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Green H_2 for the deep decarbonization of the Alpine region :

A territorial approach for the Regions

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The Alpine region: Specific ecosystems with different challenges

Alpine valleys to mountain areas, gathering electrointensive industries, decarbonized ski resorts, and specific mobility (buses, shuttles, ski equipment, lakes facilities..)

Midsize cities and rural environment, connecting with other energy capacities (biomass, ie) and specific mobility usages

Large cities scopes, gathering complex mobility schemes, high energy demand and complex mix of renewable energy production and storage capacities.

Hydrogen could play a major role in achieving carbon- neutrality in sectors presently difficult to decarbonise and pave the way to a low carbon society.

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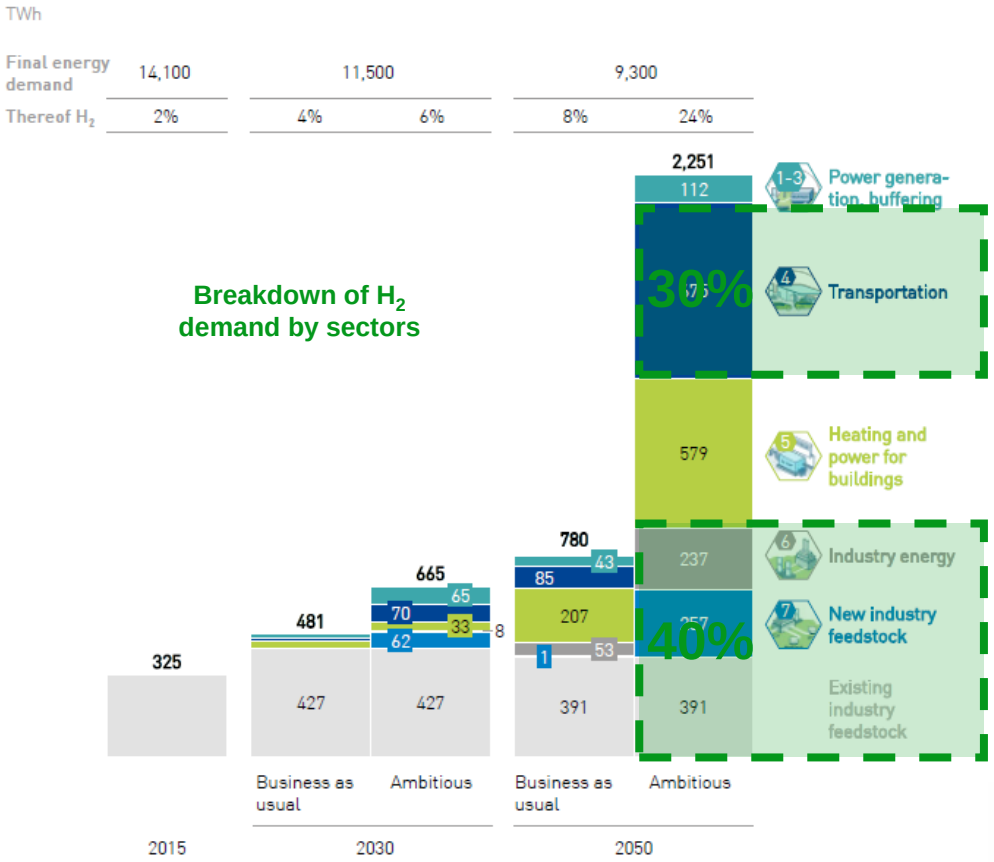
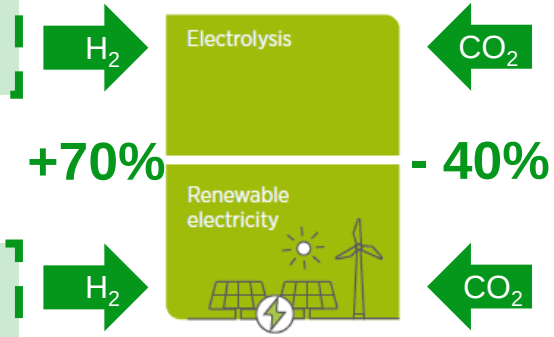
Achieve carbon neutrality in sectors difficult to decarbonise

