European Commission

Solar energy generation and storage

Horizon 2020 projects developing more sustainable processes for the planet and people

Introduction

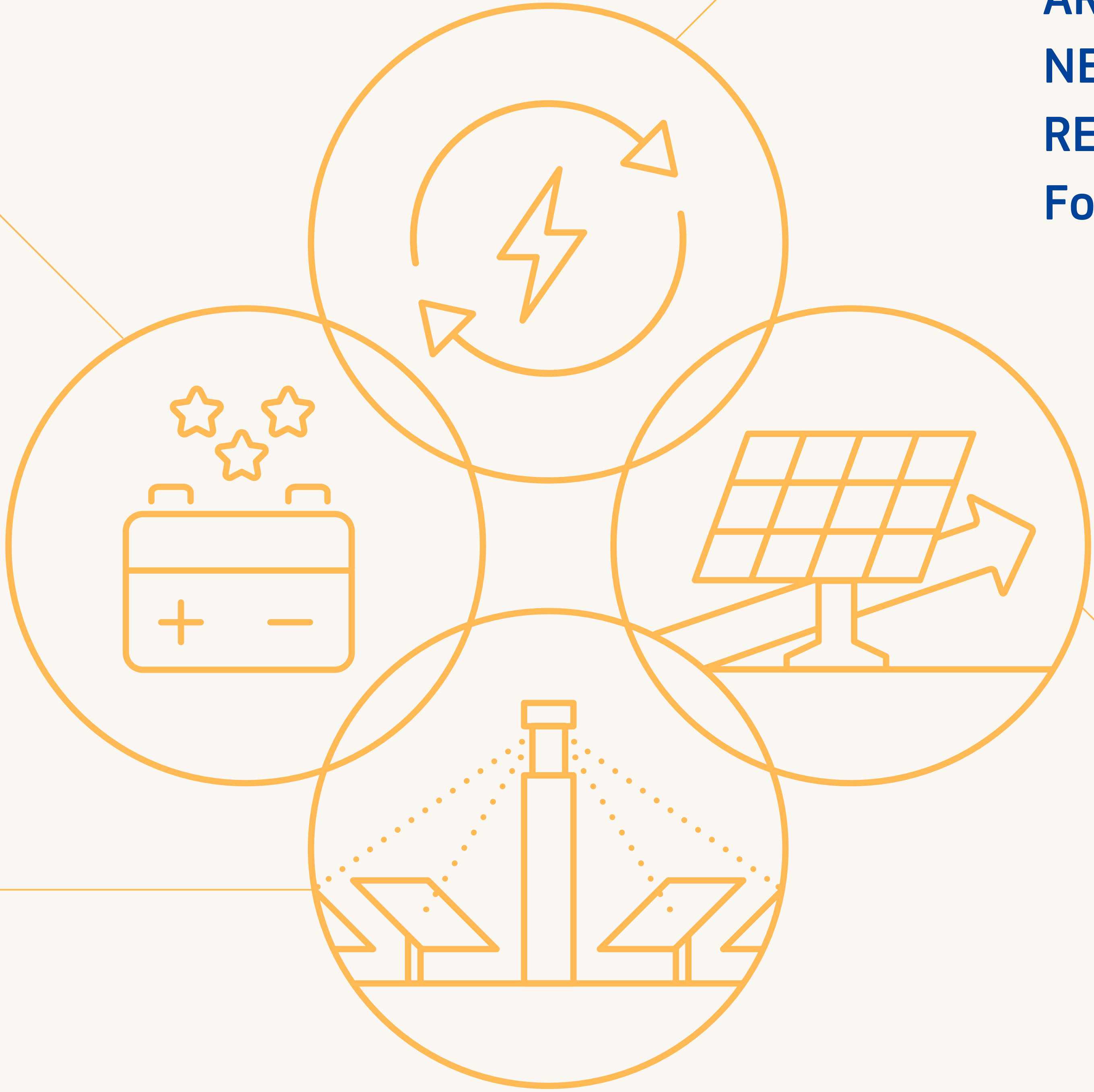
A rapid and massive deployment of renewable energy is at the core of REPowerEU - the EU's plan to accelerate the clean energy transition and put an end to its dependency on fossil fuels. Solar energy plays a key role in this transition and will spearhead this effort as outlined in the EU Solar Strategy.

