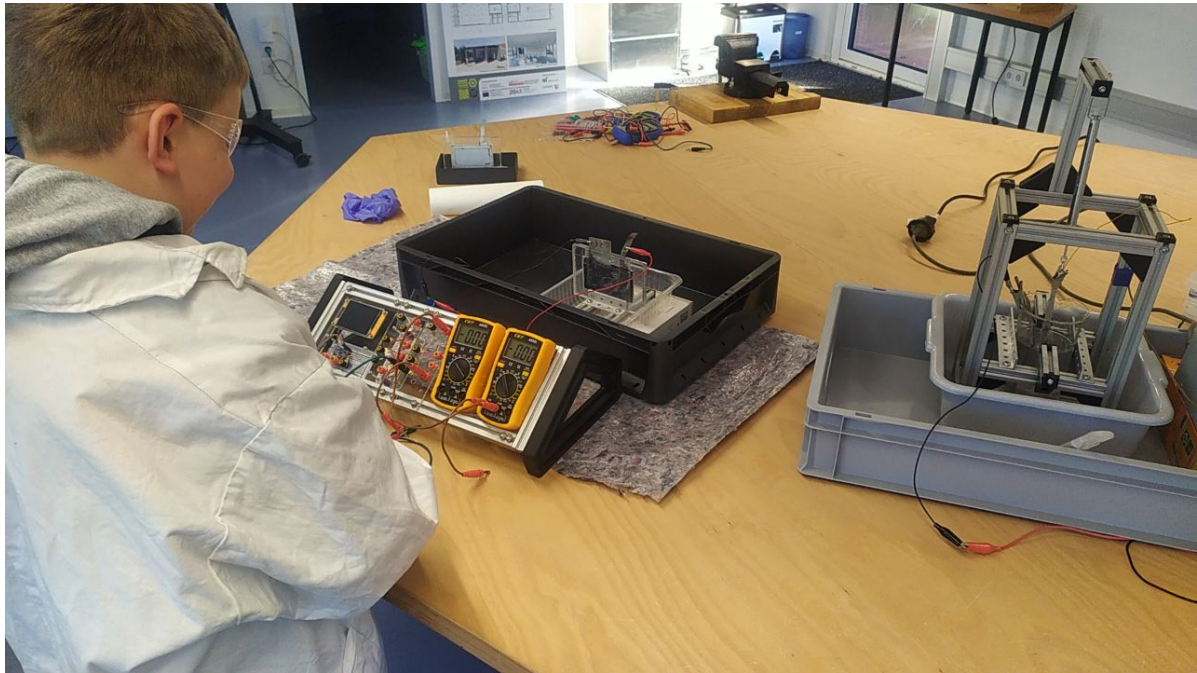


ZACplus Citizen-Science Project

Oliver Schlüter (DE)



Project

Location of initiative: Germany

Timeframe of initiative: Since 2024 as Citizen-Science project

Abstract: With our Citizen-Science project „Seasonal Longterm-Energy Storage with Zinc: ZAC+“ we are researching in a collaborative approach the zinc-air fuel-cell as a possible answer on the problem of how to take large amounts of electric photovoltaics energy from the summer into the winter, when it is urgently needed but no or only insufficient sun is available. The zinc is used as a kind of renewable "fuel", meaning an energy-carrier and storage-media which is consumed in the fuel-cell and delivers electric power, but can be regenerated in summertime by excess solar energy and can therefore act as central element in a seasonal longterm-storage system. The results will be made public available as OpenSource-licensed hardware build-instructions which can freely be modified and iterated in any directions, e.g. for integrating recent optimizations according to our scientific development process.

