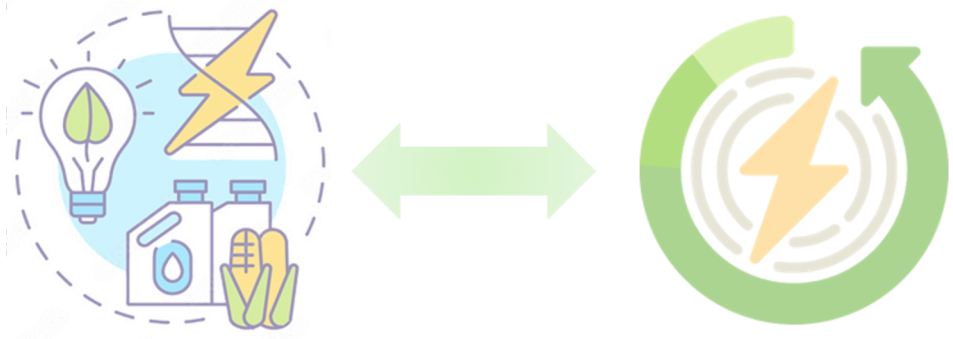
Links between bioenergy & energy storage applications

Paula Blanco Sanchez
Senior Lecturer
EBRI, Aston University

p.blanco-sanchez@aston.ac.uk



Engineering and Physical Sciences Research Council

Supergen Energy Storage

Supergen Bioenergy

Supergen Energy Storage Network+ Webinar Series

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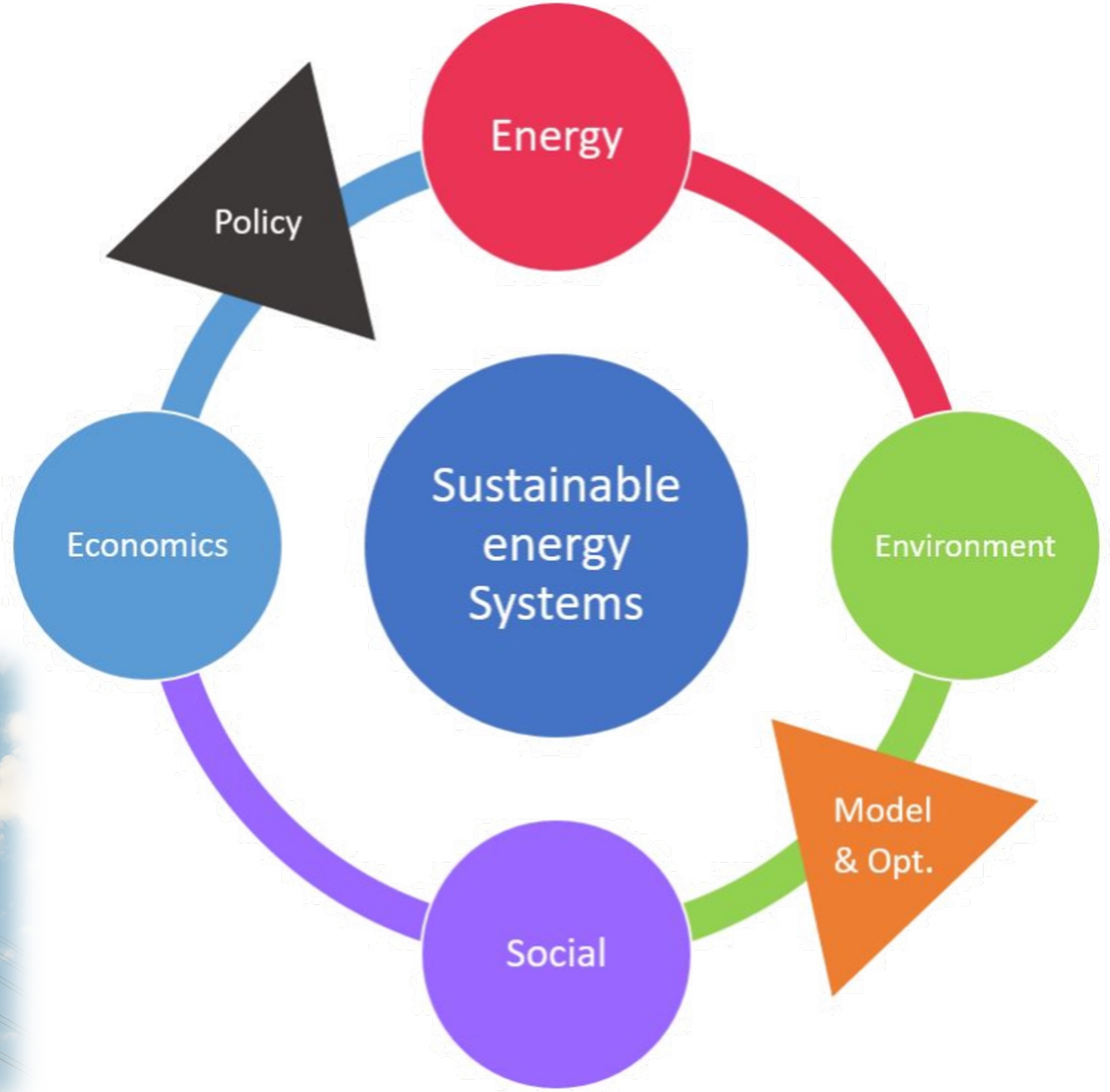
Energy systems

