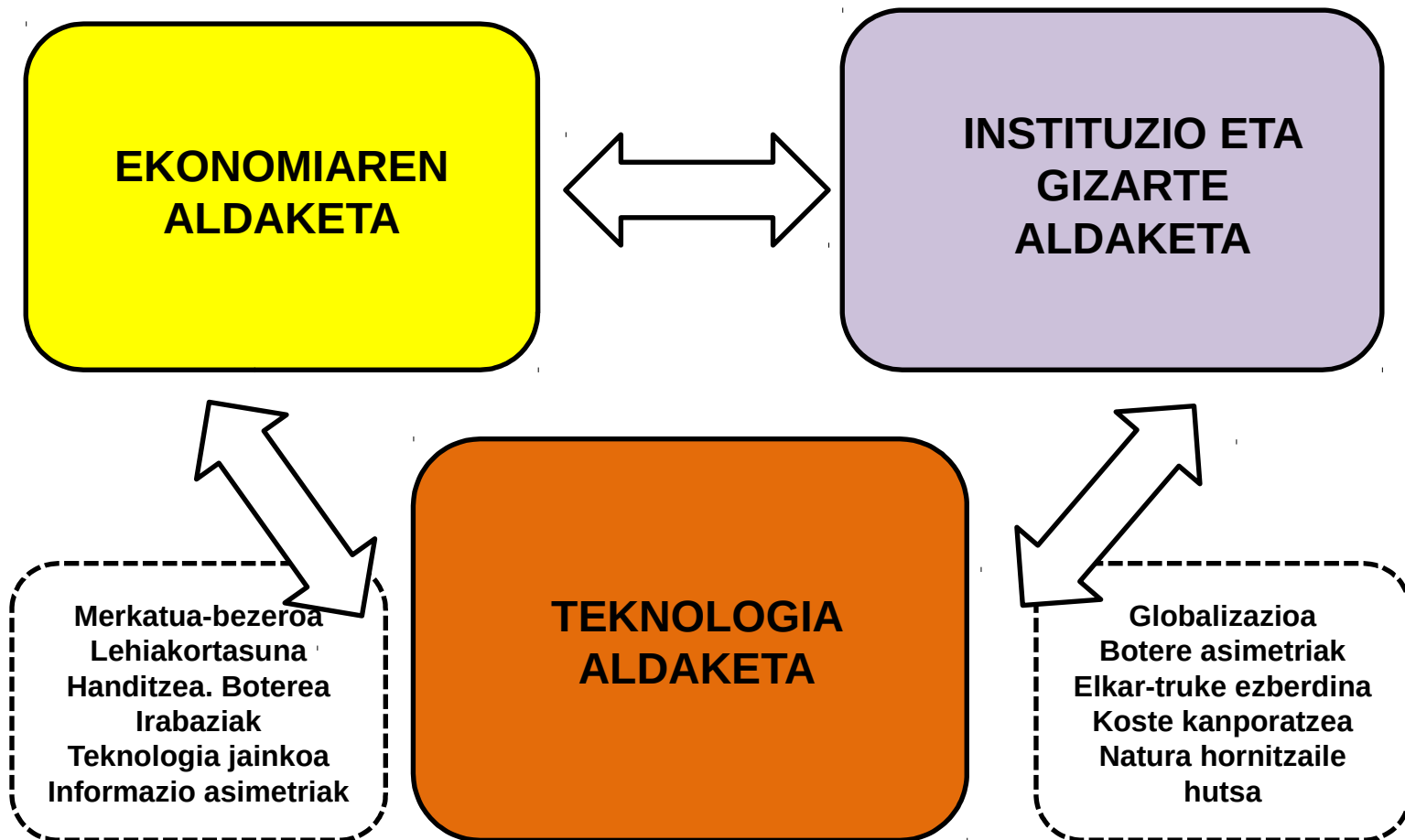
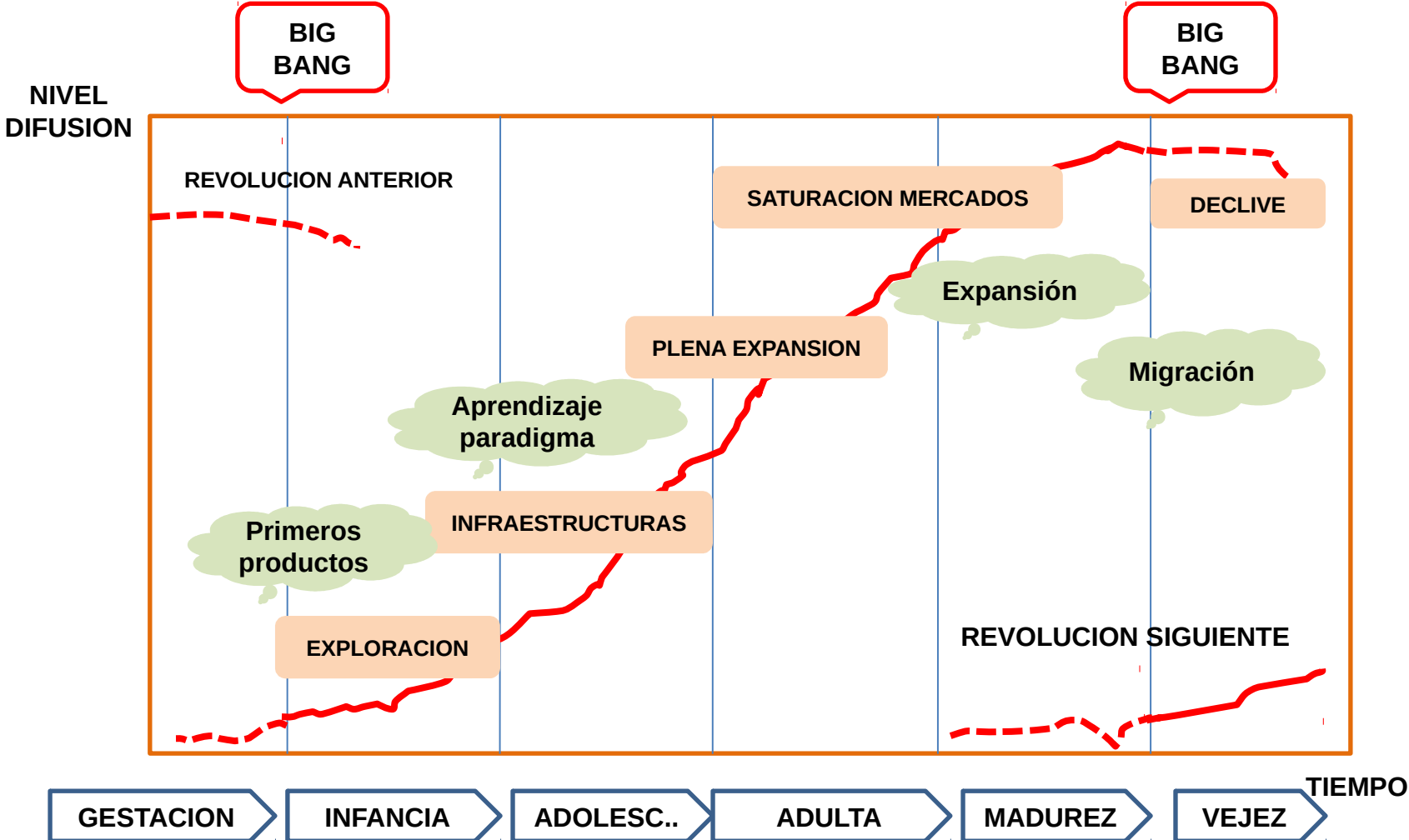