In the EU and beyond, widespread use of solar power will help green our energy across all sectors of our economies and societies, from residential heating to industrial processes. However, production and storage of solar power is still challenging mainly due to high maintenance costs, European dependence on critical raw materials and their environmental and social costs..

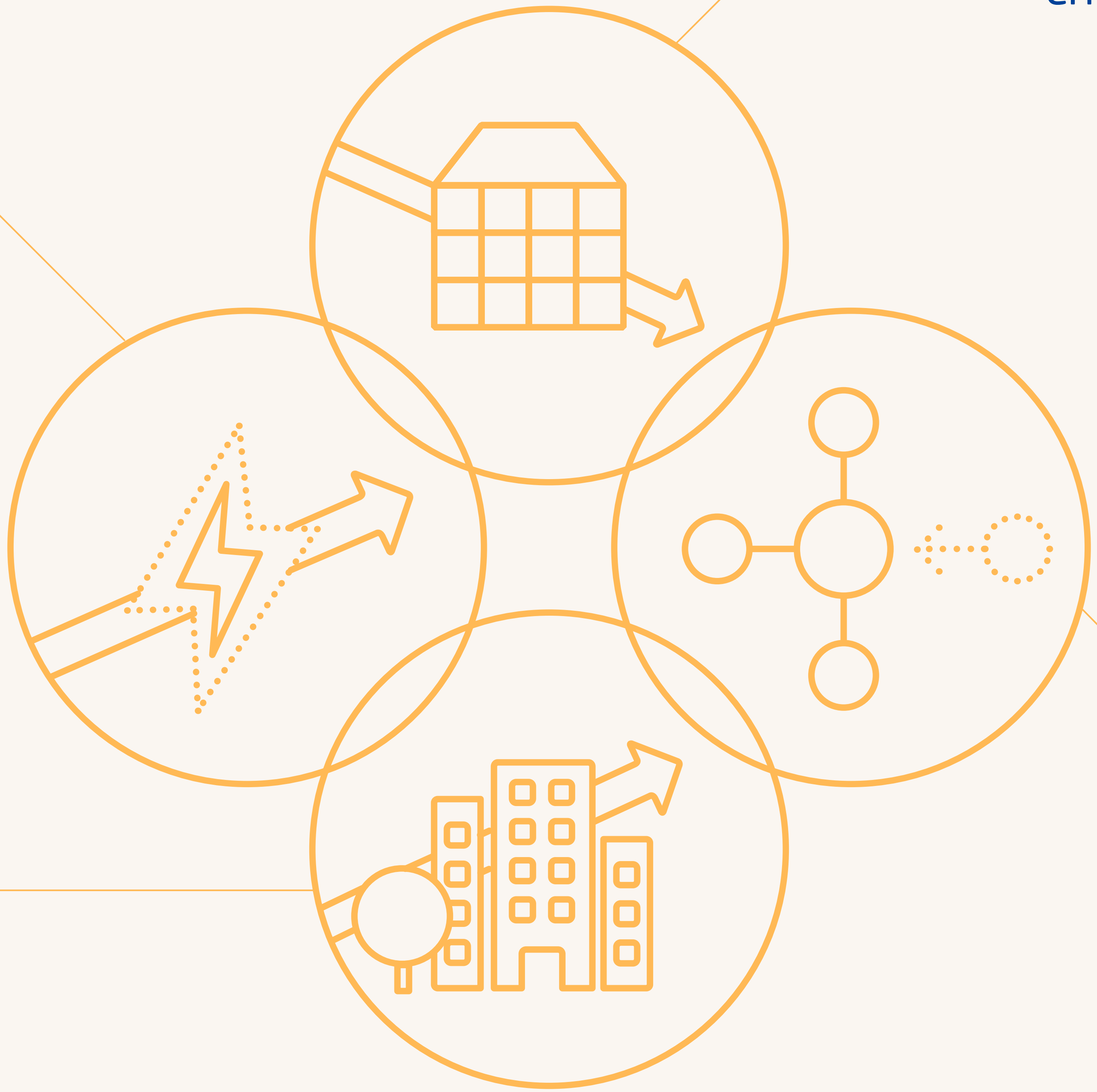
To overcome these obstacles the European Commission is investing in research and development of technologies, and in deploying them in solar energy systems, batteries and other forms of energy storage. To accelerate the clean energy transition and harness even more of solar energy it is necessary to make these technologies more efficient, sustainable and resilient.