Bioenergy (renewable energy) and **energy storage** technologies are closely linked in the context of **sustainable energy systems**.



REF: Sustainable energy systems and policy (SESP) research cluster. Indonesia, 2022. https://sesp.ui.ac.id/

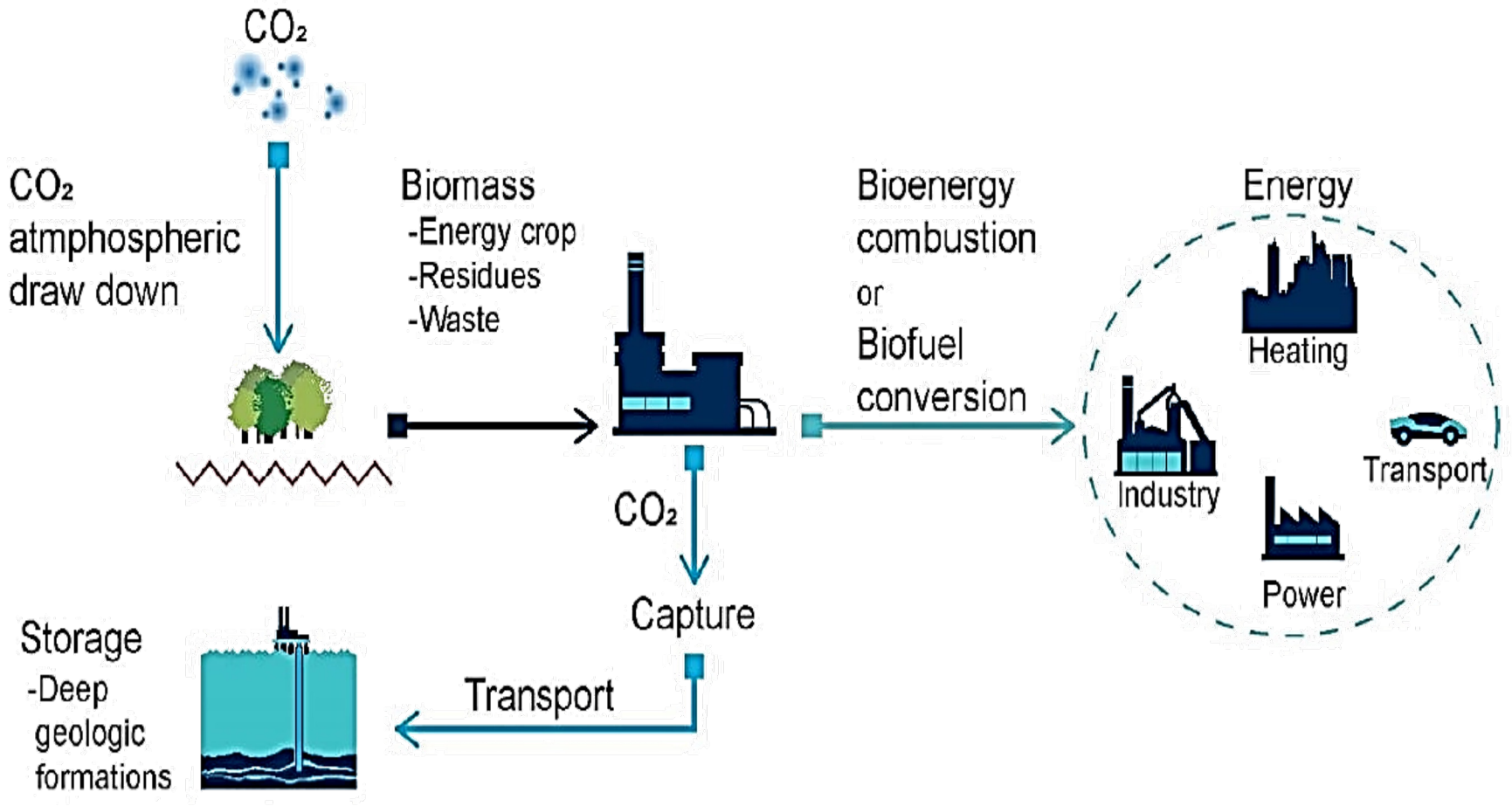
Renewable energy from biomass

BIOENERGY

Bioenergy with Carbon Capture and Storage (**BECCS**):

Consists in the **conversion of biomass** (like crops and biological waste), while **capturing** the emissions and **storing** the below ground.

