Novel CCU Technologies
A SAPEA Report

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DG Clima Workshop

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Outline

1. The CCU system
2. RES efficiency in delivering energy services
3. Carbon balances of technology chains
4. Innovation needed

1. The CCU system

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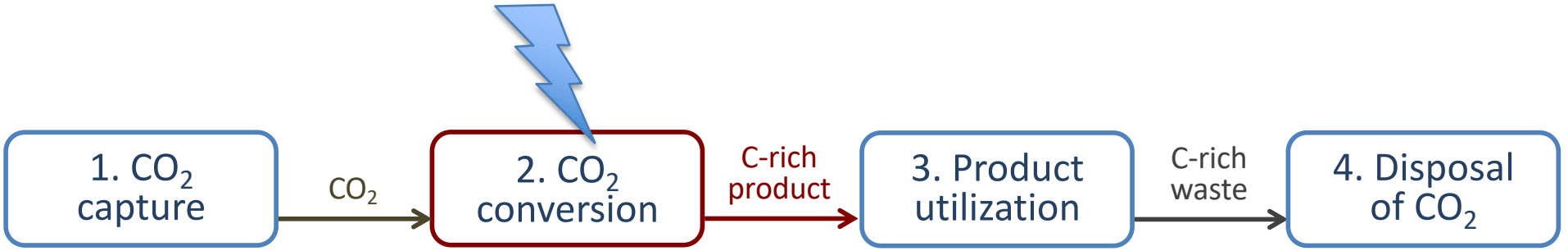

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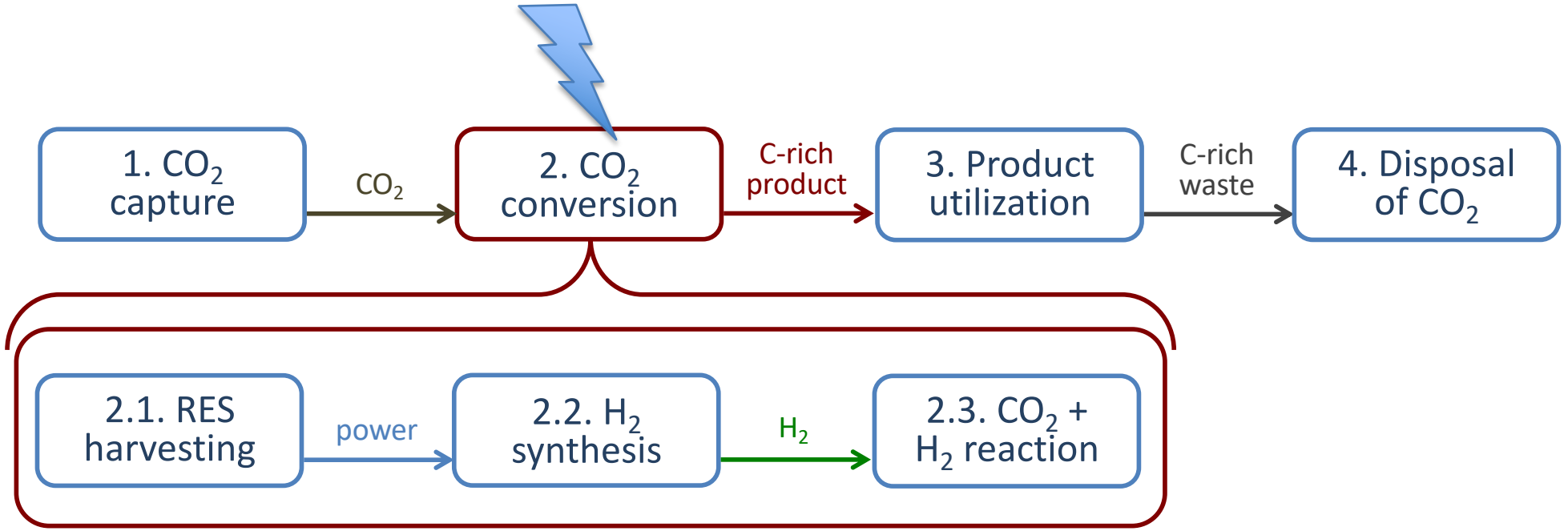

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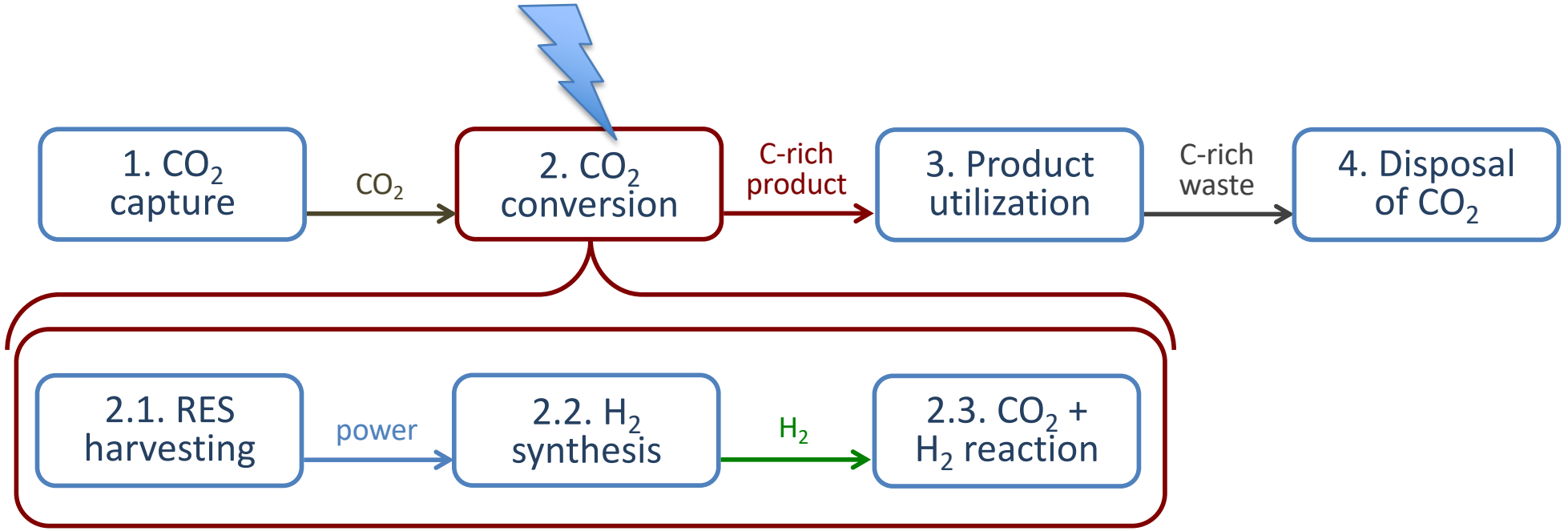

CCU POTENTIAL IN EU TO SUPPORT:

- climate change objectives;
- circular economy (O- vs. L-economy);
- energy security and RES deployment;
- evolution of CO_2 capture systems.

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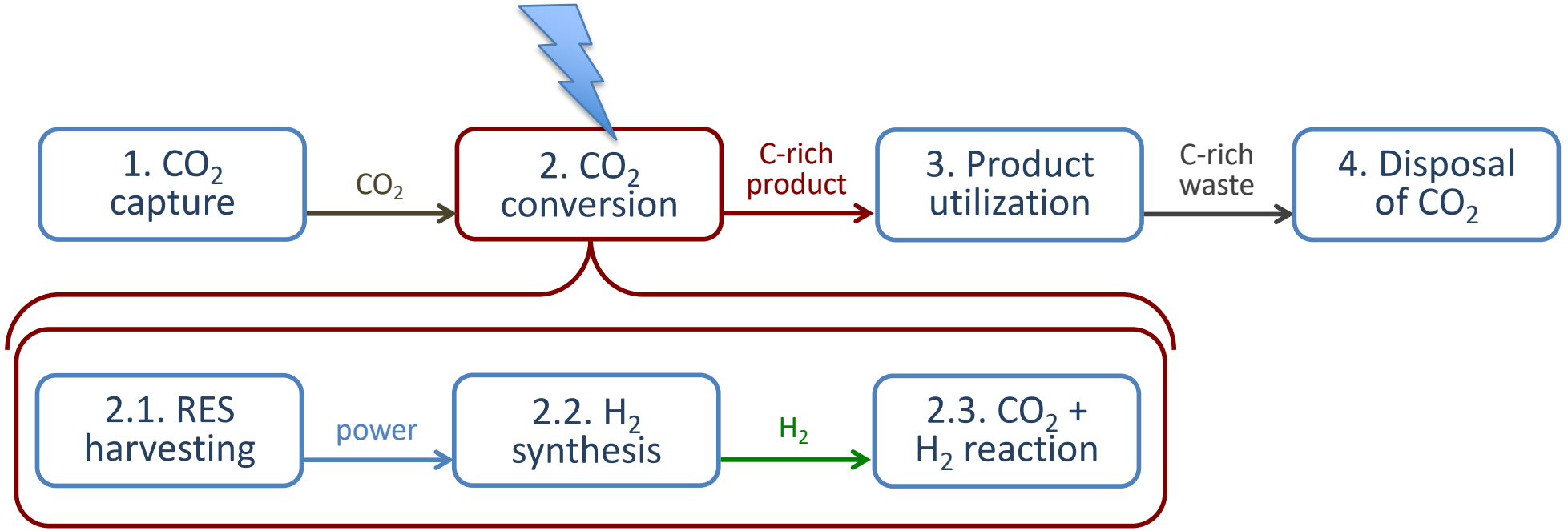

