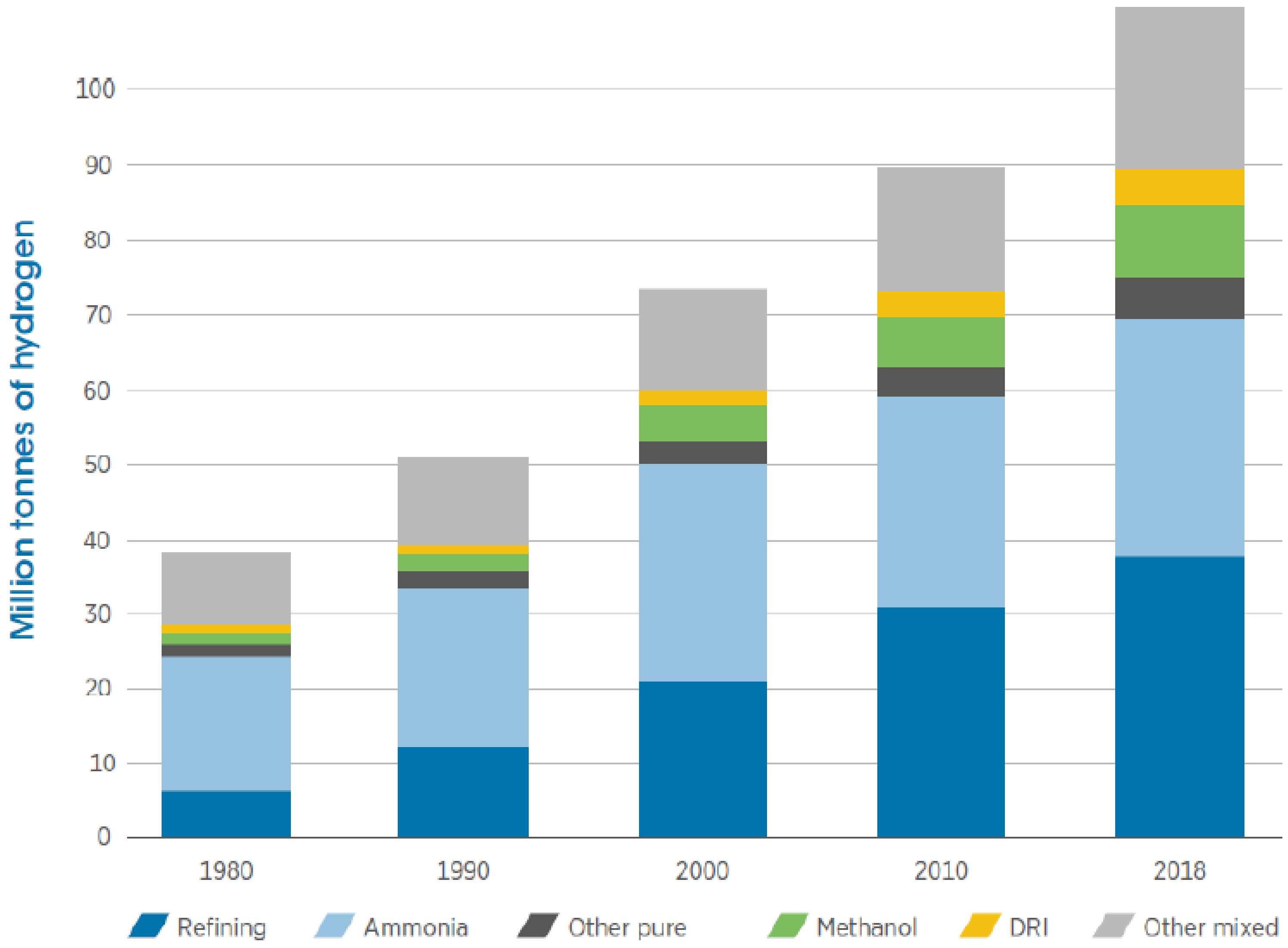
MERCADOS ACTUALES Y FUTUROS DE HIDRÓGENO.