The energy produced through can be directed toward a variety of uses, but the **key feature** is the **elimination of greenhouse gases (GHG)** addition to the atmosphere.



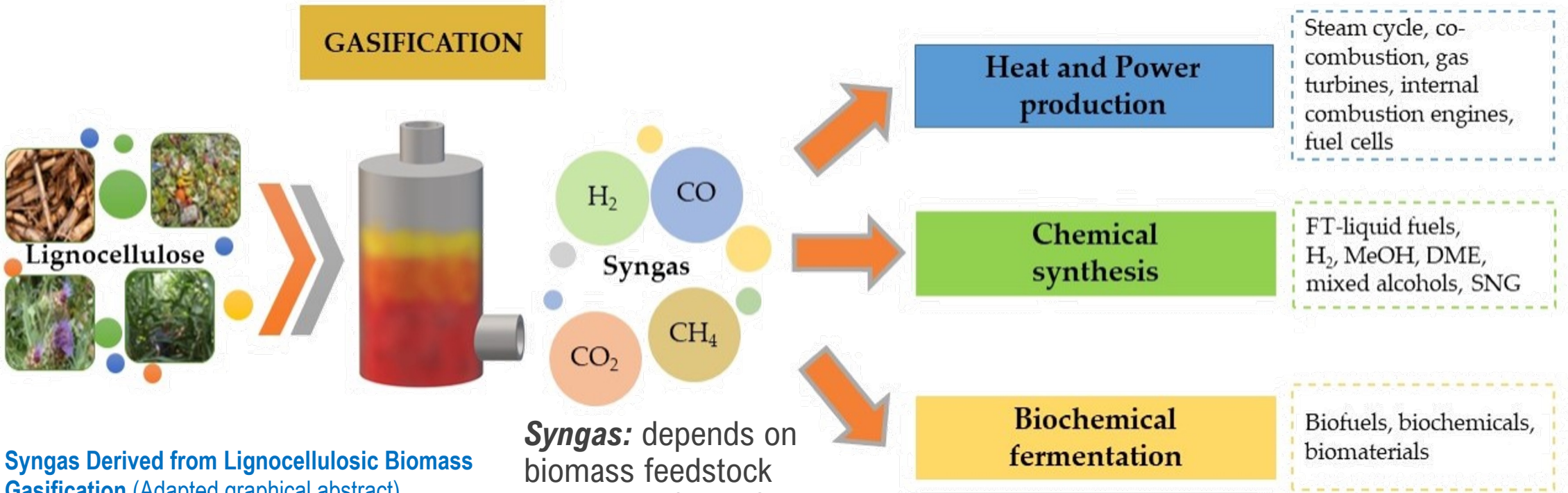
Bioenergy and carbon capture and storage (BECCS) schematic.
Source: Global CCS Institute.

Biomass gasification

One of the thermal conversion technologies used in BECCS.

Utilises temperatures **500-1000 °C** and different gasification agents (air, oxygen, steam or mixtures) to convert **~75% of solid biomass into gases**.

Output gas is known as **syngas**, it is formed by different gases: *CO, CO_2, H_2, CH_4, N_2, etc*.