WG VIEW: SOCIETAL SERVICES

- power generation and distribution;
- fuels (and power) for transport;
- long-term long-range RES storage;
- industrial products and materials.

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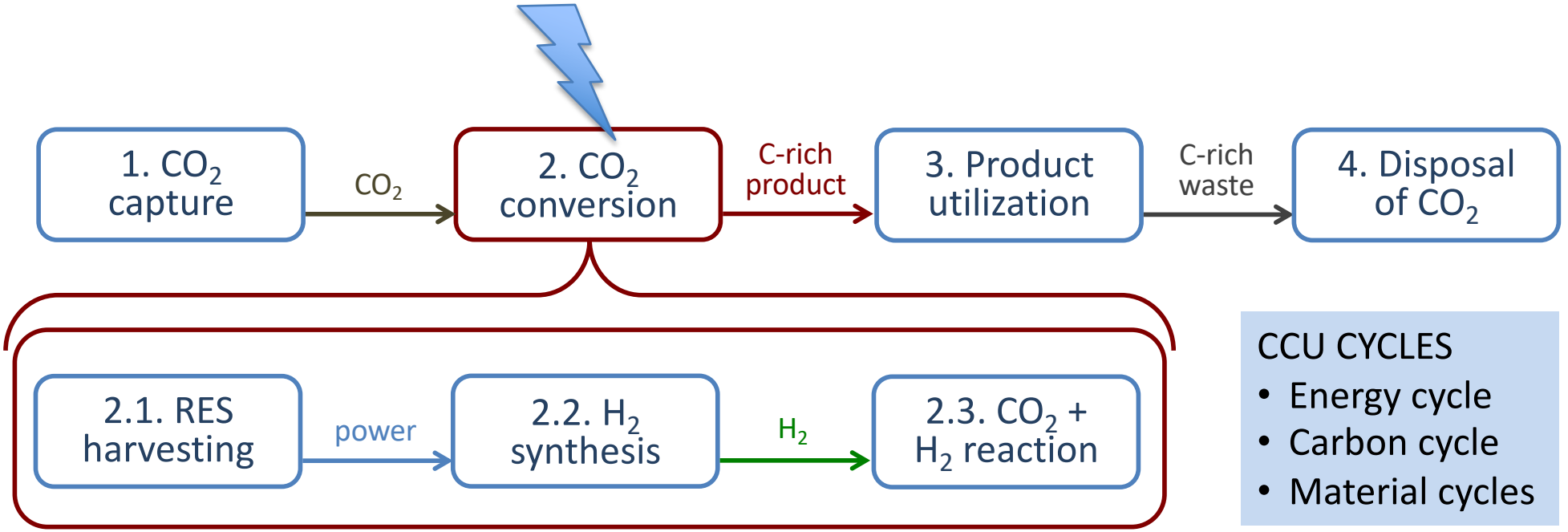

CCU CYCLES
- Energy cycle
- Carbon cycle
- Material cycles

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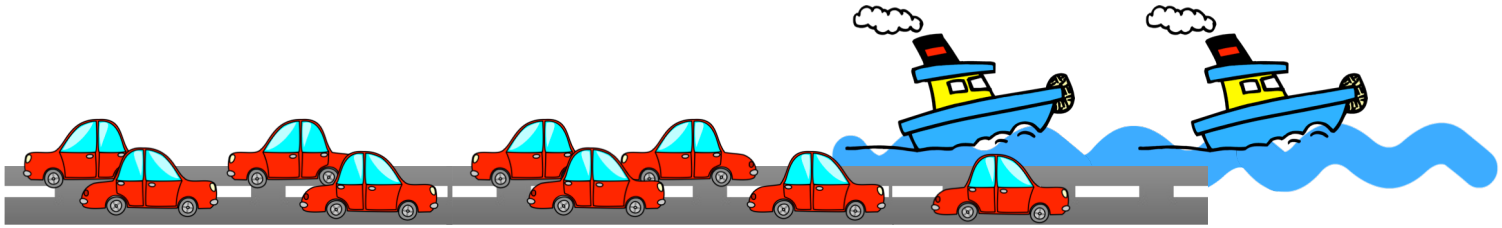

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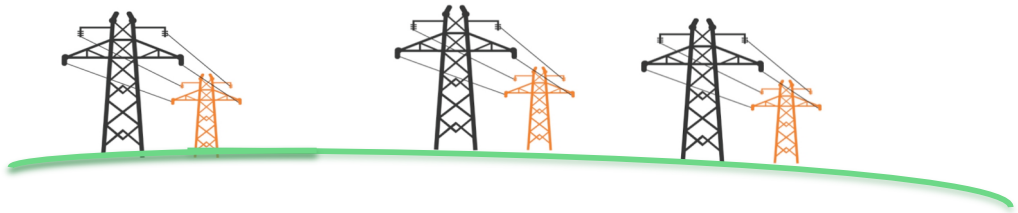