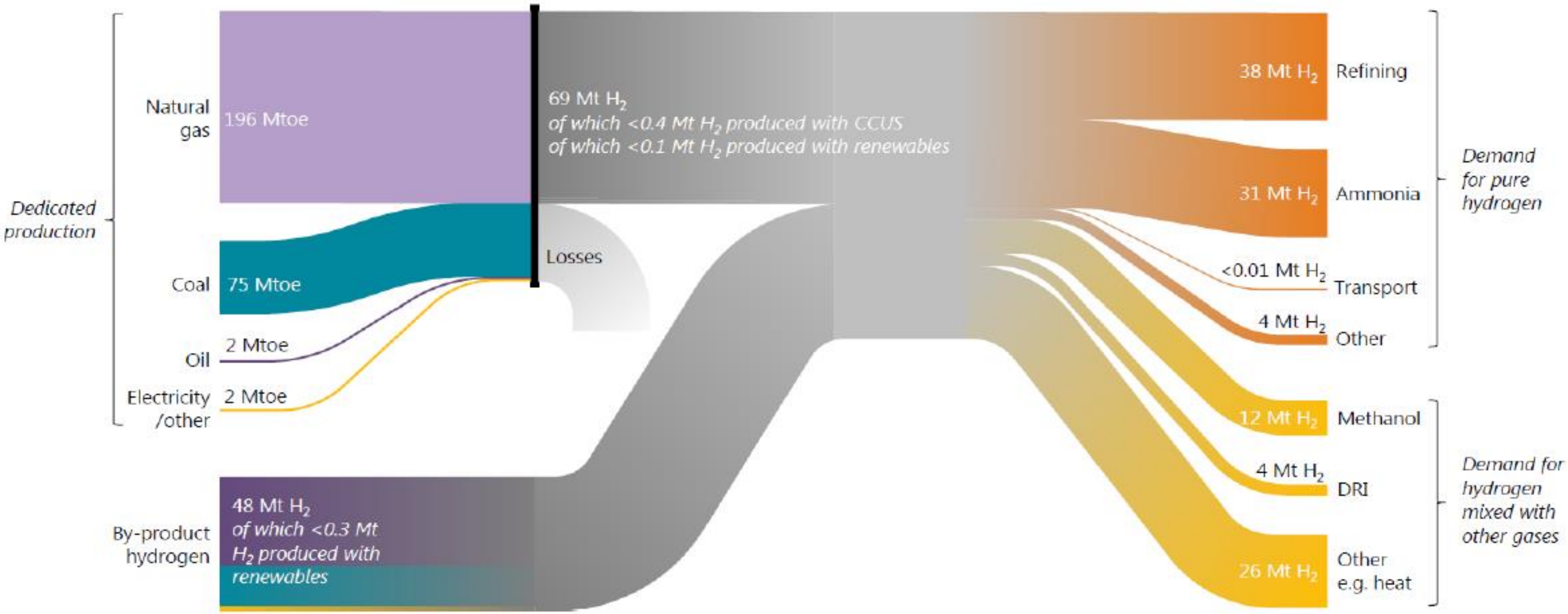
ÍNDICE

ÍNDICE

1. MERCADO ACTUAL DEL HIDRÓGENO

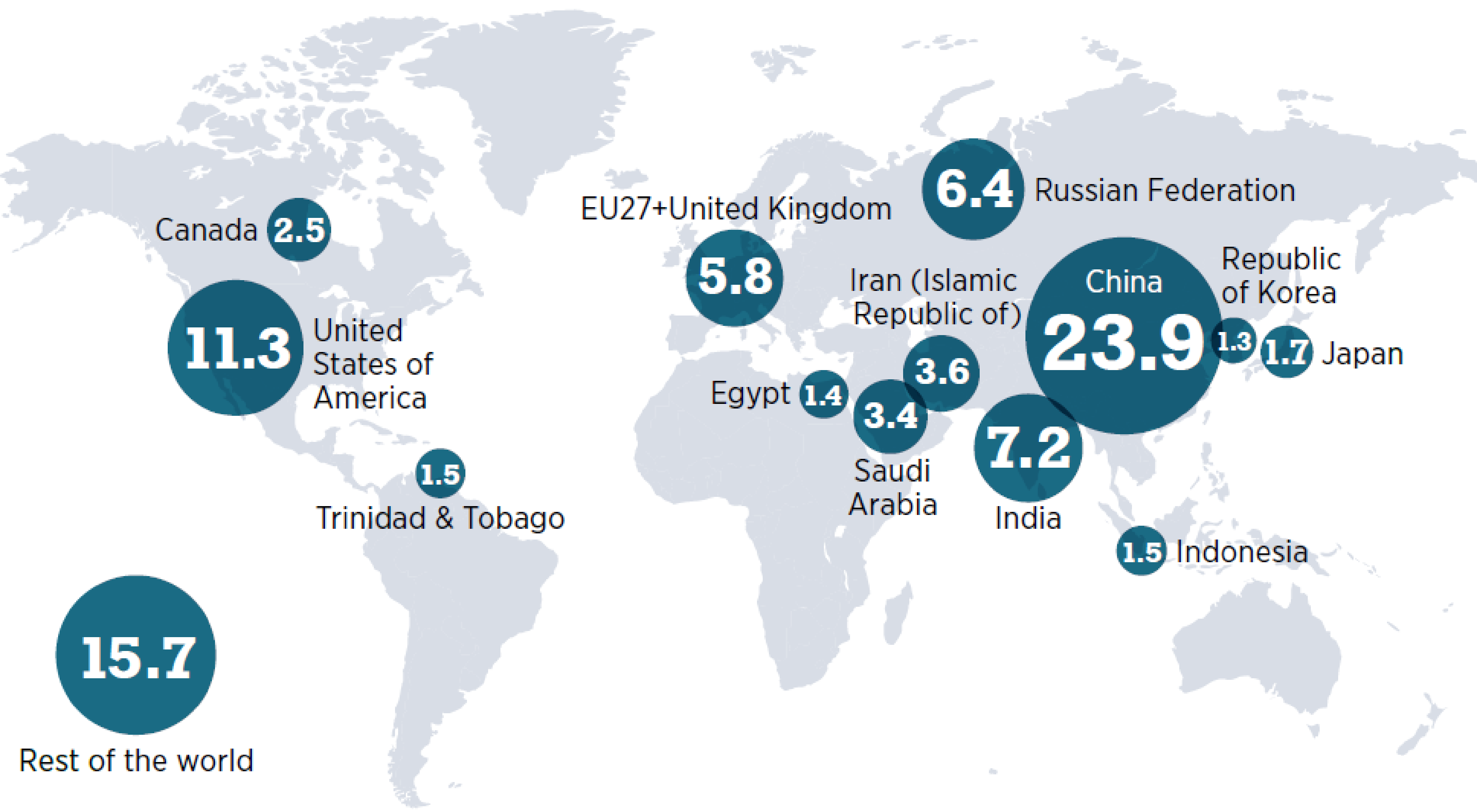


1. MERCADO ACTUAL DEL HIDRÓGENO



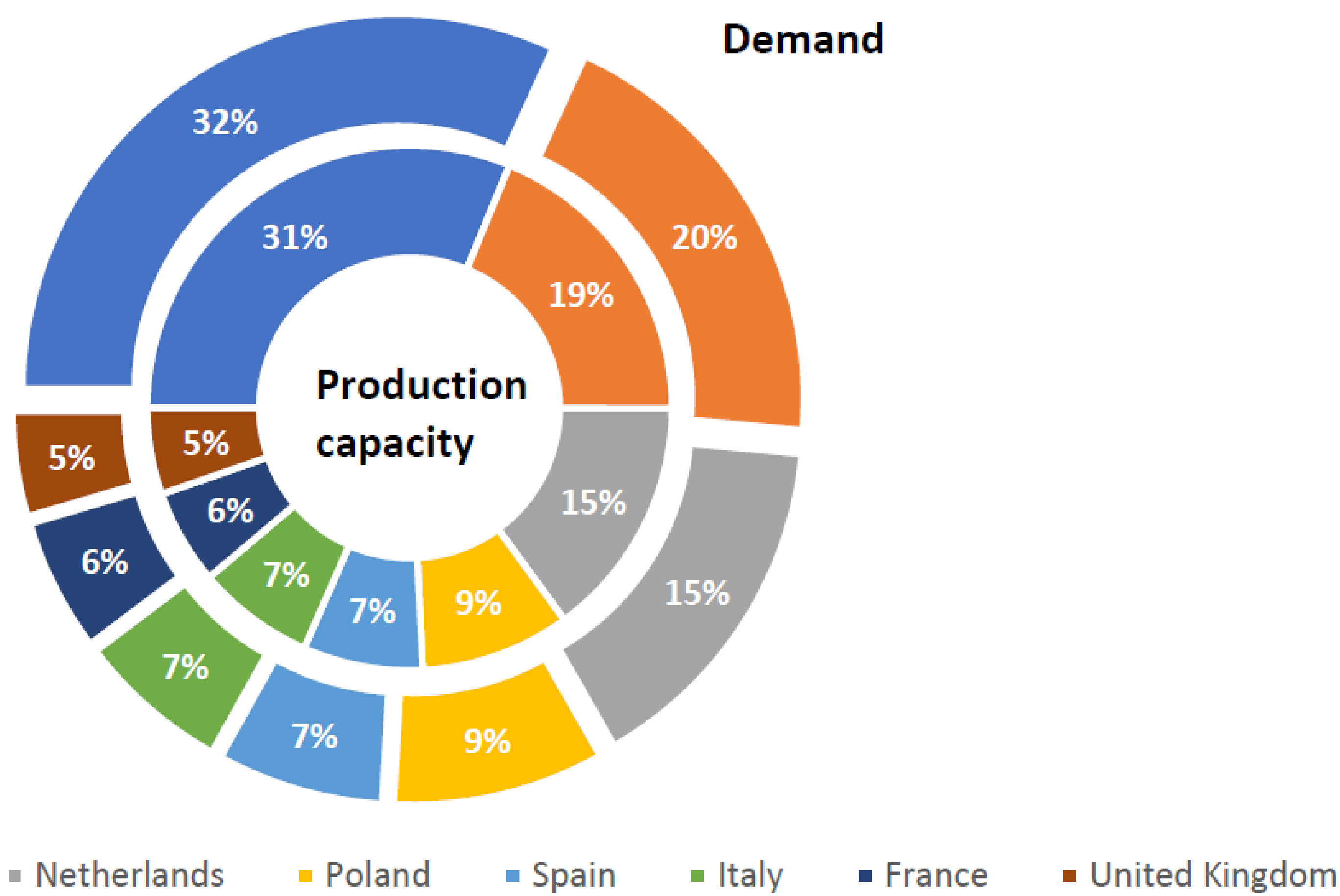
1. MERCADO ACTUAL DEL HIDRÓGENO

Figure 2.1 Hydrogen consumption in 2020 (million tonnes per year)



1. MERCADO ACTUAL DEL HIDRÓGENO

Figure 1. Total hydrogen production capacity and consumption by country in 2019



