

## Q&A

### **Can you describe what is special about this concept in an easy way?**

Solar power is available in practically unlimited quantities, but can only be collected during the day when the sun is visible. If there is no sun, the solar panels cannot produce any electricity. We need a way to store the sun's energy for later use.

Our system stores the energy in the most effective and ecological way – in a hydrogen storage. Only water and sun are needed to produce hydrogen and both materials are plentiful. However, we need the right technology to produce the gas, which can be easily stored and transformed back to electricity. The hydrogen energy storage system is the answer to all the energy needs of the future.

To make it very simple: Energy from the sun is transformed via solar panels to electricity. Any excess power will be converted and stored as hydrogen. And when there is no sun shining and we need energy, we will use hydrogen gas from the tanks to generate electricity again.

### **Can you describe your idea in one line?**

Use the sun to power your home – for 24 hours every day!

### **How does the system work?**

Solar power from photovoltaics is a proven technology which many countries are already using in large amounts. Even some countries not generally known to be sunny use plenty of solar energy. Germany, for example, underlined its high-tech capability and green leadership in Europe with its unprecedented 38 Gigawatt installed capacity. Solar panels produce power to be fed into the grid and significantly contribute to the total energy used in many countries.

Difficulty arises when no sun is visible, like on days with heavy clouds or at night. There are different ways to store energy, but many of them are not possible for smaller sized developments. The only accessible storage to come to mind are batteries, but they are not well suited for long term use. Power storage in batteries is also not ideal for huge amounts of energy. In general batteries are expensive, heavy and made from dangerous materials with questionable recycling processes.

The best way to store energy is to generate hydrogen gas via electrolyzers with solar energy and pure water during the day. Electrolyzers produce hydrogen gas by using an electric current to separate water into its composite gases: hydrogen and oxygen.

During night or when we need additional energy the hydrogen is used to produce power with a fuel cell.

Our energy storage is a hybrid battery-hydrogen system which maximizes the advantages of both the batteries and fuel cell. Batteries take the very fast and short loads, while the massive permanent energy load is supplied by the hydrogen/fuel cell.

This process is 100% clean; its only byproducts are oxygen gas and water.

### **Why do you also use some old fashioned batteries for energy storage?**

Lead-acid batteries have their deserved place in the market. Largely because of their use in automobiles, they actually have the largest market share of electric storage products worldwide.

They are popular because of their high power-to-weight ratio and their low cost.

Their major disadvantage compared to other technologies is their low energy-to-weight ratio.

By only using them to supply short peak loads during the night, we are making the best use of lead-acid batteries' strengths by instantaneously supplying high power, while minimizing their disadvantages and required capacity.

This way we can extend the expected battery life to 15 years, making our investment last that much longer.

### **Everyone speaks about carbon footprint. You say that you will reach a carbon negative footprint. What does this mean?**

First of all: There is a huge threat of global warming and evidence suggests that there is a direct connection with the increased level of carbon dioxide in our atmosphere. Technically it is not only carbon dioxide (CO<sub>2</sub>) – also methane (CH<sub>4</sub>) and several other emissions, but to make it easier and more understandable the public uses the term “carbon footprint”.

Wikipedia tells us that a carbon footprint is historically defined as “total sets of greenhouse gas emissions caused by an organization, event, product or person”.

As a builder and architect you see all efforts for a building, including land filling and the use of concrete or any other building materials – all of this will increase the carbon footprint. If you want to live in a high energy standard house you will have to build extensively which might even increase your carbon footprint. A bamboo house would most likely have the lowest carbon footprint of all.

Using better materials for isolation like double glass reduces the need for electric power and will help reduce the carbon footprint. Designing the house to stay naturally cold through isolation and airflow also means that you will reduce the carbon calculation.

By using only renewable electricity and having the energy storage emit small amounts of oxygen as a byproduct will massively help us become carbon negative very soon.

### **Is Hydrogen dangerous?**

No, not at all. Every other gas storage, including the typical LPG you can find in Thailand, is more dangerous. Hydrogen is very light and will always travel straight up. This feature means that it is technically extremely difficult for hydrogen to explode.