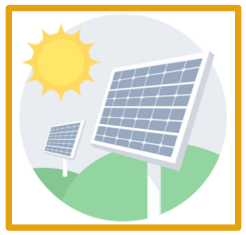

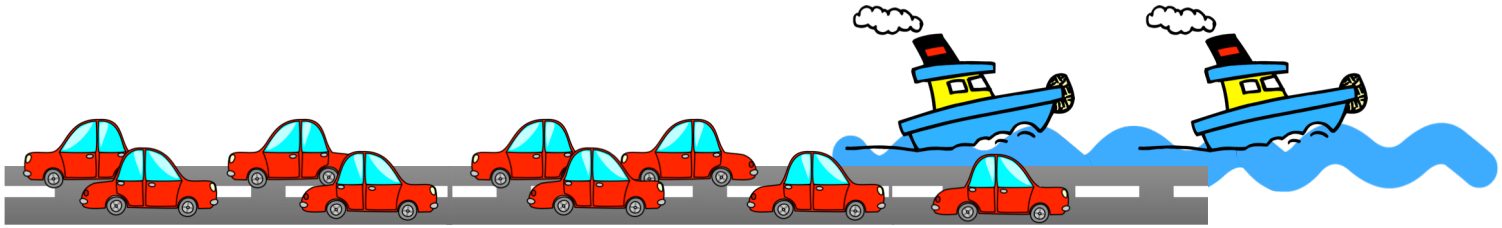

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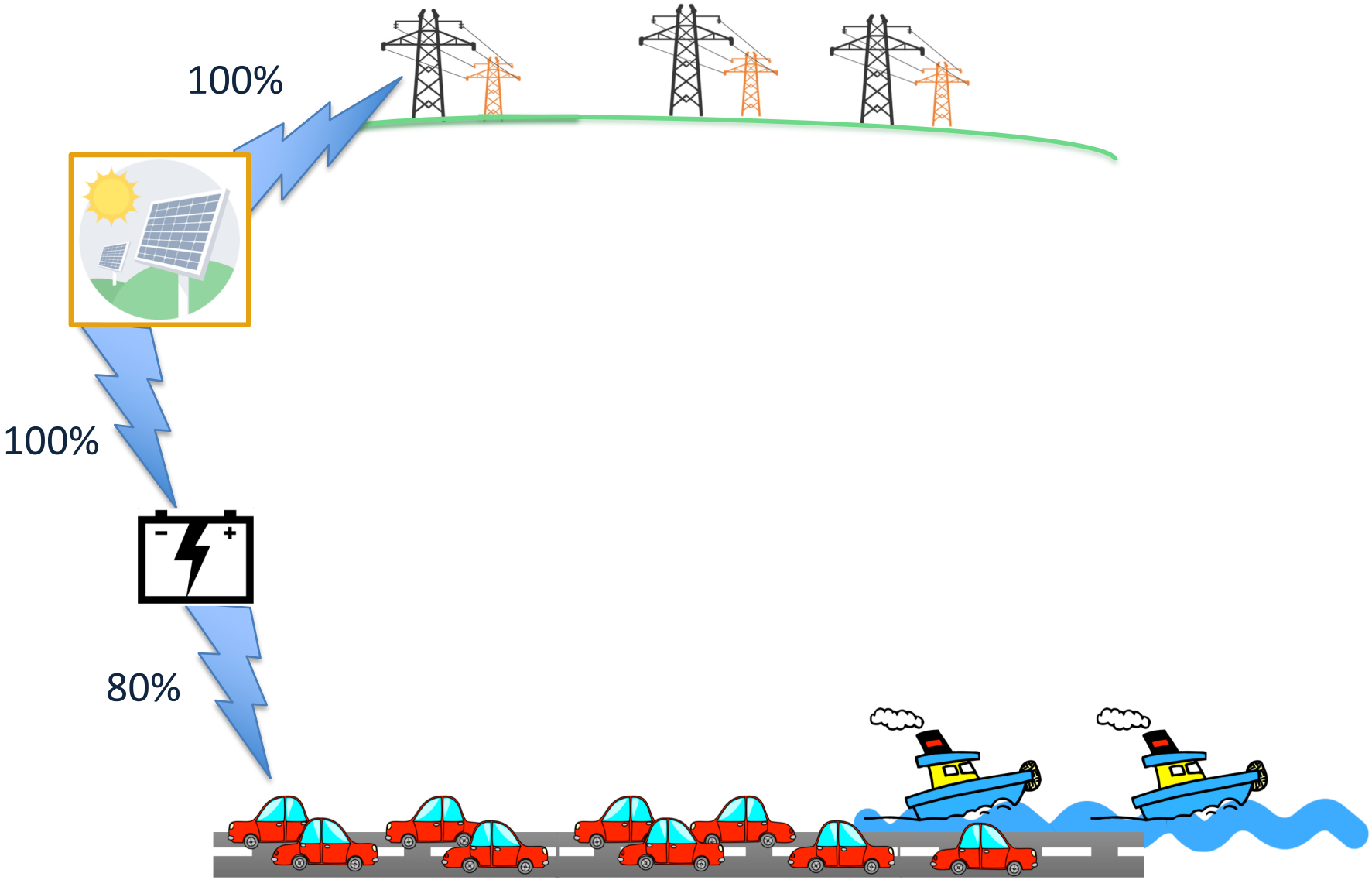

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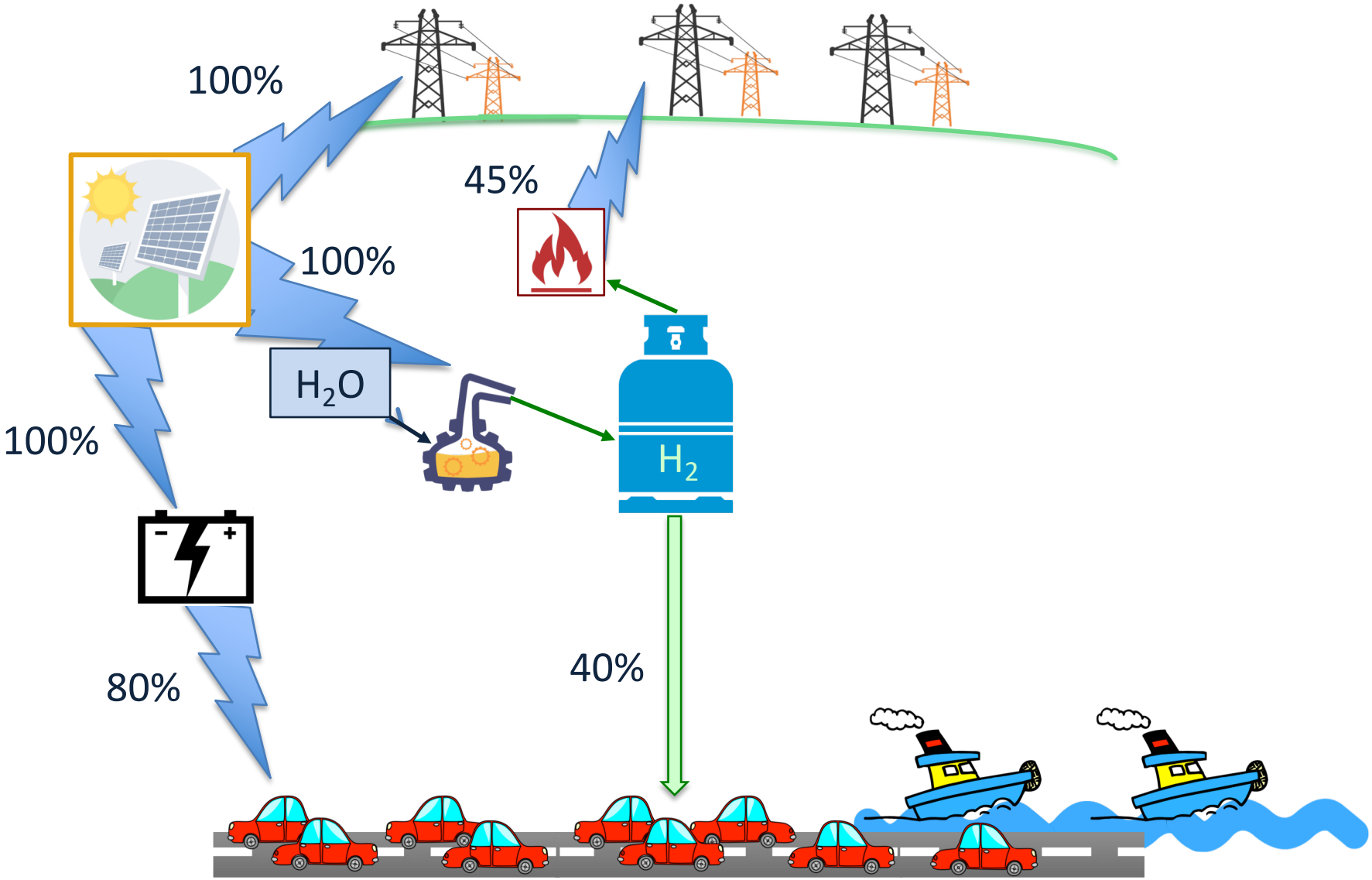