Year the project was created: 2024

Description: Seasonal saving of large amounts of electric energy during several month can be achieved today with the synthesis of Hydrogen or Hydrocarbons. Beside that there furthermore exists the possibility of oxidizing a metal, e.g. like zinc, releasing electrons and so producing an electric current. The resulting zinc-oxide can easily become stored and regenerated back to zinc in the next summer with then available excess-photovoltaic energy, so the cycle is closed. The most interesting detail is the achievable degree of overall efficiency, as a benchmark in comparison with the other mentioned systems. Here at the Open Source Ecology Germany e.V. Association (OSEG e.V.) we are working on a prototype of such a zinc-air-fuelcell and are an interdisciplinary and trans-regional team of young engineers and scientists. The main components like zinc and even more oxygene are abundant, everywhere available, harmless and non-toxic for the environment; zinc-oxide is even a component of cosmetics. The system is therefore perfectly suited for re-building in DIY-classes and workshops and offers a low-level entry. It is necessary to base the project on a broad foundation, because even if the pure implementation of the system as proof-of-concept seems to be relatively easy and is already working, there is still a huge outstanding amount of work, like ongoing optimizations, iterative adoptions of variants and implementation of experimental measurement series, with the aim, to transform the system into a practical application for regular daily use. Furthermore we optimize continuously because we want to reach the highest-possible degree of efficiency. All this requires lots of men power and can (hopefully) be reached by the Citizen-Science-Approach and as an "Open-Source-Hardware" (OSHW) project. By integrating not only the interested scientists but also involving a broad audience in the research and development process, each single user, maintainer and operator of the ZACplus-system can contribute his part and so all the

effort can be spreaded onto many shoulders. This wouldn't be possible in regular "closed-source" projects. We are bringing the developers and enthusiasts together for working on several days lasting intensive-courses in our "OpenEcoLabs". That is how we call the locations of the OSEG e.V. Association, which can offer appropriate conference rooms including accomodation facilities and a good workshop- and lab-equipment for practical work and building-projects. It is even possible to maintain such projects as longterm-installations for testing and ongoing development (Real-Laboratory). There we organize development- and/or assembly-workshops for the ZACplus-project as educational Citizen-Science-events and also occasional STEAM-classes at schools and extracurricular educational locations. The OSEG e.V. Association is experienced in OSHW-projects. We know the potential and want to support it, with good documentation materials, e.g. step-by-step assembly-guides (OER, Open Educational Resources), process-documentation and professional visual aids and illustrations. The intended mode of action is striving to develop the cell in collaboration between interested individuals (the citizens) and our core-developer-team (the scientists) into an easily replicable experimental platform that can help to announce the story and spread it to a wider public. This could trigger more people to build and explore their own cells, either within our DIY-building-events or by just replicating the cell with help of the OSHW documentation blueprints. With the feedback from a broad user-community many cell-variants could be tested, extended and improved in parallel by undergoing an iterative process which should result in an optimization of the system on one hand and on the other hand in a gradual transition towards a mass suitability for daily use. We have already seen similar effects in the history and recent developments of cheap desktop-3D-printers by an OSHW-community and this could also taken as one more evidence and demonstration, that OpenSource-development and Citizen-Science are close relatives. The community-building is not only useful for the collection of a wide data-base and a multiplier-effect, but all the different skills also have a positive interdisciplinary impact. As an important side effect we also want to mention the "Self-Empowerment", meaning, the individual can actively contribute his skills and power to the solution of a problem (like the recent energy-crisis and climate change) and even could also determine the direction of the development in a co-creative citizen-science approach. Ideally, the ZACplus project could become a kind of "volks-battery", maintained by the community and providing a significant share of supply reliability within the scope of the energy transition. See also our project website at https://wiki.opensourceecology.de/ZACplus_Citizen-Science_Workshops

Research question: The global aim of our project is certainly to create a viable storage-solution / application if possible or otherwise to document and point out clearly, what are the recent obstacles. To achieve this we are focused on two research questions: 1. What ist the overall degree of efficiency, meaning: How much percent of the solar-energy that we store into the system in summer can we get back in winter ? Which degree can we reach from the scratch and is it economical ? If not, what are feasible options for optimizations ? 2. What is the lifetime / durability of the Gas Diffusion Electrode ? Since the GDE is the most expensive component (zinc and air are comparable cheap) it is the economical bottleneck. How many working hours can we get out of it and if the number is economical insufficient, what are the limiting factors and what are possible approaches for extending the lifetime ? Currently (during the last few months) we are concentrated and working on the second question, because it requires work only at the fuel-cell front-end. The degree of efficiency optimizations instead has two entry points: the fuel-cell front-end and the recycler. The iterative construction, development, building and testing of an appropriate hardware-apparatus is also subject of our research and necessary requirement for the scientific experiments.

