Water use in hydrogen, challenges and outlook

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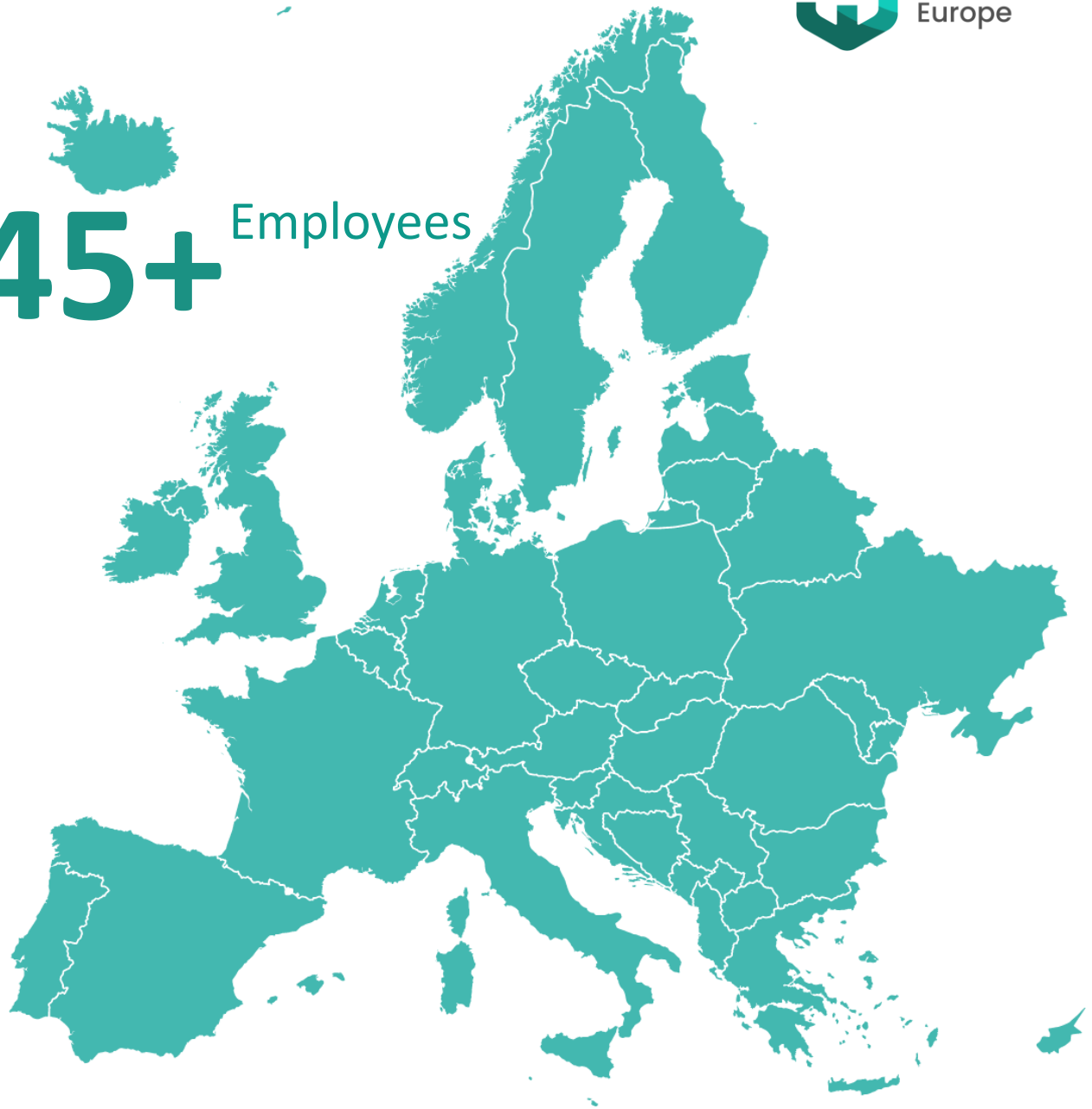