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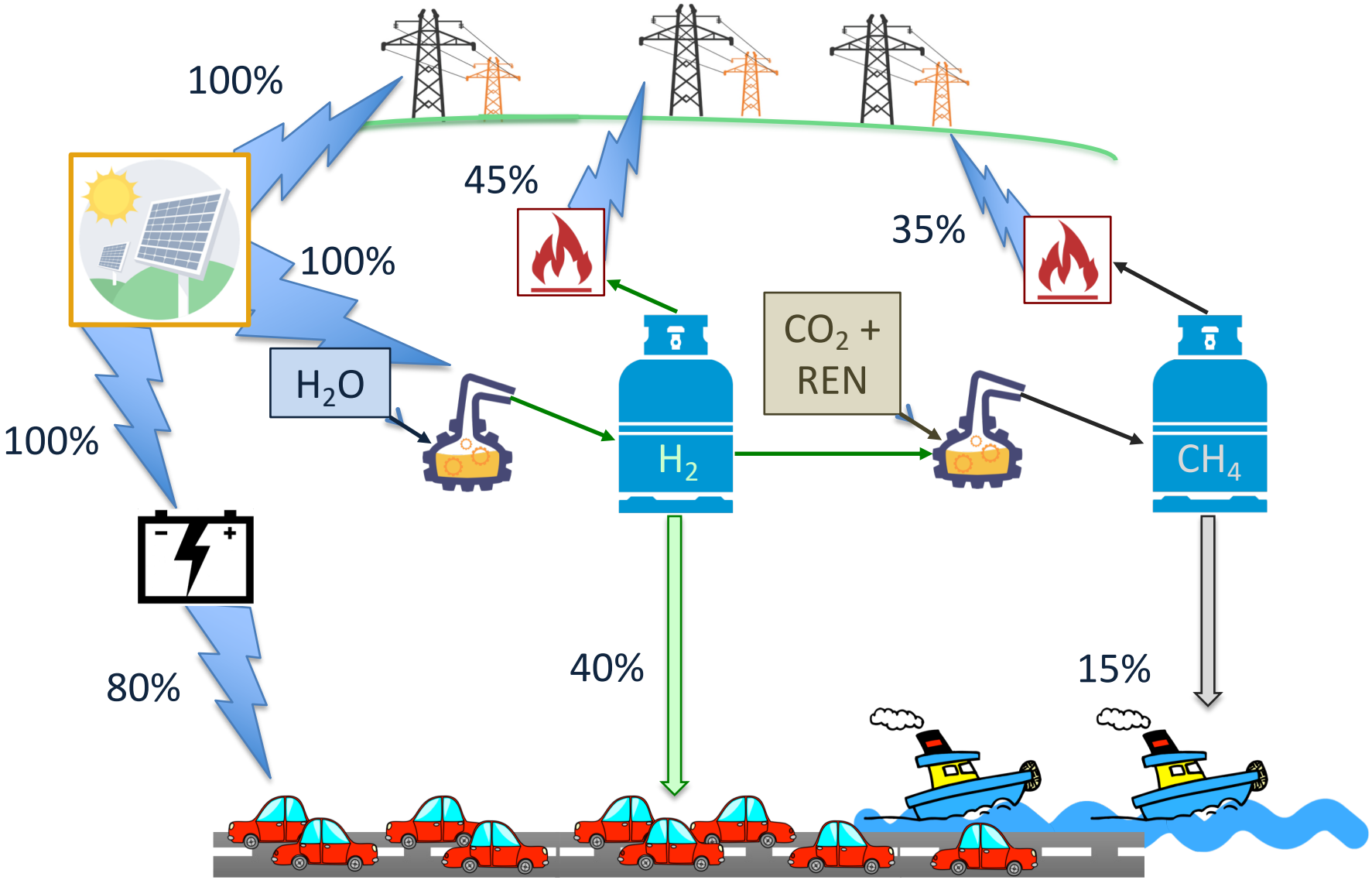
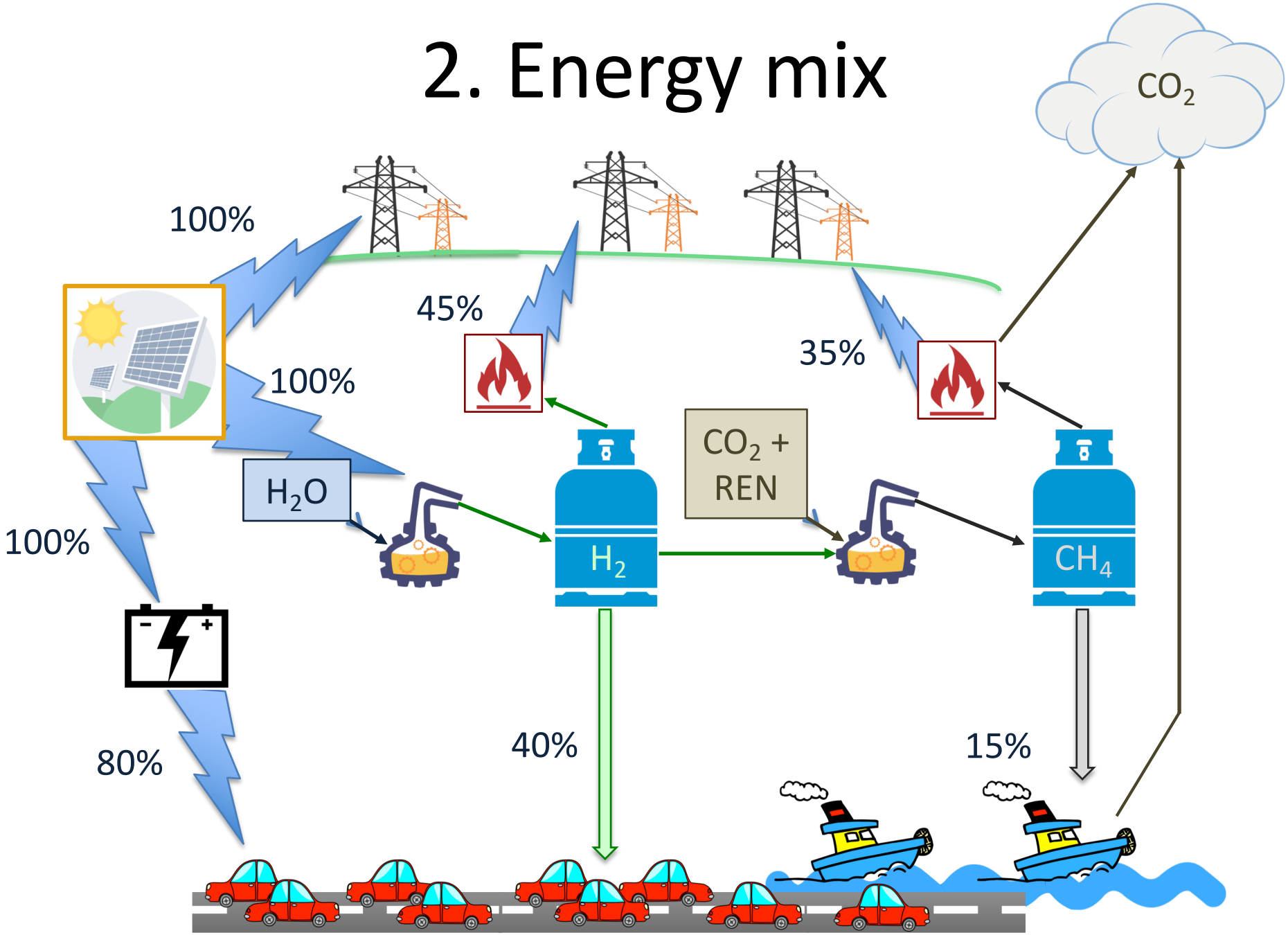
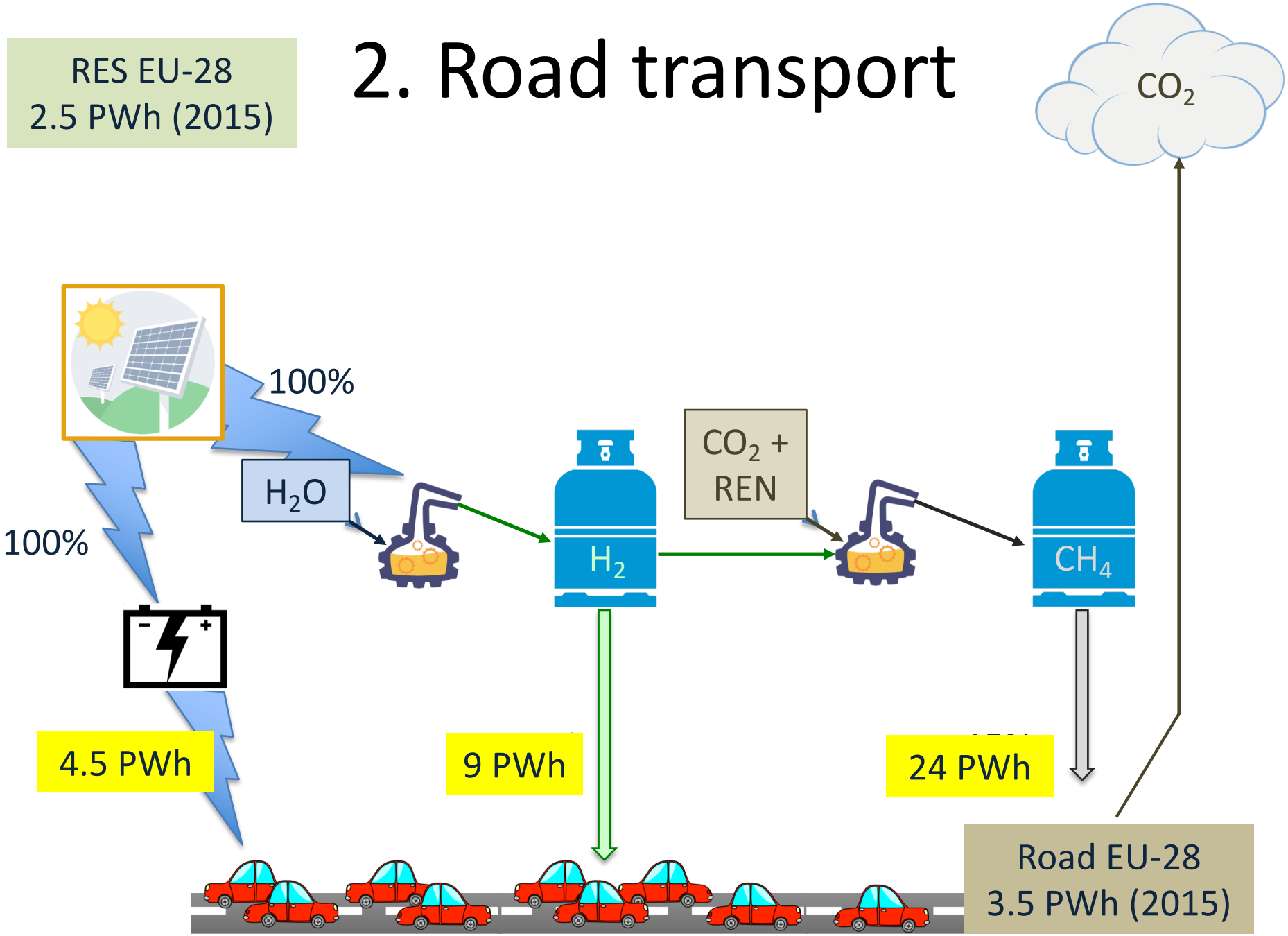