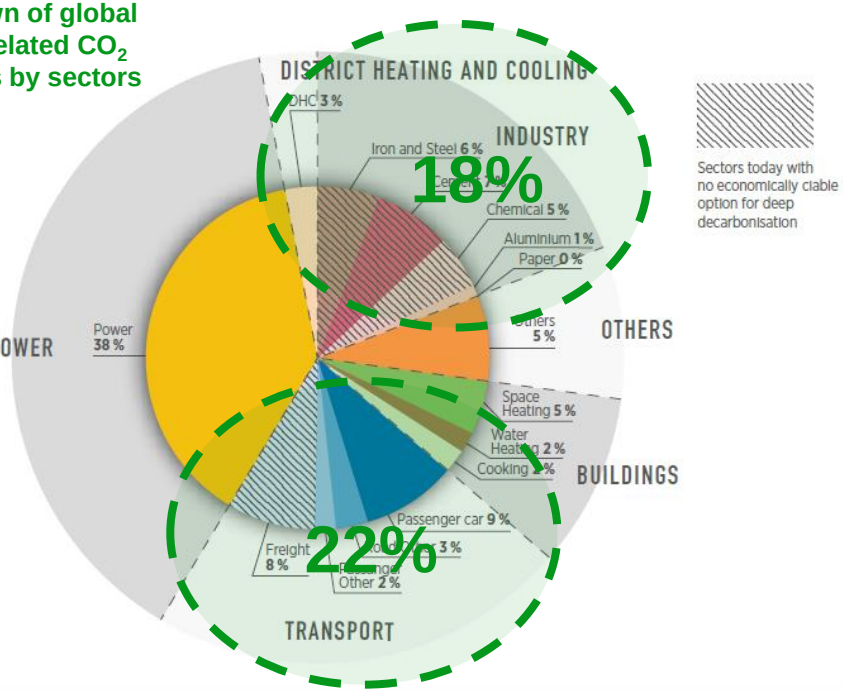
In 2050, H_2 will represent up to 24% of total energy demand / ~2,251 TWh of energy



Breakdown of H_2 demand by sectors



Breakdown of global energy-related CO_2 emissions by sectors



Source : IRENA

Source: Hydrogen Roadmap Europe – FCH-JU

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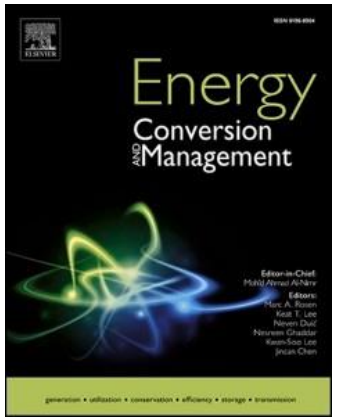
A territorial approach for the Regions ?

Green hydrogen in Europe – A regional assessment: Substituting existing production with electrolysis powered by renewables



Energy Conversion and Management 228 (2021) 113649

G. Kakoulaki [a], I. Kougias [a], N. Taylor [a], F. Dolci [b], J. Moya [b], A. Jager-Waldau [a]

[a] European Commission, Joint Research Centre (JRC), Ispra, Italy

[b] European Commission, Joint Research Centre, Petten, Netherlands

This publication describes how the currently carbon-intensive hydrogen production in Europe could be replaced by water electrolysis using electricity from renewable energy resources (RES) such as solar photovoltaic, onshore/offshore wind and hydropower (green hydrogen).

This study assesses the technical potential of RES at regional and national levels considering environmental constraints, land use limitations and various techno-economic parameters.