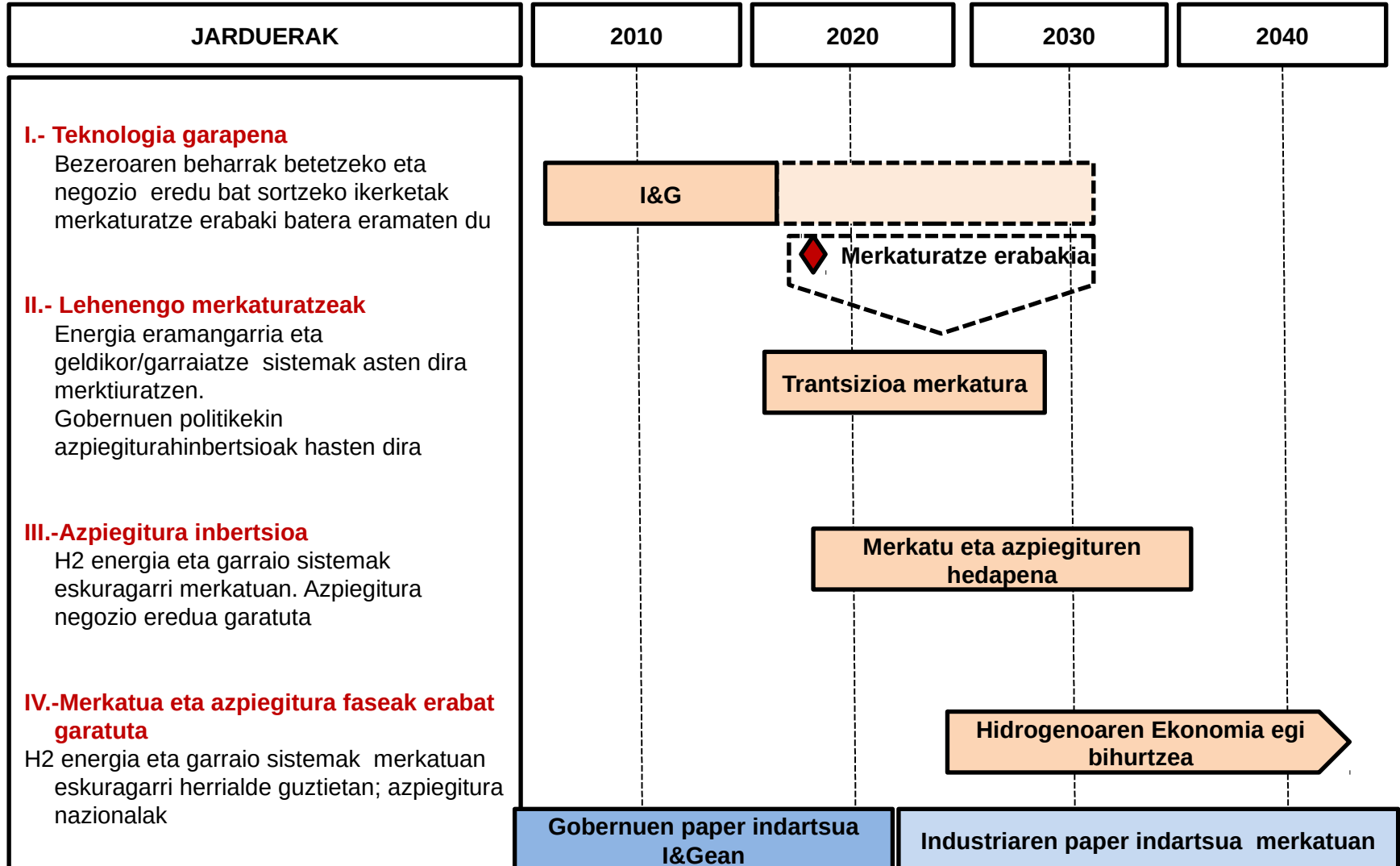
# MUNDU SISTEMAREN DINAMIKA



# LA REVOLUCION TECNOLOGICA Y EL CICLO DE VIDA DE LAS INDUSTRIAS. 50 a 70 años

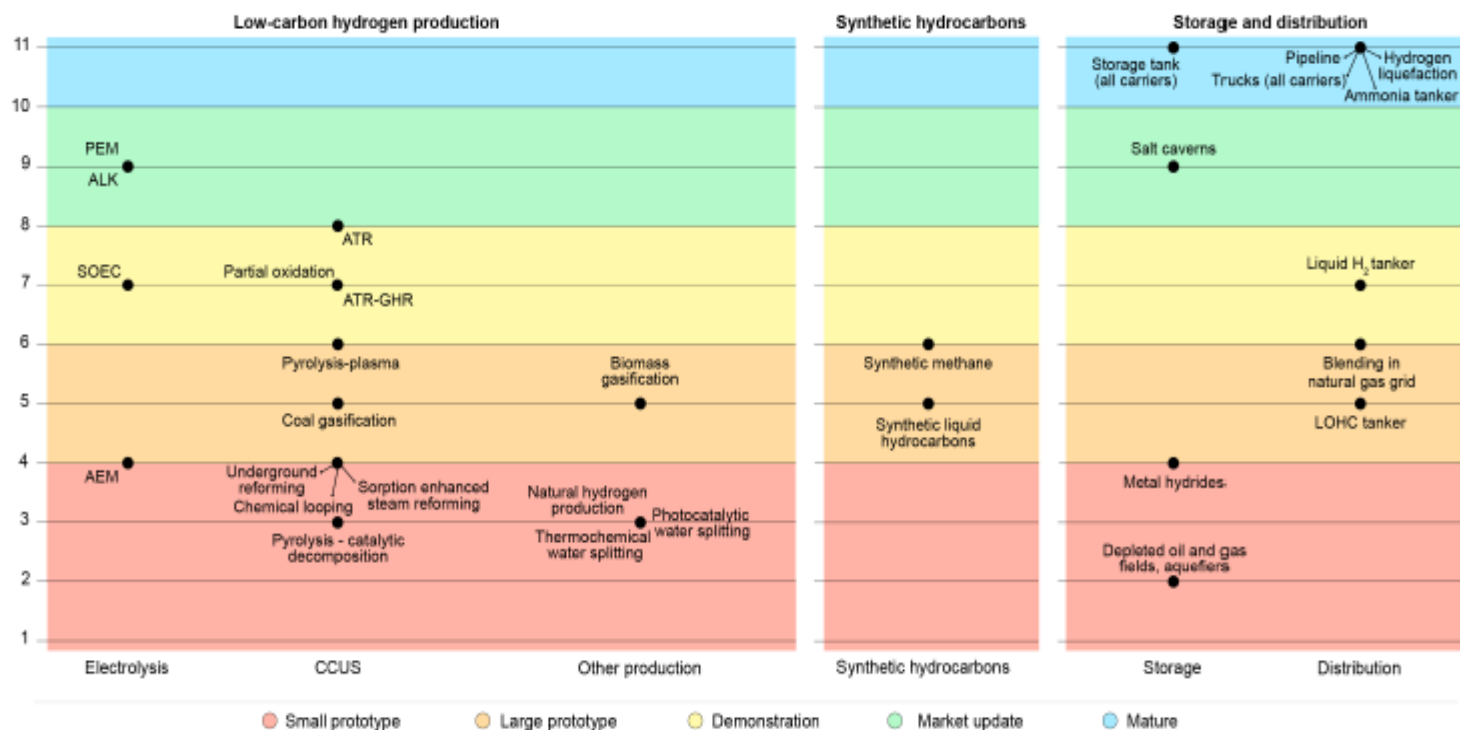


# TRANSIZIO FASEAK



## Several hydrogen technologies not yet commercially available

Technology readiness levels of key hydrogen production, storage and distribution technologies

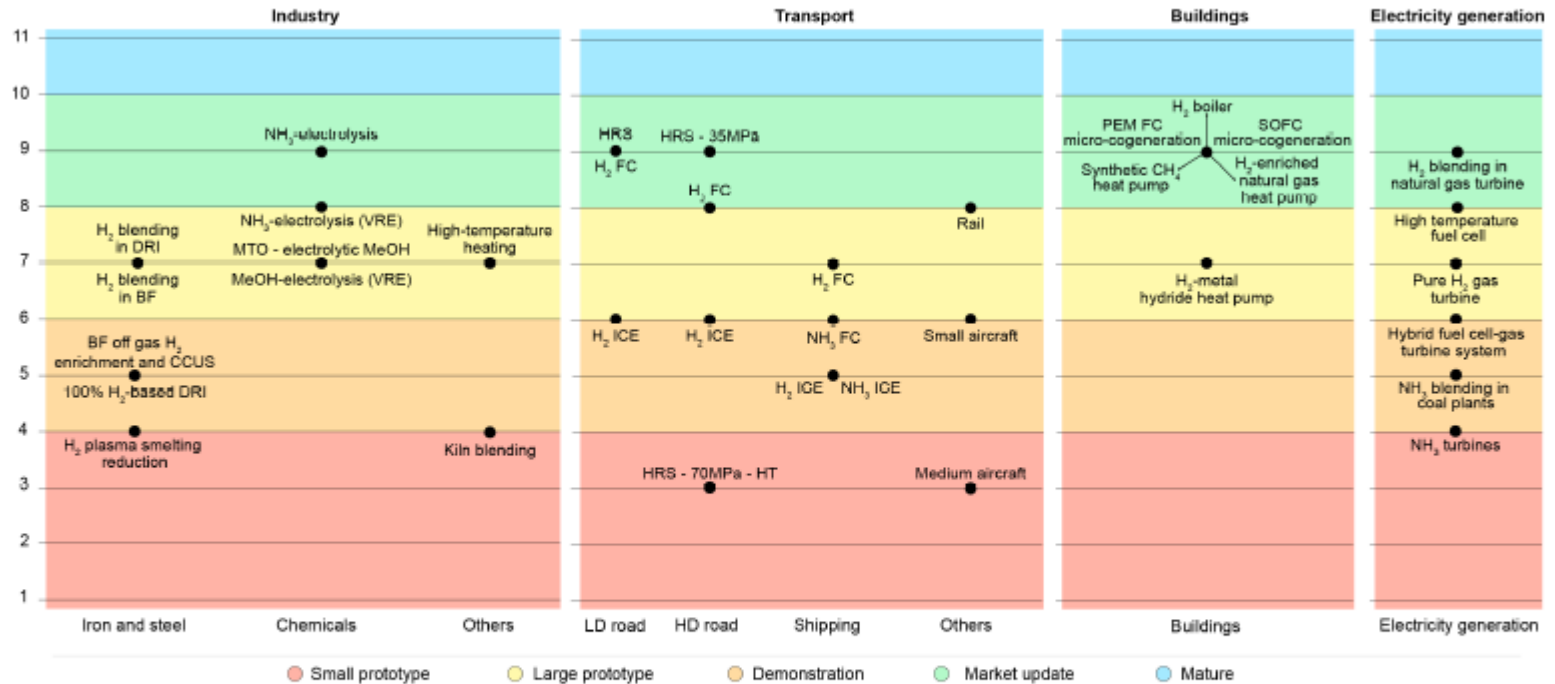


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Notes: AEM = anion exchange membrane. ALK = alkaline. ATR = autothermal reformer. CCUS = carbon capture, utilisation and storage. GHR = gas-heated reformer. LOHC = liquid organic hydrogen carrier. PEM = polymer electrolyte membrane. SOEC = solid oxide electrolyser cell. Biomass refers to both biomass and waste. For technologies in the CCUS category, the technology readiness level (TRL) refers to the overall concept of coupling these technologies with CCUS. TRL classification based on [Clean Energy Innovation \(2020\)](#), p. 67.

