



Company, Technology & Solutions



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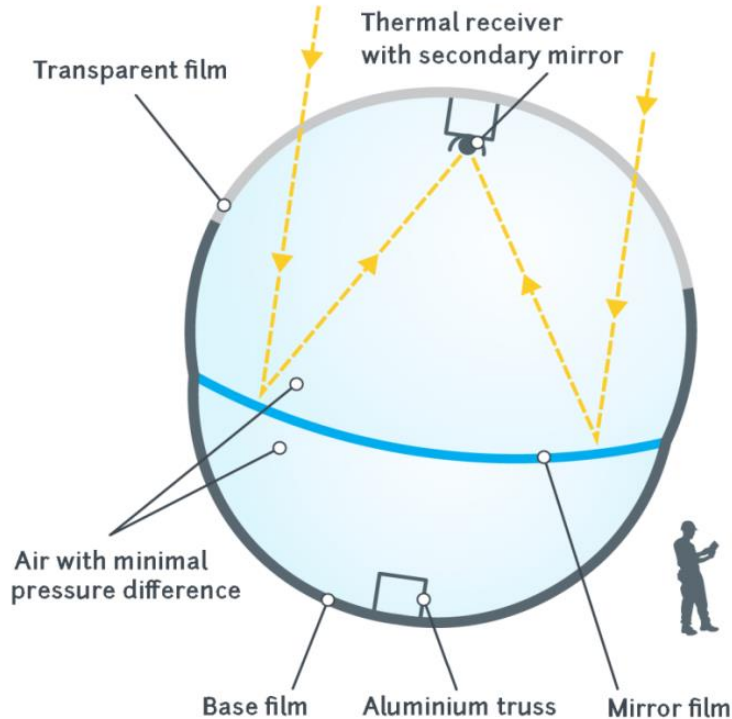
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- The **solar technology company HELIOVIS AG** (www.heliovis.com) has spent 11 years and 27.4 million € to develop a **smart solar thermal technology** specifically designed for **cost reductions** (CAPEX and OPEX), scale economies, and for **harsh climate conditions**.
- The core of the technology is an **inflatable tube-shaped solar collector ("HELIOtube")** made of three industry-proven plastic films with a length of 220 m, an aperture of 7.8 m, and a thermal **power of 0.9 MW_{p_{th}}** driving down **CAPEX by -55 %** and **OPEX by -20%** compared to state-of-the-art parabolic trough systems.
- Due to its unique cost structure, the scalable HELIOtube produces **clean solar thermal energy** (industrial heat), in a temperature range of 90°C to > 550°C for up to 24 hours per day at **highly competitive and stable price levels**. This represents a clear **USP** vs. competing solar technologies and **opens up huge global markets** barred to all solar competitors.
- The cost structure enables **commercially viable direct applications** of the solar thermal energy especially for i) solar water desalination and brine treatment, ii) CO₂ reduction in the Oil & Gas industry, iii) solar heat for industrial processes ("SHIP"), iv) solar thermal cooling, and v) the reduction of fuel costs in Combined Heat and Power ("CHP") plants.
- With the first full-scale industrial application successfully commissioned in 2017 in Spain (proof-of-concept), preparations for serial roll-2-roll production completed, a diversified international project pipeline in place, and the supplier network ensured, HELIOVIS' solar solution is **ready for international roll-out**.



- Privately owned Austrian **joint-stock company** („Aktiengesellschaft“)
- HQ in the commercial area of **Vienna / Austria**: Commercial operations, HELIOtube production facilities, test field & labs
- **Subsidiaries & branch offices**
 - HELIOVIS Spain S.L.U., Madrid (100% subsidiary)
 - Branch offices in Masdar City (UAE) and Shanghai (CN)
- **23 experts** (Austria, Spain, and China)
- **Core technology**
 - i. HELIOtube solar collector (design, plastic structure, thermal system, draw-in system, wind protection, controls & software)
 - ii. Production technology (machines and processes) for the tube-shaped plastic structure
- Strong **international IP portfolio** with 12 patent families, 79 patents and patent applications, 2 trademarks
- **License contract** with Audi AG (VW group) for applications in the automotive sector



