Project name	Order number	Decimal number	Sub number/HG/UPS
ZEHTC			
Issued by	Department	Telephone	
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Zero Emission Hydrogen Turbine Center

Final report

This project has received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems' focus initiative Integrated, Regional Energy Systems, with support from the European Union's Horizon 2020 research and innovation programme under grant agreement No 775970.

Summary

The aim of ZEHTC has been to demonstrate and evaluate a possible future energy system that includes hydrogen-powered gas turbines using power-to-gas and storage technology in combination with renewable energy sources. This is highly relevant: 1. Besides electricity, hydrogen may become the most important climate-neutral energy carrier linking industry and power generation with other sectors, such as industry and transport; 2. Increased share of renewables in the grid will require the need for peak power, reserve power and inertia in the grid, for which gas turbines could play an important role.

The project is built around a demonstration plant that includes local hydrogen production and storage, power supply from a solar field and excess power from the industrial process, and battery storage. The hydrogen produced by an electrolyzer is then used as a fuel in gas turbines to demonstrate and further develop hydrogen combustion technology. This plant mimics a large-scale sustainable energy system and supports the overall zero-emissions goals of the local industry and the gas turbines' goals to run on 100% hydrogen as fuel, that will give zero CO2 emissions. It is a great showcase to illustrate key technical and economic aspects to local, regional and global networks. The plant's microgrid is studied for operational management to optimize the use of energy through storage, as hydrogen or in the battery. The value of electricity to hydrogen conversion for the power generation and coupled sectors is further investigated by modeling scenarios of energy systems in Europe.

The first year focused on plant design and the initiation of Ph.D. studies. Safety and environmental/regulatory work were initiated, and the plant concept was developed with the support of the partners. In the second year, the plant was installed and commissioned with a great success in December 2021, when own produced hydrogen was used in a gas turbine test for the first-time. In the third and final phase, the project focused on scale-up studies, demonstration to stakeholders and customers, and operation and maintenance of the plant including R&D tests.

The role of hydrogen-fueled gas turbines has been extensively explored in several academic and media publications. The project was also disseminated regionally with information to politicians, schools, local entrepreneurs, gas turbine and energy stakeholders to raise general awareness and stimulate discussion on possible synergies.

Key findings:

The design and construction of a hydrogen integrated net zero energy system with gas turbines is technically feasible. Although the demonstration plant cannot match the hydrogen demand of a full-scale industrial gas turbine, the design optimizations and choices created a representative small-scale energy system. Hydrogen consumption is determined by the gas turbine test schedule and storage level. The

hydrogen production can be limited to the self-sufficiency of the plant or also supported by external electricity for a higher demand scenario, which is ultimately limited by the hydrogen storage capacity. It has been tested that the plant can operate isolated from the external grid with the help of the battery, which is able to support a wide frequency range. Hydrogen production is successfully integrated into the gas turbine test facility and the hydrogen is used for gas turbine development and to reduce the carbon footprint from the own operation.

System studies show that hydrogen-fueled gas turbines and re-electrification of hydrogen can be of value to the future electricity system for time-shifting electricity generation. Competitiveness depends on the electricity supply mix, the evolution of fuel prices, the potential of demand response assumed and how flexible other hydrogen users will become. Gas turbines have been shown to be important during the transformation of the electricity system since they can operate with different hydrogen mixes in the fuel, as well as in a future zero carbon electricity system when operating purely on renewable fuels. From a techno-economic optimization it is concluded that the hydrogen driven gas turbine will operate more flexibly, mostly in combined cycle with more starts than today, but with less operating hours. Model-based scale-ups of the system for typical regions are used to demonstrate the potential of the hybrid energy solution to policy makers, utilities, and gas turbine customers, opening up new market opportunities for decarbonized electricity and heat. The key messages are:

- Hydrogen reduces the average cost of electricity in decarbonized energy systems.

- Hydrogen gas turbines provide plannable power to complement renewables, especially in wind-dominated systems where fluctuations are fewer, irregular and longer in duration.

- Hydrogen power plants can be critical to ensure electrical grid stability.

- Biofuels and other renewable fuels are a valuable complement to hydrogen as gas turbine fuel.

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Introduction

This project has received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems' focus initiative Integrated, Regional Energy Systems, with support from the European Union's Horizon 2020 research and innovation programme under grant agreement No 775970.

The project was carried out by Siemens Energy AB together with a consortium of the following parties: Chalmers University of Technology AB, the County Administrative Board of Östergötland, Finspång Municipality, Linde Gas AB (formerly AGA Gas) and University of Bologna (consortium partner in ERA Net). Siemens Energy AB (formerly Industrial Turbomachinery AB) led the international project consortium.