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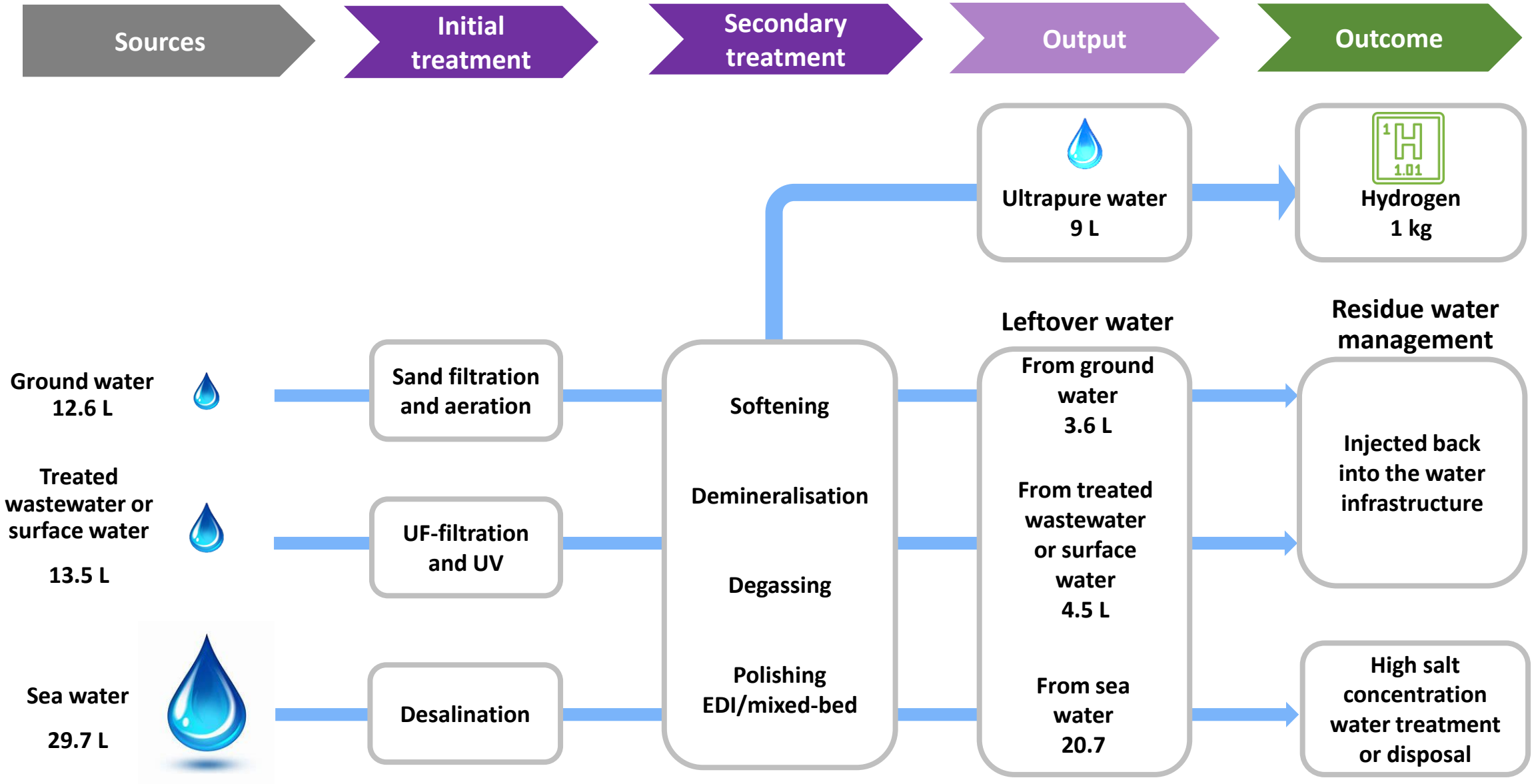
