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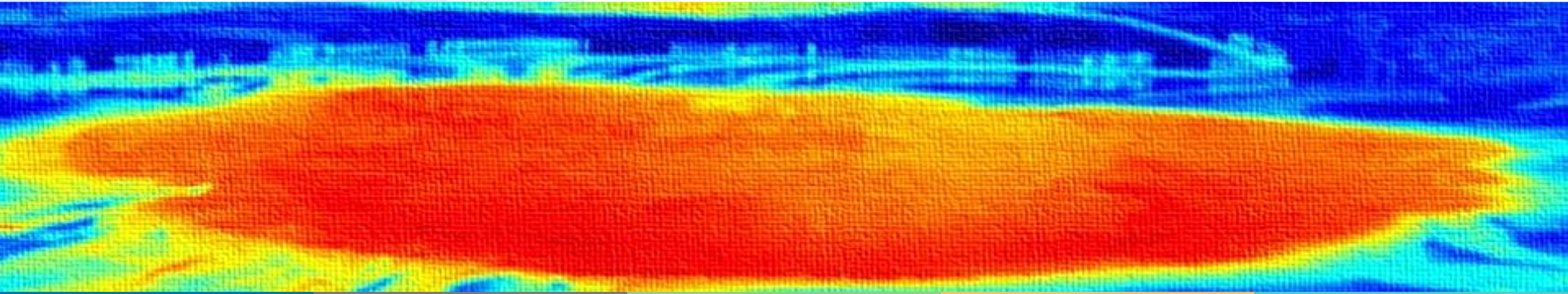

Innovation Outlook: Thermal energy storage

Francisco Boshell

Energy Community Workshop
on the energy storage technologies