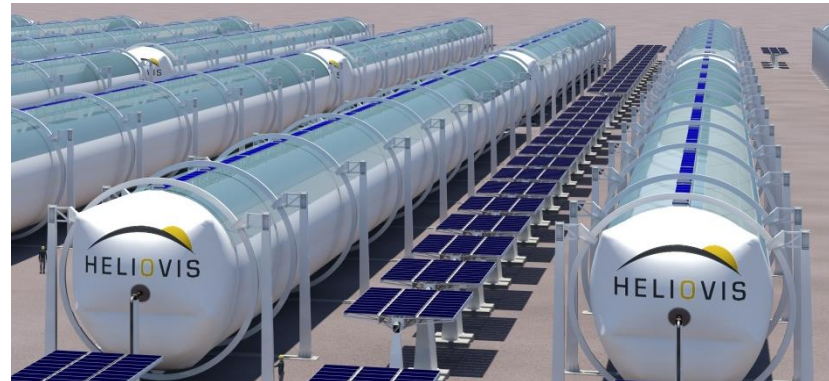
- An **inflatable solar collector made of three industry-proven plastic films** which is formed through air pressure differences in two airtight chambers (inside pressure: ca. 3 mbar)
- Works in the same way as parabolic trough technologies by **concentrating sunlight** on an industry-grade **thermal receiver**
- **Max. dimensions per HELIOtube (ca. 0.9 MW_{p_{th}})**
 - Length 220 meters
 - Aperture 7.8 meters
 - Diameter 9 meters
- **Unique features leading to -55 % in CAPEX and -20 % in OPEX**
 - Roll-2-roll serial production process
 - Highly durable but inexpensive input materials
 - Easy logistics through shipping in standard 40-ft containers
 - Fast installation & on-site activities
 - Advanced wind protection and minimal down times
 - Cheap operation & maintenance
 - Max. use of space by integrated PV-based wind shield system

Conventional parabolic trough



- **Costly technical components**, incl. mirrors and thermal receivers **exposed** to external factors (wind / storm, sand, aerosol particles etc.)
- **Glass mirrors** mounted on steel construction **shatter in storm** due to turbulences, rigidity, and brittleness
- Frequent breakages **increase downtime and drive OPEX**