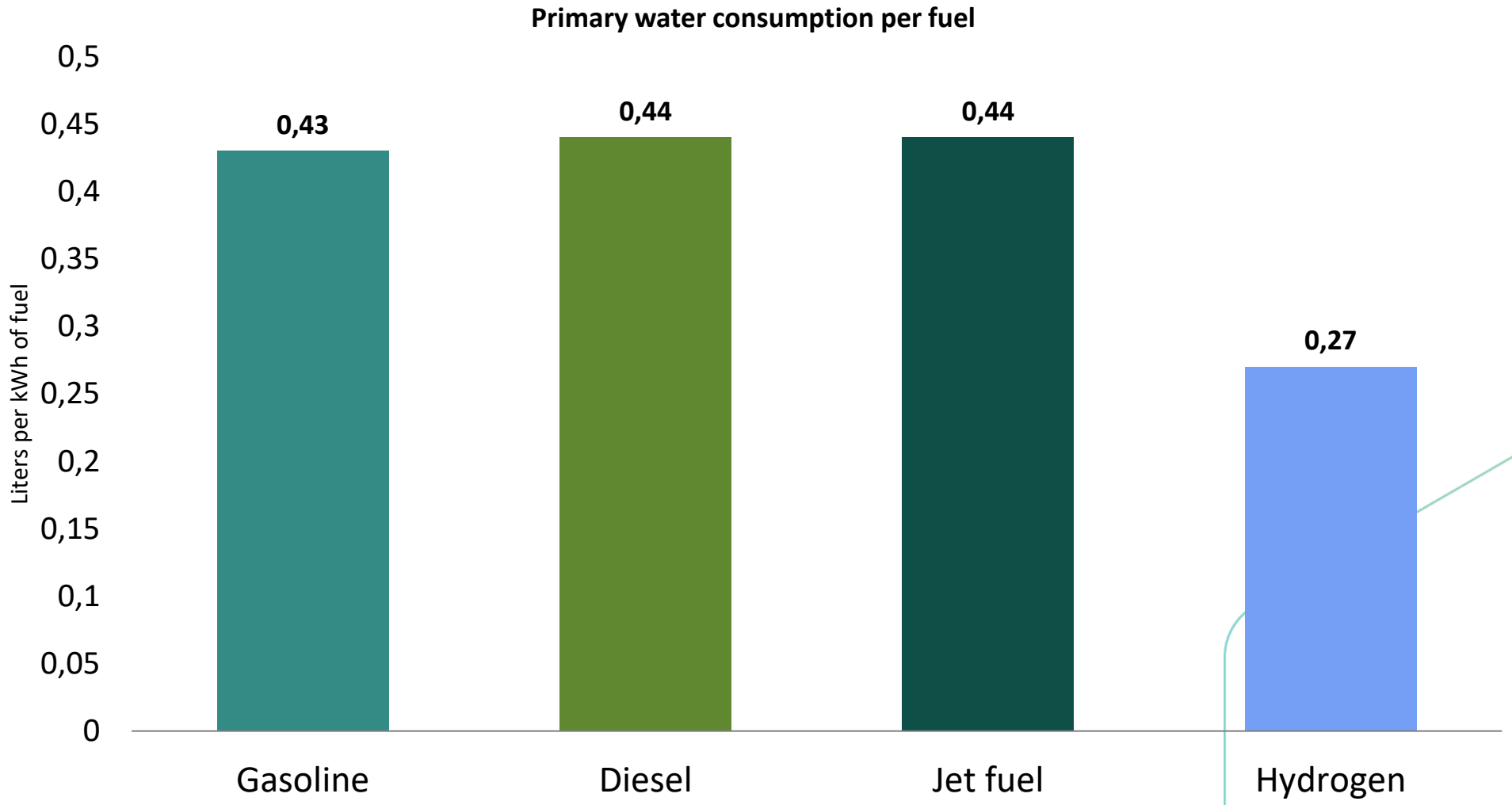
Raw water demand for the production of 1kg of electrolysis-based H2

