZERØ is to take cars out of city streets, indirectly reducing emissions from the transportation sector. But it goes beyond that. According to our simulations, in a country like Germany, for example, **each parklet could save up to 1.5 tons of CO2 every year**²! By disconnecting itself from the grid, H2ZERØ can generate clean electricity, not relying on our fossil-dominant electrical grids. However, if connected, H2ZERØ's hydrogen system can use the grid only when renewable energy share is high, keeping emissions low and helping utilities stabilize the grid and avoid curtailment.

H2ZERO is not only a leisure space but a solid partner to join **Enapter's mission to solve climate change with green hydrogen**, all while making our cities literally greener!

² More countries and the source can be seen in the annexes.

Annexes

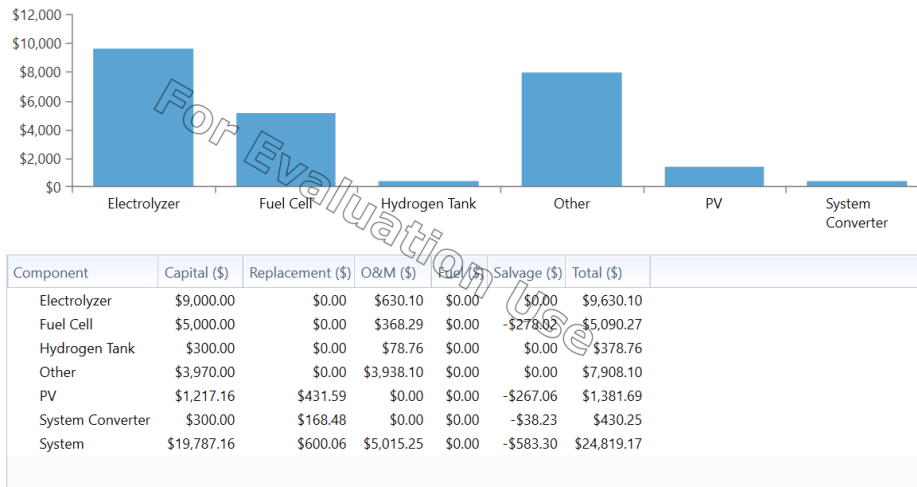


Figure 1. The net present cost of H2ZERØ's system, not including the parklet's structure.

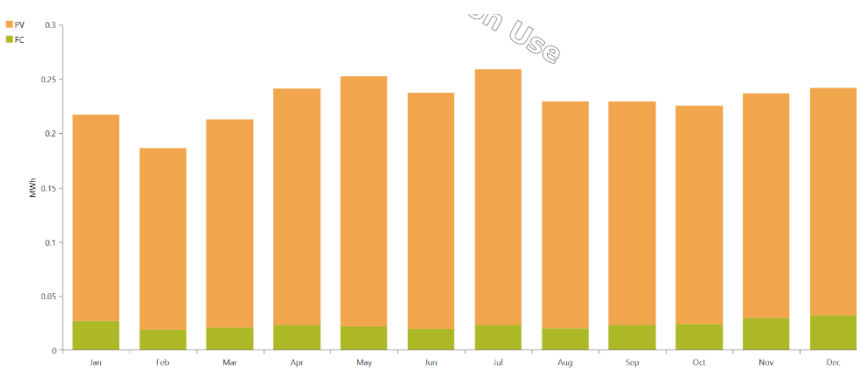


Figure 2. Monthly electrical power consumption with its source.

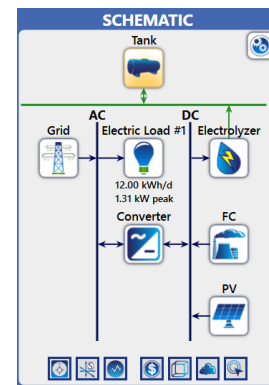


Figure 3. System Architecture.

Table 1. Load estimation for one H2ZERØ parklet.

Component	Qty	hours used	W	P tot (W)	kWh/d	Source
Totem	1	24	450	450	10.8	3
Computers	2	10	60	120	1.2	4
Phones	4	12	5	20	0.24	5
LED lights	6	10	10	60	0.6	6
Total					12.84	

³ <https://www.sbservice.info/2020/06/03/outdoor-touch-totem-49/>

⁴ https://energyusecalculator.com/electricity_laptop.htm

⁵ https://energyusecalculator.com/electricity_cellphone.htm

⁶ https://energyusecalculator.com/electricity_ledlightbulb.htm

Table 2. Estimated CO2 emissions avoided by one H2ZERØ in each EU country, according to each country's electricity mix.⁷

Ref. Year	Country	Emissions (g/kWh)	Savings (kg CO2/yr)
2019	Estonia	891	3902.58
2019	Poland	719	3149.22
2019	Cyprus	651	2851.38
2019	Greece	598	2619.24
2019	Czechia	431	1887.78
2019	Bulgaria	421	1843.98
2019	Netherlands	390	1708.2
2019	Malta	357	1563.66
2019	Germany	338	1480.44
2019	Ireland	316	1384.08
2019	Romania	293	1283.34
2019	European Union - 27 countries (from 2020)	275	1204.5
2019	European Union - 28 countries (2013-2020)	275	1204.5
2019	Portugal	244	1068.72
2019	Italy	233	1020.54
2019	Slovenia	231	1011.78
2019	United Kingdom	228	998.64
2019	Hungary	212	928.56
2019	Spain	207	906.66
2019	Belgium	167	731.46
2019	Croatia	145	635.1
2019	Denmark	126	551.88
2019	Latvia	117	512.46
2019	Slovakia	114	499.32
2019	Austria	91	398.58
2019	Finland	86	376.68
2019	Luxembourg	74	324.12
2019	France	52	227.76
2019	Lithuania	22	96.36
2019	Norway	19	83.22
2019	Sweden	8	35.04

⁷ European Environment Agency, https://www.eea.europa.eu/data-and-maps/daviz/co2-emission-intensity-6#tab-googlechartid_googlechartid_chart_111_filters=%7B%22rowFilters%22%3A%7B%7D%3B%22columnFilters%22%3A%7B%22pre_config_date%22%3A%5B2018%5D%7D%3B%22sortFilter%22%3A%5B%22index_2018%22%5D%7D