Syngas Derived from Lignocellulosic Biomass Gasification (Adapted graphical abstract) Ciliberti, C., et al. Processes 2020, 8(12), 1567

Syngas: depends on biomass feedstock properties & gasification conditions.

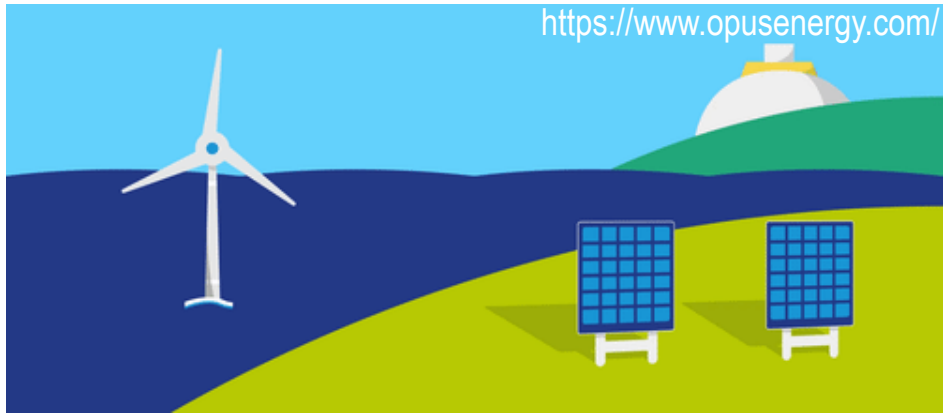
Intermittent Energy sources

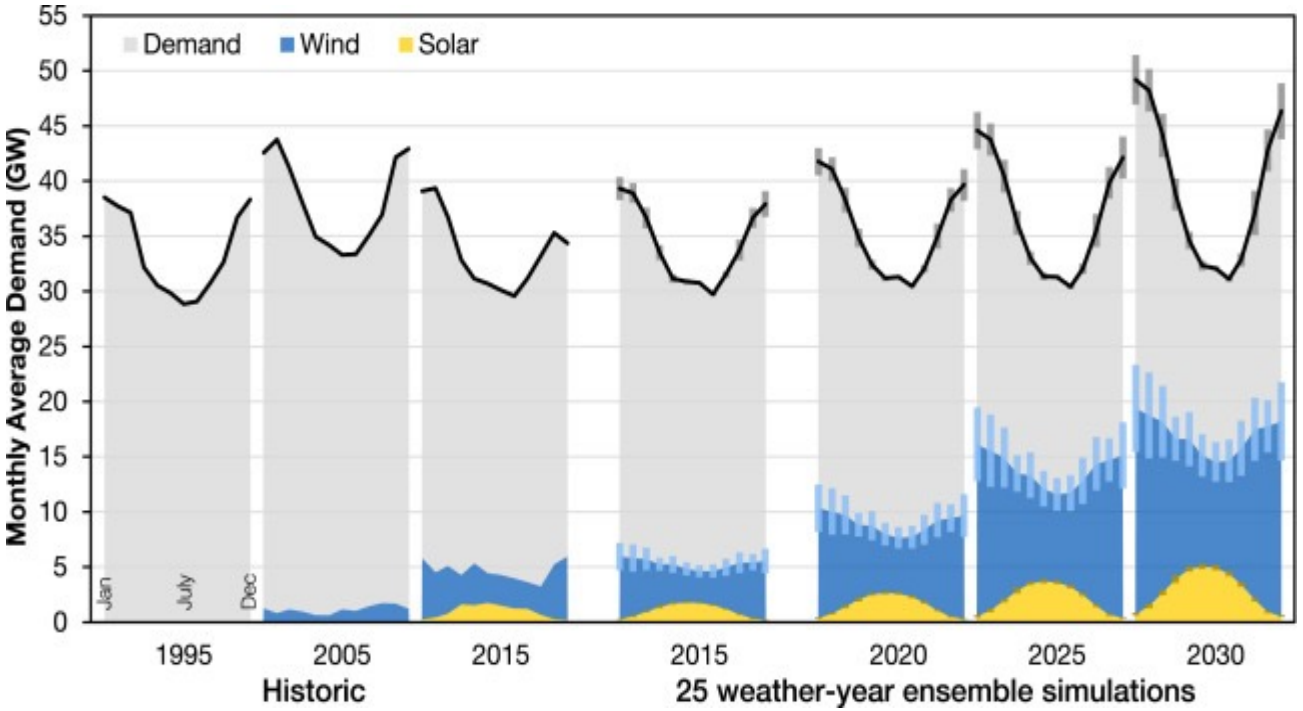
Renewable energy sources such as wind and solar are **intermittent** in nature.