The work was also controlled with a local steering group within Siemens Energy to ensure project integration with the company's operations. For the development of the facility, internal processes were followed.

The project hired several external actors to ensure implementation: Euromekanik AB, Stella Futura AB, Kraftpojkarna AB, Caverion Sverige AB, WSP Sverige AB and Renall AB, among others.

Project duration: October 2019 – April 2023

Objectives and goals

The project had the following objectives and goals:

- Decarbonization of the Siemens Energy Finspång test facility by the reuse of power from the gas turbine tests, renewable electricity production and the use of hydrogen as fuel.
- Knowledge sharing regarding hybrid, power-to-gas and smart micro grids solutions with local, regional and global networks of municipalities, utilities and industries.
- Demonstrating de-carbonization island mode solutions to customers and communities world-wide as a basis for promotion of hybrid solutions, power-to gas, energy storage, optimization of smart micro grids and use of hydrogen as fuel (co-firing) in gas turbines.
- Develop competences to optimize the use of gas turbines in the changing energy system as part of hybrid, energy storage and smart grid solutions. Develop competence to operate low NOx gas turbines on fuel mix containing

higher proportions of hydrogen with the target to reach 100% hydrogen as fuel in gas turbines before 2030.
- Contribute to the development of a sustainable society regionally, nationally, globally through providing solutions that are enabling communities to meet increasing energy demands with reduced CO2 emissions.

Exploitation

The goals of the project address key aspects of the global energy system transformation in terms of technology, competence, marketing, economics, communication and society. They are achieved thanks to the successful implementation of the demonstration plant, together with academic research and dialogue with stakeholders. Beyond the project, there is still more to learn both on operational aspects as well as on scale-up market and economics. Also, regional spin-off projects and implementations could be realized in the future, depending on local decision-making. The following sections highlight the main achievements.

Decarbonization
The test facility contributes to decarbonize the local site by replacing natural gas with hydrogen. Together with the use of biogas this became an important part of the company's journey to become climate neutral from its own operations by 2030 This is part of the internationally recognized “Science Based Target Initiative” (SBTI). Availability of hydrogen is still very limited in the market, so the new in-house hydrogen production allows for further hydrogen testing and increased flexibility of local operations to prove new technologies. The testing hub is motivating new collaborations and funding to implement hydrogen in power generation and puts the region on the world hydrogen map, securing an attractive industry in the region. Suppliers and local authorities working with the project have gained new knowledge useful for other decarbonization projects. The hydrogen storage capacity will be expanded to allow longer testing periods with more hydrogen.

Knowledge
The project has made significant contribution to sharing knowledge about the value of hydrogen. Through its integration with the gas turbine production site the team reaches many energy providers through media and site visits. Complex techno-economic energy system models were developed and applied to assess the role of hydrogen-fueled gas turbines in the future electricity system. The outcome is of high value as it provides more confidence in business models for a dynamic energy system transition period. It was published in high quality refereed scientific papers and also discussed in the public debate, demonstrating the feasibility of an electricity system with high levels of non-dispatchable generation. The generated knowledge on standards, regulations and routines is directly used in contact with stakeholders. A scale-up model and a public decarbonization calculator help to explore further

hydrogen opportunities and to support energy stakeholders in developing solutions. The project has also opened new avenues to develop other hydrogen carrier options, such as ammonia and methanol.

Demonstration

The small-scale demonstration of a hydrogen-based sustainable energy system including gas turbines is a key achievement of the project. It has been accompanied by models for optimal design of a renewable hydrogen production facility and strategies for energy management of such a microgrid system using a hydrogen-fueled gas turbine. The scientific results have been presented and published in high quality refereed conferences. Today, the demonstration plant inspires customers and stakeholders to participate in future sustainable energy systems, which can in some cases build on existing gas turbines and infrastructure. The possibilities of using hydrogen as a link between sectors become very tangible and the techno-economic modeling in the project shows that hydrogen will play an important role in a future modern electricity system with high shares of non-dispatchable electricity generation from wind and solar power.

Competence

Access to hydrogen is essential to develop the competence to run gas turbines on 100% hydrogen, and hence the project results will be further exploited to reach this goal. The project has contributed to increase the competence of Siemens Energy employees, the public sector and gas turbine stakeholders. The municipality and the county administrative board have trained officials, politicians, and stakeholders at both local and regional level. The universities have trained MSc and PhD students within the project. In the longer term, the demonstration plant will be used to educate students. This is important as the supply of skills has been identified as a challenge for the current and future energy transition. Therefore, access to real demonstration plants should be key to attract students to energy and engineering education. In addition, local entrepreneurs, and associations such as Hydrogen Sweden will benefit from the project with increased competence and motivation to drive the transition to hydrogen use in the energy system.