2. Energy mix



RES EU-28
2.5 PWh (2015)

2. Road transport



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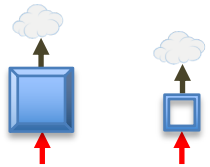
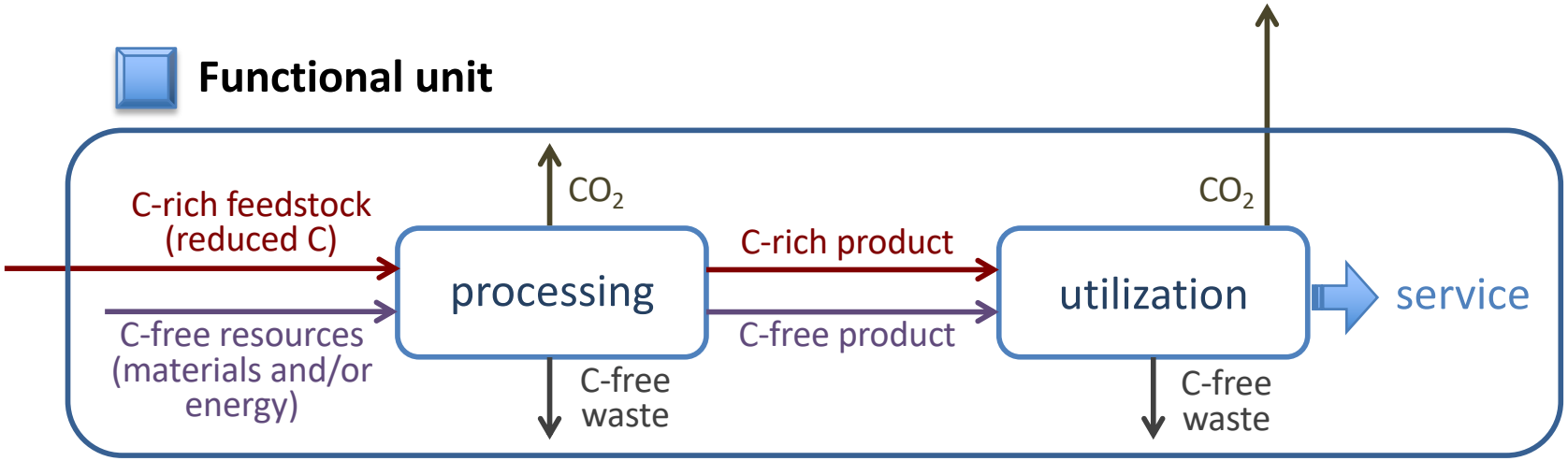


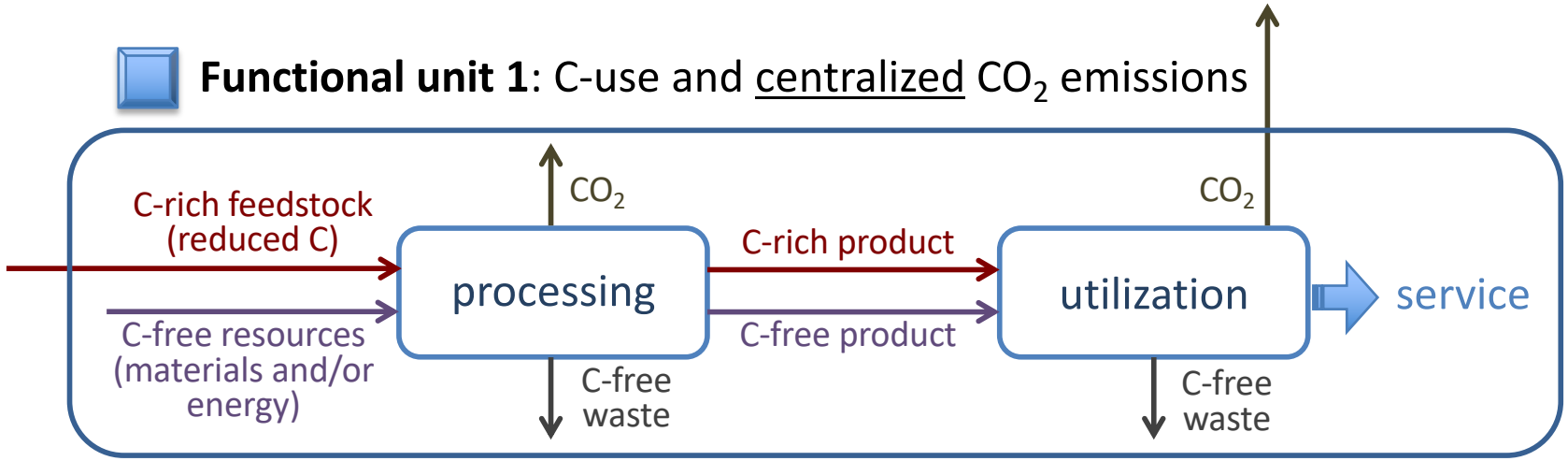
1. L-economy

3. Carbon balances



3. Carbon balances

Functional unit 1: C-use and centralized CO_2 emissions



Functional unit 1:

- fossil-fuel-fired power plant
- large scale industrial boiler for heat generation
- chemical plant coupled to incinerator for C-rich waste disposal (polymeric materials)