For example, they are dependent on weather conditions, thus not providing a consistent energy supply.

Electricity supply and demand are becoming increasingly weather-dependent.

Energy storage: plays a crucial role.





Seasonal variation in demand and supply from wind and solar power.
Stafell, I., Pfenninger, F. (2018) *Energy*, 145: 65-78

Why is energy storage relevant?

February 2022:
Nearly **£7 million** awarded to turbocharge UK projects that were developing innovative **energy storage technologies** (*gov.uk*).

Will be crucial as the UK transitions towards ***cheap, clean, domestically-produced renewable energy***.

Maximise the potential of renewables to lower costs in the shift to a ***greener energy system***.

The intermittent nature of renewable power (solar and wind) means that ***energy can be produced when it is not needed***.

New technologies: ***energy can be stored for longer, helping manage electricity generation variations and increasing resilience, while also maximising value for money***.

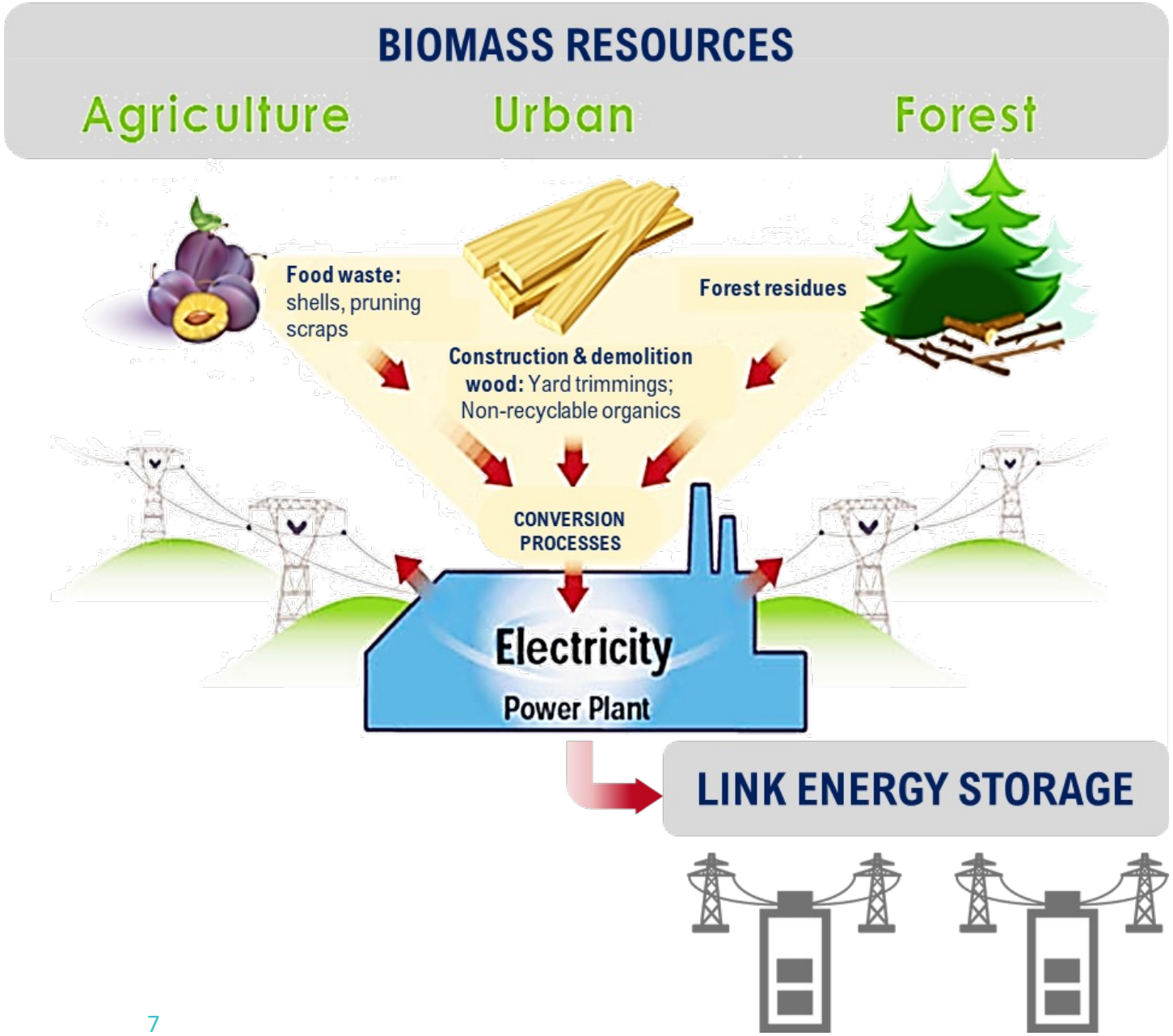
Bioenergy & energy storage

BIOENERGY

Use of biomass to generate biofuels, biochemicals, heat, or **electricity**.

ENERGY STORAGE

Energy storage technologies involve **storing excess energy for later use**, thereby enabling a more reliable and flexible energy supply.



Hydropower generation

How can we store renewable energy?

Magnetic systems (superconducting magnetic energy storage)

Electrochemical systems (batteries, fuel cells, etc.)

Hydro systems (water pumps)

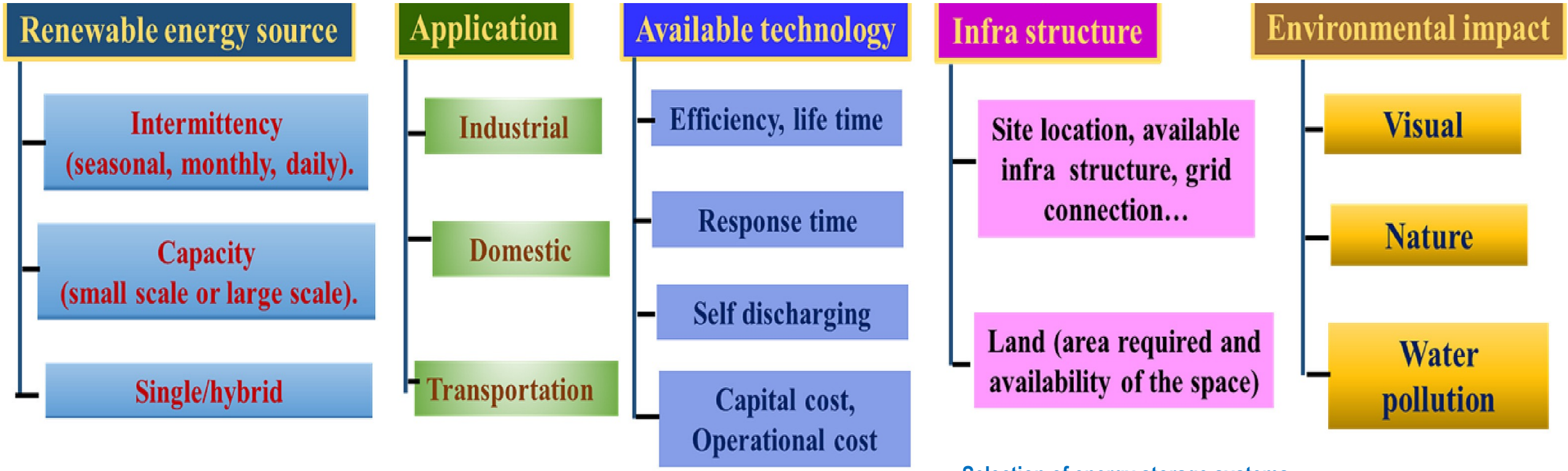
Pneumatic systems (compressed air)

Mechanical systems (flywheels)

Thermal systems (molten salts, water or oil heaters)