Source: Fuel Cells and Hydrogen Observatory

1. MERCADO ACTUAL DEL HIDRÓGENO

Out of the 326 identified hydrogen production plants which were using fossil fuels as feedstock, only three were using carbon capture technologies:

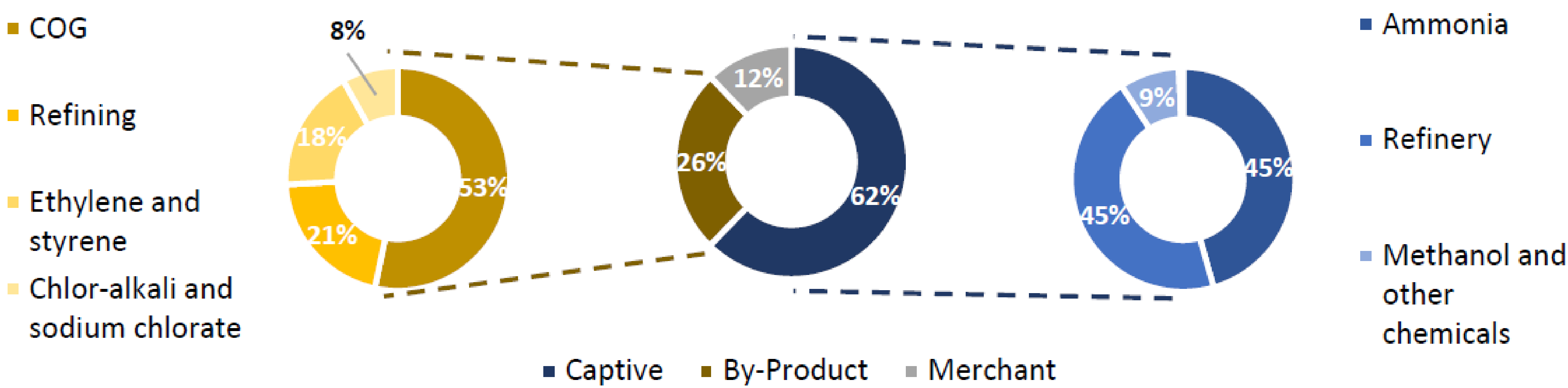
- Grupo Sappio hydrogen production unit in Mantova, Italy with a capacity of around 1,500 Nm3/h that started operating in 2016.
- Air Liquide Cryocap installation in Port Jerome, France, capturing CO2 from hydrogen supplied to an Exxon refinery, with a capacity of around 50,000 Nm3/h that started operating in 2015.
- Shell refinery in Rotterdam, Netherlands where CO2 from hydrogen production is captured and sold for agricultural use as part of the OCAP project since 2004.