Discover below some of HaDEA's projects funded under Horizon 2020 that are developing solutions to address the challenges of making renewable energy generation and storage as sustainable as possible.

The projects



Impacts



Using fewer harmful and/or critical (raw) materials

Increasing lifetime, capacity or output

Offering new ways of implementation within existing infrastructure

Providing other economic or social valuable output, apart from power/fuel

Power-to-X

Energy carriers with reduced raw material needs – hydrogen & ammonia

ARENHA

Advanced materials and Reactors for ENergy storage tHrough Ammonia

€5 684 325

1 April 2020 – 31 March 2024

arenha.eu

Project description

ARENHA seeks to develop, integrate and demonstrate key material solutions using ammonia for flexible, safe and profitable storage and utilisation of energy. Ammonia is an excellent energy carrier due to its high energy density, carbon-free composition, industrial know-how and relative ease of storage.

Specifically, ARENHA will develop advanced solid oxide electrolyser cells for renewable hydrogen production, catalysts for low temperature/pressure ammonia synthesis, solid absorbents for ammonia synthesis intensification and storage, and catalysts and membrane reactors for ammonia decomposition.

Energy discharge processes studied in ARENHA tackle various applications from ammonia decomposition into pure hydrogen for fuel cell electric vehicles, direct ammonia utilisation on solid oxide fuel cell for power, to internal combustion engines for mobility.

Challenge addressed

Using ammonia as a storage medium for electricity is promising as it can store even more energy than hydrogen. At the same time, ammonia can also be used as a vehicle fuel directly – without emitting any CO2.

NEXTAEC

Materials for next generation alkaline electrolyzer

€4 399 445

1 April 2020 – 31 March 2024

www.nextaec.eu

Project description

The PEM electrolyser can operate at high current densities due to the low internal resistance of a thin acidic ion conducting membrane, but it relies on expensive noble metals. In contrast, the alkaline electrolyser does not need noble metals but it suffers from higher internal resistance because it does not have a thin ion conducting membrane.

To address this, NEXTAEC will develop an alkaline electrolyser around the new concept of an ion-solvating membrane. It is a polymer, which dissolves the electrolyte of the electrolyser (aqueous potassium hydroxide). Like an ion-exchange membrane, it is nonporous and it can therefore - contrary to a porous diaphragm - be as thin as an ion exchange membrane.

Challenge addressed

The absence of noble metals, including platinum group metals which are critical raw materials, makes it possible to roll out the technology in the multi GW scale that is needed in the green transition away from the dependence on fossil fuels.

RECYCALYSE

New sustainable and recyclable catalytic materials for proton exchange membrane electrolysers

€5 560 727

1 April 2020 – 31 March 2023

recycalyse.eu

Project description

RECYCALYSE will disrupt the energy storage market through novel and recyclable catalytic materials made of abundant elements to be used in the most promising type of electrolysers to date, i.e. proton exchange membrane electrolysers (PEMEC). It aims at developing and manufacturing highly active sustainable oxygen evolution (OER) catalysts that will reduce or eliminate critical raw materials (CRMs), thus decreasing CO2 emissions and costs.

This will be achieved using novel supports and by substituting CRMs with earth abundant elements such as nickel, manganese and copper. Secondly, a recycling scheme for PEMEC catalysts, electrodes and overall system will aim at reducing the dependence on materials imports in Europe and implementing the recovered elements in the new developed catalysts.