Total annual production of hydrogen in Europe

Hydrogen market in Europe

- Total annual production of hydrogen in Europe is in the range of 9.75 Mt.
- Four sectors correspond to 90% of the total hydrogen consumption in Europe : Oil refineries account for approximately at 30%, ammonia at 50%, methanol production (ca. 5%) and use in metal industries (ca. 3%)

Switching the current annual EU hydrogen production of 9.75 Mt to electrolysis would require 290 TWh of electricity (about 10% of current production).

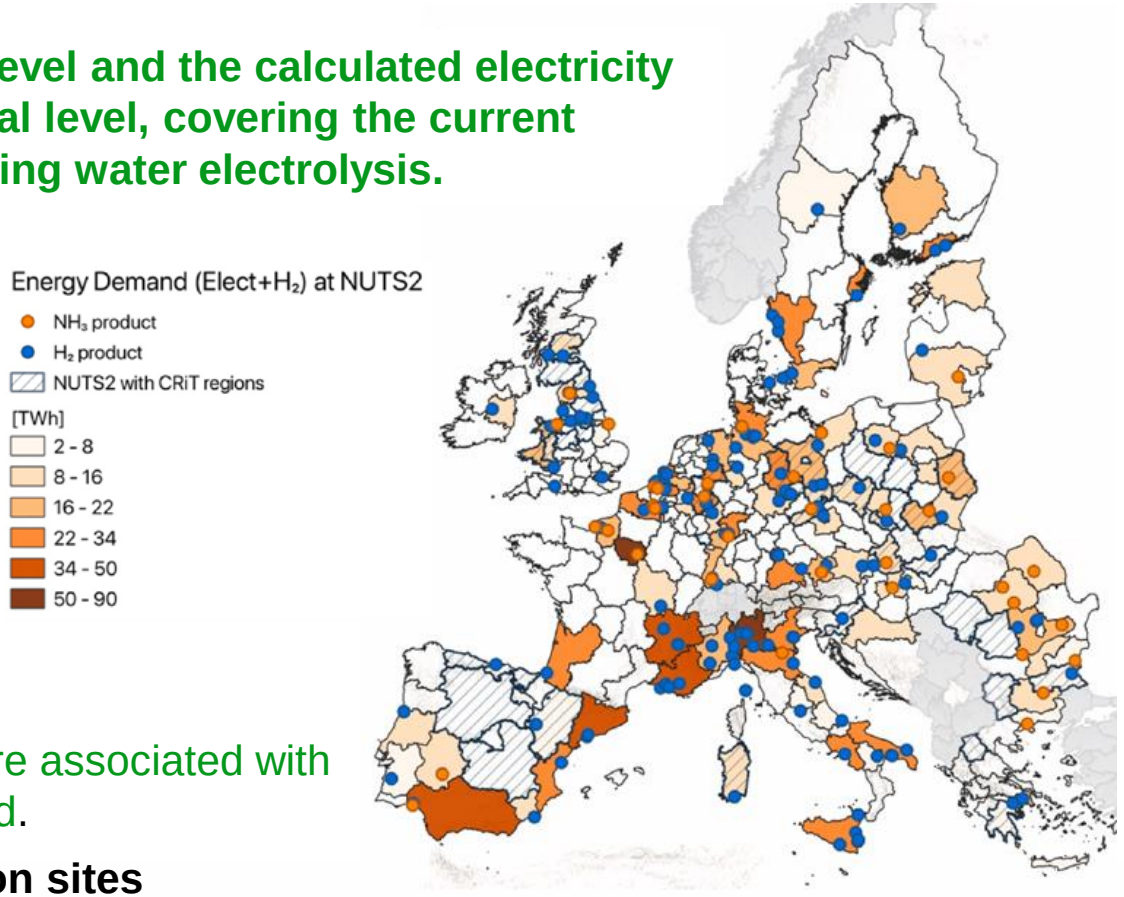
Source : Energy Conversion and Management 228 (2021) 113649

Distribution of main H_2 production hubs

Distribution of the main H_2 production hubs at regional level and the calculated electricity demand across all sectors per year (2019) at regional level, covering the current consumption and demand of hydrogen by using water electrolysis.