Source: IEA (2020), [ETP Clean Energy Technology Guide](#).

## Technology readiness levels of key hydrogen end-use technologies



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Notes: BF = blast furnace. DRI = direct iron reduction. FC = fuel cell. HRS = hydrogen refuelling station. HD = heavy-duty. HT = high throughput. ICE = internal combustion engine. LD = light-duty. MeOH = methanol. MTO = methanol to olefins. PEM FC = polymer electrolyte membrane fuel cell. SOFC = solid oxide fuel cell. VRE = variable renewable electricity.

Co-generation refers to the combined production of heat and power. Technology readiness levels based on [Clean Energy Innovation \(2020\)](#), p. 67.

Source: IEA (2020), [ETP Clean Energy Technology Guide](#).

# ITER ERAIKINA

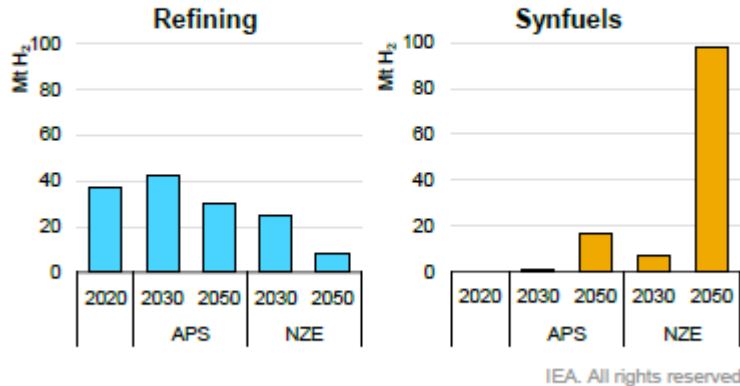




European gas infrastructure

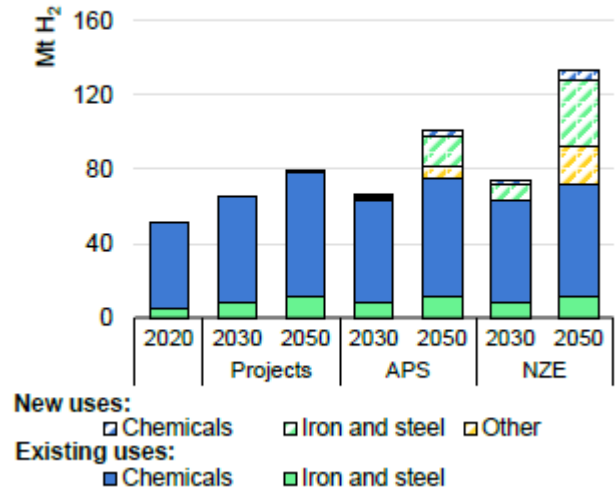


Hydrogen demand in refining and synthetic fuels production in the Announced Pledges and Net zero Emissions scenarios, 2020-2050

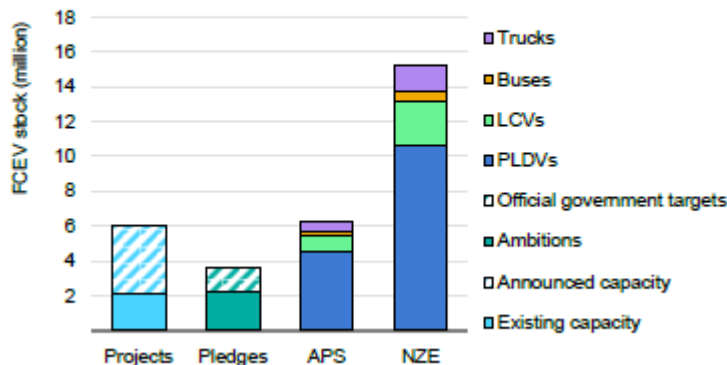


Notes: APS = Announced Pledges Scenario. NZE = Net zero Emissions Scenario.

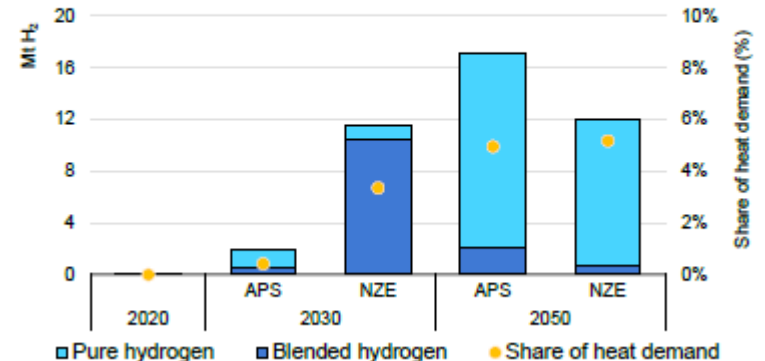
Total hydrogen demand



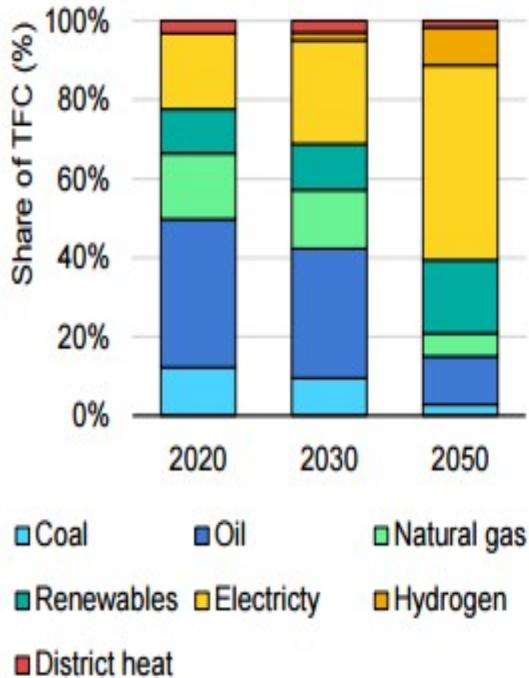
FCEV stock in the Announced Pledges and Net zero Emissions scenarios in 2030 vs current and announced cumulative fuel cell manufacturing capacity and FCEV deployment targets