Challenge addressed

Water electrolysis is a key technology for storing excess renewable energy. RECYCALYSE aims to break the bottlenecks that hold back the further development of PEMEC, namely the high capital costs and the use of CRMs. Its recycling scheme and its approach to sustainable development and management of materials could ultimately reduce EU imports and create a circular economy.

FotoH2

Innovative Photoelectrochemical Cells for Solar Hydrogen Production

€2 578 971

1 January 2018 – 31 December 2021

fotoh2.eu

Project description

FotoH2 made for breakthroughs in cell lifetime, conversion efficiency, cost-efficiency, and hydrogen purity by introducing anion-exchange polymer membranes and porous hydrophobic backing concepts in a tandem photoelectrochemical cell. The project also proposed a novel way to stabilise the photoelectrodes based on a surface phase transformation.

This approach allows the use of cost-effective metal oxide electrodes with optimal bandgaps and a simple flow-cell design without corrosive electrolytes.

Challenge addressed

The use of solar energy for photoelectrochemical water splitting faces several challenges, such as low solar-to-hydrogen efficiency, expensive electrode materials, fast degradation, energy losses and water vapour in the output stream. FotoH2 developed new materials for achieving cost-effective solar-driven hydrogen production.

New battery technologies

Beyond Lithium-ion (Li-ion) – modelling and materials for safe and sustainable batteries

NanoBat

GHz nanoscale electrical and dielectric measurements of the solid-electrolyte interface and applications in the battery manufacturing line

€4 966 912

1 April 2020 – 31 March 2023

www.nanobat.eu

Project description

NanoBat aims to develop a novel nanotechnology toolbox for quality testing of Li-ion and beyond lithium batteries. With the aim of surpassing currently available non-destructive quality testing techniques, the toolbox will focus on the nanoscale structure of the SEI layer (solid electrolyte interphase) – an electrically insulated layer preventing ongoing electrolyte decomposition.

It will contain novel high-frequency GHz methods to test and quantify the electrical processes at the SEI which are responsible for battery performance and safety, but difficult to characterise and optimise.

Challenge addressed

Being faster and more accurate than existing methods, the radio frequency nanoscale techniques to be developed in NanoBat have the potential to redefine battery production and greatly benefit the clean energy and e-mobility transition in Europe.

SPIDER

Safe and Prelithiated hIgh energy DEnsity batteries based on sulphur Rocksalt and silicon chemistries

€7 975 192

1 January 2019 – 31 August 2022

www.project-spider.eu

Project description

The SPIDER project proposes a multidisciplinary approach to develop safe and long-lifetime, high energy density cells. This approach is based on new materials, improved chemistries, new industrially relevant manufacturing process steps and complimented by in-depth characterisation, safety, modelling and Life-cycle cost analysis studies.

Challenge addressed

The demand for electric vehicles is growing. Improvements of Li-ion battery cost, performance, recyclability, increased range and safety, as well as shorter charging times are key to increase the electric vehicles' market share. SPIDER developed a next generation Li-ion battery with the potential to provide the technological progress that is necessary to accelerate the deployment rates of electric vehicles.

ALISE

Advanced Lithium Sulphur battery for xEV

€6 852 301

1 June 2015 - 31 May 2019

cordis.europa.eu/project/id/666157

Project description

Batteries are still the limiting factor for mass scale adoption of electric vehicles (EV) and there is a need for new batteries that enable higher driving range, higher safety and faster charging at lower cost. Lithium sulfur (Li-S) is a promising alternative to Li-ion, is free of critical raw materials and non-limited in capacity and energy by material of intercalation. ALISE is dedicated to the development of new materials and the understanding of the electro-chemical processes involved in the lithium sulfur technology.

The project achieved 500 Wh/Kg stable Li-S cell. The project involves dedicated durability, testing and life cycle assessment activities that will ensure the safety and adequate cyclability of the battery being developed and availability at competitive cost.

Challenge addressed

Lithium sulfur batteries contain no cobalt and therefore greatly reduce the content of critical raw materials for this battery technology.