Green and blue dots represent chemical industries with hydrogen and ammonia production

Background colours represent total demand in TWh per year i.e. the sum of electricity consumption and the potential demand for electrolysis only in hydrogen-producing regions



From the 309 studied regions (EU27 UK), 109 regions are associated with hydrogen production that was geolocated.

Alpine region : High density of H_2 production sites

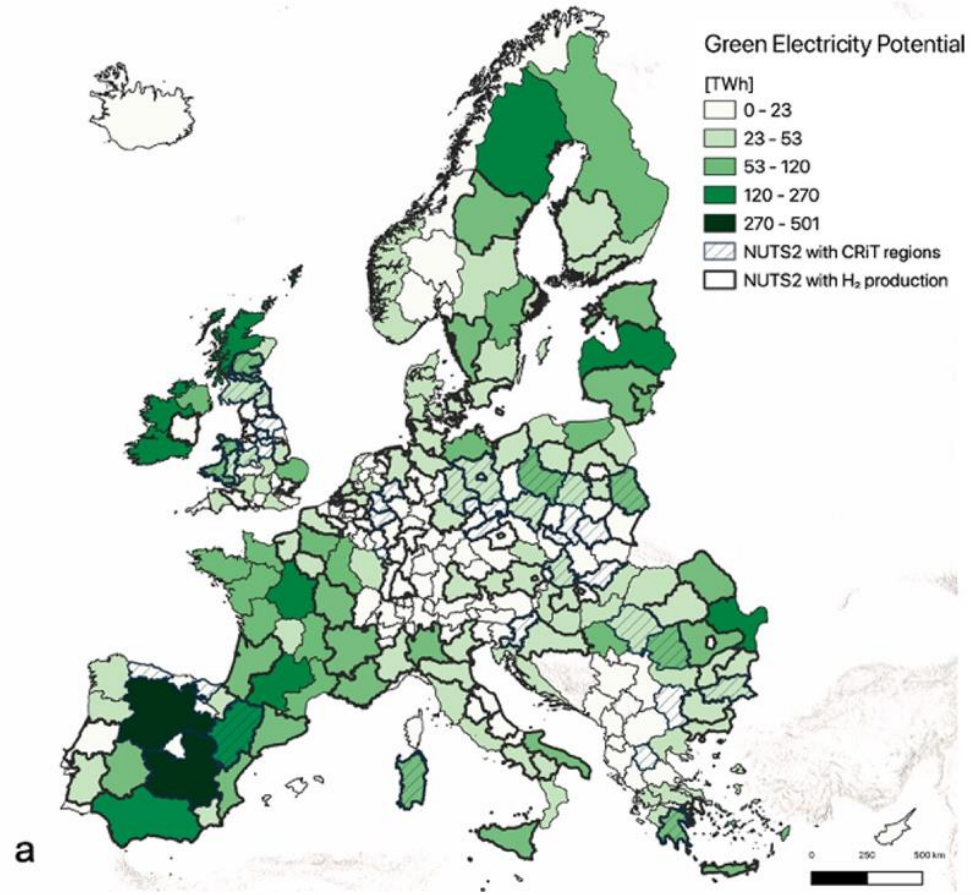
Source : Energy Conversion and Management 228 (2021) 113649

Green electricity potential

The green electricity potential has been calculated for each region.

- The analysis considered the technical potential for electricity generation from wind, solar photovoltaic and hydropower resources.
- Biomass electricity generation is excluded.
- Concerning hydropower, the analysis assumed that capacities will not expand significantly from current levels. This is because Europe has already developed approximately 60% of it hydropower technical potential, the highest share among all continents.
- Ocean and geothermal energy were also omitted as they are not at the same level of maturity as wind and solar technologies. You can see that we have a high potential in the Alpine region.