Society

Hydrogen gas turbines can provide increased flexibility and stability in emerging energy systems. This adds value to the development of sustainable societies and the project is accelerating the readiness to offer gas turbines running on 100% hydrogen. It has contributed to the development of hydrogen ready concepts connected to new sales and service upgrades. The project knowledge also contributes indirectly to the review and formulation of policies like the EU Taxonomy and the Swedish hydrogen strategy.

Demonstration plant operation and scale up

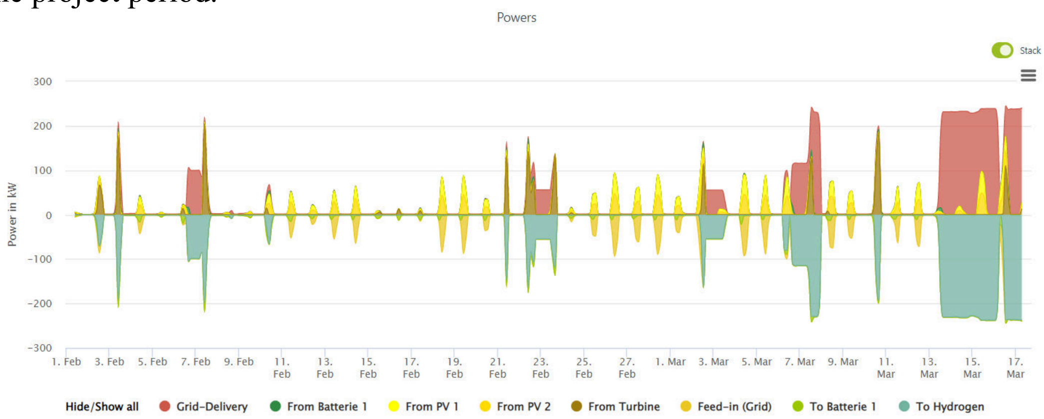
Operation

The operation of the plant is mainly determined by the local demand of hydrogen for gas turbine operation and limited by the storage capacity. Two demands can be met at the production site in Finspong, Sweden:

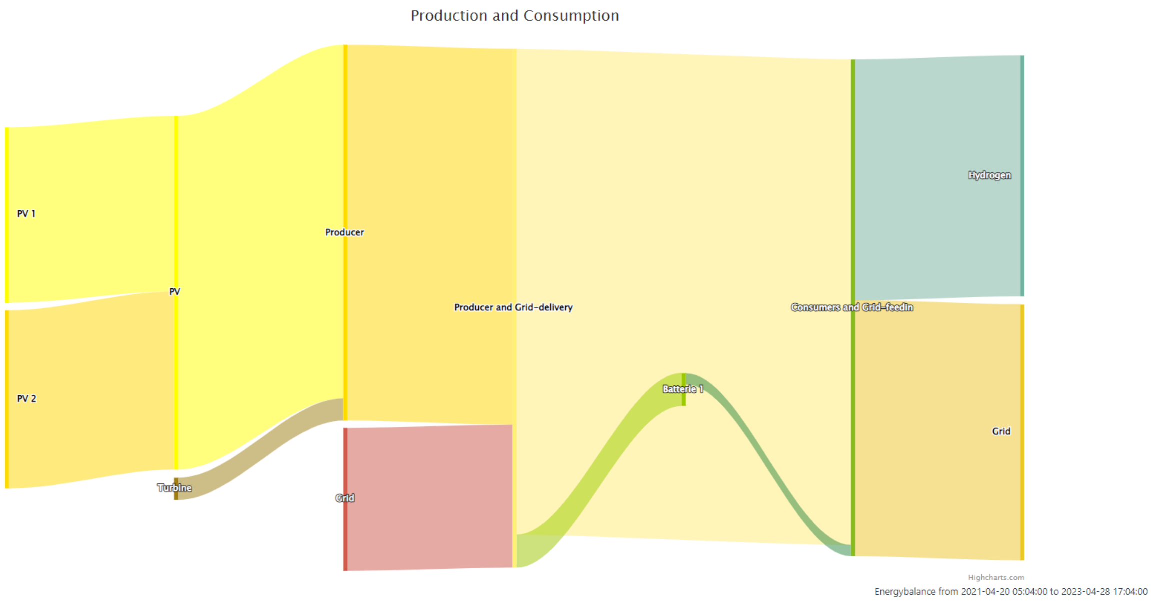
1- Mechanical running tests of engines before delivery to customers: Up to 20%vol can be mixed into the natural gas to run the gas turbine. The engine testing period is a few hours. The replacement of natural gas reduces the carbon footprint of the test. Approximately 1 ton CO2 reduction per operation hour can be achieved.