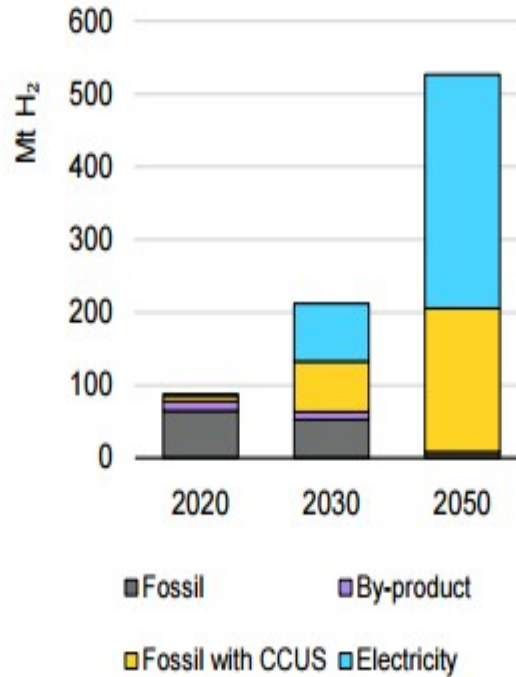
Hydrogen use in buildings and shares of heat demand in the Announced Pledges and Net zero Emissions scenarios, 2020-2050



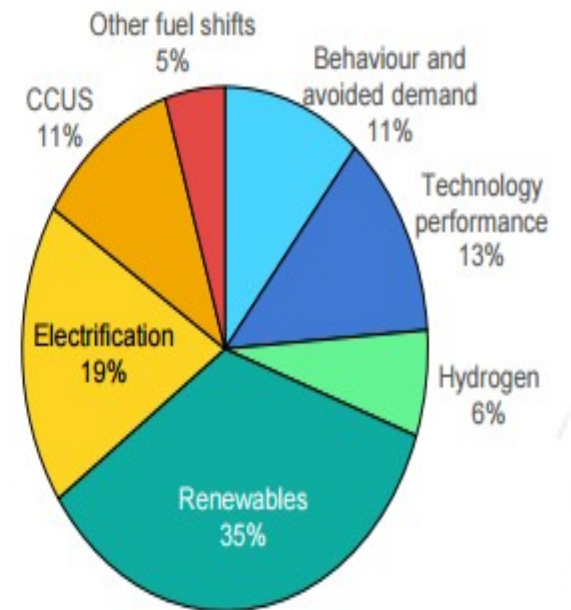
Share of total final energy consumption by fuel in the NZE, 2020-2050



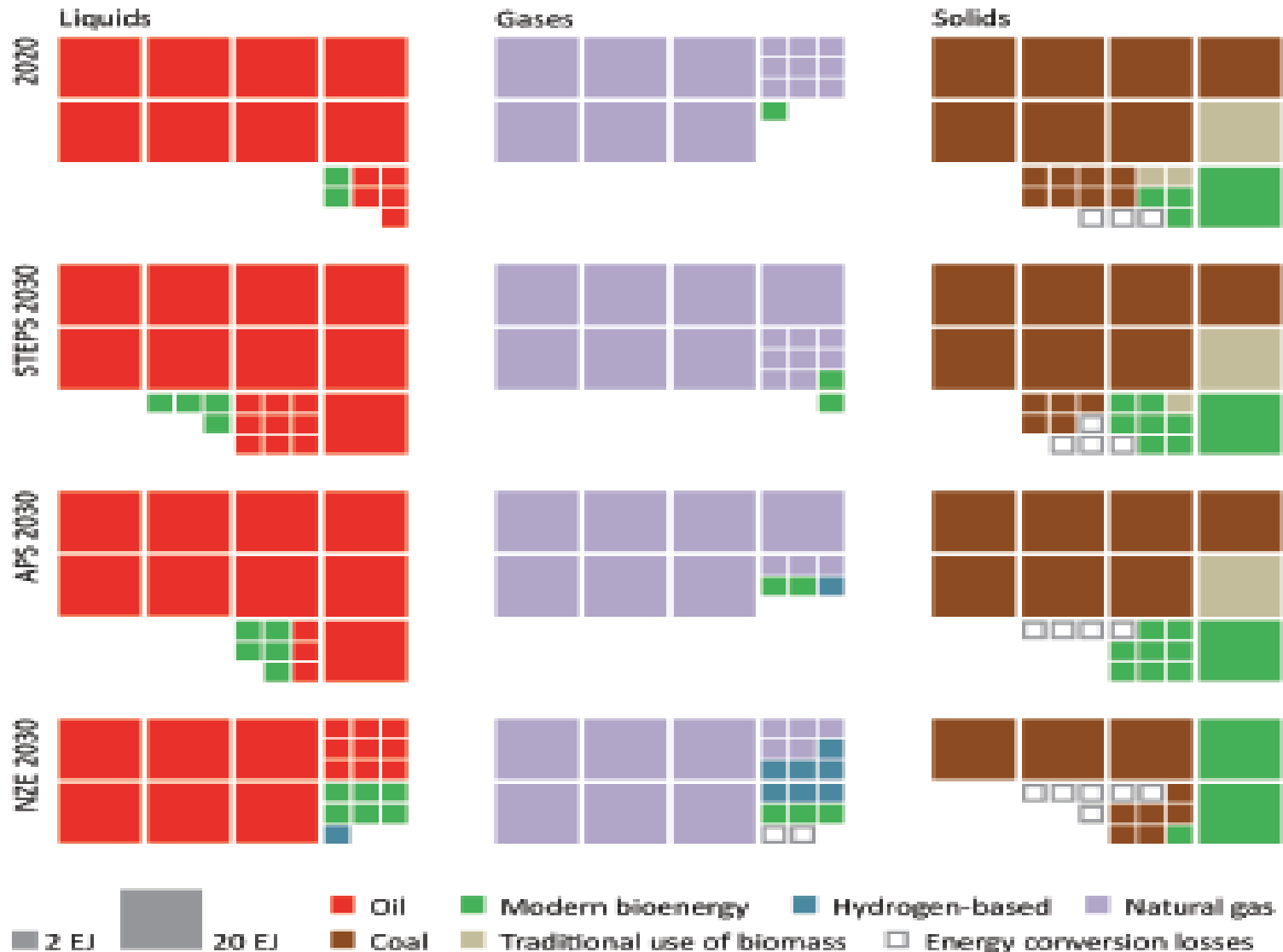
Sources of hydrogen production in the NZE, 2020-2050