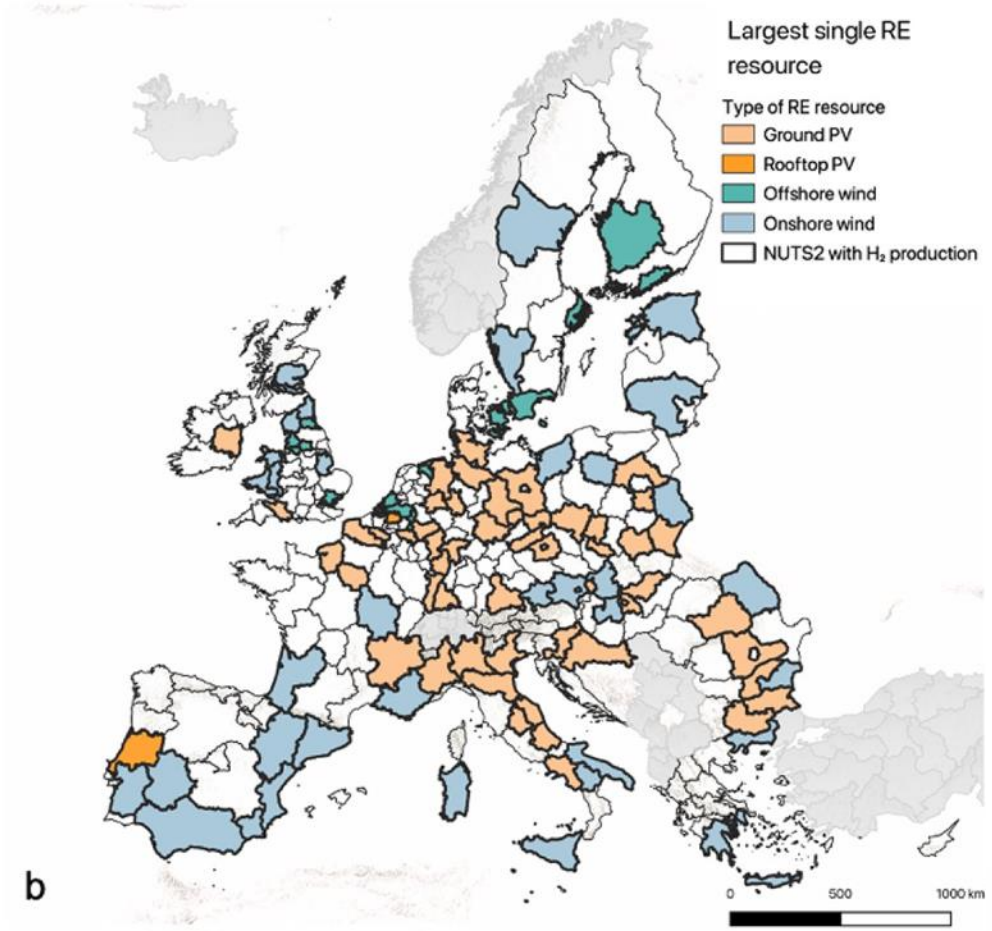
Alpine region : Great potential in term of green electricity



Source : Energy Conversion and Management 228 (2021) 113649

Largest single resource per region

- Ground-mounted PV and wind sources are globally dominant, with the former mainly for in land regions and the latter for regions closer to the coast.
- Rooftop PV technology was of secondary importance.