2- R&D testing to validate gas turbine technology for high hydrogen content: These tests use 75% - 100% hydrogen content per volume in the fuel. The ZEHTC plant contributes to locally produced hydrogen.

The below figures give some insight in operation experiences with this plant during the project period.



Operation example Power over time: The operation profile above shows the amount of power into the system as positive values (production) and the amount of hydrogen produced as negative values (consumption). The shorter spikes in the diagram are periods of commissioning and tuning of the gas turbine tests, for which some hydrogen has been needed. Then, at the end of the period a major testing is performed and lots of hydrogen is needed. To be able to produce enough hydrogen for these tests, electricity from the external grid in used together with the power from the solar power and the earlier turbines tests. The chosen period show preparation *and operation of the ZEHTC to support R&D testing with the target to validate turbine combustion technology for more than 75% vol hydrogen content in the fuel.*



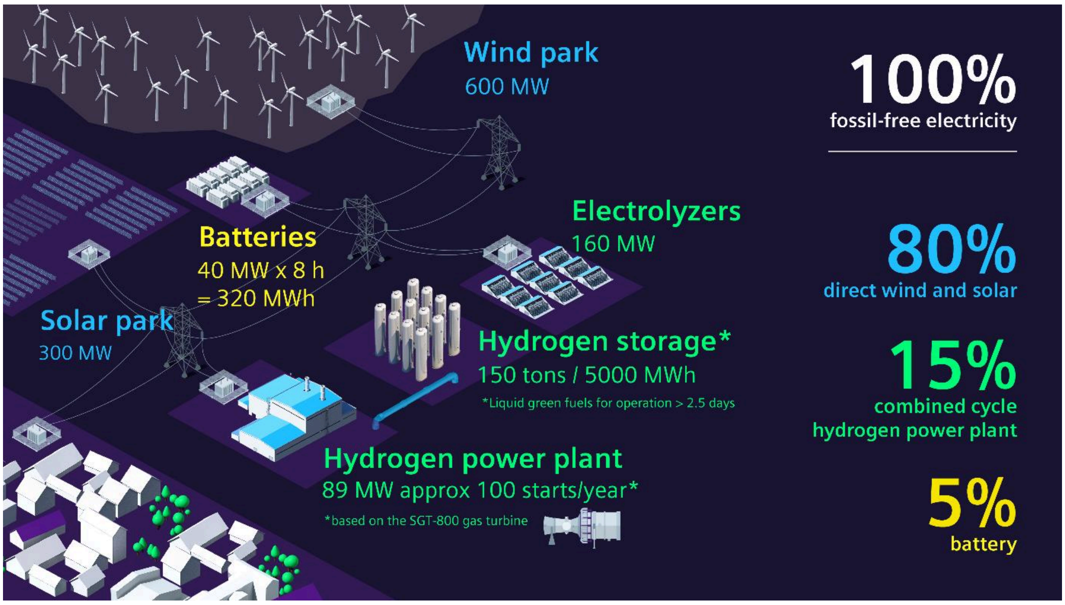
ZEHTC production and consumption: The energy diagram above is for the complete project period and it illustrates the main energy flows in the demonstration plant. As can be seen in the diagram, nearly half of the energy has been used to produce hydrogen. The remaining energy has been fed back into the electrical grid. On the production side the PV system contributed with the major share of energy in the system, which was also much earlier in operation than the hydrogen system. With continued operation of the plant the share of energy from turbine is expected to increase. In some periods the system was fed with power from the external grid. The battery has a buffering function and is useful to provide idle power for example during night.

Management and optimization

From a control and optimization perspective this operation is fully demand controlled. Studies have been made that operation could be controlled by other parameters and also automized, for example to availability of hydrogen in the storage tanks or a cost optimization. An inhouse hybrid controller system (OHC) has been installed and operated passively in parallel. This testing allowed to identify key operation requirements from ZEHTC that were adapted into the controller standard. The OHC has functionalities that could be beneficial for ZEHTC, for example the automatic operation of electrolyzer units.

A specific energy management strategy has been elaborated by the University of Bologna. It specifically demonstrated that optimizing the management strategy, the system is always able to meet the assumed demand of hydrogen; It was also concluded that with a larger hydrogen storage capacity, the microgrid would be able to exploit a higher amount of renewable production, achieving also the total renewable energy exploitation.

Scale up solution



The scale up system is building on the components demonstrated in the project and based on realistic conditions for a fictional city in northern Germany with about 250'000 inhabitants and including industry. The model behind is based on historical weather data and hourly load demand. It is optimized for a stable 100% renewable electricity system based on system levelized cost of electricity (LCOE), gas price and CAPEX in 2022 values. It also reflects on the footprints for the various components to illustrate the size of the hydrogen storage compared to other components.

