Final report

1. Project details

Project title	SunCharge
File no.	64017-0702
Name of the funding scheme	EUDP
Project managing company / institution	Heliac
CVR number (central business register)	35841911
Project partners	Aalborg CSP, E.On, Siemens, DTU Mekanik
Submission date	30 September 2022

2. Summary

Formålet med projektet var at demonstrere evnen til at hurtigoplade en elbil ved brug af et stenlager der kan gemme varme og drive en dampturbine. Grundet leveringsvanskeligheder af denne turbine blev hovedfokus for projektet I stedet at forudsige hvor meget el der kunne være blevet produceret ud frae n virtuel dampturbine. Projektet er kommet I mål med at konstruere et fuldt funktionelt dampsystem der er koblet til en første generation af stenvarmelageret. Lageret kan oplades og aflades, og der har været produceret damp ved 150C og 5 bar tryk. Arbejdet fortsætter efter projektafslutning for at nå det oprindelige mål om 300C og 19 bar tryk som systemet er designet til, ved at implementere resultaterne fra denne første generation af stenlageret. Aktiviteterne vil fortsætte I EUDP projektet RockStore.

The objective of the project was to demonstrate the ability to make electrical power for fast charging of electric vehicles using a rock-based heat storage. Due to delivery problems with the turbine responsible for generating the electricity, the project instead used a virtual steam turbine, where steam data was used to predict the electrical production. The project has realized a full steam generating system and the first iteration of the rock-based heat storage. The result has been that the storage can be charged and discharged, and that steam have been produced at 150C and 5 bars pressure. The work will continue after project end to reach the goal of 300C and 19 bar steam for which the steam system has been designed, where the learnings from the first iteration rock-storage will be used for making a second iteration, which will be anchored in the EUDP project RockStore.

3. Project objectives

The objective of the project was to demonstrate the ability to make electrical power for fast charging of electric vehicles using a rock-based heat storage. To do this, a rock-based heat storage has been developed, as well as improvements in the steam system, where a steam generator based on a standard plate heat exchanger with a novel anti-scaling coating has been demonstrated to be able to produce steam.

4. Project implementation

The project started with the construction of the concrete shell for rock containment, which went as planned. The concrete container was filled with granite rocks as foreseen, and the container was sealed and connected to the vacuum system. The system was tightened using elastomeric high temperature silicone, after which the system was airtight to an acceptable degree. Simultaneously, the steam and oil systems were developed with the assumption that a steam turbine would be integrated into the system. When the design of the system was finalized, it became clear that the steam system could not be delivered, and a large part of the steam system has to be re-designed for a virtual steam turbine where the produced steam was vented instead of being condensed after the steam turbine. This caused a substantial delay in the project which were extended. After finalization of the design, the system was constructed. In the construction phase, delays due to faulty welding were encountered. However, the system became operational within the extended project period and were tested for a limited time, where temperatures of 150C and a pressure of 5 bars in the steam system were reached.

The lack of a real steam turbine redefined several milestones and caused delays which has been the biggest problem that has been encountered in the project. However, the main perceived risks from the beginning of the project, namely the integrity of the concrete when heated, has not been observed, probably due to the limited temperatures that have been reached so far.

5. Project results

The original objective of fast charging an electrical vehicle was made impossible due to the absence of a turbine. However, the mitigation plan was to demonstrate the novel rock-based storage technology, which has been demonstrated to a large extent, and where the optimization and limit-testing continues.

During the planning of the evaporator, it became clear that the standard technology, a shell-and-tube-heat exchanger was both too costly and large to be implemented in the technology if it should be commercially feasible. A much smaller plate heat exchanger was chosen, and the expected problem with scaling in the evaporator part was prevented by using a novel anti-scaling coating.

Commercially, Heliac is in contact with one of the largest food manufacturers who is willing to help bringing the technology to a commercial point. They see heat storage as essential for them to decarbonize their food production. However, they are not mainly interested in electricity, but more interested in having steam output in the temperature range of 130C-165C, which has been demonstrated in the project. This learning has made us make further market analysis, and it seems like the industrial steam market is easier to approach than the electrical power market.

6. Utilisation of project results

The results will form the base of the EUDP-project RockStore which is in progress. Also, the results will be used to propose a plant to a commercial customer to Heliac's solar fields where the supply and demand needs to be balanced, and where other commercial solutions are economically infeasible.

The problem that the storage will solve can be solved in other, (more or less) competitive ways. The first solution is to accept a lower share of green energy and use the fossil gas solution that most customer use today, when no renewable heat is available, and when renewable heat is available, but no demand is present, throw the excess production away. A second option is to use another type of storage, such as pressurized steam tanks. However, the cost of these is ballpark 10 times too expensive for a 2-day storage. The final and best alternative is to use the produced heat in the (typical) weekends where industrial steam use is low or absent, to alternative uses, such as making thermal desalination of seawater into industrial pure water. However, this solution does not solve the problem of limited share of renewable energy in the energy mix of the industrial customers.

The main sales barrier today is that the technology needs to be finalized and demonstrated in a real operational setting. The plan is to do this in the RockStore project.

7. Project conclusion and perspective

The proposed core technology of a Rock-based storage has been demonstrated, although many problems with "standard" technology has been encountered. The work with the technology will continue in the framework of EUDP project RockStore, and both technical and commercial learnings suggest that the technology can be ready for the market within a few years, starting with the industrial heat/steam market.

8. Appendices

Technical report on results.