Improved photovoltaics

Lightweight for many purposes – new photovoltaic materials

SUN-PILOT

Subwavelength Nanostructure Pilot (Sun-Pilot)

€7 056 398

1 January 2018 – 30 June 2022

www.sunpilot.eu

Project description

The impact of SUN-PILOT for the optics industry is a disruptive technology that will boost the performance/cost ratio of photonic devices by piloting mass fabrication of scratch and wear resistant nanopatterned antireflective optical surfaces.

Significant enhancement will be achieved in the efficiency of optical components and systems incorporating these devices, such as laser systems, electronic displays, security cameras and medical devices. The automotive industry will benefit from a novel method to produce functional surfaces at lower cost and lighter weight than existing lamination methods.

Challenge addressed

Reduced reflectivity in solar panels will increase their productivity. SUN-PILOT developed a novel and cost-effective platform for up-scaling sub-wavelength nanostructures fabrication techniques that can be applied to curved surfaces such as optical lenses, and the mass production of metal moulds for injection moulding of plastic parts.

STARCELL

Advanced strategies for substitution of critical raw materials in photovoltaics

€4 832 185

1 January 2017 – 31 December 2019

cordis.europa.eu/project/id/720907

Project description

STARCELL was established to advance the development of a thin-film photovoltaic (PV) technology based exclusively on materials that are abundant in the Earth's crust. This is a critical undertaking, as the main PV solutions available in the market contain at least one (or more) critical raw material, such as indium.

STARCELL worked to identify and solve the main fundamental problems that are currently limiting the conversion efficiency of the solar cell devices. Solutions based on doping and alloying strategies have been applied with success.

Challenge addressed

STARCELL developed technology in PV that avoids the use of critical raw materials identified by the European Commission. Access to a fully sustainable PV technology that can be completely produced in Europe will enhance energy security, create high-quality jobs, and help improve green energy production.

ARCIGS-M

Advanced aRchitectures for ultra-thin high-efficiency CIGS solar cells with high Manufacturability

€4 498 700

1 December 2016 - 30 November 2020

cordis.europa.eu/project/id/720887

Project description

ARCIGS-M developed:

1. surface functionalised steel substrates,
2. nano-structuring strategies for optical management of rear contact layers,
3. passivation layers with nano-sized point openings,
4. and ultra-thin copper-indium-gallium-selenide thin film absorber layers for novel photovoltaic device architectures.

ARCIGS-M targets enhanced performances, yields and stability, while maintaining manufacturability.

Challenge addressed

ARCIGS-M targets very specifically building integrated photovoltaics, which are one of the most productive, easy to deploy and environmentally friendly ways to generate electricity directly from the sun. ARCIGS-M's new design allows for an increased lifetime and better materials resource efficiency (ultra-thin layers require less Indium and Gallium and barrier and passivation layers that hinder alkali metal movement).

INFINITY

Indium-Free Transparent Conductive Oxides for Glass and Plastic Substrates

€4 003 243

1 December 2014 - 30 April 2018

infinity-h2020.eu

Project description

INFINITY developed an inorganic alternative to a scarce and high-cost material, indium tin oxide (ITO), currently used as a Transparent Conductive Coating (TCC) for display electrodes on glass and plastic substrates. Thin films made from transparent conducting oxides (TCO) are used in a variety of optoelectronic devices including flat panel displays (LCD), photovoltaic cells and hetero-junction solar cells.

The project set out to produce a demonstrator PV and display devices using printed indium-free anodes, with performance characteristics equivalent to current devices.

Challenge addressed

The most commonly used TCO is indium tin oxide (ITO) due to its high electrical conductivity and high light transmission. However, indium is a scarce and expensive metal. The project substituted indium tin oxide with inorganic alternatives and worked on novel printing procedures to enable direct writing of multi and patterned nano-layers, removing the waste associated with etch patterning.

Concentrated solar power

From sun to heat to electricity – materials for longer lifetime

IN-POWER

Advanced Materials technologies to QUADRUPLE the Concentrated Solar Thermal (CSP) current POWER GENERATION

€4 998 928

1 January 2017 – 30 June 2021

cordis.europa.eu/project/id/720749

Project description

IN-POWER developed and integrating new material solutions into concentrated solar technology to increase the efficiency while simultaneously decreasing the energy production costs.

