"The coolest cold from the cleanest heat"

The handy glossary for RE-WITCH

RE-WITCH



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Terminologies

- Page 3 TES: Thermal energy storage: The storage of thermal energy for later reuse.
- **Page 4-DHN:** District Heating Network Distributing heat generated in a centralised system for residential and commercial use.
- Page 5-BIM: Building Information Modelling-the process of creating and managing information for a built asset.
- **Page 6-LCA:** Life Cycle Analysis a methodology for calculating the environmental impacts of the entire lifecycle of a product/service.
- Page 7-LCC: Life Cycle Costing-all the costs that will be incurred during the lifetime of the product, work or service.
- Page 8 BOS: Balance of system encompasses all components of a photovoltaic system other than the photovoltaic panels.
- **Page 9-SIL approach:** Software-in-the-loop-a method of testing and validating code in a simulation environment to improve the quality of the code.
- Page 10-HEX: Heat exchanger-used to transfer heat from one medium to another.
- Page 11-WH: Heat generated as a by-product of an industrial process.
- **Page 12-TRL:** Technology readiness level a type of measurement system used to assess the maturity level of a particular technology.
- Page 13 Digital twin platform-a digital model designed to reflect a real world object or process.
- **Page 14-STEP:** Standard for exchange of product data model-an international standard to exchange product data between CAD systems with a neutral file format and data structure.
- **Page 15-Impeller:** An impeller or impellor is a driven rotor used to increase the pressure and flow of a fluid. It is the opposite of a turbine, which extracts energy from, and reduces the pressure of, a flowing fluid./Impellers transfer energy from the motor that drives the pump to the fluid being pumped by accelerating the fluid radially outwards from the centre of rotation.
- **Page 16-Thermal COP:** A measure of the energy efficiency of a thermally-driven sorption cooling device. It is defined as the ratio between the cooling energy provided and the high-temperature energy used to drive the sorption device (it can be provided by waste heat source and/orrenewable heat).
- **Page 17-MOFS:** Metal Organic Frameworks-MOFs are crystalline porous solids composed of a three-dimensional (3D) network of metal ions held in place by multidentate organic molecules.
- **Page 18-HVFP:** An innovative, high performing non-concentrated solar thermal technology developed by TVP Solar. The technology combines high vacuum (below 0.1Pa) and flat design. Existing HVFP-based systems deliver heat up to 180C and have been designed for large-scale applications of industrial heat and district heating. The next generation of HVFPs is under development and aims to reach up to 250C.
- **Page 19 Absorption vs adsorption:** The main difference is that while absorption involves the mass transfer of particles into another material (one substance absorbing another), adsorption takes place with the adhesion of particles onto the surface of a substance.
- **Page 20 BREF:** BAT reference documents a publication resulting from a series of exchanges of information between a variety of stakeholders.

ANDMORE:

- **P&ID:** Piping and instrumentation diagram, shows the piping and related components of a physical process flow.
- **TRNYS:** Transient System Simulation Tool-a commercial simulation software for energy systems.
- **REIIs:** Resources and Energy Intensive Industries.

TES Thermal Energy Storage





Employing widely different technologies, it allows surplus thermal energy to be stored for hours, days, or months. Scale, both of storage and use, varies from small to large – from individual processes to district, town, or region. Usage examples are the balancing of energy demand between daytime and nighttime, storing summer heat for winter heating, or winter cold for summer cooling. How? By heating or cooling a substance so the energy can be used when needed later.

In **RE-WITCH**, partners will develop and demonstrate innovative thermally-driven technologies into four demonstration cases in Spain, Poland, Greece and Italy. TES will allow these demo cases to manage heat and cold energy flows for their processes by efficiently storing high-temperature heat (50-200°C) and cold (-35°C to 5°C), helping manage fluctuations in cooling and heating demand thus enhancing energy flexibility.

In RE-WITCH, there is a clear connection between TES and solar thermal collectors. The solar thermal collectors -particularly the High Vacuum Flat Panels (HVFPs) manufactured by partner TVP Solar- capture solar energy, which can then be stored using TES systems and offer turnkey solar thermal systems for industrial-scale applications. TES allows the storage of heat from the solar collectors and provides flexibility by releasing the stored energy when needed, even during periods when solar energy isn't available (night or during cloudy days). This combination enhances energy efficiency and flexibility in industrial processes by ensuring a continuous supply of thermal energy.