14 Nov 2023

Renewables, efficiency and electrification dominate energy transition

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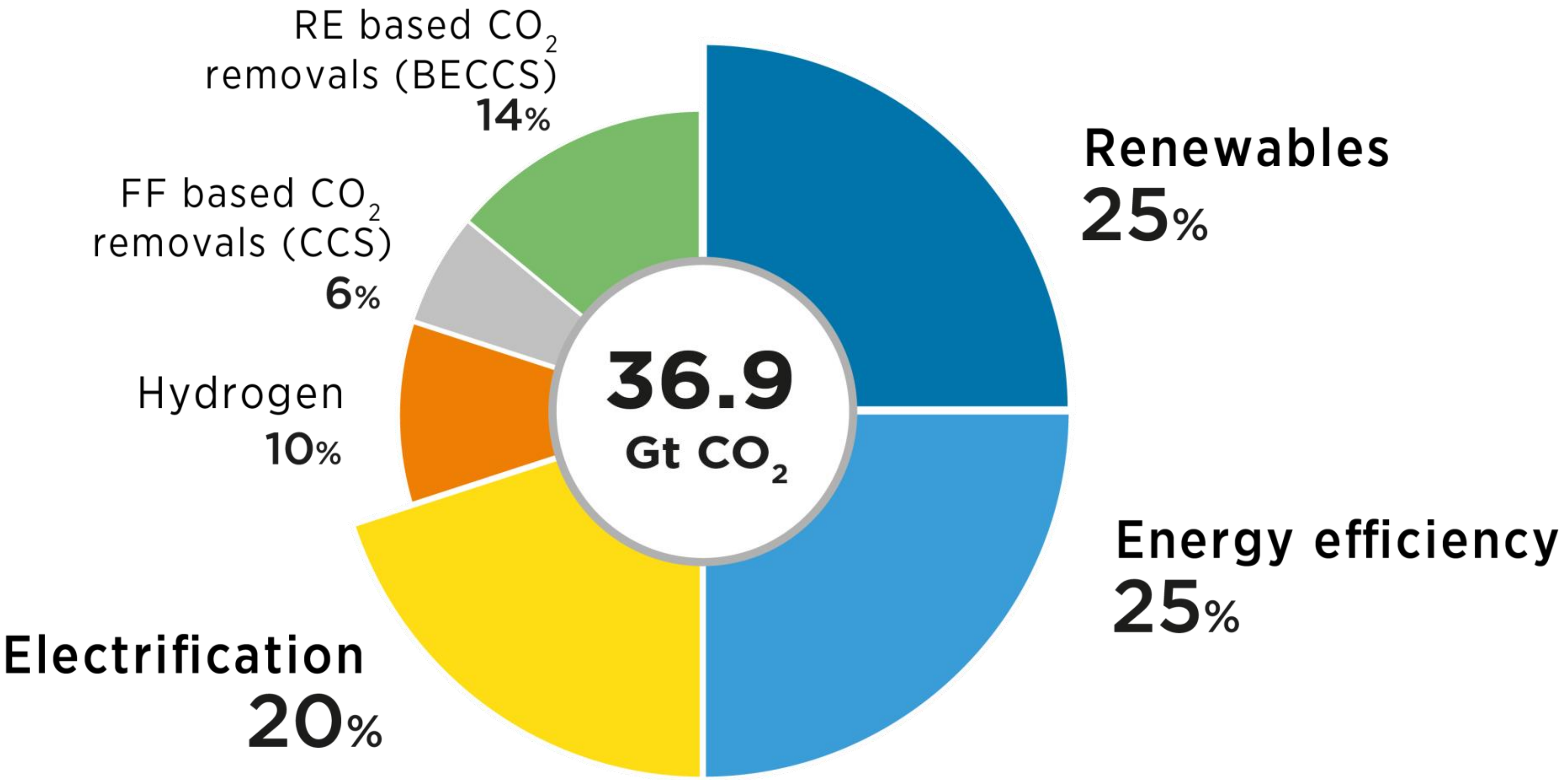
Six components of the energy transition strategy