Water footprint ranges from 12.6 to 29.7 liters per 1 kg of H2



Notes: Graphic refers to an electrolyser's feedstock only and does not consider water use in the cooling system. In the case of closed-loop cooling systems(most common), water consumption is negligible.
Sources: Silhorko-Eurowater

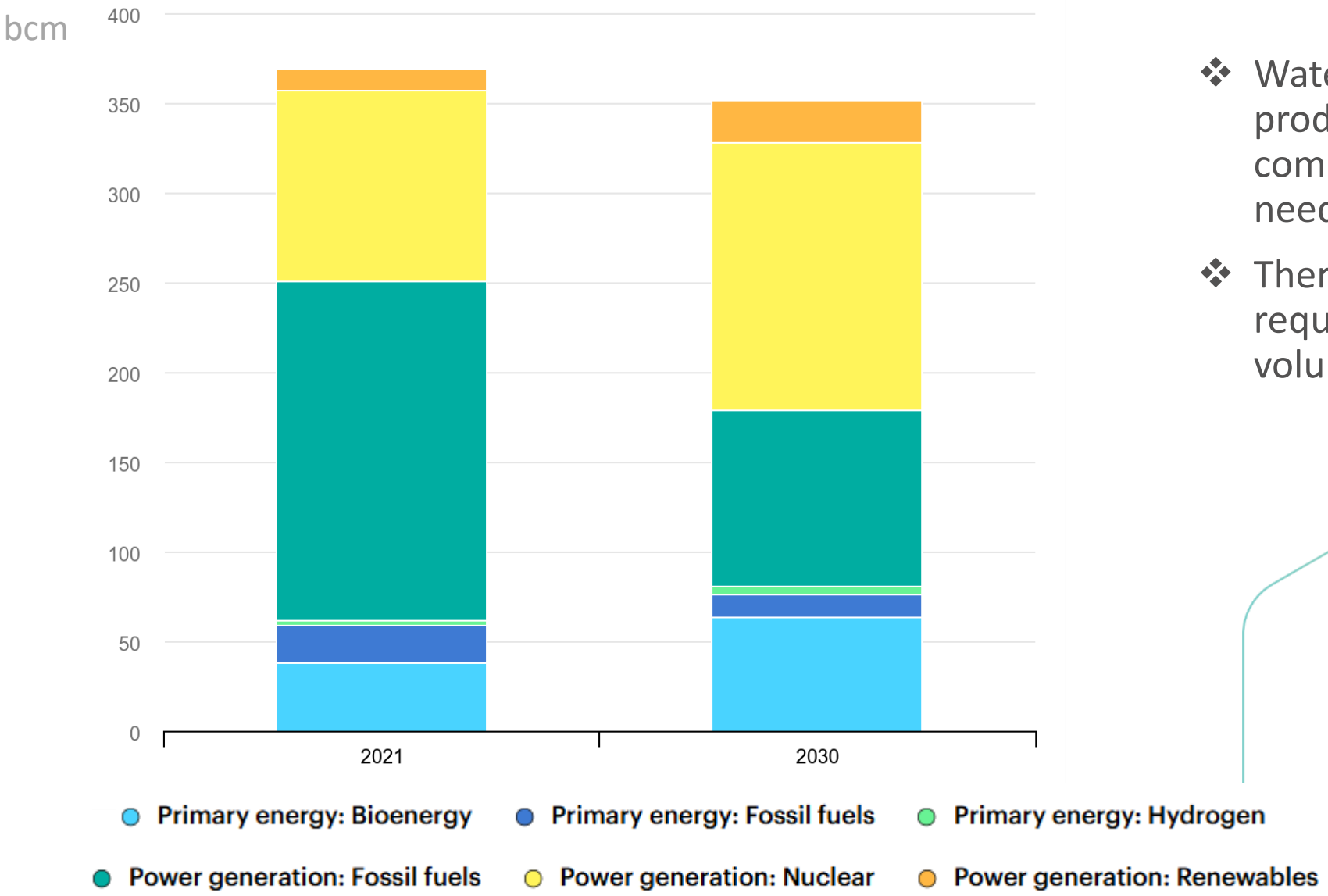
Hydrogen production's water consumption in the context of the energy sector



Notes: *Water consumption* refers to water withdrawn and not returned to the original water source