Optimised techno-economic integration between low-grade (<100 °C) industrial waste heat and high-efficiency vacuum flat plate solar collectors, will drive process cooling generation and provide process heating. Specific tools will support determining the solar thermal system layout, the integration within the industrial environment as well as with the other technologies. The integration routes will be tested and modelled with BIM modelling.





https://www.wbcsd.org/resources/renewable-industrial-heat-navigator-brief-thermal-energy-storage/

DHN District Heating Network



District Heating Networks are essential for optimizing the recovery and redistribution of waste heat generated by industrial processes. By utilizing this otherwise wasted energy, RE-WITCH enables heat to be delivered to multiple consumers efficiently via a network of insulated pipes, ensuring minimal energy loss. This system reduces dependence on fossil fuels and maximizes the use of local waste heat sources.

The project enhances traditional DHN systems by integrating advanced hybrid heat pumps and thermal energy storage technologies. These components allow RE-WITCH to balance energy supply and demand dynamically, storing excess heat and making it available when needed. This innovative approach enables us to provide heating (and cooling) to residential, commercial, or industrial buildings with increased energy efficiency and reduced carbon emissions.





DHNs in the RE-WITCH project offer a scalable solution for regions with high heat demand, demonstrating the potential of waste heat recovery in the transition to low-carbon energy systems. By tapping into industrial heat sources and integrating cutting-edge technologies, RE-WITCH is setting new standards for sustainable district heating and cooling.





https://guidetodistrictheating.eu/technology/



https://www.iea.org/energy-system/buildings/district-heating

BIM Building Information Modelling

BIM is a digital modeling process that provides a shared, real-time platform for designing, managing, and visualizing systems and infrastructure. For RE-WITCH, BIM ensures that all technological components, from heat exchangers to heat pumps, are optimally designed and integrated into industrial settings.

BIM's Role in RE-WITCH:



- **System Visualization**: BIM enables detailed visualizations and simulations, allowing us to identify potential inefficiencies before implementation.
- Integration Across Components: It ensures smooth coordination between technologies, reducing installation time and costs.
- **Scalability:** BIM supports the replicability of RE-WITCH solutions across various industrial applications, adapting to site-specific needs.

Through BIM, RE-WITCH achieves higher precision in project design and execution, paving the way for a future where digitalization and sustainability go hand in hand.

LCA Life Cycle Analysis



Life Cycle Analysis is a critical process in RE-WITCH, assessing the environmental impact from the start to the end of our technologies' life. By examining emissions, energy consumption, and resource usage at every stage, we gain a comprehensive view of the environmental benefits introduced by our solutions.



In RE-WITCH, Life Cycle Analyses focus on:



- ✓ Emissions Reduction: Quantifying GHG savings across demo sites to measure the environmental benefits of our tech.
- ✓ **Sustainability Metrics:** Using pre-defined KPIs to ensure that each step meets strict environmental standards.
- ✓ **Circular Design:** Evaluating recyclable and non-harmful materials for a lower environmental footprint.

RE-WITCH is working on these processes with STAM S.r.l., Sorption Technologies GmbH, dr. jakob energy research GmbH & Co.KG, IDP Ingeniería, Medio ambiente y Arquitectura, TVP SOLAR SA, TECNALIA Research & Innovation, BS Nova Apparatebau GmbH.

LCC Life Cycle Costing



Life Cycle Costing is a methodology that considers all costs incurred throughout the lifetime of a product or service, from initial investment and installation to operational and maintenance costs, as well as end-of-life expenses. By taking this comprehensive approach, RE-WITCH ensures that its advanced cooling systems are not only environmentally sustainable but also economically viable.

How is LCC Applied in RE-WITCH?