### **Why self-refueling hydrogen storages can save the world?**

There are many potential applications for this technology:

- It could be used for off-grid backup power- *It is already being used in telecommunication backup stations and we are using it for a residential area*
- Fuel cell vehicle charging stations could produce hydrogen on-site; there would be no logistics problems
- It could contribute power to the public grid – *The grid is already decentralizing through the use of renewables. Decentralizing the energy storage will make power grids more stable and resilient and will reduce the dependency on main energy suppliers*

**Is this really the first installation of this kind worldwide?**

Although the fuel cell industry is growing and well represented in the media overall, electrolyser technology is still a small market. Some telecommunications sites already use electrolysers and fuel cell systems for backup power, as do a few enthusiastic individuals with experimental installations around the world, but the Phi Suea House is the first multi-house compound worldwide to use a hydrogen energy storage system.

This unique setup's central energy system for multiple houses is the reason that the hydrogen energy storage is also financially viable on a household-by-household level.

This kind of technology is already possible and we are sure that further improvements in electrolyser and fuel cell technologies and the expected price drop from mass-productions will allow for hydrogen energy storages to become widely used all over the world.

**You have signed an agreement with the NTU (Nanyang Technology University) in Singapore – What is the reason for this?**

We want to absorb as much information as possible from our project, which is why we were very excited when NTU expressed their interest in the Phi Suea House. We are partnering with them to collect and analyze data, to conduct research to find improvements for the installed system and others similar and to work together to spread our knowledge about renewable energies and clean energy storage. We are also looking into other technologies.

We are also interested in working with other universities and institutions. Please do not hesitate to contact us.

**How much energy you are producing today and what is planned for the future?**

At Phase 1 (March 20<sup>th</sup>) we have installed 65kW of photovoltaic panels that are fully integrated into the architecture and design of our houses. This number is planned to almost double to 114kW by the completion of the project. With the initial installation we will generate on average 247kWh every month, enough to power all four homes and all other equipment and infrastructure, including the water pumps.

**Why you have selected March 20<sup>th</sup> for the launch date?**

There is a total solar eclipse in Europe on this date. This has drawn a lot of attention to the potential problem of all power from photovoltaics "disappearing" then "reappearing" again minutes later very suddenly. Renewables produce a large portion of energy in Europe; Germany is leading with 25% photovoltaic of the total energy mix. Around midday the percentage from photovoltaics will be even higher. There is some concern about the stability of the grid and the potential of local grid failures – we think this is an optimal time to introduce our clean energy storage system to the world.

**Who have been your partners for this project?**

We have had several partners and suppliers for this project. We have cooperated very successfully with Chiang Mai Solar and SMA in Thailand. Our fuel cell technology comes from a variety of European companies - don't forget ACTA with their world class electrolyzers. However, we try not to "sell" any specific company's technology. Therefore we will not mention brands at this event and will also not recommend any. Please also understand that we are starting the official test phase on 20<sup>th</sup> March 2015 and we think it is better to explain the technology and variants of different suppliers in detail only after we have had some proper experience.

**What are the cost of such a system?**

There are a lot of environmental reasons "to help the world" which can't be monetized at all. But even without being the "good guy" there are some great features that come with a hydrogen energy storage system which are definitely worth the money:

- 1) The power quality is unmatched – If you have expensive household appliances like several thousand dollars of stereo-equipment or high-performance computers you will massively benefit from stable energy with a clean frequency and perfect wave shape. This also means it is free of peaks, flickers, spikes and under- or overvoltage etc. All appliances will have significantly higher lifetimes.
- 2) You will never have a party where people sit in the dark. You do not need to buy an expensive diesel generator – power is always there. Your expensive wine storage will never have temperature changes and your frozen goods will remain frozen even if the energy outside is cut by a storm/accident etc.
- 3) The opportunity to use the hydrogen for cars or cooking is a future option which might come to reality very soon.

We have calculated a return on our investment based on 5 to 6 THB/kWh. The time for a ROI will be around 15 years as of today.

Due to its widening acceptance, the cost of similar systems will drop within the next 3 to 5 years and will generate a much faster ROI.

**When I look to the roof two solar panels are missing. Why?**

These panels are with the Thai customs office. Thai politicians have ruled solar panels to have "0" tax in order to increase the use of photovoltaics in the country. However, customs considers a solar panel as a generator when it has a plug (called a connector) on its back – at least in our case.

We paid duty based on 'our generators' (10%) plus fine (20%) but they have taken away two panels "for further proof." Then Customs lost our case materials and wasn't able to answer us for several months. Now they have found the case and they asked us to describe what solar panels are. We prepared detailed explanations last week and are eager to follow this case.