Inflatable HELIOtube

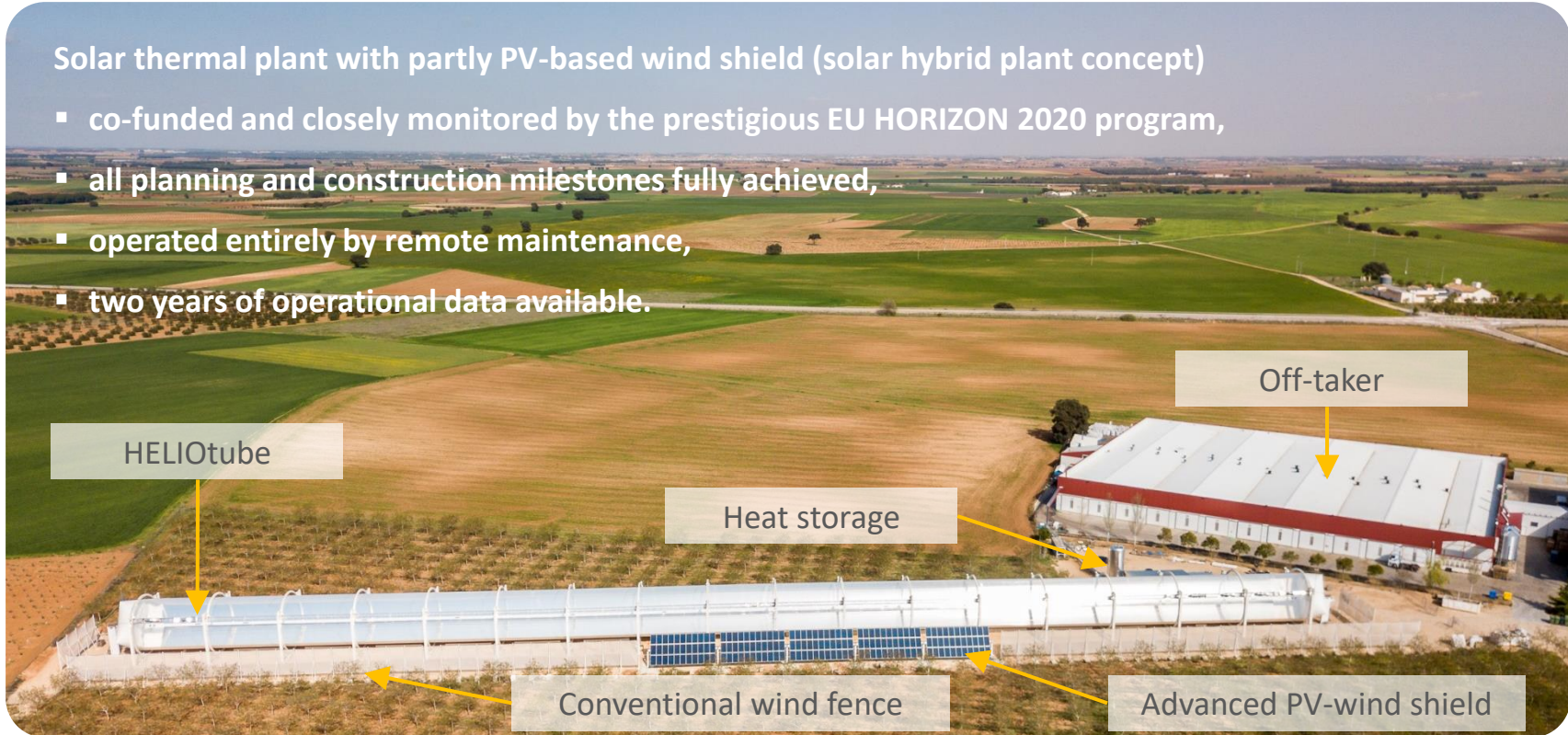


- Thermal receivers and mirror surface **fully enclosed and protected** by highly durable plastic films
- Flexible structure, aerodynamic shape, and adaptive wind protection system **minimize wind resistance**
- High resilience to harsh conditions results in **minimal downtime and low O&M costs (OPEX)**

First full industrial-scale application successfully commissioned in 2017¹

Solar thermal plant with partly PV-based wind shield (solar hybrid plant concept)

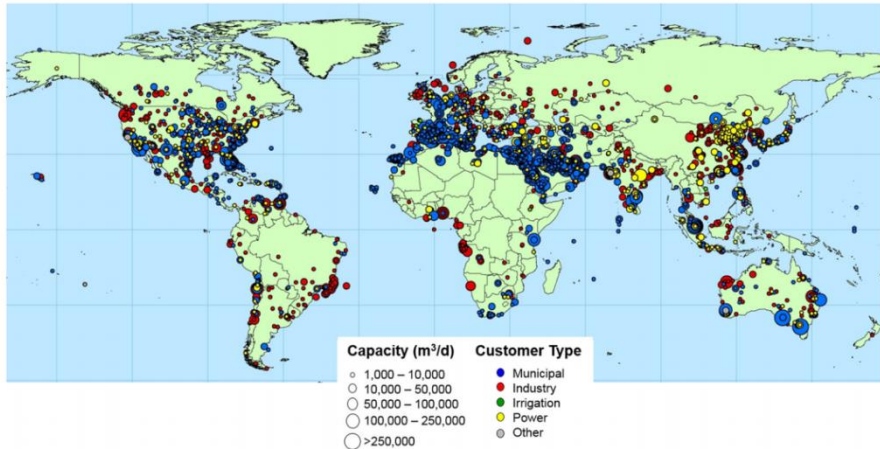
- co-funded and closely monitored by the prestigious EU HORIZON 2020 program,
- all planning and construction milestones fully achieved,
- operated entirely by remote maintenance,
- two years of operational data available.



¹ First industrial-scale project in Spain.