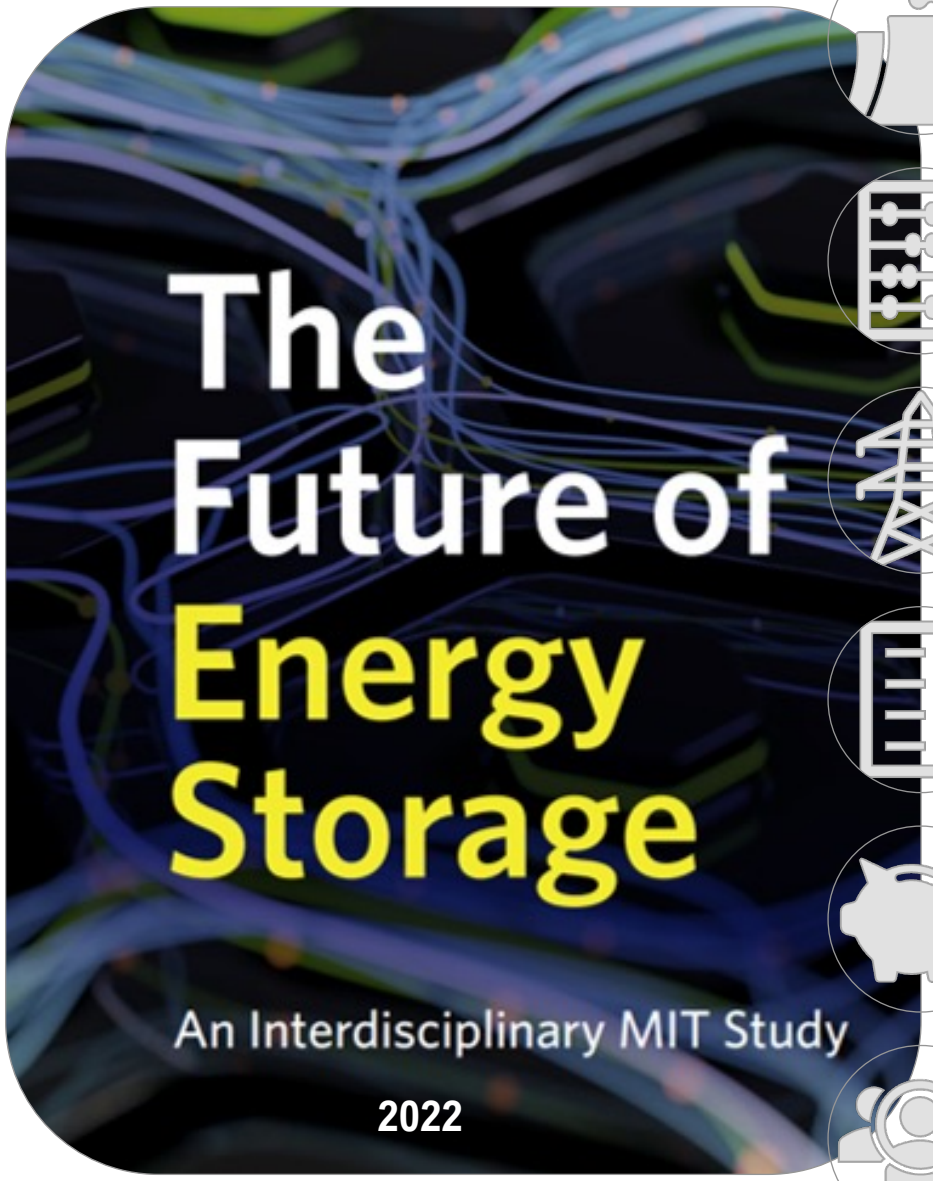
Challenges & selection of technology

- Imbalance between supply and demand of electricity
- Impact on stability of power grid from numerous installations of renewable energy
- Safety of battery systems & long recovery time of system failures
- Regional power shortages



Selection of energy storage systems
Olabi and Abdelkareem (2021) *Energy*, 219: 119634

Analysis of the key components in decarbonising energy infrastructure and combating climate change.



- Storage enables deep decarbonisation of electricity systems
- Recognize trade-offs between “zero” and “net-zero” emissions
- Developing economy countries: important market for electricity system storage
- Invest in analytical resources and regulatory agency staff
- Long-duration storage needs government/ federal support
- Reward consumers for more flexible electricity use

How to achieve a good integration?

Energy storage will be useful not only for intermittent renewable energy production, but useful for diverse energy generation sources, including **bioenergy**.

Different energy sources will be needed to cope with demand.

Energy storage: Suitable and reliable technology.

To propose robust planning strategies for the investors.

Common goal: to achieve 100% renewable energy and provide an adequate solution to the energy storage systems by 2050.

Thanks for your attention!

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