90% of all decarbonisation in 2050 will involve renewable energy through direct supply of low-cost power, efficiency, electrification, bioenergy with CCS and green hydrogen.

Future global energy mix in a Paris Agreement aligned scenario

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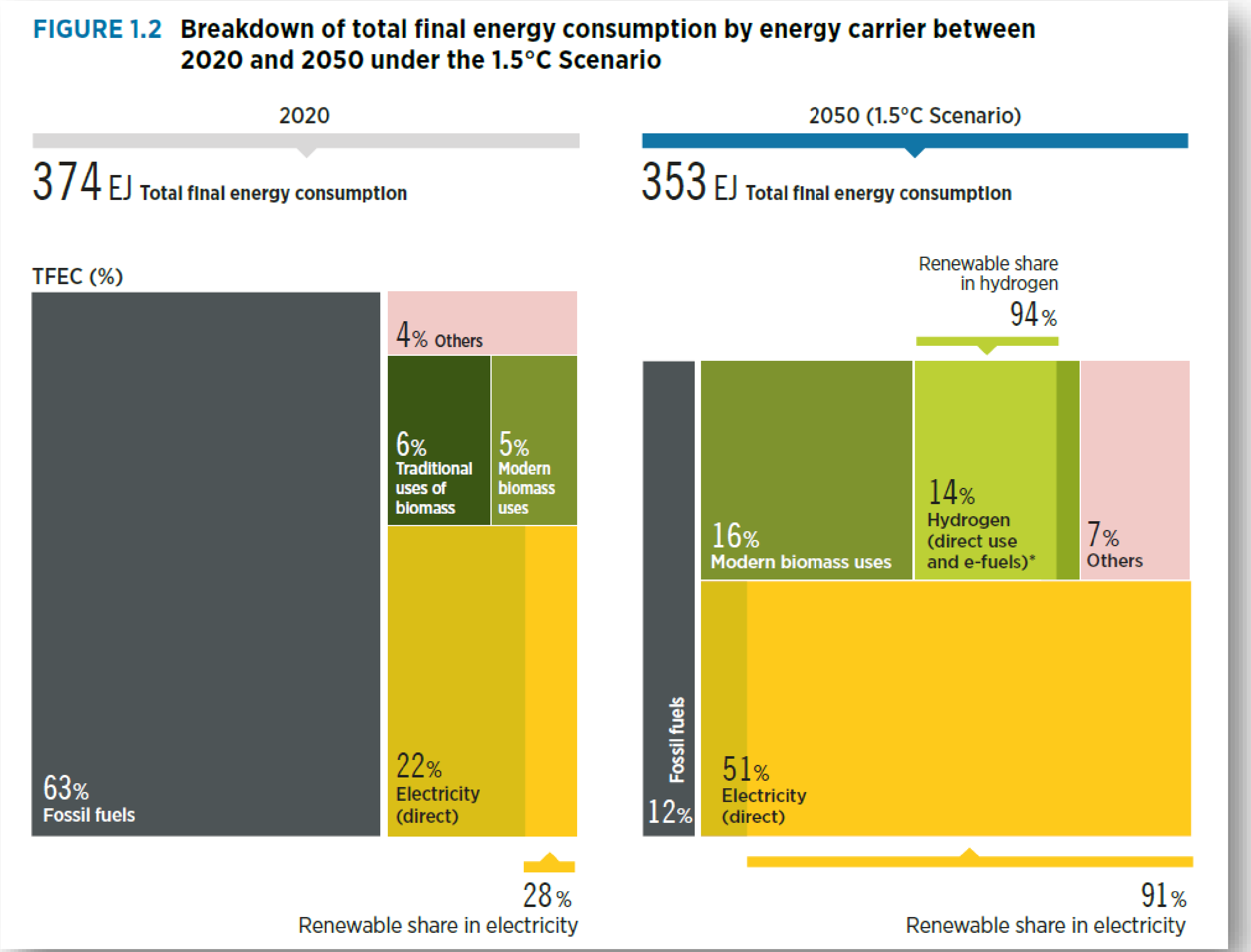
- The **global energy transition is off-track**
- Current plans are **not enough to limit the global temperature** increase below to 1.5°C.
- **Investments** in renewables must **quadruple**
- By 2050 in a 1.5oC Scenario -> **electricity is the king energy carrier**
- It has to **come from renewables**
- ~ **50% direct use** and ~ **14% indirect use as Green Hydrogen**



Source: IRENA (2023), World Energy Transitions Outlook 2023: 1.5° C Pathway, Volume 1

The role of Thermal Energy Storage (TES) in the Energy Transition

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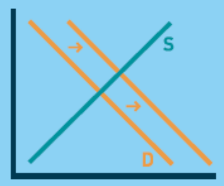
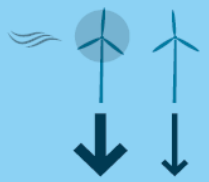
TES technologies offer unique benefits compared to other forms of flexibility:



Demand shifting

TES can facilitate flexibility in the delivery of heat and cold, decoupling supply and demand



Variable supply integration

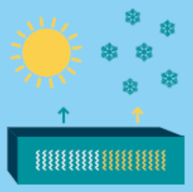
Heat/cold produced at times of peak supply of renewable electricity can be used to meet demand even when the sun is not shining and the wind is not blowing

Sector integration

TES enables whole system benefits through increased sector integration, allowing renewable electricity to reliably meet a greater proportion of energy demand

Network management

Increased flexibility arising through the deployment of TES can alleviate the strain on electricity networks, and can reduce the need for costly grid reinforcement