To reach a 100% fossil free electricity for a city of approx. 250'000 inhabitants, 80% of the electricity would come directly from the wind and solar, and 20% of the power will be storage and re-electrified. When the wind and sun is not delivering enough electricity to meet the demand, batteries and hydrogen gas turbines power plants would support. In a wind dominated system like this, the combined cycle power plant with hydrogen fired gas turbines would deliver around 15% of the electricity demand, and 5% from the battery. Note that the heat demand is not part of this scale up study.

Modelling approach:

In the modelling some simplifications are done and average data for e.g., energy use/person and energy production from different sources are used. Some financial simplifications are that liquid natural gas (LNG) assumes to cost 20 USD/MWh, the project time is 25 years and that 1 USD=0,88 EUR (all modelling is done using USD). It is also assumed that the investment cost for PV (solar power) is 1100 USD/kW and for wind is 1300 USD/kW installed capacity. The gas turbine is assumed to have an efficiency of 58 % for a combined cycle and 38 % for a simple cycle. The maximum amount of hydrogen in the blending is set to 60 % of energy content and the efficiency and CAPEX of the electrolyzer to 60 % respectively 900 USD/kW. The CAPEX of the batteries is set to 250 USD/kWh installed (energy component), 150 USD/kW charge and 150 USD/kW discharge (power component). The simulation and optimization are conducted in a techno-economic software. Here, a system can be built by using nodes and flows where the nodes could be components or just focal points. Each component has its own parameter settings, which can include technical parameters such as efficiency, but also economical parameters such as specific CAPEX and LCOE. By this information the program can design a cost-optimal system, both from a design perspective, but also from an operational perspective. For the Net Zero System simulation the LCOE was optimized. The free parameters in this simulation are: installed PV capacity, installed wind capacity, installed gas turbine fleet capacity with fuel and load at every hour, size of listed storage technologies, power for listed storage technologies and total output power at each hour for the different listed re-electrification technologies. It is a large optimization problem, but linear.

Prerequisites for scale up

A hydrogen infrastructure needs to be developed in parallel to the energy system. There are also other energy carriers that may come into use as a hydrogen carrier, for example ammonia or methanol.

The knowledge and standards for hydrogen used in industry need to be applicable also in the energy sector. Acceptance of hydrogen still needs to be improved, which requires education.

It is expected that green hydrogen will become a very valuable resource for several sectors. The share of hydrogen gas turbines in the energy landscape depends on the market development for hydrogen and on alternative energy solutions to provide back-up power and grid stability in decarbonized energy systems.

Project Impact

One well recognized result is the modelling of a sustainable energy system done by Chalmers University showing that hydrogen fired gas turbines can play an important role balancing fluctuating renewables in the electricity sector. Time-shifting of electricity using hydrogen provide value to the European energy system by reducing the average cost of electricity. Hydrogen gas turbines are competitive to balance renewables in wind power dominated energy systems since fluctuations are relatively few, irregular and longer in duration. In solar dominated energy systems, where fluctuations are shorter but more frequent, battery storage play a large role and hydrogen gas turbines would more take the role as back-up with fewer operational hours. It was also highly appreciated by the energy community that a complete energy system has been realized and gone live to integrate gas turbine technology with renewable energy technology.

The ZEHTC is an enabler for the required R&D to reach the target of 100% hydrogen capability in gas turbines. The work has been accompanied by models for optimal design of a renewable hydrogen production facility and strategies for energy management of such a microgrid system. Upscale models and a decarbonization calculator are provided to support energy system stakeholders with key knowledge.

The project results inspire gas turbine customers and new offers on gas turbines often include hydrogen capability and fuel flexibility to meet the future market requirements. Several of Siemens Energy’s customers have during the project time bought gas turbines that are prepared for hydrogen operation to a certain level (up to 75% volume hydrogen) with the possibility to do upgrading of their units once the 100% capable modification is ready. The findings in the project have been used in customer meetings both physical at the ZEHTC plant and integrated into sales material. A scaled-up version has been developed to show how a net zero electricity system could look like at industrial scale and how battery storage and hydrogen re-electrification in gas turbines could complement solar and wind for a city of approx. 250 000 inhabitants.

The fast upgrade of new and existing power plants from fossil fuels to green hydrogen-based fuels would have tremendous impact on the CO2 emissions worldwide.

The project supported to accelerate the development for 100% hydrogen capability of gas turbines and new collaboration projects are searched.