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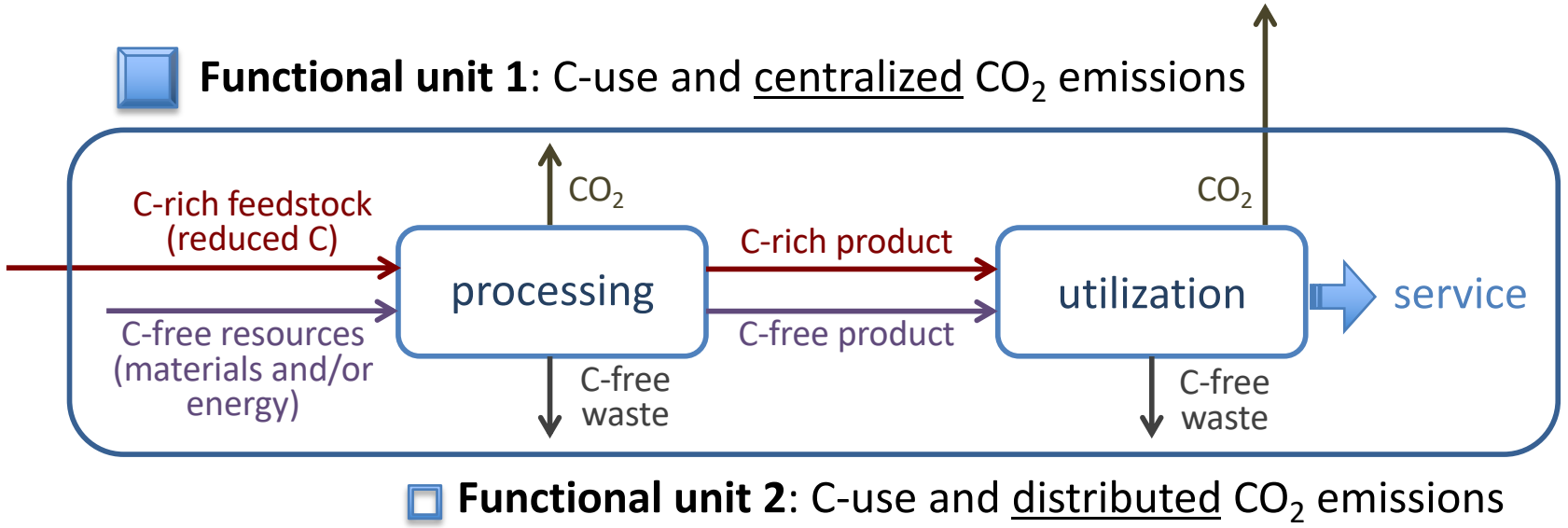


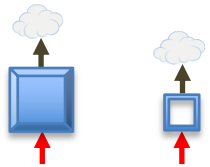
Functional unit 1:

- fossil-fuel-fired power plant
- large scale industrial boiler for heat generation
- chemical plant coupled to incinerator for C-rich waste disposal (polymeric materials)

Functional unit 2:

- urea production and use
- fuels (cars, ships, planes) synthesis and use
- chemical plant not-coupled to incinerator, or to incinerator without CO_2 capture

3. Carbon balances



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Functional unit 1: point source CO_2 emissions

Functional unit 2: distributed CO_2 emissions

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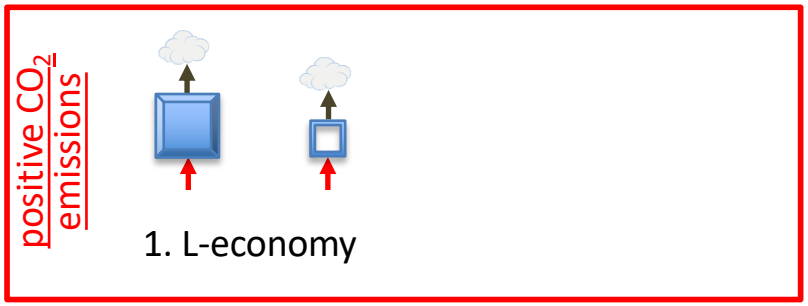

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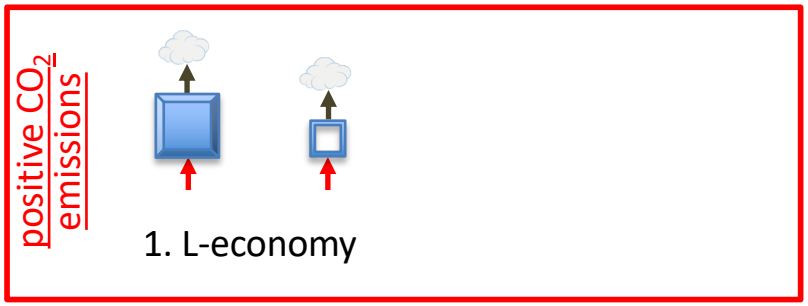


Functional unit 1: point source CO_2 emissions

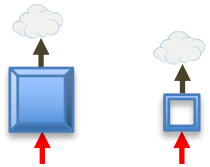
Functional unit 2: distributed CO_2 emissions

- Fossil (reduced) carbon
- Oxidized carbon (CO_2)
- Synthetic (reduced) carbon
- Biogenic (reduced) carbon
- Renewable energy source
- CO_2 in the atmosphere

- Post-combustion CO_2 capture (PCC)
- Direct air capture of CO_2 from the atmosphere (DAC)
- Underground CO_2 storage
- CO_2 conversion plant, incl. electrolyzer for H_2
- Managed biomass growth
- Biomass treatment plant

3. Carbon balances

positive CO_2 emissions



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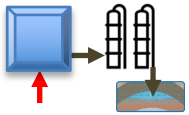
net-zero CO_2 emissions



3. L-economy w/ CCS

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Renewable energy source

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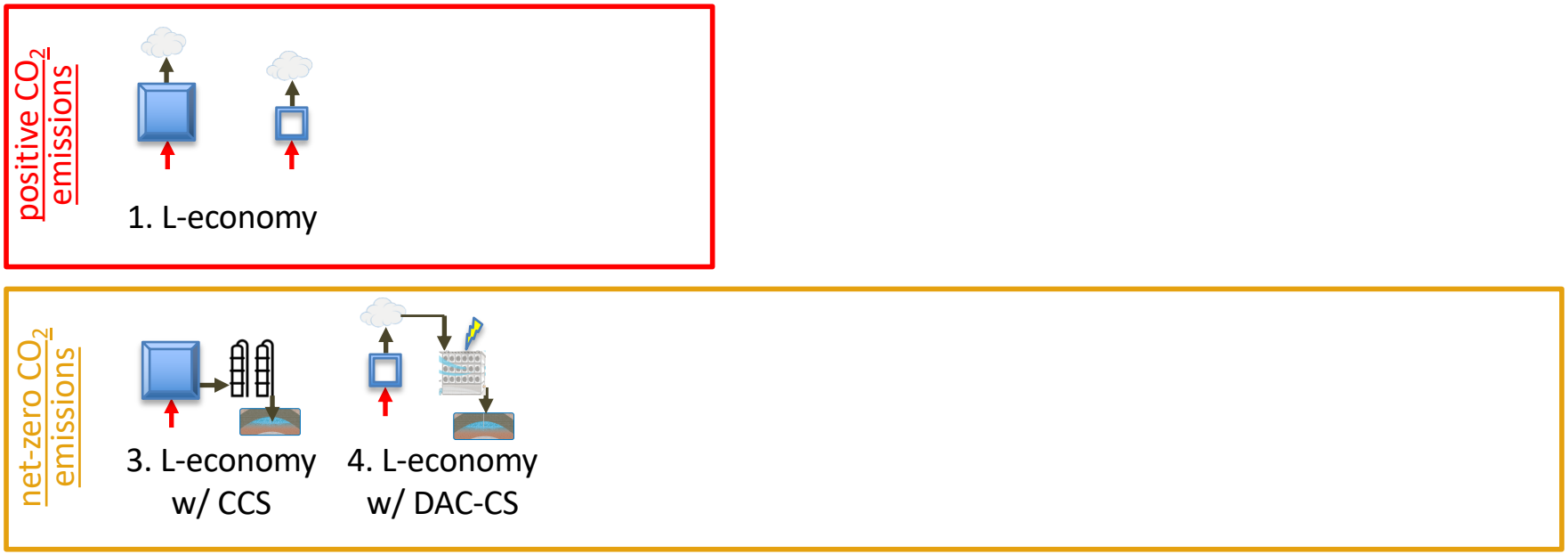