Source : Energy Conversion and Management 228 (2021) 113649

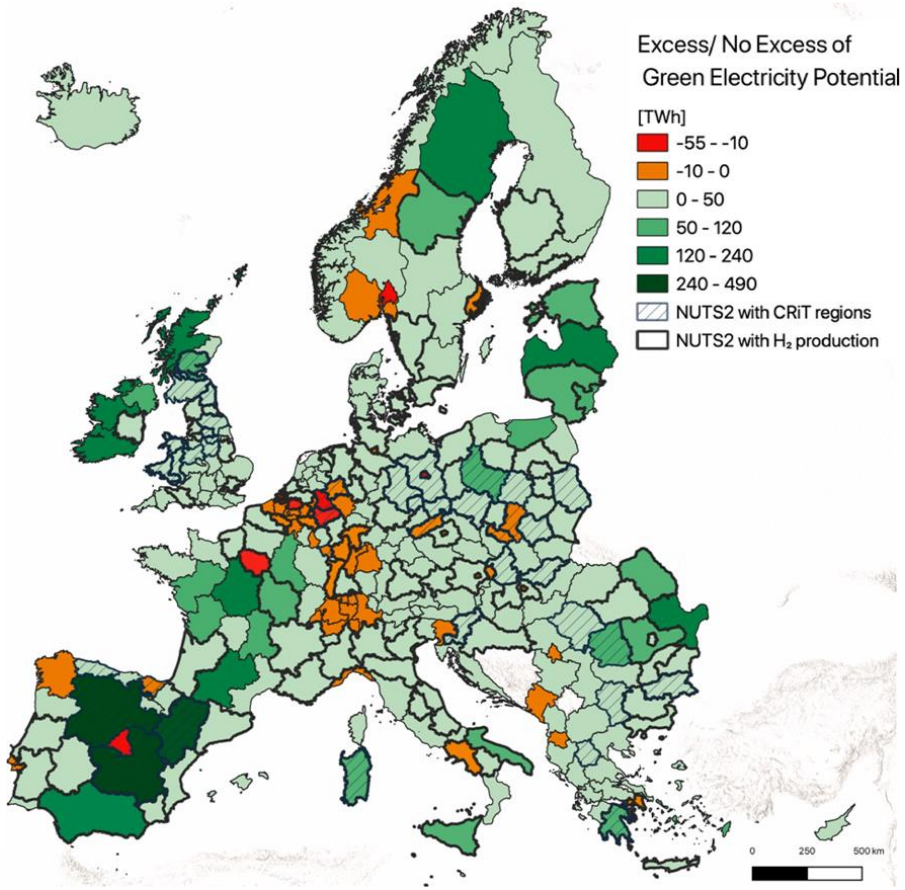
Total electricity demand compared to green electricity potential

The total green electricity potential exceeds the total electricity demand

Highlights the regions with surplus potential (marked in green) to those in deficit (flagged red/orange).

From the 309 studied regions (EU27 UK), a total of 246 regions have excess of RES electricity potential after subtracting the current electricity demand.