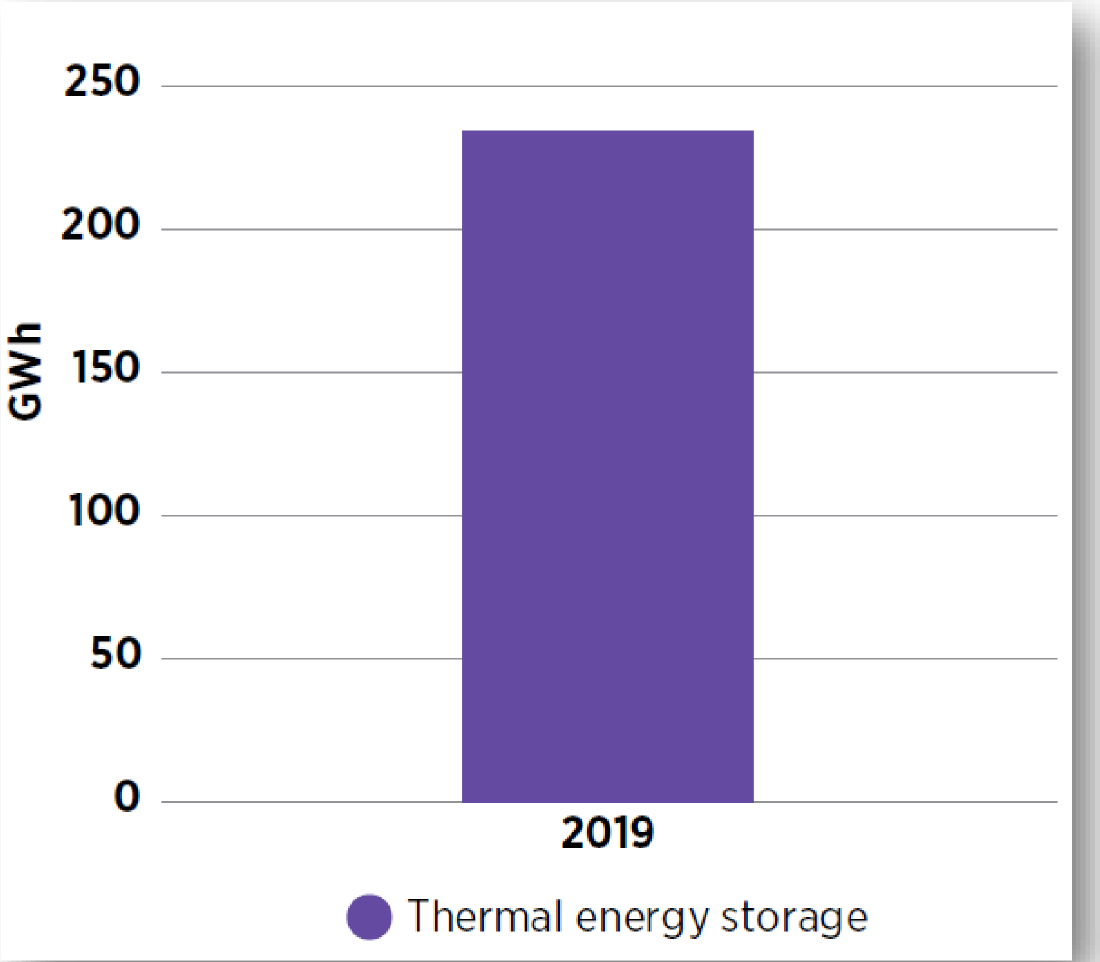


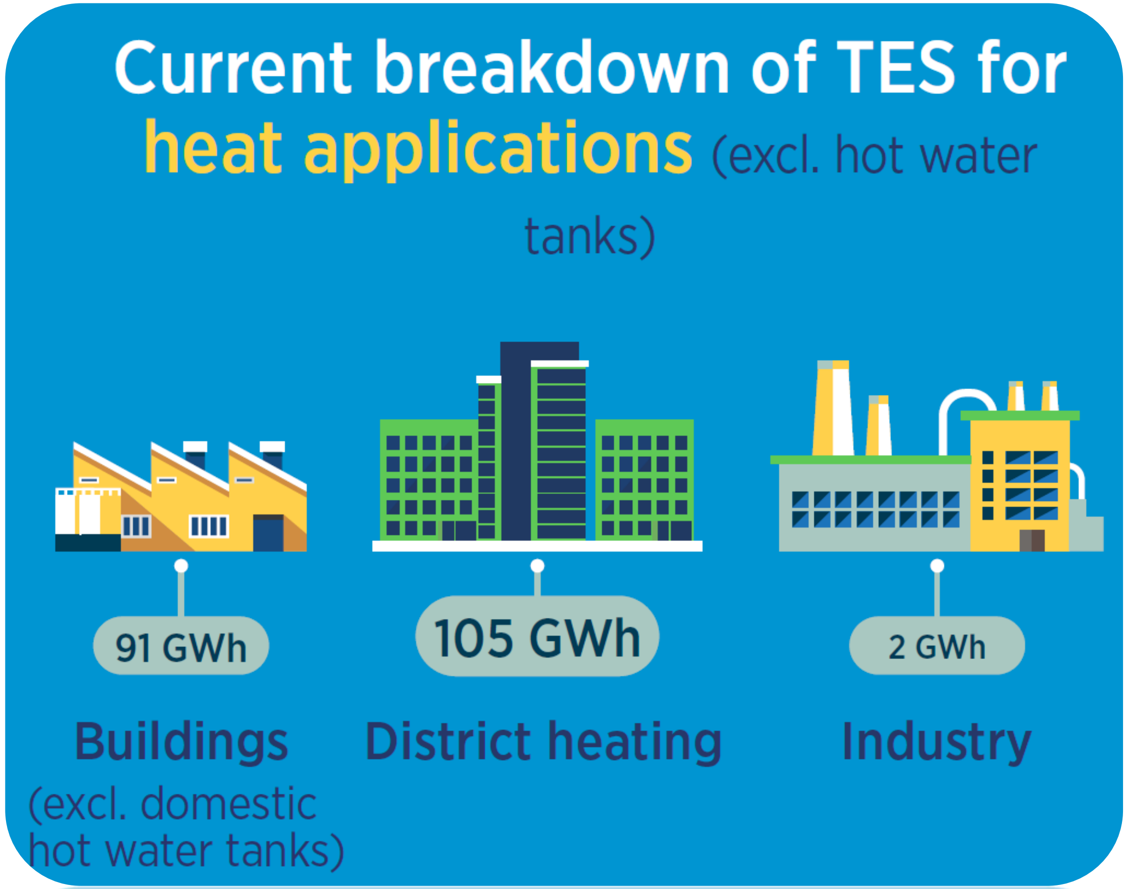
Seasonal

TES can enable winter heating demands to be met through thermal energy stored from sunny summer days, and cooling demands in summer to be met through cold stored from winter

Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

TES Market Status



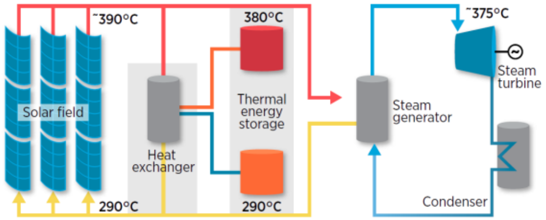


Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

Thermal energy storage categories

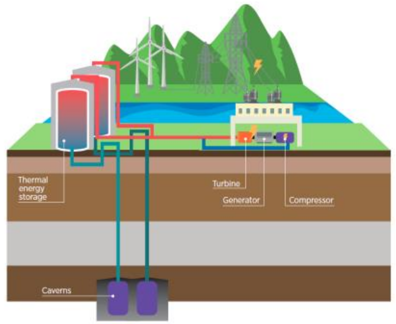
Sensible

Sensible heat storage stores thermal energy by heating or cooling a storage medium (liquid or solid) without changing its phase.