The project focused on advanced materials such as high reflectance tailored shape light free glass mirror, high working temperature absorber in vacuum free receiver, and optimised reduced mass support structure to allow upgrading current solar field.

Challenge addressed

The benefits of high efficiency concentrated solar power (CSP) and photovoltaic are well known and include environmental protection, economic growth, job creation and energy security. However, those technologies can only be applied properly in regions with high annual mean solar radiation values, and a reduced Levelled Cost of Electricity (LCOE). IN-POWER aimed validated these novel functional materials and new manufacturing processes to guarantee a decrease in the Levelised Cost of Electricity.

NEXTOWER

Advanced materials solutions for next generation high efficiency concentrated solar power (CSP) tower systems

€4 981 304

1 January 2017 - 30 June 2021

www.h2020-nextower.eu

Project description

NEXTOWER introduced a new generation of materials, especially in the thermal storage compartment, to boost the performance of atmospheric air-coolant concentrated solar power systems by working longer and at much higher temperatures.

Challenge addressed

Concentrated solar power tower systems offer tremendous potential as a sustainable power supply option for efficient (electrical and thermal) power generation. However, their industrial exploitation is hindered by limitations in the materials used both for the central receiver - the core component - and for thermal storage. Such limitations dictate maximum working temperature and in-service overall durability (mainly driven by failure from thermal cycling and thermal shocks). NEXTOWER achieved virtually maintenance-free operations and increased working temperature.

RAISELIFE

Raising the Lifetime of Functional Materials for Concentrated Solar Power Technology

€9 291 722

1 April 2016 - 31 March 2020

cordis.europa.eu/project/id/686008

Project description

The project developed novel materials with extended lifetime and performance for parabolic trough and solar tower CSP (concentrated solar power) plants and thus reducing electricity generation costs.

In particular, RAISELIFE focused on extending the in-service lifetime of five key materials for CSP technologies:

1. protective and anti-soiling coatings of primary reflectors,
2. high-reflective surfaces for heliostats,
3. high-temperature secondary reflectors,
4. receiver coatings for solar towers and line-focus collectors,
5. and corrosion resistant high-temperature metals and coatings for steam and molten salts.

Commercial implementation of these technologies could reduce the Levelled Cost of Electricity (LCOE) per kWh of electricity

Challenge addressed

Energy costs from concentrated solar power depend among other things on the lifetime of the materials making up the plants. RAISELIFE increased the lifetime of multiple components found in different kinds of concentrated solar power plants and thereby reducing the cost of generating electricity.

COMPASsCO2

Components' and materials' performance for advanced solar supercritical co2 powerplants

€5 996 892

1 November 2020 - 31 October 2024

cordis.europa.eu/project/id/958418

Project description

The project focuses on the integration of storable solar energy provided by concentrated solar power systems (CSP), into the supercritical CO2 (s-CO2) Brayton cycle. While conventional power plant cycles produce power from turbines using water or steam as the working fluid, s-CO2 cycles use CO2. CSP systems use large mirror areas to concentrate solar radiation onto a receiver and provide this energy to a heat transfer medium, which is used to produce electricity in a conventional steam cycle.

In parallel, part of the thermal energy collected is usually stored in thermal storage systems to be able to operate the turbine during night or cloudy conditions. Currently, research focuses on the development of systems that can reach higher temperatures than those applied on commercial plants (390-560°C). COMPASsCO2 focuses on material and lifetime aspects of the particles and the metals being in contact with them and to validate a particle/s-CO2 heat exchanger.

Challenge addressed

COMPASsCO2 is developing a new way of storing solar energy in high temperatures (>900ºC) allowing to run continuously industrial processes that are heat demanding. It is also generating cost savings from the fact that s-CO2 needs little energy to be compacted so the required equipment is smaller.

HW-05-22-389-EN-N

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Manuscript completed in 2022
The views expressed in this document are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission.
More information on the European Union is available on the internet (http://europa.eu).
Luxembourg: Publications Office of the European Union, 2022

Publications Office
of the European Union

ISBN: 978-92-95224-23-0
DOI: 10.2925/700193