- **Economic Assessment**: LCC complements environmental analysis by providing the financial data needed to determine the affordability of innovative cooling and heat recovery systems.
- Replicable Business Models: It supports the creation of tailored business models for various industries, demonstrating how RE-WITCH technologies can scale effectively.
- KPIs for Cost-Effectiveness: Key Performance Indicators (KPIs) like CAPEX, OPEX, and maintenance costs are monitored to evaluate the economic performance of RE-WITCH technologies. These insights help identify areas for cost optimization while maintaining high efficiency and environmental standards.



Through LCC analysis, RE-WITCH demonstrates the potential for reducing operational costs by up to 30%, ensuring a payback period of less than 6 years for its innovative solutions. This approach highlights the alignment of cutting-edge technology with real-world industrial needs, making a compelling case for adoption.

BOS Balance of System



In large-scale energy systems, the term Balance of System (BOS) refers to all auxiliary components that support the core technology, ensuring its proper integration and operation.

BOS's Role in RE-WITCH:

- Connecting and optimizing solar thermal systems for industrial cooling applications.
- ✓ Ensuring seamless integration of components, such as ab/adsorption systems, solar panels, and cooling towers, into existing industrial circuits.
- Enhancing efficiency and reliability by optimizing the layout and operation of different equipment.



Why is BOS important?



- It reduces installation time and heat losses, making industrial cooling solutions more efficient and cost-effective.
- It improves scalability, allowing for smoother adoption of thermally-driven cooling systems.
- It ensures interoperability, enabling different components to work seamlessly together.



https://blog.ecoflow.com/us/what-is-balance-of-system-solar-power/

SIL Approach Software-in-the-loop

To achieve innovation, testing and optimization are key steps in ensuring RE-WITCH's technologies are efficient and reliable. That's where the Software-in-the-Loop (SIL) approach comes in!



The SIL Approach creates a virtual testing environment where control systems for RE-WITCH's technologies are simulated. This allows us to fine-tune control logics, test configurations, and optimize processes before deployment, ensuring maximum efficiency.

How does SIL power RE-WITCH?



- Simulation & Validation: SIL allows us to simulate sequences like start-up, shutdown, and production, ensuring systems respond optimally to real-world conditions.
- POptimization: By testing plant configurations virtually, we identify the best strategies to enhance energy efficiency and performance.
- Finergy Savings: Optimized SIL controls can increase overall energy efficiency by 5-10%, supporting RE-WITCH's mission for sustainable industrial cooling and heating.
- With SIL, **RE-WITCH** brings its technologies closer to real-world application, ensuring every system is optimized for sustainability and performance.
- This method guarantees that our control systems, developed in collaboration with Consiglio Nazionale delle Ricerche, Pragma-IoT, Hochschule München University of Applied Sciences, TU Berlin and IDP Ingeniería, Medio ambiente y Arquitectura are ready to reduce energy consumption and CO₂ emissions.





HEX Heat Exchanger



Heat Exchangers are essential for transferring heat between two or more fluids without mixing them. In the RE-WITCH project, HEX plays a key role in capturing waste heat from industrial processes and transferring it for reuse in cooling or heating applications. This efficient heat recovery drastically reduces energy consumption and contributes to lower CO₂ emissions.

In **RE-WITCH**, Heat Exchangers are key components in our integrated systems, working alongside absorption and adsorption chillers to recover waste heat and transform it into usable thermal energy. By efficiently transferring this heat between fluids, HEX helps reduce energy consumption and CO₂ emissions in industrial applications. The recovered heat can then be reused for purposes like space process heating or cooling, making industrial plants processes far more sustainable.





The implementation of Heat Exchangers in RE-WITCH shows how industrial waste heat can be transformed into a valuable energy resource, contributing to the overall sustainability and energy efficiency of industrial processes.



- https://www.iqsdirectory.com/articles/heat-exchanger.html
- https://www.thomasnet.com/articles/processequipment/understanding-heat-exchangers/

WH Waste Heat



Waste Heat refers to the heat generated by industrial processes that is not used and usually released into the environment. Instead of letting this valuable energy go to waste, advanced technologies within RE-WITCH capture and reuse it, turning a by-product into a valuable energy resource.