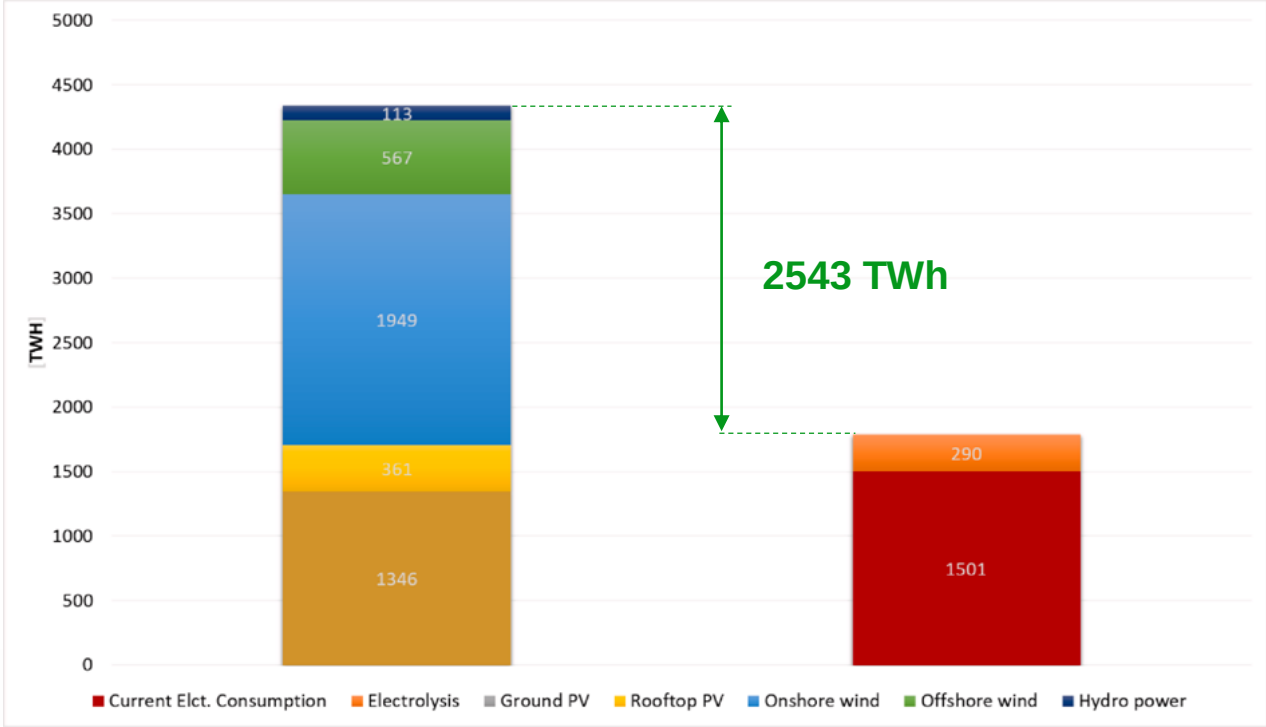
From the 109 regions with hydrogen production, 96 regions (88%) have excess green potential and 90 of those still have an excess even after subtracting the postulated electrolysis demand (indeed for 84 the remaining excess is over 50%).



Source : Energy Conversion and Management 228 (2021) 113649

Total technical potential for green electricity / demand

The total technical potential for green electricity is 4334 TWh, showing that these resources can cover the demand for electricity (1791 TWh) as well as that needed to produce all hydrogen by electrolysis.



Source : Energy Conversion and Management 228 (2021) 113649

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Conclusions of the study

- A major finding in this study is that most of the examined European regions have sufficiently high technical potentials to be self-reliant using renewable energy.
- Clean hydrogen offers new opportunities for re-designing Europe's energy partnerships with both neighbouring countries and regions and its international, regional and bilateral partners, advancing supply diversification and helping design stable and secure supply chains.
- Several major hydrogen-producing regions and especially densely populated regions (large cities, metropolitan areas) would not have sufficient green electricity to cover both current electricity consumption as well electrolytic production of hydrogen. However, given the overall technical potential for surplus of green electricity at EU and Member State level, these needs could be covered by inter-regional electricity transmission.
- This paves the way for further analyses of time complementarity between the various sources using production profiles and grid integration assessments. Second, the regional scope allows the identification of high/low production areas and reveals opportunities for energy trade in the forms of electricity and/or hydrogen.
- A conversion to a hydrogen economy offers new economic prospects to countries and regions that rely today on fossil fuel exports for a significant part of their national revenues. It may also help to create new export opportunities for countries with rich renewable energy resources.

Source : Energy Conversion and Management 228 (2021) 113649

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In the Alpines region ?