Market entry: Solar water desalination and brine treatment

Current desalination capacities (>1,000 m³/day) by sector user¹



Key facts

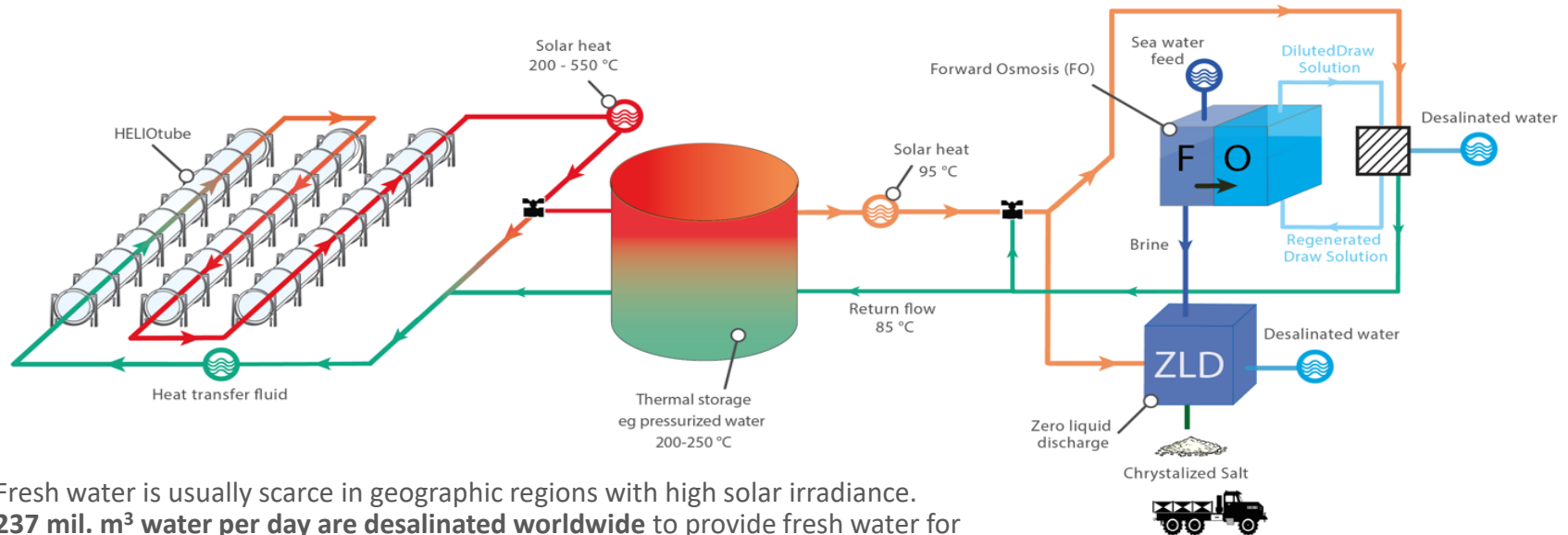
- Share of global population facing severe water scarcity
40 % (2019)
60 % (2025)
→ double digit growth of freshwater demand
- 15,906 desal plants in 177 countries (2019):
 - Feed water (mio m³ per day) 237
 - Fresh water produced (mio m³ per day) 95
 - Noxious brine (mio m³ per day) 142
- Large quantities of brine** lead to environmental damage & economic costs → increasingly restrictive legislation
- Current technologies are very **energy intensive** (electricity)

Operated with low cost solar heat (HELIOVIS), forward osmosis (technology partner secured) ...