Sources: Argonne National Laboratory, Silhorko-Eurowater, Eurostat, NACE

Global water withdrawal in the energy sector in the IEA's Net Zero Scenario

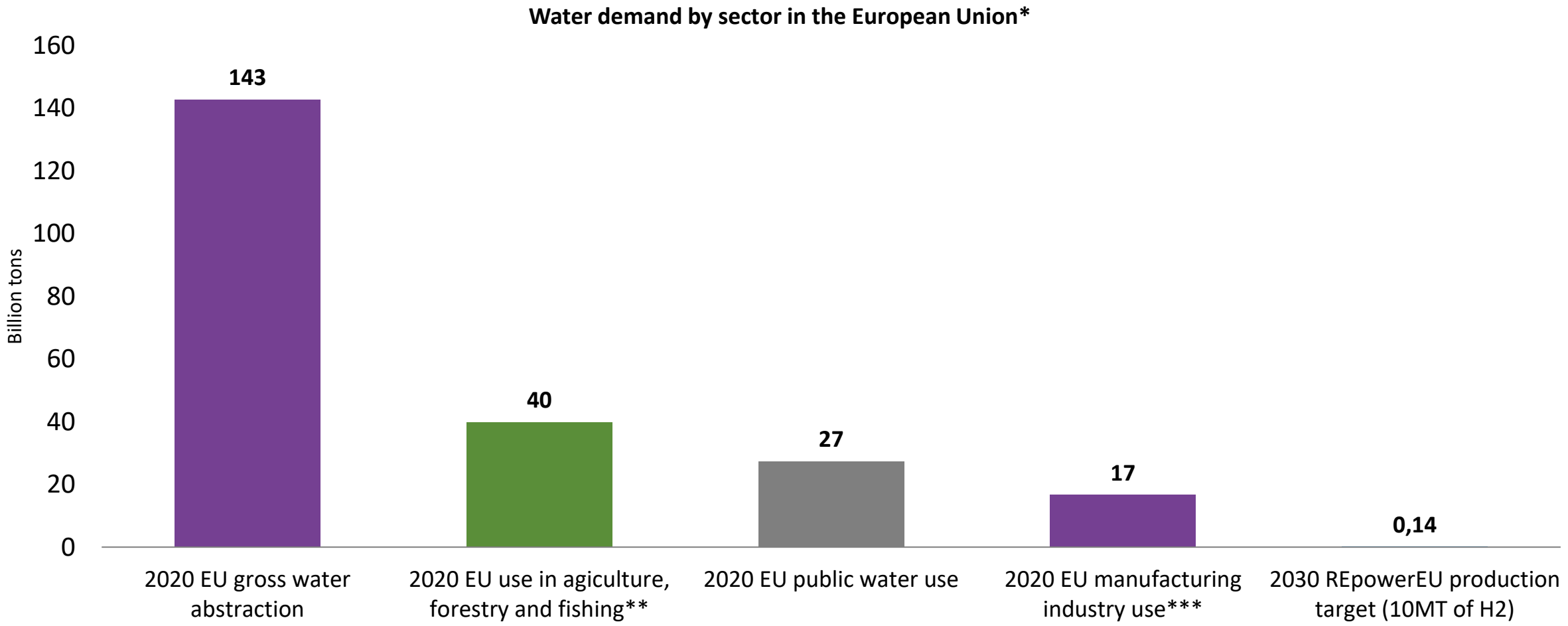


- Water needs from hydrogen production are very small compared to energy system needs
- Thermal and nuclear generation require significantly higher volumes

Source: IEA, 2023

Comparative analysis of hydrogen's water consumption

10 Mt of H2 would amount to 0.01% of current EU water abstraction



(*) Excluding AT, FI, IE and IT, as these countries' data is not available on Eurostat. Some 2020 figures are estimates based on the last year of available data.
(**) Excluding HR. (***) Excluding CY.
Notes: *Water consumption* refers to water withdrawn and not returned to the original water source (ANL); g*ross water abstraction* refers to water removed from any source, either permanently or temporarily (Eurostat); *Public water use* refers to water consumption for domestic use, offices, small factories and local authorities (Eurostat); *Agriculture, forestry and fishing* refers to exploitation of vegetal and animal natural resources, comprising the activities of growing of crops and raising and breeding of animals (NACE Rev.2, 1-3); *Manufacturing industry* refers to the physical or chemical transformation of materials, substances, or components into new products, from processed food to light bulbs (NACE Rev.2, 10-33).
Sources: Argonne National Laboratory, Silhorko-Eurowater, Eurostat, NACE.