In **RE-WITCH**, waste heat recovery is a core element of our energy-saving approach. By capturing heat from industrial processes such as pasteurization or cooling cycles, with **ADsorption** and **ABsorption** chillers and integrating it with our hybrid heat pumps and thermal energy storage systems, we can reduce overall energy consumption and CO₂ emissions. The recovered heat can then be used for secondary processes like space heating or even cooling through advanced thermally-driven technologies.



TRL Technology Readiness Level

Ever wondered how advanced technologies transition from the lab to the real world? **TRL is a 9-level scale** used to evaluate the maturity of a technology. It provides a roadmap for advancing innovations, ensuring they meet performance, safety, and integration benchmarks before full-scale deployment.

The TRL Scale:

- TRL 1: Basic principles observed The idea emerges and foundational research begins.
- **TRL 2**: Technology concept formulated Early-stage explorations of feasibility.
- TRL 3: Experimental proof of concept Initial experiments validate the concept.
- TRL 4: Technology validated in lab Testing moves into controlled environments.
- **TRL 5**: Technology validated in relevant environment Prototypes are tested under simulated real-world conditions.
- **TRL 6**: Technology demonstrated in relevant environment Scaled prototypes are tested in relevant operational settings.
- TRL 7: System prototype demonstration in operational environment Near-final systems are demonstrated in the field.
- TRL 8: System complete and qualified The technology is finalized and passes final tests.
- **TRL 9**: Actual system proven in operational environment Fully operational and market-ready.

In **RE-WITCH**, we're elevating our thermally-driven cooling and heating systems from TRL 4 to TRL 7, demonstrating their effectiveness in real industrial settings. This includes:

- > Hybrid heat pumps designed to recover and repurpose waste heat.
- Advanced adsorption and absorption chillers scaled up for larger industries.
- Integration of control systems for seamless operation in demo sites spanning food, beverage, bio-refinery, and pharmaceutical sectors.

Focusing on TRL ensures each technology meets stringent real-world criteria for performance, efficiency, and integration. By advancing through TRL stages, RE-WITCH guarantees its solutions are not just innovative but also viable for large-scale deployment in sustainable industries.





DT - Digital twin platform

In the digital era, simulation and modeling are changing the way we approach energy systems. For this reason, the Digital Twin Platform represents one of the main elements of RE-WITCH's strategy for the optimization of industrial processes and energy efficiency.

(i)

A Digital Twin Platform creates a virtual model of real-world systems, enabling simulation, monitoring, and optimization in real time. In RE-WITCH, the DT Platform allows us to visualize, test, and refine our technologies, from heat recovery systems to hybrid heat pumps, prior to their actual implementation in the real world.

DT Platform's role in RE-WITCH?

- Real-Time Monitoring: The DT Platform enables real-time tracking of energy flow and system performance, ensuring maximum efficiency.
- Simulation and Testing: By simulating different operational scenarios, it helps refine system performance before implementation.
- Seamless Integration: The platform ensures that RE-WITCH technologies are smoothly integrated into industrial settings with minimal disruption.
- RE-WITCH is working on this approach with IDP Ingeniería, Medio ambiente y Arquitectura, dr. jakob energy research GmbH & Co.KG, Gruppo Sigla, TVP SOLAR SA, TECNALIA Research & Innovation, Sorption Technologies GmbH, BS Nova Apparatebau GmbH, STAM S.r.l., Centre for Research & Technology Hellas (CERTH), Pragma-IoT, Gradyent.



STEP

Standard for the Exchange of Product Data model



STEP is an international data exchange standard that ensures seamless interoperability between different engineering tools and software. By providing a neutral file format, it allows industries to efficiently share, process, and manage complex product data across multiple platforms.

How is RE-WITCH using STEP?



- ✓ Standardized data formats for modeling and exchanging industrial cooling system designs.
- ✓ Interoperability between different digital engineering tools, reducing design inconsistencies and errors.
- ✓ Integration with BIM-based engineering, ensuring accurate data flow across different industrial sites and cooling processes.

Why does this matter?



- ✓ Reduces data silos and improves communication across industrial partners.
- ✓ Facilitates the scalability and replication of innovative cooling technologies.
- ✓ Ensures compliance with industry-wide digital engineering standards.