- delivers water at **highly competitive price levels**,
- minimizes brine** production (ZLD)¹,
- is **self-sufficient in energy** thus CO₂ neutral,
- works on- and off-grid for 24/7,
- is good for a broad range of feed water qualities,
- allows brine treatment of existing plants by ZLD retrofitting,
- is ideally suited for the global sunbelt region with its growing water demands

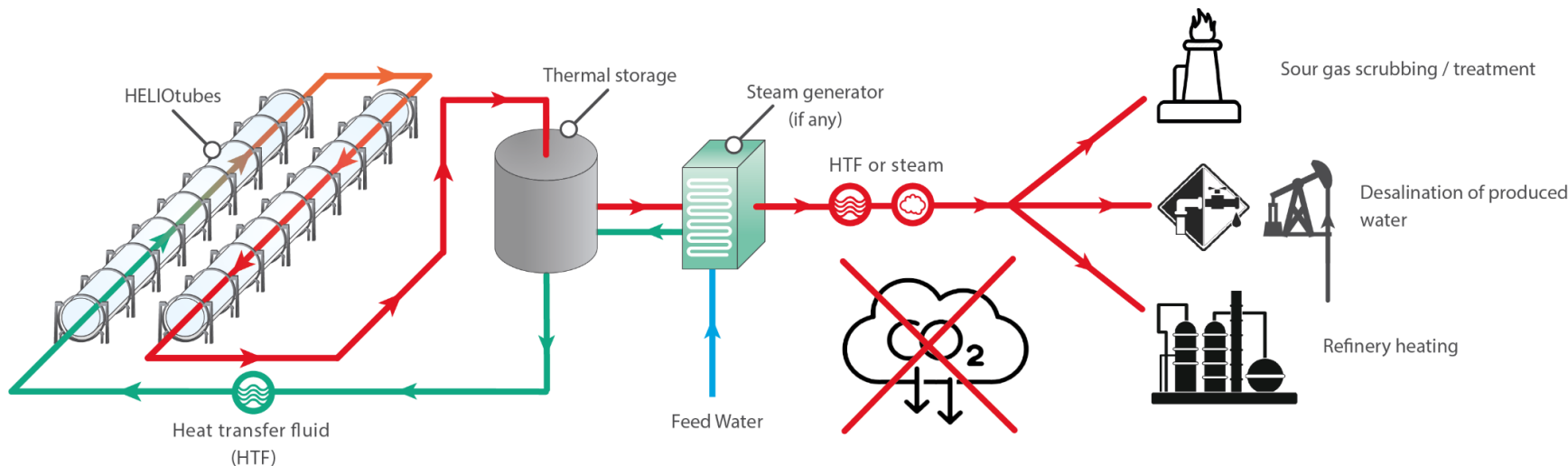
1) ZLD (Zero Liquid Discharge) is an advanced water treatment process in which all wastewater is purified and recycled leaving zero discharge at the end of the treatment cycle.
Source: Jones et al: "The state of desalination and brine production: A global outlook.", Science of the Total Environment, 657 (2019) 1343-1356, Elsevier.

Application 1: Water desalination & brine management



- Fresh water is usually scarce in geographic regions with high solar irradiance. **237 mil. m³ water per day are desalinated worldwide** to provide fresh water for drinking, agriculture, industry, power plants, and special purposes.
- With HELIOVIS' low-cost solar heat, **sea water can be desalinated** i) at highly **competitive and stable prices**, ii) with a **minimum of toxic brine** production, iii) for **24/7**, iv) **CO₂ neutral**, and v) **both on- and off-grid**. The latter makes it **particularly applicable** to countries with decentralized power production and/or infrastructure challenges.
- In addition, **retrofitting existing desalination plants with zero liquid discharge (ZLD) technology** for brine treatment represents a rapidly growing market.

