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OPERATION OF A NOVEL SOFC-BATTERY INTEGRATED HYBRID FOR TELECOMMUNICATION ENERGY SYSTEMS

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Telecom technology

Marco Ferraro offers an insight into a collaborative European project that aims to revolutionise telecommunication energy systems through the development of novel hybrid battery technology

What are the main aims and objectives of the Operation of a Novel SOFC-battery Integrated hybrid for Telecommunication Energy systems (ONSITE) project?

The ONSITE project aims at developing a proof of concept based on a hybrid of solid oxide fuel cell (SOFC) and sodium nickel chloride (NiNaCl) battery technology, with progress beyond state of the art and towards ICT market requirements. From the system design point of view, the overall objective of ONSITE is the construction and operation of a system based on SOFC/NiNaCl battery hybridisation that generates more than 20 kW at high efficiency and economically competitive costs.

Could you explain how the ONSITE consortium became involved with energy systems?

The consortium's involvement in energy systems arose from the growing demand for high-value services in the ICT sector. These services need growing network infrastructures in terms of the number of telecom station (even in remote areas) and datacentre installations as well as electrical power production, efficiency and availability over time.

What are the key advantages of a system based on SOFC/NiNaCl battery hybridisation when it comes to generating electricity efficiently and economically?

Among combined heat and power (CHP) technologies, high temperature fuel cells offer high electric performance, eg. for SOFCs expected electric efficiency is about 50-60 per cent and they could provide a significant amount of heat in comparison with other fuel cells, leading to potential values of overall CHP efficiency as high as 80-85 per cent. SOFCs are able to supply reliable power from different fuels (hydrogen, natural gas, biogas, LPG) while NiNaCl batteries are intrinsically maintenance free, show long life and high reliability, and are fully recyclable. Additionally, by choosing these kinds of technologies, the consortium aims at exchanging thermal energy between the two devices in order to enhance the total efficiency of the final system. As a result, the realisation of a hybrid system – one that is capable of connecting production and storage devices on the one hand, and of managing and controlling the energy and its exchange with the grid on the other – represents the synergy of two innovative technologies.

Despite being considered state of the art, SOFC technology is still only in the laboratory and niche market devices stage. Can you explain why SOFCs are not commercially available on a large scale yet?

Above all, this delay is due to high costs and limited lifetime. Several research teams are facing these limitations by developing new materials manufacturing processes. The ONSITE consortium is instead integrating a SOFC system with one or more storage devices utilising the inherent advantages of each system. From this point of view, NiNaCl batteries may support and enhance SOFC-based systems decreasing investment costs.

How does the ONSITE consortium intend to assess the fuel cell system's ability to successfully compete with existing technologies? Assuming it proves the concept, what will be the next steps in development for this hybridised system?

The project will assess competitiveness in terms of system life duration, market potential and impact on the environment. The proof of concept is expected to involve more than 2,000 hours of field tests, and cumulatively reach more than 3,000 hours once tests among partners are taken into account. Energy efficiency will also be evaluated in terms of operational expense reduction (with respect to currently available technologies) through market analysis of telecom systems' power supply that takes into account how much telecom operators will expand their networks due to the achievable cost effectiveness.

After demonstrating the concept is capable of fulfilling ICT market requirements, the partnership will be able to move to industrialisation and market, together with a scale-up in production and cost optimisation.

Is wide-reaching dissemination an important aim for you and your collaborators? How are you disseminating your findings?

Dissemination is fundamental for the whole consortium; in particular, it is of pivotal importance to begin raising awareness of the positive aspects and advantages of fuel cell adoption in telecom applications and distributed generation in general.

With this in mind, our results and achievements will be disseminated through a number of means, including publications in scientific/technical journals, presentations at conferences, and through a dedicated project website (www.onsite-project.eu). Results will also be disseminated at conferences and workshops hosted by other EU projects and national bodies/universities. Moreover, assuming the project produces a patentable product, further dissemination will result from the patenting process and its subsequent publication.