IMPELLER or impellor

In the world of industrial cooling and heating, efficiency is everything and impellers play a key role in making that happen!

But what exactly is an impeller?



An impeller is a rotating component that increases the pressure and flow of a fluid. By accelerating the fluid outward from the center of rotation, it powers essential processes in cooling systems, making them more efficient and effective.

Why is this important for RE-WITCH?

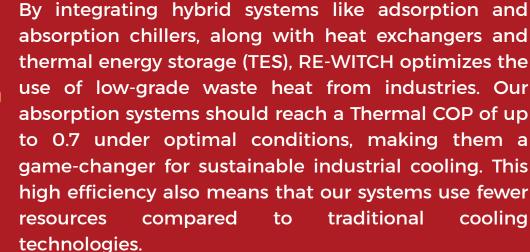


In our drive to create sustainable industrial cooling through adsorption and absorption technologies, impellers are vital to ensuring smooth fluid dynamics and maximizing energy transfer. This enhances the performance of systems that harness waste heat and renewable energy sources.

Thermal COP

Thermal COP is a measure of how efficiently a cooling system uses heat to produce cooling energy. In RE-WITCH, our advanced thermal systems should achieve a high Thermal COP, enabling us to convert waste heat into useful energy for cooling with minimal energy input. This high efficiency is essential for reducing both energy costs and CO₂ emissions in industrial processes.

Why Thermal COP matters in RE-WITCH?





MOFS Metal Organic Frameworks



Metal Organic Frameworks (MOFs) are advanced materials with a unique porous structure that enables them to trap and store gases or liquids efficiently. Known for their high surface area and tunable properties, MOFs offer exciting opportunities for improving energy efficiency in adsorption cooling processes.



In the RE-WITCH project, MOFs are being studied as potential adsorbent materials to enhance adsorption system performance. Their ability to optimize the adsorption process aligns with the project's mission to develop thermally-driven cooling technologies powered by renewable and waste heat sources.

By incorporating MOFs, the project aims to deliver compact, efficient, and sustainable solutions, reducing industrial cooling's environmental impact.

HVFP solar thermal technology High Vacuum Flat Panels



HVFPs are cutting-edge solar thermal collectors, developed by TVP SOLAR. Known for their exceptional efficiency, these panels both capture and diffuse solar energy, operating reliably even during winter or under cloudy conditions. Thanks to their high vacuum, HVFPs drastically reduce heat loss and can generate temperatures up to 200°C, making them ideal for industrial-scale applications.

In the RE-WITCH project, HVFPs are pivotal. Assessed and engineered for three demo sites, they'll deliver renewable heat up to 110°C to power RE-WITCH's hybrid heat pumps, efficiently meeting heating and cooling needs. This optimal integration of the solar thermal systems into the RE-WITCH heat and cold solutions supports energy savings and significant reductions in CO₂ emissions, ensuring more sustainable industrial processes. Specific tools will support determining the solar thermal system layout, the integration within the industrial environment as well as with the other technologies. The integration routes will be tested and modelled with BIM modelling.





Additional engineering innovation at system level has further improved overall performance and cost-effectiveness. This includes standardised panel arrangements and connectors, reduced external piping, alternative system layouts, monitoring & control system, etc.

The company's unique technology is protected by 10 patent families (177 patents granted) covering the core technology, the manufacturing process, and the solar thermal system. TVP Solar delivers solar heat up to 180°C to decarbonise industrial heating and cooling.



TVP's manufacturing process & facility: https://www.youtube.com/watch?v=xShX8B56BgEkd.in/dzdDrzTr



Difference between Absorption & Adsorption

Absorption refers to a process where one substance (usually a gas/vapors) is dissolved into a liquid. In the RE-WITCH system, absorption chillers use a liquid solution, a mix of water and lithium bromide, absorbing water vapor as refrigerant. This technology exploits heat which drives a cooling cycle, turning waste heat from industrial processes like pasteurization or drying into usable cooling energy. What makes absorption chillers stand out is their ability to work with low-grade waste heat—heat that would otherwise be discarded. By utilizing this 'free' energy, we dramatically reduce overall energy consumption while cutting down on CO₂ emissions.