Application 2: CO₂ reduction in the Oil & Gas industry

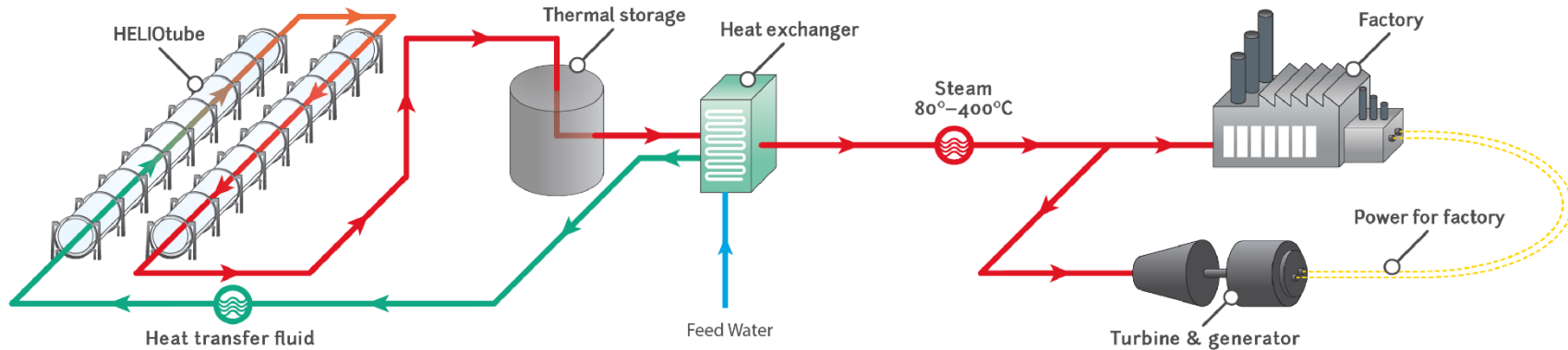


- The potential for **CO₂ savings in the upstream and downstream processes** of the oil and gas industry are enormous. **Stanford University (USA)** estimates the global potential for solar thermal energy in the industry to be **76 – 200+ GW_{th}¹**
- There are **multiple potential applications** of the HELIOVIS technology along the entire oil & gas value chain. One concrete upstream application is in the treatment (**gas scrubbing**) of **sour gas**, which accounts for **60 % of gas production in the Middle East**.
- Upstream applications are likely to qualify as **Upstream Emission Reductions (UERs)** under the EU Fuel Quality Directive (FQD)².
- Other applications include solar **Enhanced Oil Recovery (EOR)**, process heat for **refineries**, and **desalination of produced water**.

1) Source: J. Wang: "Potential solar energy use in the global petroleum sector", Energy 2017.

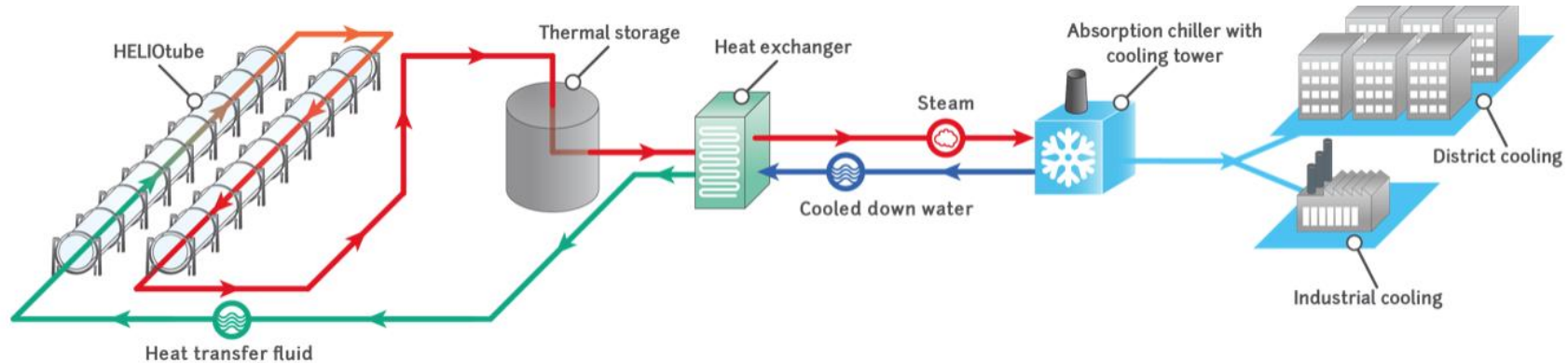
2) Implemented by Council Directive (EU) 2015/652 of 20 April 2015.