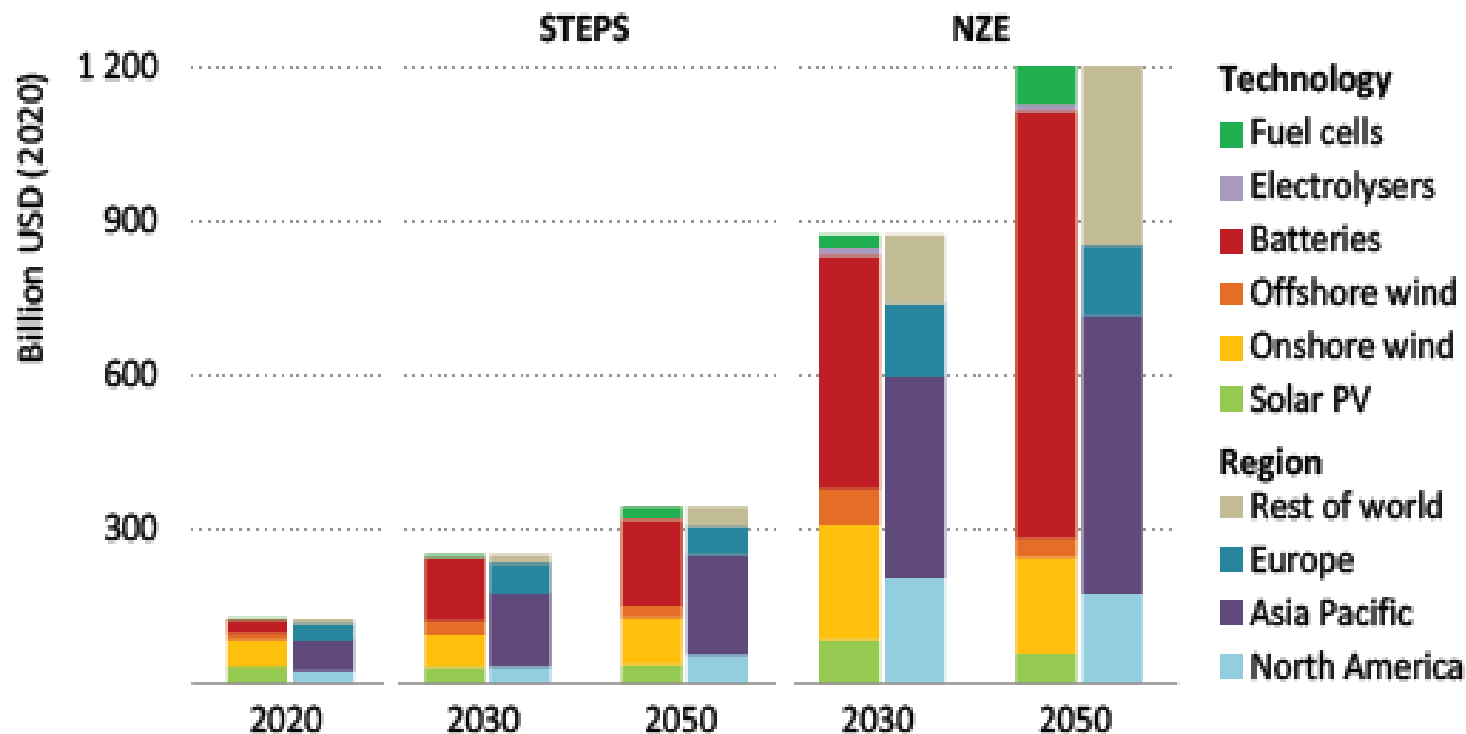
Cumulative emissions reduction by mitigation measure in the NZE, 2021-2050



## The rising share of low emissions fuels in the energy mix



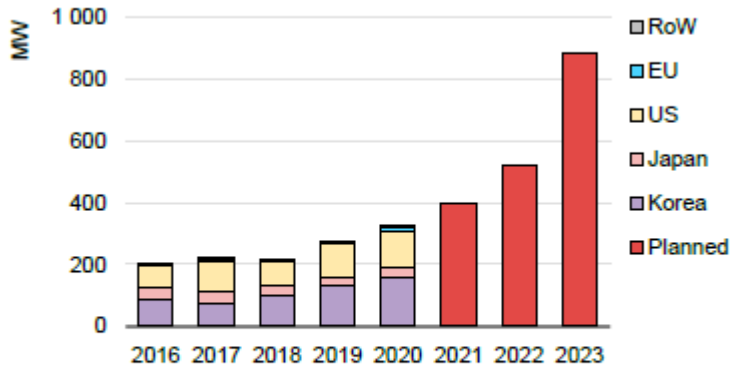
## Estimated market size for selected clean energy technologies by technology and region, 2020-2050



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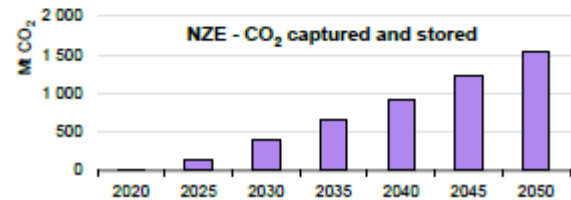
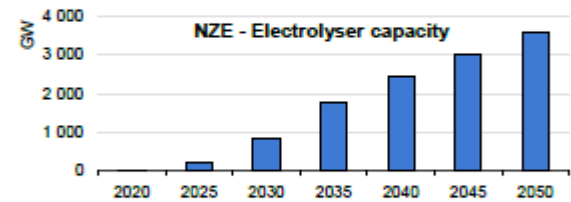
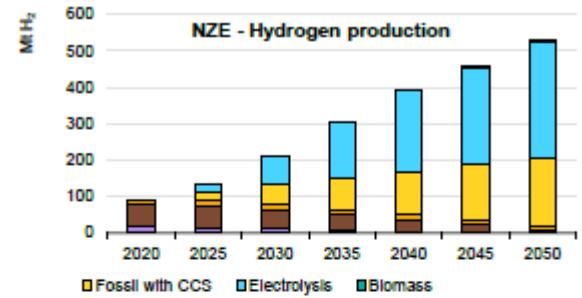
*There is explosive growth in clean energy technologies over the next decade in the NZE, leading to a clean energy market worth a cumulative USD 27 trillion by 2050*