Follow up actions

- The demonstration plant will be further utilized and extended.
- Further communication and education about existing solutions to design a future sustainable electricity system will be provided by all partners.
- Lighthouse projects showcasing the large scale implementation of hydrogen based electricity production with gas turbines are envisioned.
- Other routes are explored for example the utilization of oxygen and waste heat from the electrolyzer.
- Collaboration between industry and academic partners is continued in various forms to build on the common knowledge.
- Possible spin off projects in the region focusing on hydrogen use in transports

- Attendance of a national cooperation between the regional administrative boards in Sweden with focus on hydrogen use in the industry.
- Further development projects and collaborations have been initiated to accelerate the testing and validation of technology to burn 100% hydrogen content in the gas turbines.
- Further projects are searched focusing on grid services coupled with industry needs.

Dissemination

The project has been very active in dissemination of results in using three main channels.

Academic results have been published in relevant journals and presented at key conferences. This resulted in 7 peer reviewed articles including one licentiate thesis (academic step in Sweden towards a PhD).

The use of hydrogen received large interest from the public and project team members wrote several non-peer reviewed articles and participated in many workshops, seminars and panel debates. With this the project progress on the usage of hydrogen in the energy system contributed significantly to the public debate. Clearly, the public awareness for potential role of gas turbines in a sustainable energy system has been significantly improved. More than 60 separate dissemination activities have been counted during the project period.

Once the demonstration plant was built and in operation the production site in Finspång received tremendous interest from customers, suppliers, company employees, local entrepreneurs and other partners to visit the site and learn more about the progress on hydrogen use in the energy system. More than 50 registered demonstration site visits have been done only during 2022, and the interest is continuing to be large also during 2023.

Dissemination overview

	2019	2020	2021	2022	2023	Total
Peer reviewed articles, books, book chapters etc. published with or submitted to academic publishers	0	1	2	4		7
Non-peer reviewed publications (reports, briefs, books, articles targeting policy-makers, industry or other end users)	0	1	2	1		4
Media coverage (opinion pieces or interviews/appearances in all types of mass media)	5	8	5	5		23
Events targeting end users organised by the project (such as conferences, side events or workshops)	1	2	1	3	1	8
Presentations targeting end users given by project participants (including participation in panel debates)	0	12	4	7		23
In how many conferences / events did your project participate (not organised by project itself)?	1	5	4	6	5	21

Figure of dissemination overview reported to Era Net SES final report

References

Project web site

www.zehtc.org

List of peer-reviewed articles

Maria Alessandra Ancona, Michele Bianchi, Lisa Branchini, Francesco Catena, Andrea De Pascale, Francesco Melino, and Antonio Peretto; Renewables exploitation via hydrogen production in gas turbine test facilities: the ZEHTC Project; 100RES 2020 – Applied Energy Symposium (ICAE); ; ; E3S Web Conf., 238 (2021) 02006; DOI: https://doi.org/10.1051/e3sconf/202123802006

M. A. Ancona, M. Bianchi, L. Branchini, A. DePascale, F. Ferrari,F. Melino, A.Peretto; Optimal Design of Renewable Hydrogen Production for Gas Turbine Test Facilities; Proceedings of ASME Turbo Expo 2021: Turbomachinery Technical Conference and Exposition, Paper No: GT2021-59218, 007T16A005; 10 pages; ; ISBN: 978-0- 7918- 8500-0; Vol 7, 2021; https://doi.org/10.1115/GT2021-59218

Simon Öberg, Mikael Odenberger; Filip Johnsson; Exploring the competitiveness of hydrogen-fueled gas turbines in future energy systems; International Journal of Hydrogen Energy; 624-644; ISSN:
0360-3199; vol 47,issue 1,2022; https://doi.org/10.1016/j.ijhydene.2021.10.035

Simon Öberg, Mikael Odenberger, Filip Johnsson; The value of flexible fuel mixing in hydrogen-fueled gas turbines – A techno-economic study; International Journal of Hydrogen Energy; 31684-31702; ISSN 0360-3199; Volume 47, Issue 74, 2022; https://doi.org/10.1016/j.ijhydene.2022.07.075

Simon Öberg, Mikael Odenberger, Filip Johnsson; The cost dynamics of hydrogen supply in future energy systems – A techno-economic study; Applied Energy; ; ISSN 0306-2619; Volume 328,
2022,120233; https://doi.org/10.1016/j.apenergy.2022.120233

Ancona M.A.; Bianchi M.; Branchini L.; Catena F.; De Pascale A.; Melino F.; Ottaviano S.; Peretto A.; Optimal Strategy of the Energy Management Within the Microgrid Using the Hydrogen Fueled Gas Turbine; Proceedings of the ASME Turbo Expo 2022: Turbomachinery Technical Conference and Exposition. Rotterdam, Netherlands. June 13–17, 2022. Paper No: GT2022-80385, V007T16A002. ASME; ISBN: 978-0-7918-8605-2; Vol 7, 2022; https://doi.org/10.1115/GT2022-80385

