The use of thermochemical fluids for energy saving and storage in agriculture (The Greefa Project)

What is the challenge?

Increasing the **efficiency** of the thermochemical fluid systems is one of the major difficulties. Multiple processes are required to convert thermal energy to chemical energy and vice versa, and it is essential for overall efficiency to reduce energy losses at each stage.

Expanding the most common current technology, pumped hydroelectric storage, is **limited by geography**, and lithium-ion batteries are too **expensive for storing excess renewable** power over multiple days (around €140/kWh). The storage period defines how long the energy is stored (i.e., hours, days, weeks), and this is a challenge associated with implementing thermochemical energy storage.

Integration and compatibility: To ensure seamless integration, thermochemical fluid systems should be compatible with current energy systems and infrastructure. This covers considerations for energy storage, transportation, and consumption in various applications. The need to develop and operate coupled thermochemical energy storage systems makes thermochemical energy storage implementation difficult.

Stability and durability: Thermochemical fluids must be stable and durable over multiple cycles of energy conversion and storage. They should be able to tolerate high temperatures and other difficult operating conditions without significant degradation, ensuring an extended operational lifetime.

For broad adoption, the **cost-effectiveness** of thermochemical fluid systems must be competitive with other energy storage techniques. To make these systems economically viable, cost-effective materials and manufacturing processes must be developed.

Scalability: Developing thermochemical fluid systems that can be scaled up for practical uses is another challenge. Fluid systems must be designed to be easily implemented on a wider scale, allowing for widespread adoption and integration with existing energy infrastructure.

Environmental impact: The choice of fluids and associated materials should minimize negative environmental effects, including emissions and natural resource depletion.

Policy Recommendations

Strengthen and expand the EU's commitments to **combat climate change** with the goals of the Paris Agreement and ensure their effective implementation by member states by setting more ambitious emission reduction targets and **promoting the transition to a low carbon economy** and ensure their effective implementation by member states.

The **European Commission has recommended ten points for EU Member States to maximize energy storage** to its full potential. The Commission's suggested reforms for Europe's electricity design underline the fundamental role of flexibility that storage can provide to the electricity system. According to their recommendations, Member States should develop new market products, particularly for peak shaving, curtailment prevention, and congestion management, to secure predictable revenue streams for storage, both utility-scale and behind-the-meter. A lower carbon cap needs to be mandated in the capacity market.

On 14 March 2023, the Commission Recommendation Energy Storage – Underpinning a decarbonized and secure EU energy system was adopted. It addresses EU countries on the most important issues contributing to the broader deployment of energy storage. They should consider the double role of "consumer-producer" of storage by applying the EU electricity regulatory framework and by **removing barriers**, including **avoiding double taxation** and **facilitating permitting procedures.**

Joint EASE/EERA recommendations for a European Energy Storage Technology **include the need to develop and implement thermal energy storage** systems that are coupled to power-to-heat technologies, classify thermal storage systems based on the mass of the storage medium, the heat capacity of the storage medium, the temperature difference, and the melting or phase change enthalpy, and consider the storage period of thermal storage systems, which defines how long the energy is stored (i.e., hours, days, weeks).

Implement policies to **encourage renewable energy sources,** such as increasing support for research and development, **providing incentives** for renewable energy projects including solar, wind, and hydroelectric powers and removing barriers to their deployment.

Develop and implement regulations that **support energy efficiency** across sectors, including efficiency in buildings, transportation, and industrial sectors and the exploitation of the potential of energy storage in the design and operation of the networks.

Consider the specific characteristics of energy storage when designing network charges and tariff schemes and **facilitate permit granting** and encourage further exploitation of the potential of **energy storage in the design** and operation of the networks.

Encourage the **adoption of sustainable agriculture techniques**, such as organic farming, pesticide and fertilizer reduction, and the application of circular economy principles in the food production and distribution chain.

Boost **sustainable consumption** and production practices through **education, awareness** campaigns, and economic incentives.

Foster innovation and entrepreneurship in agricultural practices through **sponsoring R&D** activities, giving startup finance, and **fostering** favourable regulatory frameworks **for emerging technology.**

As part of the Policy and Valuation Track of the Energy Storage Grand Challenge Draft Roadmap, **provide tools, analyses, and recommendations** that **maximize the value of energy storage** to electric and thermal energy systems.

Expected Impacts

Thermochemical fluids + TES (Thermal Energy Storage) systems can help to **reduce greenhouse gas emissions from agricultural** energy use. Farmers can reduce their carbon footprint and environmental impact by improving energy efficiency and increasing the use of renewable energy sources. Supporting a more sustainable and environmentally friendly agricultural sector will help the EU to meet its climate goals.

Agricultural **heating and cooling systems,** such as greenhouse climate control, may take advantage of thermochemical fluids. These fluids can **efficiently transfer and distribute** heat, allowing crops to thrive in optimal conditions while minimizing energy consumption.

Thermochemical fluids can be used in **crop drying processes.** When compared to standard drying procedures, these fluids can efficiently **remove moisture** from harvested crops**, lowering drying time and energy requirements**. This improves crop post-harvest preservation.

Promoting renewable energy and energy efficiency can lead to a decrease in fossil fuel combustion and subsequently **improve air quality**, reducing the negative health impacts of pollution.

Thermochemical fluids can **improve crop nutrient absorption** by increasing nutrient solubility and availability in the soil. These fluids can aid in the breakdown of complex nutrients into more absorbable forms, resulting in enhanced nutrient uptake by plants.

Thermochemical fluids can **increase soil water retention**, lowering crop water stress. These fluids can aid in the **retention of moisture** in the root zone, resulting in a more regular water supply for plants, particularly in arid or drought-prone areas.

Thermochemical fluids can **aid in high-efficiency energy conversion processes**. It is now possible to convert low-grade waste heat into useful energy by using the reversible chemical interactions of these fluids, hence boosting

total energy efficiency. This has the potential to have a large influence on industrial processes, power generation, and heating systems.

Diversification of the energy mix through the expansion of renewable energy sources can enhance the EU's energy security by **reducing dependence on imported fossil fuels**.

Thermochemical fluids can improve agricultural energy **efficiency** by **storing and releasing thermal** energy as needed. Excess energy created during **peak hours** (such as from renewable sources like solar or wind) can be stored for **later use** using TES (Thermal Energy Storage) devices, decreasing waste, and optimizing energy utilization.

Thermochemical fluids + TES (Thermal Energy Storage) systems can aid in the **management** of agricultural **energy demand.** Farmers can lessen their dependency on the electrical grid during expensive or stressful seasons by storing thermal energy during low-demand periods and releasing it at peak demand, reducing strain on the overall energy system.

Waste heat recovery systems can make use of thermochemical fluids. They can convert waste heat from industrial operations, electricity generation, and other sources **into usable energy.** This decreases energy waste while also **improving overall system efficiency**.

Adoption of thermochemical fluid-based energy-saving technology can result in **financial gains**. Improved energy efficiency **saves money** for companies, businesses, and consumers. Furthermore, the development and implementation of these technologies create new prospects for energy sector innovation, job creation, and economic growth

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