Nonetheless, water access is in some cases an issue, especially in project outside industrial complexes

1. European Legislation: Industrial Emission directive & Environmental Impact Assessments

- Main rational: water consumption
- Scope: project > 50 tons H2/day (electrolytic, gas reforming, mineral oil refining)
- Best Available Technology Reference Doc: being developed to expand to water-electrolysis

2. Local environmental legislation / water management & access

- Access to excess water in industrial clusters: subjected to competition with other projects
- Water disposal (e.g. restrictions due to excess of) nitrates
- Relatively long permitting process (sometime double than max permitted delays)

Main Permitting challenges (examples from Spain)

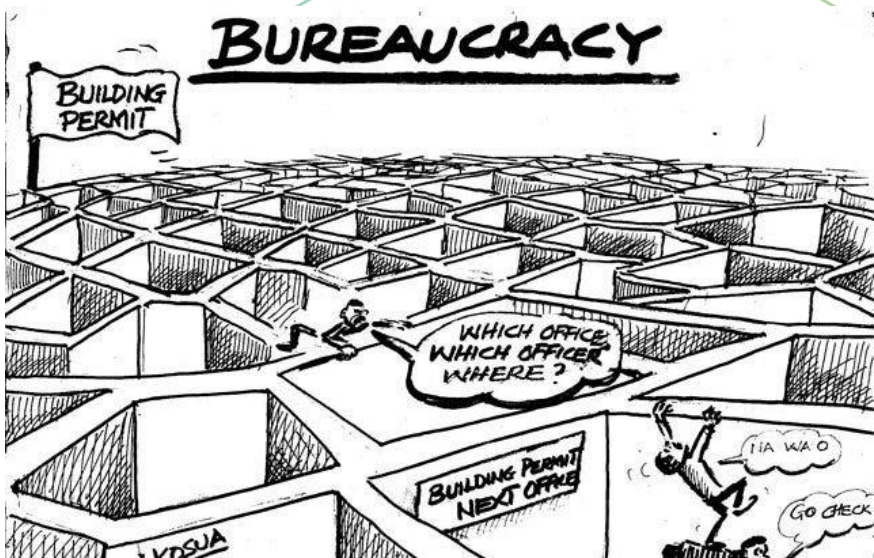
Water Access/Withdrawal

1. Interlocutors: Water access is managed by the river confederations (Which belong to government)

- Small rivers: Managed by Regions. Fast and good access. Fast permitting
- Large rivers: managed directly by national ministry. Long, very slow & complex process.

2. Access/permit is obtained:

- Directly via the river Confederation (for large projects) *Long process*
- Or by actors owning withdrawal concession (e.g. townhall, old power plants, agriculture water distribution.
  - This is easier, but if water use changes, then the Confederation will need to approved, *long process*