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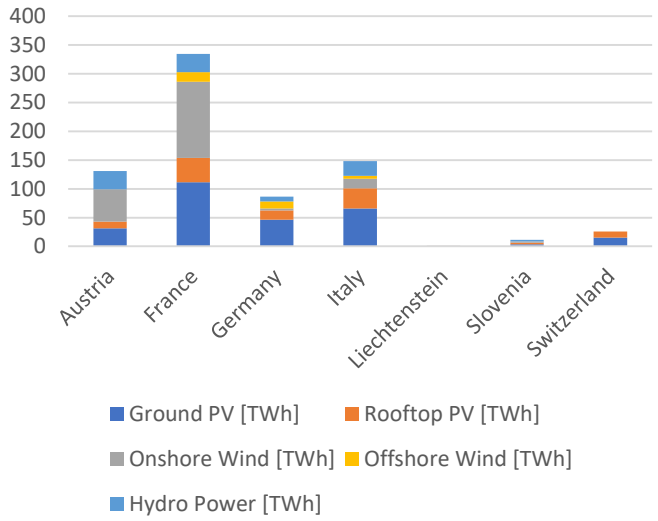
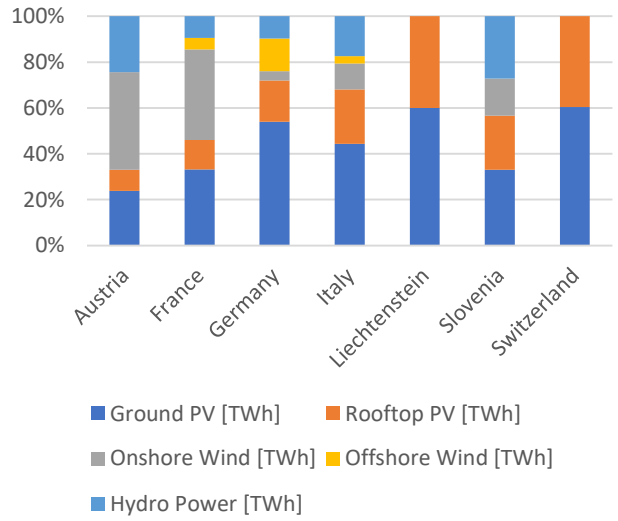
Green electricity potential of the Alpine region

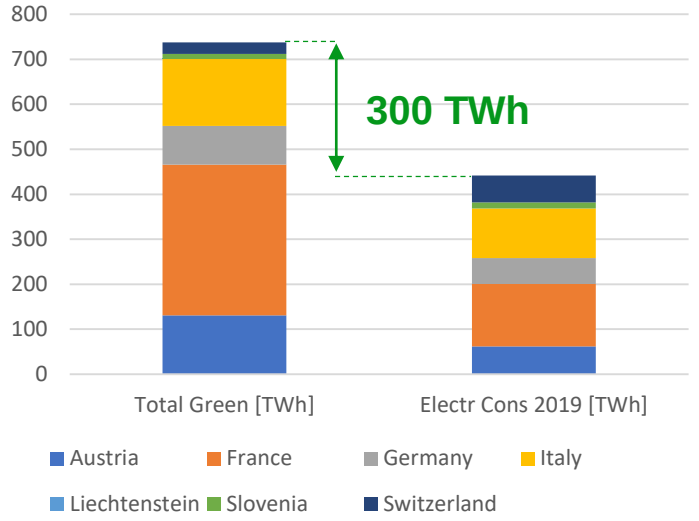
Alpine region: Austria, France, Germany, Italy, Liechtenstein, Slovenia and Switzerland

Alpine region: Green electricity potential per countries





Alpine region: Total green electricity potential and electricity demand (2019)



+300 TWh of green electivity potential = Potential production of 10 Mt of Green H_2 by electrolysis

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Next steps for the project ?

- Identify regions interested in the project ?
- Identify the type of sectors to decarbonise ? Industry ? Transport ? Other ?
- What will be the H_2 demand (Mt) for these different sectors ?
- The green electricity potential of these regions (TWh) ?
- The energy mix (PV, Onshore or offshore wind, Hydro power) ?
- Green H_2 production potential of these regions (Mt) ?
- Opportunities for energy trade in the forms of electricity and/or hydrogen at regional level ?
- Funding scheme / program for this project ?

How to get in touch with us?

Elisabeth Logeais
CEO
GSM : +33 608 75 03 59
elisabeth.logeais@tenerrdis.fr

Hervé Muguerra
European project officer
GSM : +33 615 83 01 97
herve.muguerra@tenerrdis.fr

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