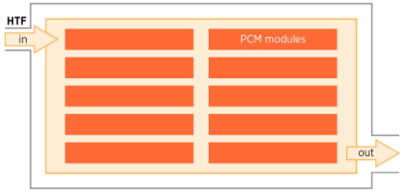
Mechanical-thermal

Couples TES systems with mechanical energy storage technologies, providing complementary capabilities from both technologies.



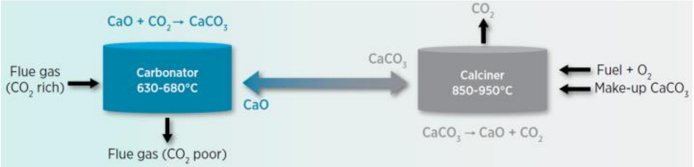
Latent

Latent heat storage uses latent heat, which is the energy required to change the phase of the material to store thermal energy.



Thermochemical

Energy is stored in endothermic chemical reactions, and the energy can be retrieved at any time by facilitating the reverse exothermic reaction. It can be divided into reversible reaction-based storage and sorption based energy storage.



Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

Type of TES	TES technology	Applicable scale			Storage period				Potential vectors					
		Small	District	Utility	Hours	Days	Weeks	Months	In			Out		
Sensible	WTTES	✓	✓	✓	✓	✓	✓	✓	H	C	P	H	C	P ✗
Sensible	UTES	✓	✓	✓	✓	✓	✓	✓	H	C	P	H	C	P ✗
Sensible	Solid state	✓	✓	✓	✓	✓	✓	✓	H	C	P	H	C	P
Sensible	Molten salts	✗	✓	✓	✓	✓	✗	✗	H	C ✗	P	H	C ✗	P
Latent	Ice thermal energy storage	✓	✓	✗	✓	✓	✗	✗	H	C	P	H ✗	C	P ✗
Latent	Sub-zero temperature PCM	✓	✓	✗	✓	✗	✗	✗	H	C	P	H ✗	C	P ✗
Latent	Low-temperature PCM	✓	✗	✗	✓	✗	✗	✗	H	C	P	H	C	P ✗
Latent	High-temperature cPCM	✓	✓	✓	✓	✓	✗	✗	H	C	P	H	C	P ✗
Thermo-chemical	Chemical looping (calcium looping)	✗	✗	✓	✓	✓	✓	✓	H	C ✗	P	H	C ✗	P
Thermo-chemical	Salt hydration	✓	✓	✗	✗	✓	✓	✓	H	C	P	H	C ✗	P ✗
Thermo-chemical	Absorption systems	✓	✓	✗	✓	✓	✗	✗	H	C	P	H ✗	C	P ✗
Mechanical-thermal	CAES	✗	✗	✓	✓	✓	✓	✗	H ✗	C ✗	P	H ✗	C ✗	P
Mechanical-thermal	LAES	✗	✓	✓	✓	✓	✓	✓	H ✗	C	P	H ✗	C	P

Notes: green denotes applicable; red denotes not applicable; C = cold; H = heat; P = power.

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TES Technologies by type of service

- Scale
- Storage period
- Output vector
- Temperature range
- Maturity stage

Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

TES Power Applications status and outlook

Example: Solid state TES with wind power

- Siemens-Gamesa commissioned in 2019 Hamburg, Germany
- Over 1,000 tons of rock provide thermal storage capacity of 130 MWh of electric energy at rated charging temperatures of 750° C
- The heat is re-converted into electricity through steam - electricity output 1.5 MW

Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

TES District Heating and Cooling Applications status and outlook

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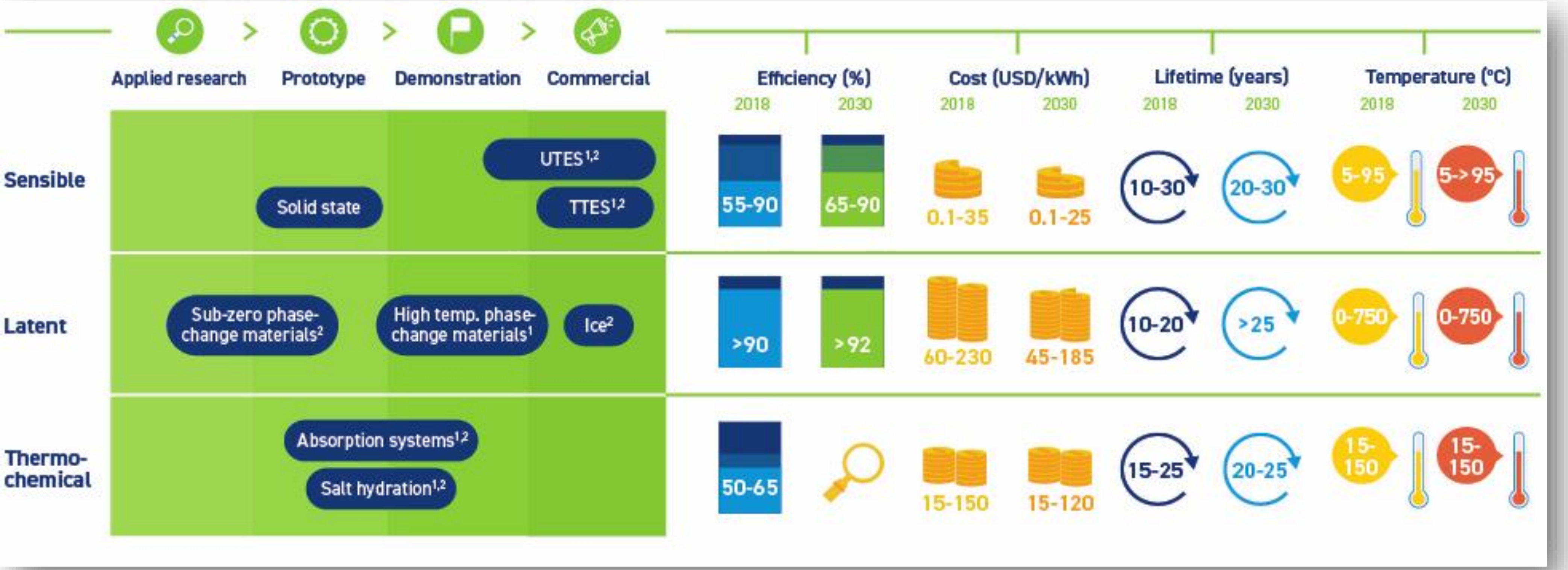

Example: Drake Landing Solar Community in Canada

- Solar thermal energy and seasonal UTES for a district heating scheme
- 52 houses in Alberta, Canada
- 1.5 MW of solar thermal capacity installed on the garages of each house
- provision of almost 100% of space heating from local solar thermal generation

Source: IRENA (2020), Innovation Outlook: Thermal Energy

TES Buildings Applications status and outlook

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Example: Summerside in Canada

- Use of local wind power for heating
- "Heat for Less" programme, which encouraged residents to replace oil-based heating appliances with either electric thermal storage technology (using ceramic bricks) or time-of-use electric water heaters (TTES) at discounted rates.

Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

TES Industry Applications status and outlook

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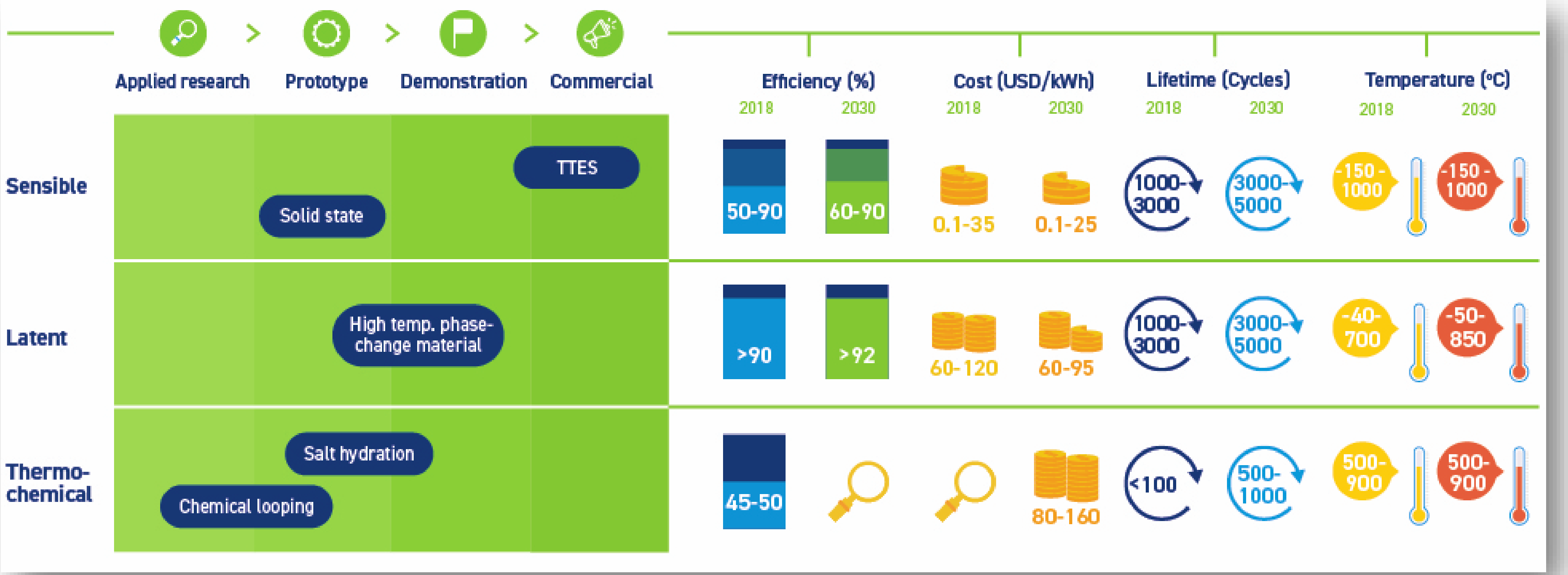

Example
There is a growing use of water TTES in conjunction with solar thermal plants for low-temperature process heat generation and storage.

Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

Policy messages to Support TES development and deployment

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Policy makers can also address sector-specific challenges with targeted interventions

Power
- Provide subsidies or other technology push interventions to improve financial value propositions and increase consumer awareness and acceptance for novel technologies
- Develop industry supply chain and skills

Industry
- Employ market pull mechanisms such as cap and trade schemes to improve the financial proposition of onsite renewables and thermal storage compared to fossil fuels
- Introduce certification schemes, media campaigns and demonstration projects to increase awareness and build trust in new technologies

Cold chain
- Address systemic barriers to energy storage in regulatory frameworks, as part of holistic energy policy
- Provide price signals for flexibility, to improve the value proposition for storage technologies
- Increase funding for R&D and demonstration projects that look specifically at TES

Buildings
- Investment support mechanisms and command and control mechanisms, *e.g.* public procurement can accelerate development of renewably powered district heating/cooling schemes
- Provide clear guidlines and regulations for planning, building standards and environmetal protection

District heating and cooling
- Increase funding for R&D and demonstrations to help accelerate technology development
- Encourage consumers uptake through media campaigns and price support mechanisms for TES or enabling infrastructure such as heat pumps
- Introduce mandatory building codes to shift away from fossil powered heating systems

Source: IRENA (2020), Innovation Outlook: Thermal Energy Storage

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