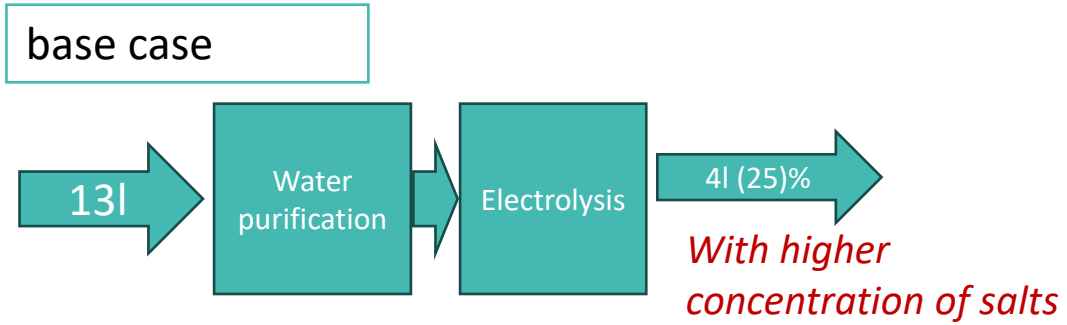


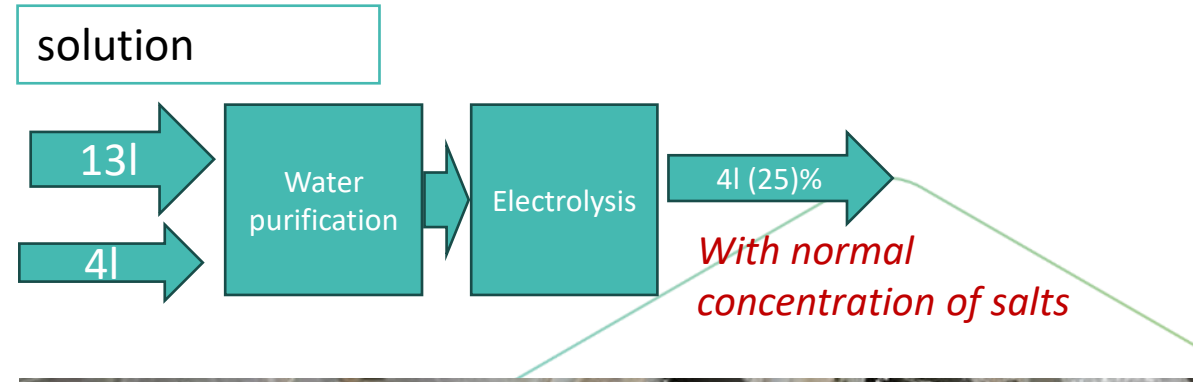
Main Permitting challenges (examples from Spain)

Water disposal

- Current limits for salt concentrations often force promoters to contract large amounts of water
- Although In some cases, higher salt concentrations can be regarded as positive (e.g. agriculture)

- Current limits/Regulation is not fit for purpose.





Alternative solutions to freshwater withdrawals

Solutions

1. Seawater desalination
2. Direct use of seawater
3. Use of treated wastewater

1. Seawater desalination

- **Energy needs are relatively low:** The process of reverse osmosis seawater desalination requires around 3-6 kWh of electricity per m3 of water, resulting in a cost for hydrogen production of around USD 0.05/kg H2.

- **Challenge:** seawater cooling and brine discharge from desalination can cause thermal pollution and environmental impacts.

*Project partners agree to build new generation of desalination plant powered by 100% renewable energy in **NEOM***

2. Direct seawater electrolysis

- **Energy needs event smaller:** This new technology could remove the need for desalination, the removal of salt and other substances and microorganisms from seawater by reverse osmosis at relatively low energy needs, costing about 0.035kWh of electricity per kilogram of hydrogen — a fraction of the 50-65kWh/kgH2 needed by electrolyser

- **Challenge:** Still very early state of development, purification, efficiency of the separation membranes, etc.

Chinese state-owned wind turbine maker Dongfang Electric has successfully produced green hydrogen directly from seawater during ten days of testing on a floating offshore platform
Source: hydrogen Insight, 2023

Conclusions

- Water consumption of hydrogen is relatively low compared with the production of conventional fuels
- Water consumption needs for hydrogen are likely to remain small in comparison to other energy/fuels production, even in Net-zero scenarios
- Regulation in Europe already address water needs in H2 production plants
- Worldwide, technology development government incentives and (possibly regulation) will lead developers to take good decision on water use.
- However water access & treatment is often a challenge for project promoters as they compete with other users and need to undergo long permitting processes.
- Best practices much be extended and permitting authorities must increasing knowledge and experience with hydrogen projects to accelerate process in water-constrain regions.

Thank You

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