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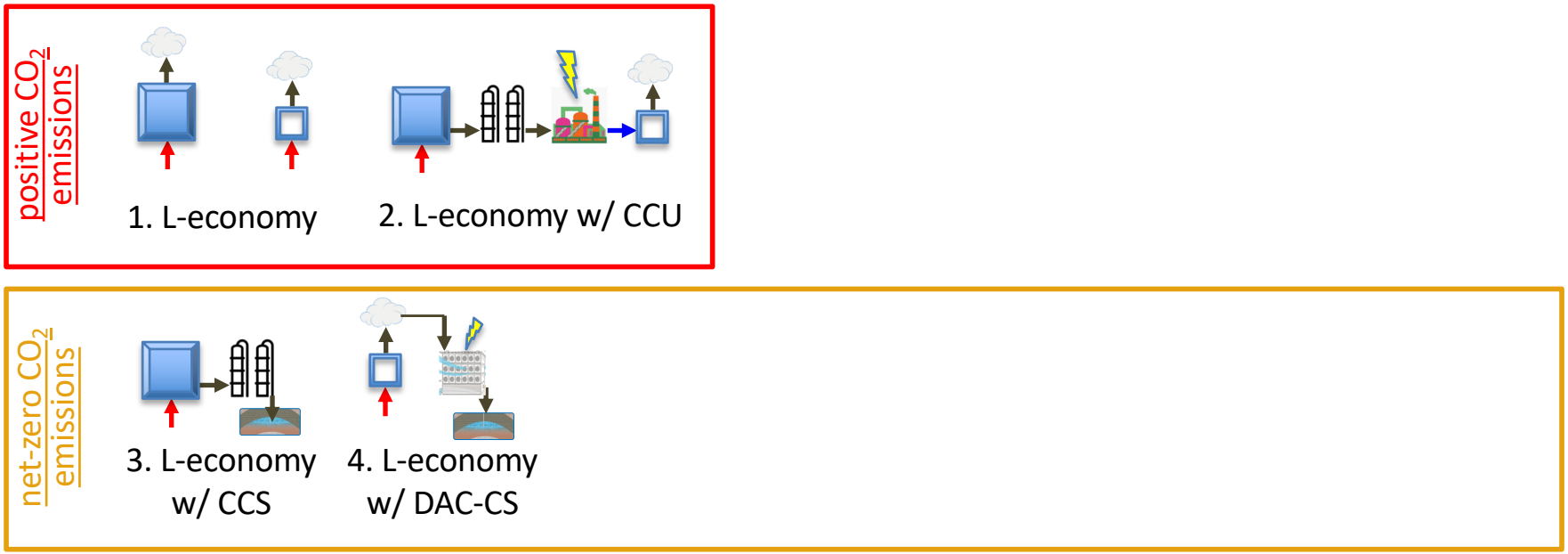

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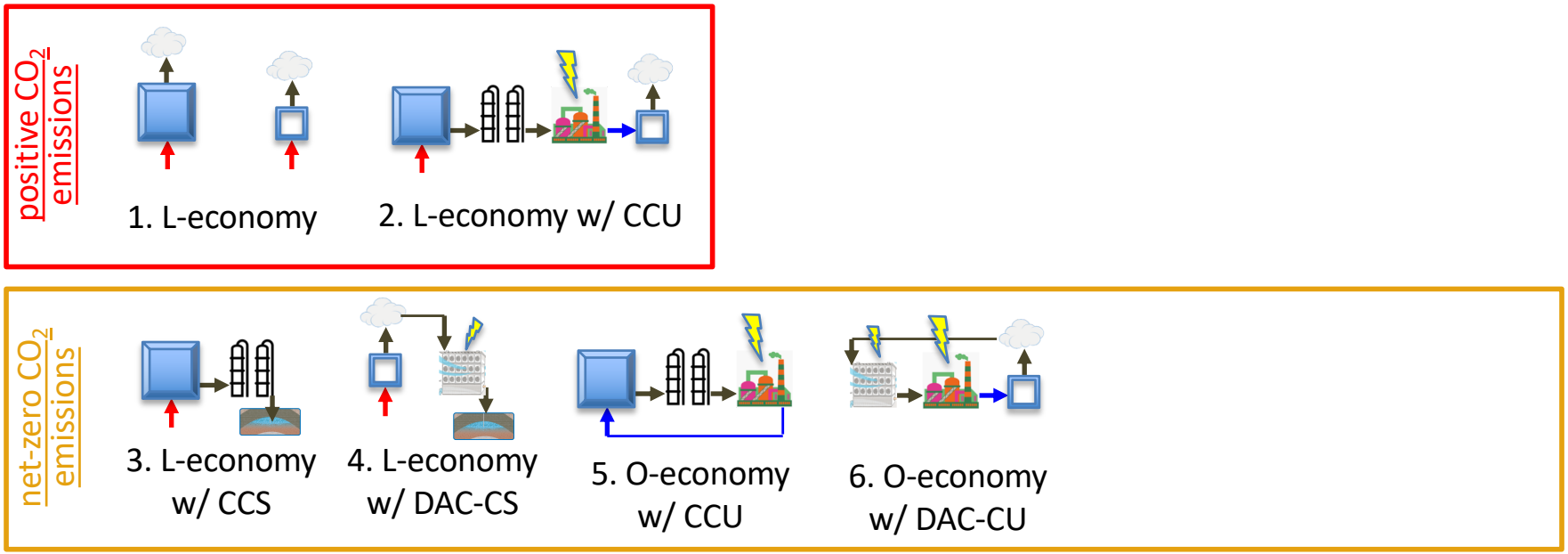

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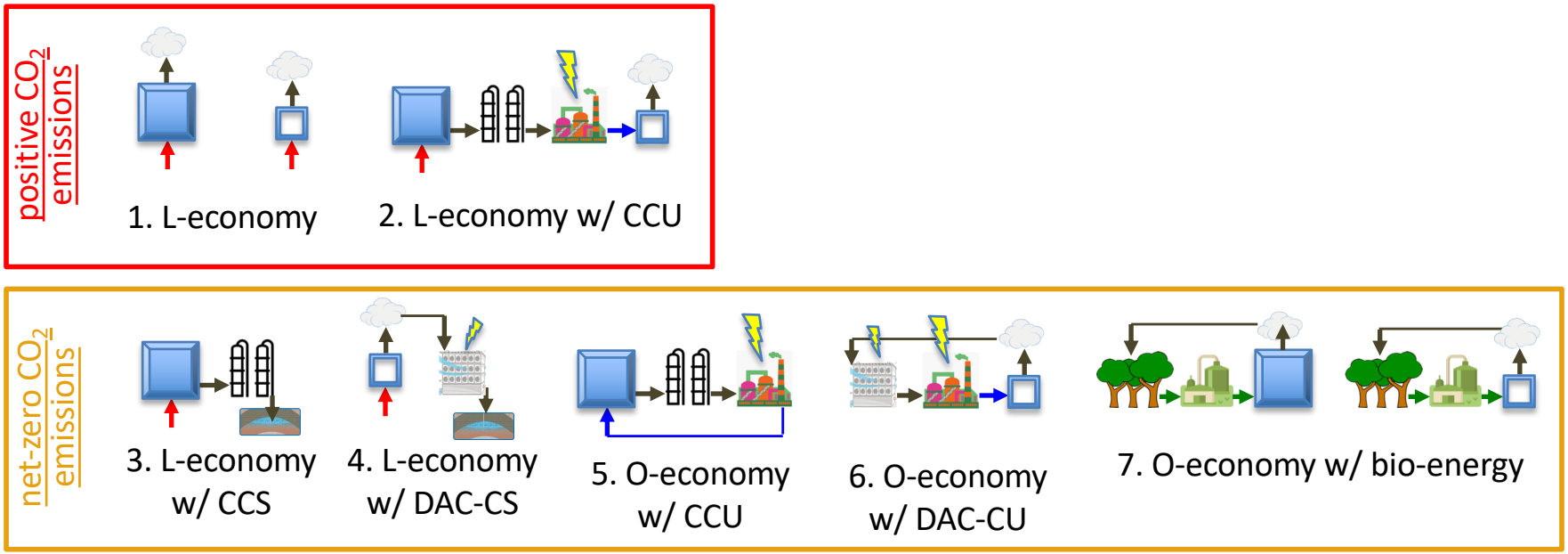

