Electric home storage – autonomy for private households and buildings

State-of-the-art battery performance and the innovative design of power electronics have created commercially viable storage systems. Combined with PV or co-generation at home, E3/DC has created significant volumes in Germany based on professional, industrial production and a new product architecture. Andreas Piepenbrink, founder and CEO, explains the company and product strategy.

Demand for storage: motivation

Energy and power producing products for homes and small businesses were supposed to replace central power plants in the same way as the PC did with central computing in the 80s. Today, PCs, laptops and smartphones have achieved major volumes of the total computing market.

In recent decades, mainly ‘decentralised’ heating systems have been installed at home, and electrical power is still coming from central grids and plants. A paradigm change has been needed to drive a trend called self-consumption. Inflation, the EU debts and visions of personal autonomy have generated product ideas to generate electrical power at home.

After having had a decade of state subsidies according to the EEG law (Feed-in Tariff), private individuals have started to invest in PV as a private power station. Now, combined with automotive and industrial battery technology (lithium-ion), new storage systems are turning up and trying to enable personal electric storage as the future of mainstream building and home efficiency technology.

By maximising the self-consumption at 75%, such systems are able to fix the energy costs for the system lifetime (around 20 years and more). However, mankind and household owners are not used to investing in electric energy generation. But the size of the PV market and the heating market with Co-Generators enables this business as a future volume market more and more.

Even without Feed-in Tariffs, people start to become familiar with the ways of making themselves significantly autonomous and they are willing to invest into long-term reduction of their total energy cost. (The price rises of utility companies [including energy tax and grid costs] have led to 10-12% cost increases in 2012 alone.)

In 2012, E3/DC began series production and sales. In February 2013, 350 units were installed, all of them 100% remote serviceable and connected by internet.

Following Apple’s vision to provide better usability and better functionality, E3/DC products are driven by design and the resulting products follow the functionality of an embedded ‘iPhone’ for energy in the household.

Product features

- 1x1m unit with integrated storage, power and cabinet that can provide a real 3ph household with up to 43kW (63A×3)
- Electric energy storage up to 15kWh
- Electric power generation up to 12kW AC
- Emergency power real 3ph up to 3kW

Option: retrofit (AC) or new (DC)
Having now passed the German winter and series production rollout, the learning curve includes a three stage sales and installation process – the performance of few hundred customers. Load and production profiles are known and system performance has been continuously updated by software in all systems. Certified installers in Germany have been trained to handle the system in the best field possible. And new installation procedures have been set up to keep the installation clear and simple, and to not violate the law given for inverters, grid and battery.

**S10 – household in Germany**

System performance and market approach

The product offers 1ph and 3ph operation in order to have tailor-made solutions for different household consumptions, roof size and the customers’ targets of autonomy. Modularity of the battery (including top-up capability of single modules) enables customer to upgrade the system to maximum level of autonomy.

The S10 is chosen by customer and installed, if...

- The complex load profiles of customer requires electric storage (no other option is available) to increase self consumption and a reduction of grid dependency
- Complex production profiles (solar module, fuel cell, stirling motor or other cogenerators) require storage, because there is no other way of conserving the production energy of these units
- Appliances for heating (e.g. heat pumps) or high power appliances shall be activated during peak production (using the S10 integrated energy management)
- Weak grids lead to power outages, where the S10 can continue complete 3 phase household operation without any modifications of the household appliances (USP)
- Limitations of Feed-in leads to the need for storage in order to not constrain the production power (60-70% rules in Germany)
- Time selective storage to charge and discharge will exploit price spreads (day, peak, night tariffs). This has a particular focus on countries such as Turkey and Germany, when considering the future fact that three to eight times more power is available than needed

Those considerations lead to the following business applications for residential households and small commercial buildings.

Smartphones, tablets and web-based visualisation of the home energy flow are essential for the customer to have their energy scene online.

**PV with storage: market and sales**

When the total cost of energy reduction is in focus, the investment costs for PV (installed) are 1500EUR / kWp installed and 2500EUR / kWh storage (installed @4kWh including electronics and warranty) down to 900EUR / kWh system price (installed @15kWh including electronics and warranty).

The total investment in Germany is actually between 18.000-22.000EUR for small (4kW AC with 4-6kWp, 4kWh, S10 1ph) and between 20.000-30.000EUR (12kW with up to 15kWp AC, 15kWh, S10 3ph) excluding VAT, because all systems are benefitting from 100% write-off as private, but entrepreneurial investment.

The buying decision for customer is influenced as follows:

- The electricity production costs per kWh with storage are up to 25% lower than the grid cost per kWh (on a lifetime basis) and fixed for the system lifetime
  i) price rises and inflation can be fixed (assuming 3-6% inflation)
  ii) return on investment of up to 12-15 years is given (spare battery is considered in the customer offer)
- The annual autonomy is maximised up to 75% (grid kWh are reduced to 25%)
- Up to 40% upfront tax advantage and investment safety are given
- Emergency power is added to household

The system follows the annual solar performance:

- In summer, roughly a quarter of total PV energy is fed into the grid and the rest provides up to 100% daily autonomy
- In spring and fall, around 2/3 of total PV energy for up to 100% autonomy and feed-in close to zero
- In winter, grid power of up to 50% daily autonomy is possible, but 25% of annual consumption comes from the grid

If the production in kWh matches the customer’s consumption, 2/3 autonomy is achievable. Without any storage, 1/3 autonomy is achievable.