A hybrid solution

A consortium comprised of energy experts from across Europe has come together through the **ONSITE** project to deliver innovative and patentable power system technology to meet the telecommunications demands of the future

THE ENERGY SECTOR is currently facing a multitude of challenges, from rising demand to environmental concerns. Telecom companies in particular are looking for ways to overcome these obstacles while also meeting future power demands caused by increasing ICT services needs and a worldwide push towards faster and more accessible networks and internet connectivity. As such, telecom industry stakeholders around the world are looking into the latest technological advances and novel energy systems capable of meeting their current and future requirements.

One option that has gained significant traction in recent years is the use of fuel cells for power production. Substantial advantages such as having control of the on-site system and being able to simultaneously heat (and cool) make fuel cell power systems attractive. Hydrogen- and methanol-fed proton exchange membrane (PEM) fuel cells are already showing potential for telecom applications. "Nowadays, PEM fuel cells sustain small-size (1-10 kW) off-grid telecommunication power stations," elaborates Marco Ferraro of the National Research Council of Italy's Istituto di Tecnologie Avanzate per l'Energia 'Nicola Giordano' (CNR ITAE). "However, solid oxide fuel cells (SOFCs) show more far-reaching promise when natural gas or propane are used to feed the fuel cell generator."

When used in cogeneration or trigeneration (generating electricity and useful heat, and/or cold simultaneously) applications – for example, in energy-consuming datacentres – it is expected that SOFCs could achieve overall efficiency as high as 85 per cent. Furthermore, their potential high fuel flexibility means that a diverse range of different energy sources can power them, and they are able to reliably supply power efficiently. However, SOFCs still have notable limitations: an insufficiently quick response to electrical load transients, high costs and short lifetime in comparison to competing technologies.

BEST OF BOTH

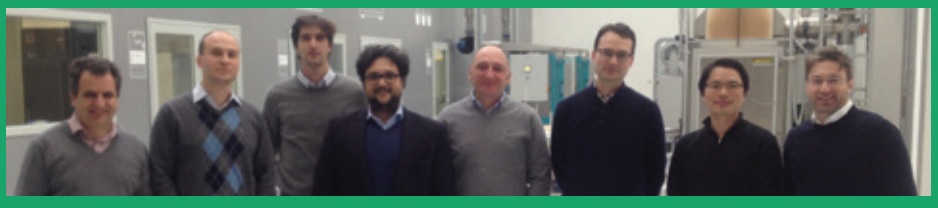
The solution? A novel hybrid system that combines the advantages of SOFCs with the benefits of high-temperature batteries. High-temperature batteries are emission-free, operate quietly and have a long cycle life. Sodium nickel chloride (NaNiCl) batteries in particular are maintenance-free, have high reliability and are fully recyclable.

Combining (electrically and thermally) SOFCs and NaNiCl batteries within a single hybridised architecture would create a system wherein the NaNiCl battery could provide additional power during peak times or in cases of emergency, and then simply be recharged by the SOFC during periods of lesser energy demand. This would create a reliable energy system in which the SOFC experiences little load variation, thus prolonging system lifetime while simultaneously reducing operational costs. "To approach next-generation telecom applications in grid-tied stations, natural gas-fed SOFCs and innovative high-temperature batteries appear to be the natural choice – in particular in a smart city scenario where energy and ICT will strongly interact," emphasises Ferraro.

Of course, achieving a functional hybrid system is no mean feat; such an architecture must connect production and storage devices while also managing and controlling energy and its exchange with the grid. Although technologies that can achieve these individual aims already exist, successfully combining them into a single system requires collaborative work on an international scale.

A POWERFUL PROOF OF CONCEPT

With this in mind, a European consortium comprised of energy specialists from leading research institutes, industrial companies and SMEs has united around one common goal: to develop a proof of concept for such a system. The exact aim of their project – entitled Operation of a Novel SOFC-battery Integrated



The ONSITE team at the new Solidpower SOFC production line.