Application 3: Solar heat for Industrial Processes (“SHIP”)



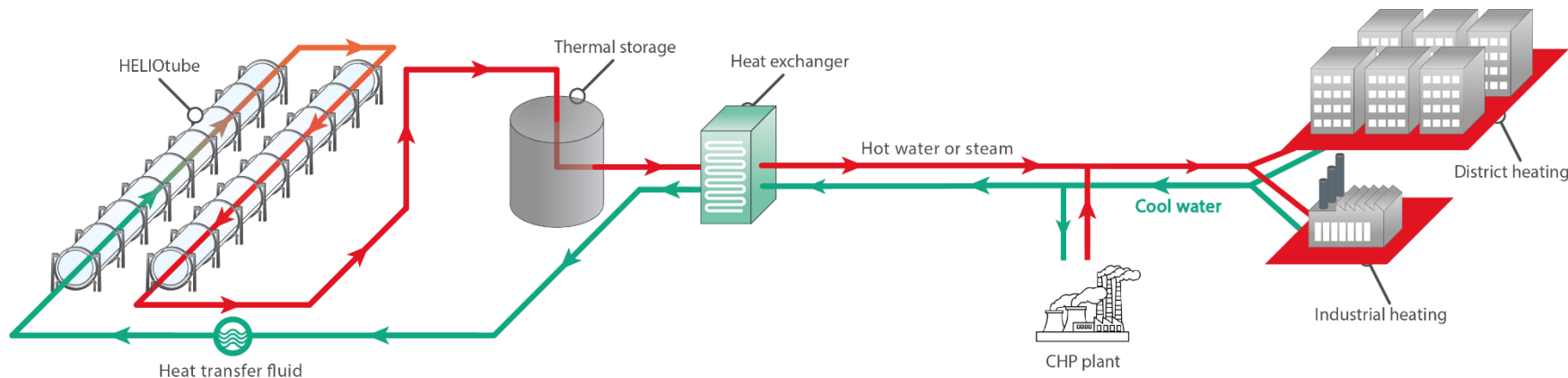
- A **Heat Transfer Fluid (HTF)** is heated in the solar field and stored in thermal energy storage tanks before it is directed towards a heat exchanger (HE) where it produces steam. The HTF runs through a closed loop and flows back to the solar field where it is re-heated. The technology can also be used as a pre-heater.
- Factories can benefit from **Solar Heat for Industrial Processes (SHIP)** and also from electricity generated by steam turbines. SHIP is **ideally suited** to serve applications in the **low and medium temperature range between 90° and 350°C** where 59 % of the global industrial heat demand (783 TWh) is set.
- In **Central Europe**, where industrial process heat is typically produced in **CHP plants**, the technology helps save fuel costs on **sunny days** when electricity prices are low. On such days, the **technology** provides an **alternative source of thermal energy, allowing shut down** of the CHP plant **without interrupting the heat supply**.
- **Four industrial segments** are most suitable for SHIP applications: Food & Beverage, Pulp & Paper, Chemicals, Textile & Leather.

Application 4: Solar thermal cooling



- Water is chilled in the district cooling plant and supplied to customer buildings through a network of pipes. The chilled water is fed into the cooling system of individual buildings through heat exchangers and then directed back towards the cooling plant in a closed loop. There it is chilled again and redistributed.
- **Solar thermal cooling systems** with thermally driven absorption chillers reduce the conventional air-condition loads at a **fraction of the costs** and guarantee substantially lower operating costs.
- **Cooling of buildings currently represents about 70 % of the peak electricity load** in the Gulf Cooperation Countries (**GCC region**).
- Required input temperatures from the solar field are in the range 90°-210°C which chills water down to 5°-9°C.

Application 5: District heating in combination with CHP plants



- The heat for most **district heating** grids (and many industrial off-takers) in Central Europe is produced in combined heat and power (**CHP**) plants. They make efficient use of primary energies and produce heat and power at the same time.
- **On sunny days, electricity prices drop sharply** due to a surplus of power generated by PV plants. This effect is projected to increase in the future and power prices around or even below zero are expected whenever generation from PV panels spikes.
- For CHP plants this results in **negative margins** on sunny days, especially if biofuels are used, which are relatively cost intensive.
- In this situation, Heliotubes can support existing CHP plants by providing an **alternative source of thermal energy**. This allows CHP plants to be operated at lower capacities or fully turned off, **saving fuel and avoiding negative power prices**.

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