Adsorption, on the other hand, works on a surface level. Instead of dissolving substances, adsorption chillers utilize solid materials like silica gel or zeolite to capture a natural refrigerant, usually water. Gases or vapors adhere to the surface of these solids, where the process of adsorption stores and then releases heat for cooling purposes. Adsorption chillers excel in recovering waste heat from low-temperature sources, making them perfect for industries with fluctuating heat output. Their efficiency and versatility are essential in harnessing waste heat for secondary uses like process heating or cooling, contributing to both energy savings and sustainability goals.





In RE-WITCH, both adsorption and absorption technologies will be integrated with heat pumps and thermal energy storage systems to maximize efficiency. These systems work together to capture, store, and repurpose waste heat, reducing industrial energy consumption and lowering CO₂ emissions. Whether the waste heat comes from high-intensity processes or fluctuating sources, RE-WITCH has the solutions to transform it into valuable energy.

RE-WITCH is working on these processes with Consiglio Nazionale delle Ricerche, Hochschule München University of Applied Sciences, BS Nova Apparatebau GmbH, Technische Universität Berlin, TECNALIA Research & Innovation, Sorption Technologies GmbH.



BREF Best Available Techniques Reference Documents

BREFs are key EU reference documents that define the Best Available Techniques (BAT) for various industrial sectors. These documents help industries minimize environmental impact by setting benchmarks for energy efficiency, emissions, and sustainability.

In the **RE-WITCH** project, Institute for European Energy and Climate Policy Foundation (IEECP) will contribute to the update of the Industrial Cooling Systems BREF by integrating heat-to-cold technologies, solar cooling, and thermal renewable energy sources. The goal? To ensure next-generation industrial cooling solutions align with the latest environmental and energy efficiency standards.

Did you know? The last Industrial Cooling Systems BREF was updated in 2001! With new advancements in adsorption and absorption cooling, it's time for an upgrade and RE-WITCH is here to make it happen!





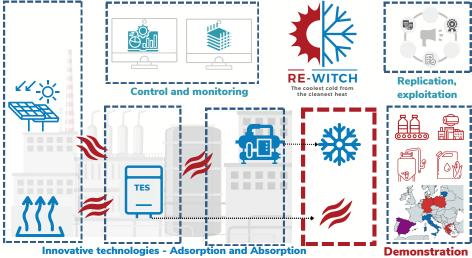
Find the last Industrial Cooling Systems BREF here: https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-

O3/superseded_is_bref_1201.pdf

The overarching aim of RE-WITCH is to deliver cost-competitive, game-changing solutions in the field of sustainable industrial cooling and heating.

To do so, RE-WITCH will demonstrate advanced thermally-driven industrial cooling technologies based on ADsorption and ABsorption processes driven by an optimized mix of low-grade waste and renewable sources (Optimized techno-economic integration between low-grade (<100 °C) industrial waste heat and high-efficiency vacuum flat plate solar collectors, to drive process cooling generation and provide process heating).





Such solutions will be demonstrated in 4 demo sites encompassing food and beverage sectors as well as industrial sectors where heat-to-cold solutions are not yet widely explored:

- bio-refinery,
- food and beverage,
- pulp and paper.

RE-WITCH will be complementing the demonstration with 3 replication sites, covering other possible relevant sectors (DHN-connected industries, data centers), investigating RE-WITCH potential applications and benefits.

The project will be delivered by an industrial-driven consortium of 26 partners from 10 countries and it is composed by some of the most innovative SMEs, LEs and R&D centers in the field of industrial renewable H&C leveraging experience from industrial and EU-funded projects. The multi-disciplinary composition of the consortium ensures that all the challenges (technical and non-) will be addressed to ultimately bring RE-WITCH solutions to the market by 2029. Innovative open access modelling platforms and engineering solutions will also be developed to facilitate the design, upscale, replication and integration in industrial processes of the proposed technologies. Thanks to a stakeholders' driven dissemination and communication campaign, RE-WITCH will ultimately demonstrate transformative technological solutions that unlock the combined potential of low-grade waste and renewable heat use in industries, hence also targeting integration of heat-to-cold technologies into relevant EU policies.

Our partners