The market access is given by large PV sales networks, building new houses and real estate business. Funding programs known from former EEG related mechanics are starting in May 2013 in Germany. Furthermore, to strengthen their customer bindings, utility companies are promoting the storage systems.

**S10 – 3 phase product up to 43kW house connection**

**IPAD® as energy management console**

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PV with storage and electrical heating (heat pump, pure electric heating based on infrared technology): market and sales

Gas, coal and oil fired heating systems are being more and more replaced by heat pumps or pure infrared based heating systems (95% efficiency). PV and electric storage systems are chosen to fuel also the heating system and to exploit the self consumption capabilities in winter and fall.

Meanwhile, electric heating investment costs of 10.000-25.000EUR have led to lowest annual operating cost for heating. Now additional PV and storage - depending on the location – may cut the remaining costs for heating and electrical power by 50% (operating cost plus total investment over lifetime). These systems are 100% free of heating material.

The summer performance is very close to PV without electrical heating. When infrared heating for the house is used, investment costs for piping and water based radiators are completely omitted. Due to radiation instead of convection based heating, the efficiency of infrared heating is much higher and the peak electric power needed is lower, perfectly matching the battery and PV average power.

The market access is given by large international and well established players out of the heating business, energy architects, house building companies and from the fact that heat pumps have 50% market share in new residential buildings, which generates natural demand for additional PV systems.

PV with storage and co-generation (PEM, SOFC fuel cells or Stirling Motors): market and sales

The series production of PEM fuel-cells, SOFC fuel cells and Stirling Motors has led to a few thousand installations in Germany. Those systems (German: BHKW or English: Co-Generation: heat and electrical power) are mainly generating electric power proportional to the outside temperature and therefore their electric contribution is focused on the so called winter period (in Germany: generally from October till April). The storage system is used to increase the self consumption of the co-generator up to 90% and more. The total investment for the overall system including 4kWh storage is between 25.000-30.000EUR.

Dr. Andreas Piepenbrink, CEO and founder of E3/DC GmbH tells PES about recent developments within the successful Germany-based company.

PES: Can you begin by explaining a little about the company.

E3/DC sounds like R2/D2, the robot out of Star Wars!

Andreas Piepenbrink: The name E3 refers to the triptych of efficiency, energy saving and energy renewability; DC is our product key technology (Direct Current).

PES: The end of oil is far away. The electric car is predicted to be dead again due to cost. So home storage has the same technology and is predicted to be major future market? Please explain?

AP: The electric car has reached the level of series production (Renault, Tesla, VW and others) and faces the cost challenge that was predicted. Home storage is easier on battery technology due to lower requirements in power and temperature. The inverter technology is more complex. The cost challenge is same, but on a different level. The future market size is not known.

PES: Many competitors – established and major brands of inverter business
and battery companies – seem to offer the same solutions. What is key for E3/DC to be different?

AP: Only very few battery companies have the 20 years’ necessary production reference, and only very few inverter companies have solved the efficiency problem in battery converters. In addition, both of them have to invest into full integrated product with 100% remote service for updates and maintenance. E3/DC has done its homework very carefully.

PES: It sounds like it’s not simple for the customer to decide, and we’ve read about both DC and AC systems. What is key for customers?

AP: S10 is DC and AC in same hardware. This is unique in 3 phase architecture. One system for all needs (new and retrofit). S10 is up to 40% more efficient up to 1500W power than conventional AC systems. 1500W power is 90% of all private load profiles in Germany. Therefore the focus is not peak performance known from PV inverters.

PES: What is the advantage of a 3 phase system?

AP: E3/DC has trained many companies as certified installers. Our sales network will be extended by heating product channels and building businesses in order to get closer to a business that draws from real estate equipment and building efficiency. The PV sales channel is the appropriate channel to start business with and to come to PV 2.0 without Feed-in Tariffs. I do not see serious alternatives for self consumption.

PES: How might utility companies react if your storage systems take part of their revenue?

AP: Utility companies have a main interest in customer binding, based on which they sell: telecommunication, energy and gas. Utility companies will follow their customers and trends. Many utility companies are already offering the system.

PES: How many systems do you predict in the next years?

AP: The storage for homes will have three pillars. Utility (including grids), heating business and PV driven systems. Therefore I do assume 10 to 50% of all systems in the next 20 years could be equipped with storage for maximum efficiency.

PES: What are the projected numbers for Germany and Europe?

AP: Generally D-A-CH (Germany, Austria and Switzerland) are in our focus up to 2015, followed by Italy and Turkey. An additional region might be New Zealand, supported by utility companies.

PES: Your lithium-ion systems have now one year’s field experience. How did the systems survive in winter?

AP: All systems have got many software updates, including updates from the battery manufacturer in order to provide maximum discharge of up to 96% in winter time and to use maximum possible light during snowfall. We are happy, because we had no service issues from customers. Our concept has been confirmed and improved. We consider ourselves to be prepared for few thousand systems now.

PES: What is the advantage of a 3 phase system?

AP: According the grid rules, 3 phase systems are needed to extend 4,6kW limit per phase. Therefore it can be seen as power extension only. But we have integrated emergency power for 3 phase household without any modification. Retrofit (AC) is possible without any modification. In the space of 1 x 1m and including cabinet and battery, this is very compact.