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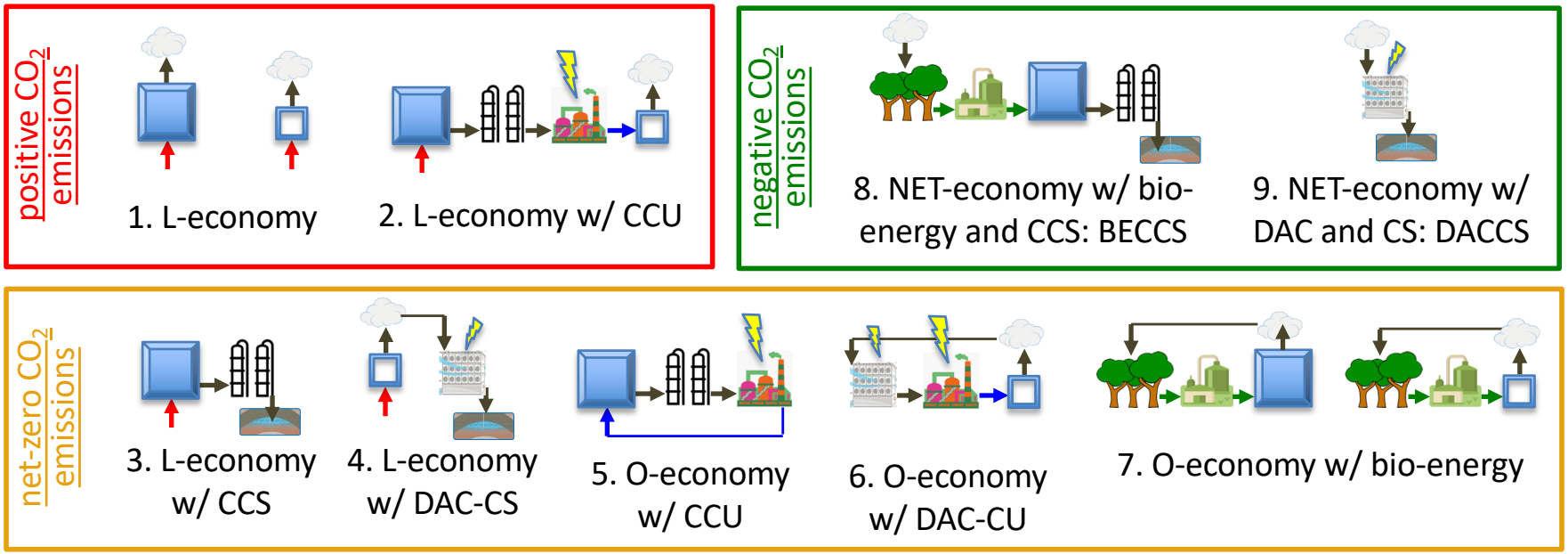

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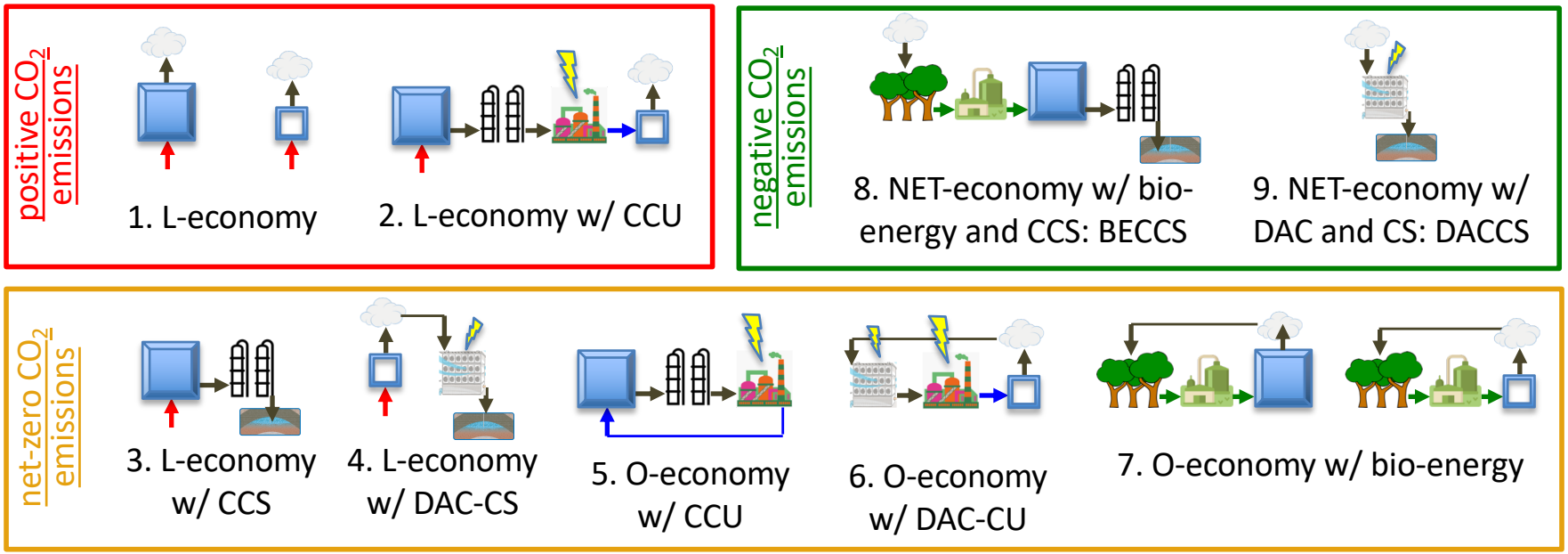

A FEW COMMENTS

- C-free RES to be LCA-assessed;
- CCU neither sufficient nor needed for O-economy, while CO_2 capture needed;
- CO_2 storage necessary for NETs;
- full LCA needed to allocate CO_2 emissions to stakeholders.

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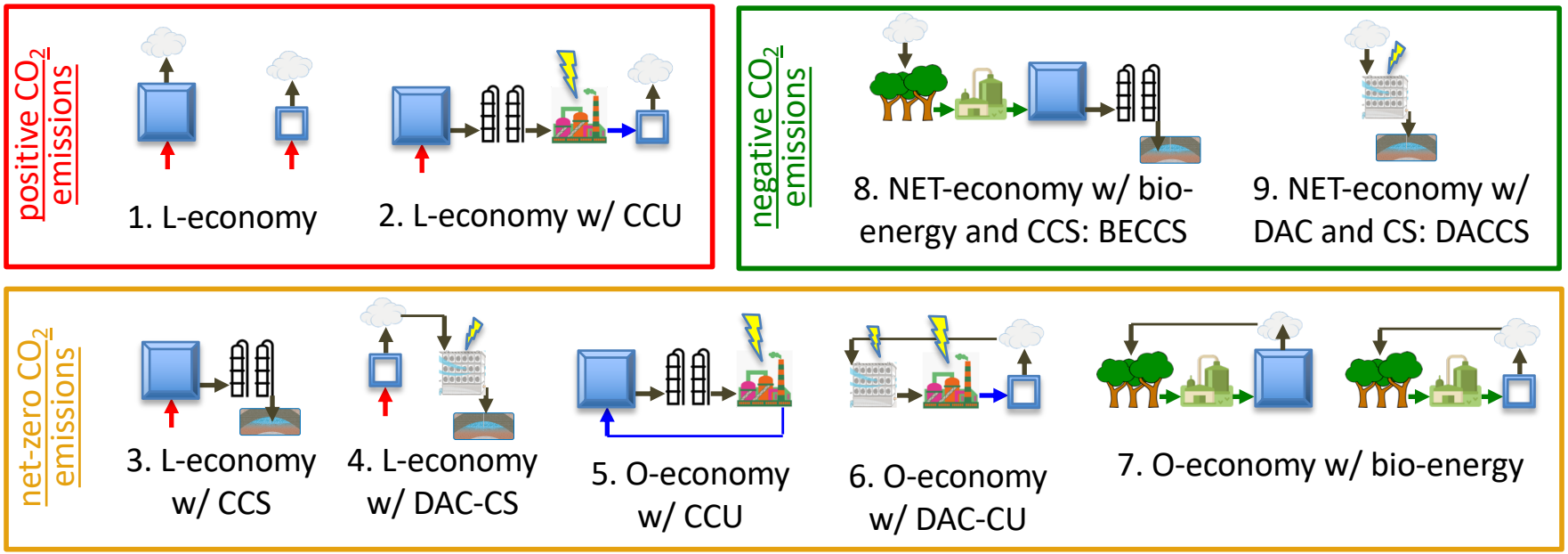

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SIMPLIFIED SYSTEM ANALYSIS

- the whole technology chain, incl. RES, CO_2 source, product, C-waste release;
- Carbon and energy balances around the system boundaries;
- infrastructure and land use needs;
- deployment current and projected scale.

4. Innovation needed

1. *Policy perspective* – Measures, regulations and incentives should examine the energy system, including CCU, in a holistic, integrated, coordinated and transparent manner.
2. *Systemic perspective* – A system approach is required when evaluating the energy system and its CCU sub-systems; progress is needed, in terms both of stakeholder awareness and of consistent definitions of system boundaries and of reference datasets.
3. *Technology perspective* – There are scientific and technical challenges in the areas of:
    1. collection and purification of CO_2 from different sources;
    2. synthesis of green-hydrogen via water splitting powered by RES;
    3. reductive activation catalytic technologies for CO_2 conversion to fuels and chemicals.