INTELLIGENCE

OPERATION OF A NOVEL SOFC-BATTERY INTEGRATED HYBRID FOR TELECOMMUNICATION ENERGY SYSTEMS

OBJECTIVE

To develop, manufacture and operate a containerised system, based on solid oxide fuel cell (SOFC)/ sodium nickel chloride (NiNaCl) battery hybridisation that generates more than 20 kW at high efficiency and economically competitive costs.

MEMBERS

For a full list of members, please visit:
www.onsite-project.eu/members-onsite.html

FUNDING

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MARCO FERRARO leads the CNR-ITAE Research Team developing fuel cell systems for stationary and auxiliary power unit applications. The author of more than 30 papers in the fuel cell systems R&D sector, he has experience in production, storage and distribution of hydrogen, and fuel cells systems. In addition, Ferraro is Leader of a CNR team in the 'Asterix3' and 'SUAV' projects funded by FCH-JU.

A BALANCED APPROACH TO BATTERIES

Marco Ferraro presents an overview of how each partner within the ONSITE consortium contributes to its shared goal

The consortium comprises a well-balanced mix of prominent industrial companies, renowned research institutes and SMEs, each of which brings its own unique know-how and experience of managing projects related to alternative energy and hydrogen to the project. Importantly, all members of the consortium are strong believers in fuel cells and particularly in SOFCs.

MEMBERS OF THE CONSORTIUM INCLUDE:

- **ITAE**, Italy – provides state-of-the-art laboratory test facilities along with its knowledge of fuel cell materials, components, and systems building and testing
- **efceco**, Germany – an SME with more than 30 years of experience in managing large and complex R&D projects, especially those relating to fuel cells and hydrogen
- **Solid Power** (previously named HTceramix), Switzerland – a European SME leader on SOFC technology
- **FIAMM Energy Storage Solutions**, Italy – a multinational company leader on lead-acid (Pb) and NaNiCl batteries
- **Bonfiglioli Vectron**, Germany – an SME working on power conditioning
- **Ericsson Telecomunicazioni SpA**, Italy – the Italian subsidiary of LM Ericsson, the world's largest supplier of network equipment and related services to telecom operators
- **Instytut Energetyki**, Poland – an organisation that is highly experienced in SOFC modelling and has participated in a number of EC-funded R&D projects
- **Haute Ecole Specialisee de Suisse Occidentale**, Switzerland – experienced in measuring performance and characterising thermal installations

hybrid for Telecommunication Energy systems (ONSITE) – is to create a containerised system based on SOFC/NiNaCl battery hybridisation that can be operated by natural gas and that generates more than 20 kW at high efficiency and economically competitive costs. The consortium behind ONSITE envisions that, ultimately, such systems could be used to power telecom stations worldwide.

"ONSITE is exploiting results from previous SOFC research activities on both materials/ components and systems development," outlines Ferraro, the project coordinator. Building upon this existing knowledge, the team's activities revolve around optimising and developing existing SOFC technology to improve performance, particularly in terms of increasing life while lowering cost; identifying and implementing favourable manufacturing processes; and establishing how best to integrate high-temperature batteries into the completed system.

Once this basic research has been conducted, repeated tests both in the lab and within a real-world telecom environment will be used to evaluate the system. Only once a successful proof of concept has been achieved will findings be disseminated to relevant stakeholders, exploitation routes developed and potential spin-off opportunities in other market sectors (such as smart grids, smart buildings and rural electrification) investigated.

Initial tests on the SOFC module and battery electrical integration.

SCALING UP THE SOLUTION

The project, which began in July 2013, is scheduled for completion in July 2016. If all goes to plan, the resulting proof of concept will have been demonstrated to meet telecom industry requirements within this timeframe. This will put the ONSITE partners in a good position to patent the technology and bring their power system to market.

In addition to this deliverable, other project outcomes will include a wealth of new understanding relating to SOFCs and high-temperature batteries, not to mention the significant strengthening of Europe's place within this important technological field.