Simon Öberg; Licentiate thesis: Hydrogen in the European energy system - The cost dynamics and the value of time-shifting electricity generation; Chalmers University of Technology; https://research.chalmers.se/publication/530305

List of non-peer reviewed publications, public reports, magazines and web sites

Åsa Lyckström; Exclusive: Green for 'go' on hydrogen turbines (2020); Power Engineering International; https://www.powerengineeringint.com/hydrogen/green-for-go-on-hydrogen-turbines/

Siemens Energy; Siemens Energy Stories 2021: Zero Emission Hydrogen Turbine Center – on the path to decarbonization (2021) Zero Emission Hydrogen Turbine Center (ZEHTC) | Hydrogen | Siemens Energy Global

Siemens Energy; Siemens Energy Stories 2021: Into the clean-hydrogen frontier (2021); Into the clean hydrogen frontier | 2021 | Siemens Energy Global

Markus Jöcker; Putting the T in the ZEHTC and closing the Hydrogen-loop in the turbine facility (2022); LinkedIn https://www.linkedin.com/pulse/putting-zehtc-closing-hydrogen-loop-turbine-facility-markus-j%25C3%25B6cker/?trackingId=Ha7HXyxZRj21%2Feb%2FeCd1DQ%3D%3D

Åsa Lyckström, Zero Emission Hydrogen Turbine Center in Finspång -four things we've learnt; Modern Power Systems;

https://www.modernpowersystems.com/features/featurezero-emission-hydrogen-turbine-center-at-finspng-four-things-weve-learnt-10919316/

Other dissemination activities

2020

Swedish television SVT
Swedish radio P4
Magazine - Affärsstaden East Sweden-200427.
Magazine -Miljömagasinet-200430.
Magazine - Era Net awards
Magazine - Länstidningen-200124,
Magazine - Ny Teknik-191212,
Magazine - Tidningen Energi 7/2000,
Hydrogen in the future
Mariestad study trip
E-day Östergötland
Klimatkommunerna
municipal authority
Power Summit
Framtidens elsystem
World Energy Council, Romania
Hydrogen conference towards German end users
SHDC (Swedish Hydrogen Development Center)
SamsepEL Forum
ERA Net SES joint programming conference
Sustainergies towards Linköping University
Users conference SGT-800, Latin America

2021

Almedalen presentation (virtual event)
Publication and posts on Linkedin about commissioning of the plant.
Enlit Europe panel debate and film presentation of plant (23/6)
Renewables summit panel debate, Stockholm (17/3)
SNS webinar and panel debate (21/6)
Siemens Energy: SGT-800 user conference Thailand (16/6)
SamspEL Forum for project leaders 28/10
Science unparked 12/11- regional presentation
ERA-Net conference 24/11, break out session
regional Hydrogen conference 211029

2022

Almedalen presentation, Visby
Siemens Energy Magazine: Modelling net zero
Power Engineering International: Managing change to reach a decarbonised energy system
Power Engineering International: Five uncomfortable truths about the energy transition
Energy voice: Hy hopes: A green future for gas turbines?
Finpong municipality - an event with local high school students - workshop with lectures and site visit
Finpong municipality - local entrepreneurs and Hydrogen Sweden - seminar
Siemens Energy: IndX local start up event hosted at Siemens Energy
IEA Bioenergy workshop (online)
Era Net SES programme conference presentation
Conferens Framtidens Elsystem, Stockholm
SamspEL Arena: Framtidens elbehov, Stockholm
Finpong municipality -study visit in Mariestad, all on-line-published event according to hydrogen gas station
Customer conference in Latin America
Press conference in Finspong about hydrogen gas turbines
Gasdagarna 2022, Båstad, Energigas Sverige.
Macro Energy Systems Workshop 2022, Stanford University, Palo Alto.
IPowerE 2022 Conference, Kegworth, UK
HFC Nordic conference
Formel framtid, Stenungssund
Mid Sweden Hydrogen valley, Sandviken
Industridagen Östergötland
H22 Conference, Helsingborg
Users conference SGT-800, Thailand

2023
KTH Innovation Energy Event 2023
Lectures about hydrogen gas turbines
Hydrogen Sweden member committee seminar and site visit in Finspong
Introduce a girl to engineering day 2023- site visit in Finspong
Siemens Energy: Seminars with transmission system operators (Sweden and Denmark)
Visit of Linköping university sustainability transitions, PhD 2023
Global Users conference SGT-800, Amsterdam

Appendix: Selected highlights

Start of civil work August 2020

Arrival of storage containers December 2020


Solar panels installation start winter 2021


The compressor got a roof and a protection wall, June 2021

Commissioning September 2021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First operation of a gas turbine (SGT-700) with own hydrogen – a view into the control room, December 2021