Initiative team: The project was initiated by the following members of the "Open Source Ecology Germany e.V."-association: - Oliver Schlueter, main initiator and project manager, director of OpenEcoLab2 in Rahden - Timm Wille, member of core development team, head of the Berlin-section of our group - Alexander Stellmach, member of core development team - Thomas Utpatel, member of core development team

Number of citizens engaged: 22

Citizen engagement: During the year 2024 and 2025 we have offered 10 times a 2-day building- and/or constructing-workshop (resulting in a total of 20 workshop-days), which were attended by 22 people (most of them attended several workshops several times and can be seen as regular team-members). We have further offered 3 times a STEAM-workshop for schools and reached each time up to about 15 pupils (per workshop). We have also presented the ZACplus project at the MakerFaire Minden 2024 which had several thousand visitors. Events like the MakerFaire and beeing announced in local programmes helps us to recuite local people . By the OSEG e.V. association and its networks, we have an additional source for team members ... which are spreaded all over the country trans-regional. We adopted to this circumstances and made it possible to also attend the workshops online and virtually. The role of the Citizen-Scientists can be collaborative by helping to collect data from several variations of experiments or functional verifications in the case of extended or iterated hardware. But it can also be co-creative, meaning, a Citizen-Scientist can influence and determine the direction of the development. Some of them have a background in the field of engineering, which can be helpful for hardware construction or modification, even if they are no experts in electro-chemistry, but in our project the development of our own hardware is important.

How will the prize money benefit your community?: - We could offer more construction- and build-workshops (which are usually quite personal- but also material-intensive) and reach more people. - We could support our team members with travel expenses when attending a workshop and/or visiting our groups in other cities. - We could

extend the scope of our research and concentrate our focus on further related aspects like: a. Trying to make a better and optimized recycler (the re-generator of the zinc-oxide) which would result automatically in an optimized and better degree of overall efficiency. b. Enlarging the capacity of a single cell and building a stack of several cells, for enlarging the capacity of the whole fuelcell. c. One of the most expensive parts in the material list is the Gas Diffusion Electrode, which is therefore the limiting factor on how many cells we can build, but also on the capacity of the cells (e.g. building a cell stack). It is a plan for the future to try to build it on our own, for which we need more men-power and certain special equipment like a calander. d. Extending the documentation with more and better content, like producing higher quality build videos and print media.

URL(s) of the project: https://wiki.opensourceecology.de/ZACplus_Citizen-Science_Workshops

Support received from: - Open Source Ecology Germany e.V. Association (<https://www.ose-germany.de/>) - Hans-Sauer-Stiftung (<https://www.hanssauerstiftung.de/>) - ZDI Minden Lübbecke (<https://www.zdi-minden-luebbecke.de/zdi/>)

Keywords: zinc-air fuelcell, renewable energies, solar energy

Topic: Seasonal Longterm-Storage of Solar-Energy

Research discipline: Renewable Energies, Electro-Chemistry, Applied Sciences

Software: a. We use several OpenSource tools within the construction process like slicing- and controlling-software for the 3D-printer and laser-cutter, tools for 3D-construction like "FreeCAD" and for pcb-layout and -routing like "KiCad", Programming environments like the Arduino-IDE. b. We are developing our own software for use within the project (but it is of course also OpenSource) e.g. controlling-firmware for the fuelcell, tools for monitoring, measuring and automated data-collection and -visualization.

Hardware: a. We use several Hardware devices like 3D-printer, CO2-Laser-cutter, a melting furnace for producing thick zinc-plates, a local photovoltaics-system producing the solar-energy we use for testing (the storage capabilities), a RaspberryPi as Server for data-collection and -visualization. b. We are developing our own Hardware, like parts of the fuelcell, the recycler and the automated measuring station and data collector.

Would you like your submission to the European Union Prize for Citizen Science to be additionally considered for the STARTS Prize competition?: Yes, I want my submission to be additionally considered for the STARTS Prize.

Core European aspects of the submitted project: Energy Autonomy

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