SILSTORE. Solutions for high temperature energy storage and conversion

Thermophotovoltaic-based solutions for energy storage and conversion in high temperature applications: waste heat recovery in industry, concentrated solar power (CSP) and electricity storage and cogeneration in urban areas.

World electricity consumption is expected to grow 60% from 2011 to 2030, being most of this new generation capacity attributed to intermittent renewable energy sources such as solar or wind. In this scenario there are two main challenges for the future: energy efficiency and energy storage. Researchers from UPM have developed thermophotovoltaic devices for the direct conversion of high temperature heat into electricity. Using these devices, SILSTORE develops turnkey solutions for waste heat recovery in high temperature industries (e.g. steel factories). Besides, SILSTORE is developing a patent-pending technology for ultra-high temperature energy storage able to provide extremely high energy densities, much higher than current existing technologies (e.g. batteries) at affordable prices.

Technological solution promoted by the Universidad Politécnica de Madrid

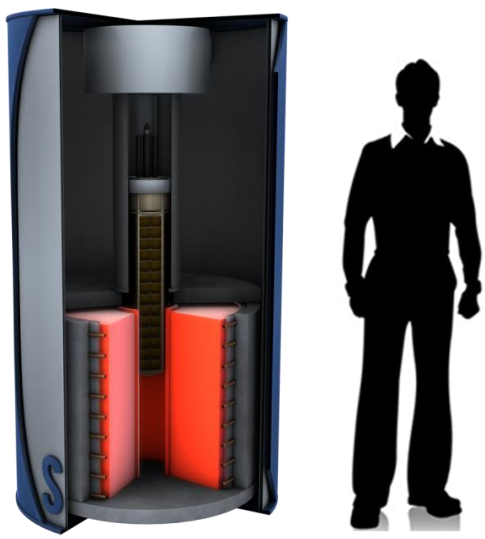
Technical solution

A thermophotovoltaic (TPV) device operates in the same way than a solar cell to transform the radiant heat emitted by incandescent bodies into electricity. The attractiveness of TPV if compared with conventional heat engines is that it does not require moving parts nor direct contact with the heat source, making it a simple and robust alternative to conventional heat engines for extremely high temperature operation. Furthermore, TPV is able to produce extremely high power densities, in the order of 100-500 times than that of a conventional solar cell. SILSTORE is using these devices for the waste heat recovery in high temperature industries, such as steel and glass factories. SILSTORE has also patented a technology for high temperature energy storage that uses TPV devices for energy conversion and molten silicon (at 1400C) as storage medium. This system has potential to reach higher energy densities than competing technologies (e.g. batteries) and uses abundant materials, such as silicon, the second most abundant element on earth crust.

Application sectors

- **Waste heat recovery in industry:** In high temperature factories (e.g. steel).
- **Energy storage:** In concentrated solar power (CSP) and urban cogeneration (e.g. district storage and heating).

***"SILSTORE* uses silicon as storage medium. Silicon is the second most abundant element on earth crust and allows reaching energy densities as high as 500 kWh/m^3, well above the potential of most of the competing technologies"**



1 MWh
Energy storage for >30 homes

Market necessities

- **Waste heat recovery in industry**
  - From 20 to 50% of the energy in industry is lost in the form of heat. This wasted heat represent annual losses of 10's of M€ per factory.
  - Robust, simple and scalable systems are needed for waste heat recovery that do not interfere with the production process, and with payback times below 5 years.
- **Energy storage**
  - Low cost technology: This is the main drawback of current storage technologies.
  - Use of abundant and safe materials.
  - Increase the energy density and efficiency.

"In a steel factory, for instance, there exist large incandescent surfaces radiating heat 24 h the 365 days of a year. SILSTORE provides photovoltaic solutions to recover this heat and produce electricity on-site"

Market potential

- **Waste heat recovery in industry**
  - Annual growth of 6.5% CAGR to reach 53,120 M$ in 2018 [marketandmarkets.com].
  - Our segments: steel, ferroalloys, silicon, etc.
- **Energy storage**
  - CSP sector: 2,510 M$ in 2013 and it is expected to reach 8,670 M$ in 2020: CAGR of 20%.
  - Electricity storage sector: It is expected to reach the 50,000 M$ in 2020 [LuxResearch], from which 2,800 M$ correspond to stationary storage (excluding transportation and portable electronic devices).

Competitive advantages

- **Waste heat recovery in industry**
  - Simple, robust and scalable technology non-intrusive with the factory production process.
  - Ultra-high surface power density (>1 kW/m^2)
- **Energy storage**
  - Ultra-compact systems
  - Cogeneration (simultaneous production of heat and electricity)
  - Low cost and abundant materials.

"Thermophotovoltaic converters generate electricity from incandescent heat and produces extremely high power densities, in the order of 100 to 500 times than that of conventional solar cells"

References

- The Instituto de Energía Solar (IES-UPM) is a cutting-edge research center in the field of photovoltaic energy conversion, with broad relationship with industry.

Intelectual property

- Patent pending in US: US 2015/0256119A1, WO 2015/132305 A1.
- Patent pending in Spain: 007-16

Development stage

- ◯ Concept
- ◯ Reserach
- ⊕ Lab prototype
- ◯ Industrial prototype
- ◯ Production

SILSTORE contact

Alejandro Datas
e: a.datas@ies-def.upm.es
Instituto de Energía Solar (IES-UPM)
w: http://www.ies.upm.es

UPM contact

Área de Innovación, Comercialización y Creación de Empresas
Centro de Apoyo a la Innovación Tecnológica – UPM
e: innovacion.tecnologica@upm.es