Presentation for schools in Finspong, March 2022

ZEHTC project consortium meeting, May 2022

One of many conferences, 2022

Press visit September 2022

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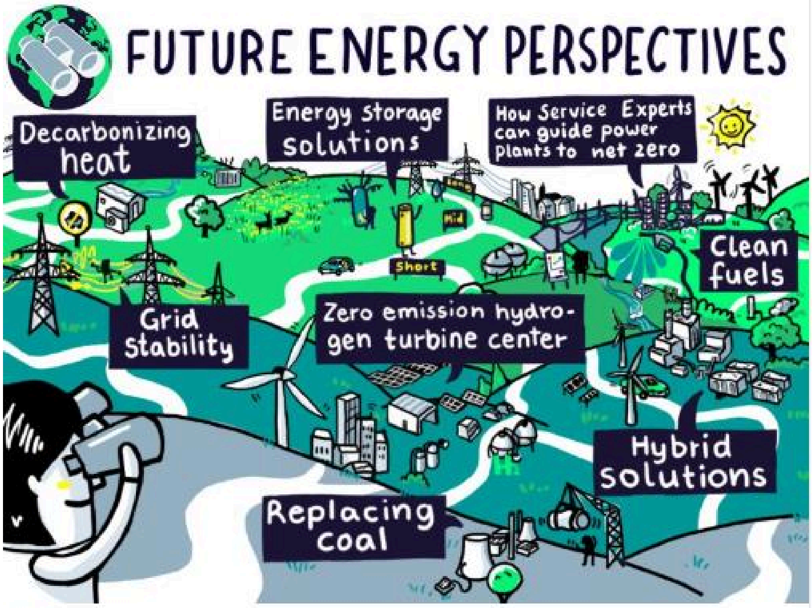
The world is moving towards a net-zero economy – and it needs to. However, while important steps are being taken such as phasing down coal or accelerating renewables, nobody knows exactly how the future energy landscape will look. That's why Power Engineering International and Siemens Energy experts have teamed up for a nine-part series of articles that delivered incisive insight into the essential pathways to a decarbonised world.

View all of them here: https://lnkd.in/d7StbTKW



158
3 comments • 22 reposts

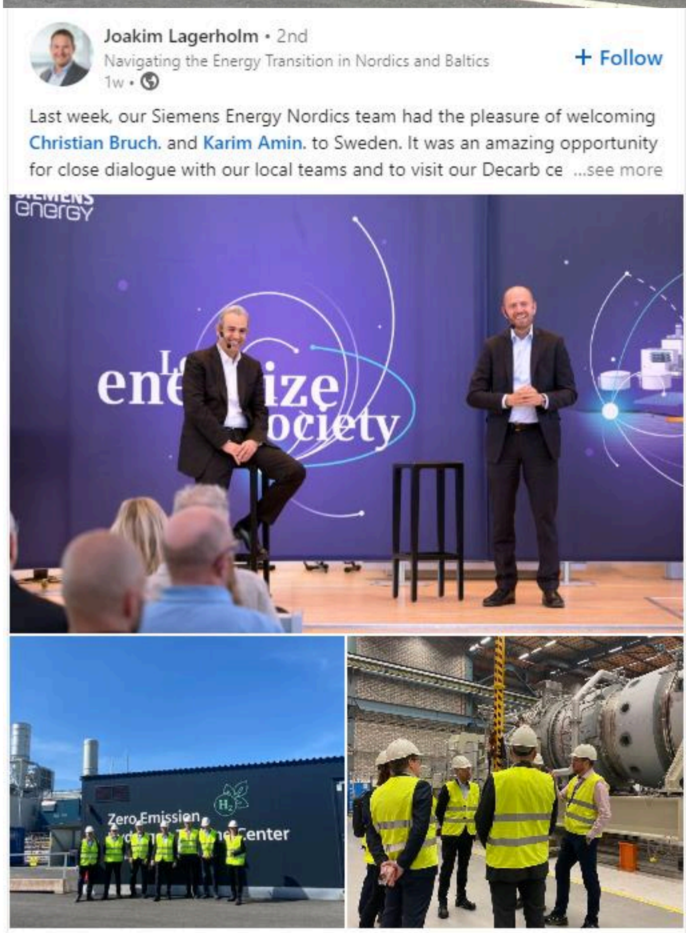
The ZEHTC in the press, 2022

Hydrogen Sweden visits the Finspong location, 2022

ZEHTC project active in the ERA Net SES program of funded projects, 2022

A local event for entrepreneurs interested in hydrogen technology, 2022

One of many customer visits, 2023



Siemens Energy CEO Christian Bruch and executive board member Karim Amin visits the site in May 2023