Stationary fuel cell capacity deployment, 2016-2023



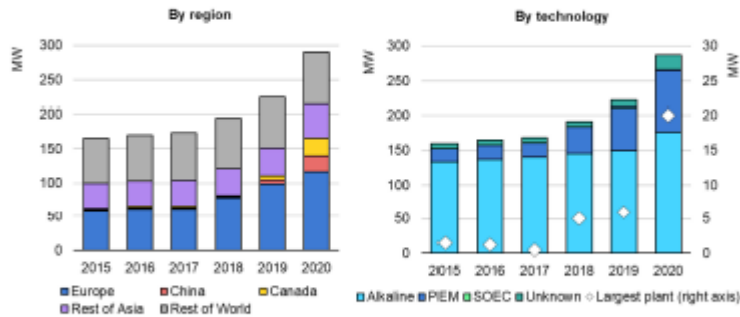
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Notes: RoW = rest of world. Data for 2020 estimated based on Q1-Q3 information. Planned capacity (2021-23) based on capacity increases and historic trends. Source: [E4tech](#).



IEA

Global installed electrolysis capacity by region and technology, 2015-2020

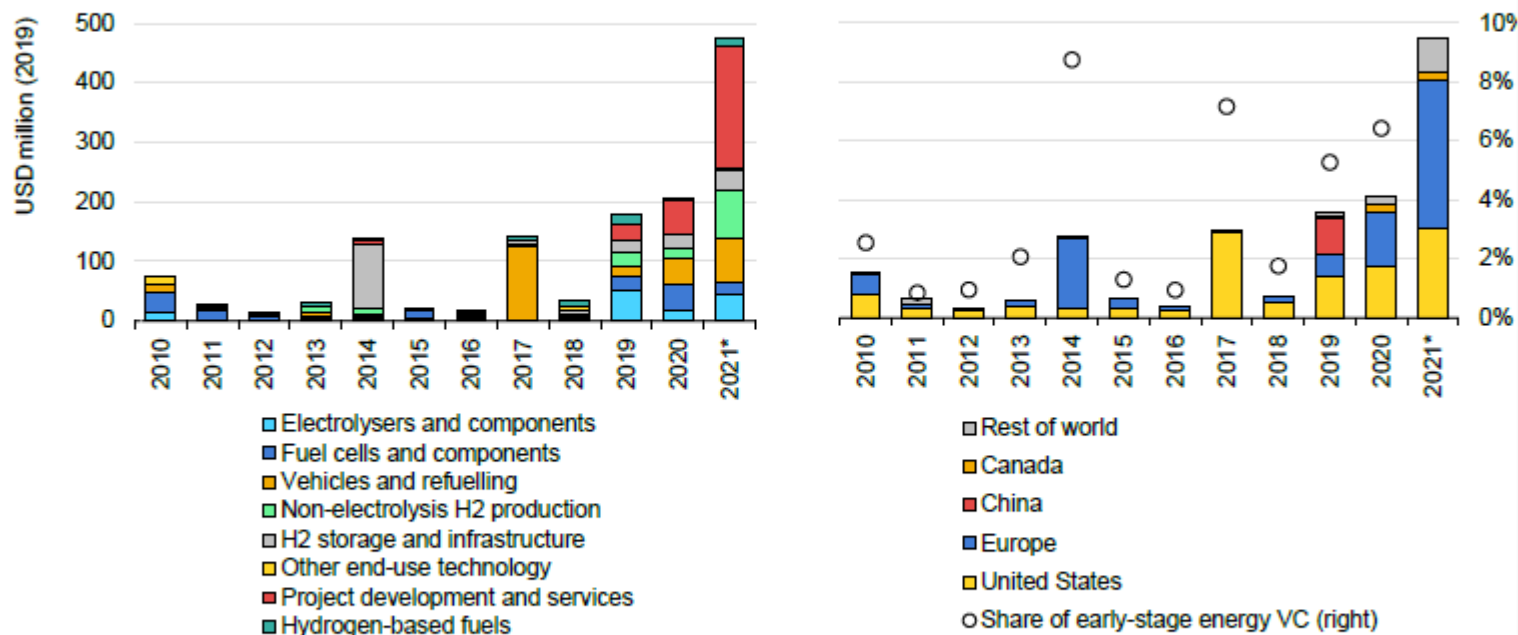


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Notes: PEM = proton exchange membrane; SOEC = solid oxide electrolysis cell. Source: IEA (2021), [Hydrogen Projects Database](#).

## More early-stage capital flowing to start-ups, especially in Europe; fastest growth in companies offering project development services or non-electrolysis supply solutions

Early-stage venture capital deals for hydrogen-related start-ups by technology area and region, 2010-2021

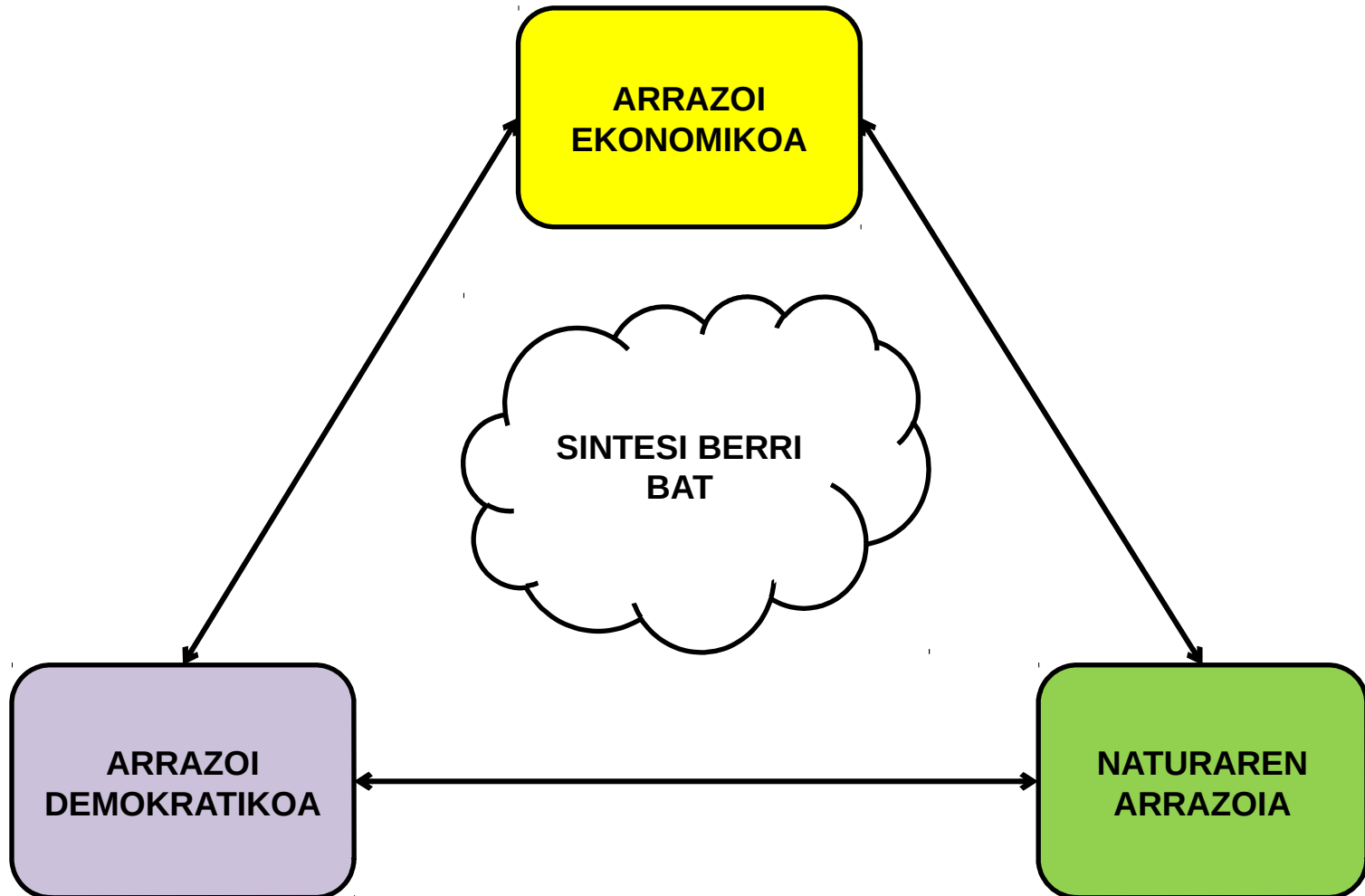


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Notes: 2021\* data up to mid-June. H2 = hydrogen. Early-stage VC includes seed, Series A and Series B. The share of early-stage energy VC excludes outlier deals above USD 150 million that distort trends (no such deal was recorded for hydrogen start-ups). Other end-use technology includes stationary turbines and non-transport mobile applications that do not involve proprietary fuel cell stacks.

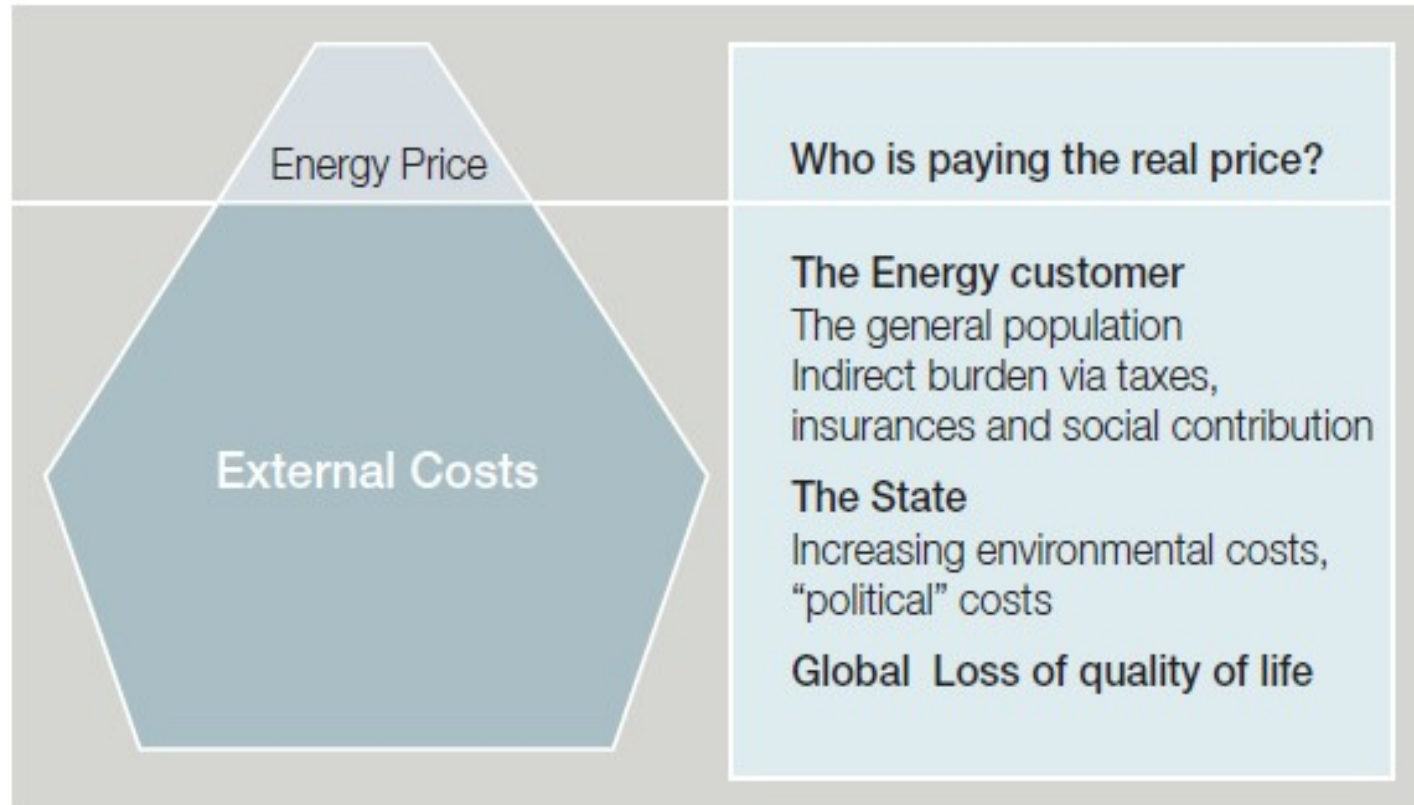
Source: Calculations based in part on [Cleantech Group](#) (2021).

# HIRU DIMENTSIOKO SISTEMA



## External Costs

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Source: EC