Total share of hydrogen production from fossil fuels with CCS/CCU was around 131 tonnes per day equating to 0.5% of the total hydrogen generation capacity.

By the end of 2019, 95 operational power-to-hydrogen (water electrolytic) projects were identified for hydrogen production. Total power of those electrolysers was 92 MW equalling to hydrogen generation capacity of ~1.7 t of electrolytic hydrogen per hour (0.14% of total production capacity). This represents a 33% increase in capacity compared to 69 MW operating in 2018.

1. MERCADO ACTUAL DEL HIDRÓGENO

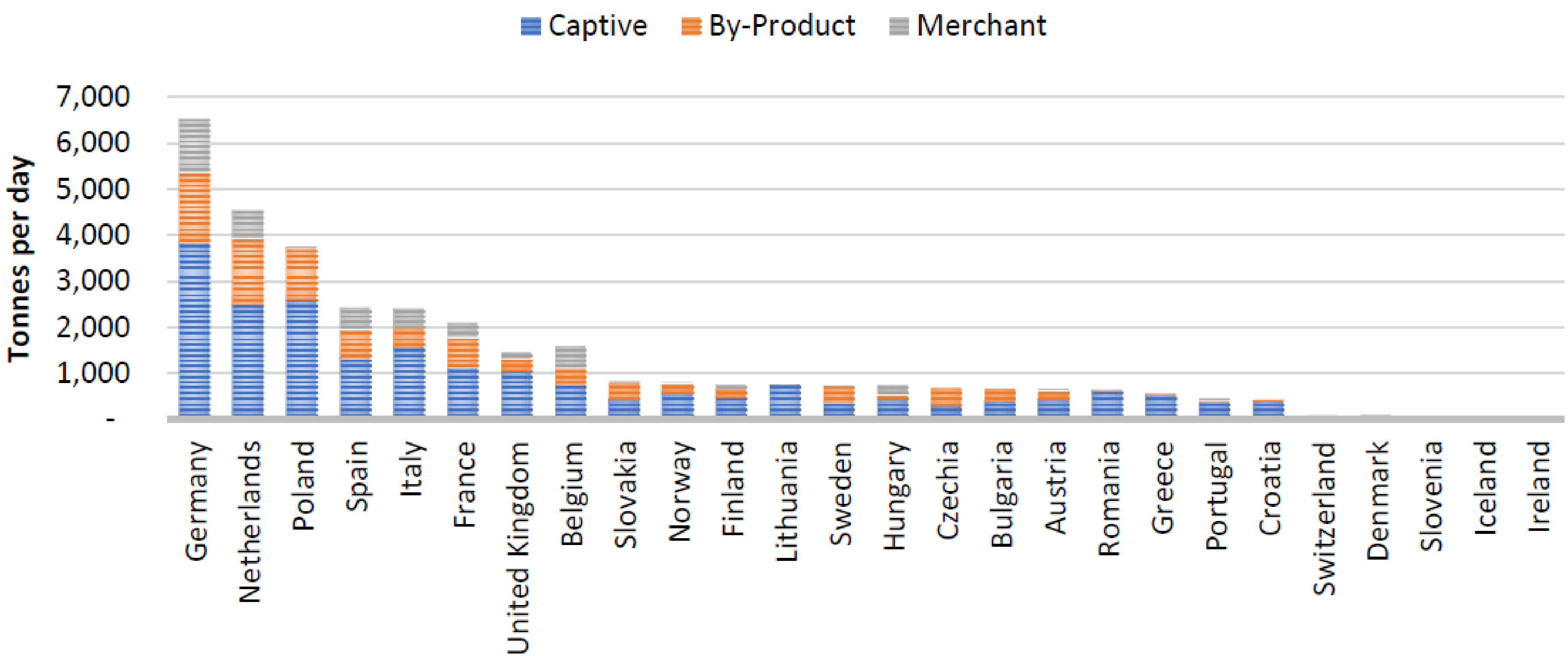
Figure 3. Structure of hydrogen production capacity



Source: Fuel Cells and Hydrogen Observatory

1. MERCADO ACTUAL DEL HIDRÓGENO

Figure 4. Total hydrogen production capacity by country



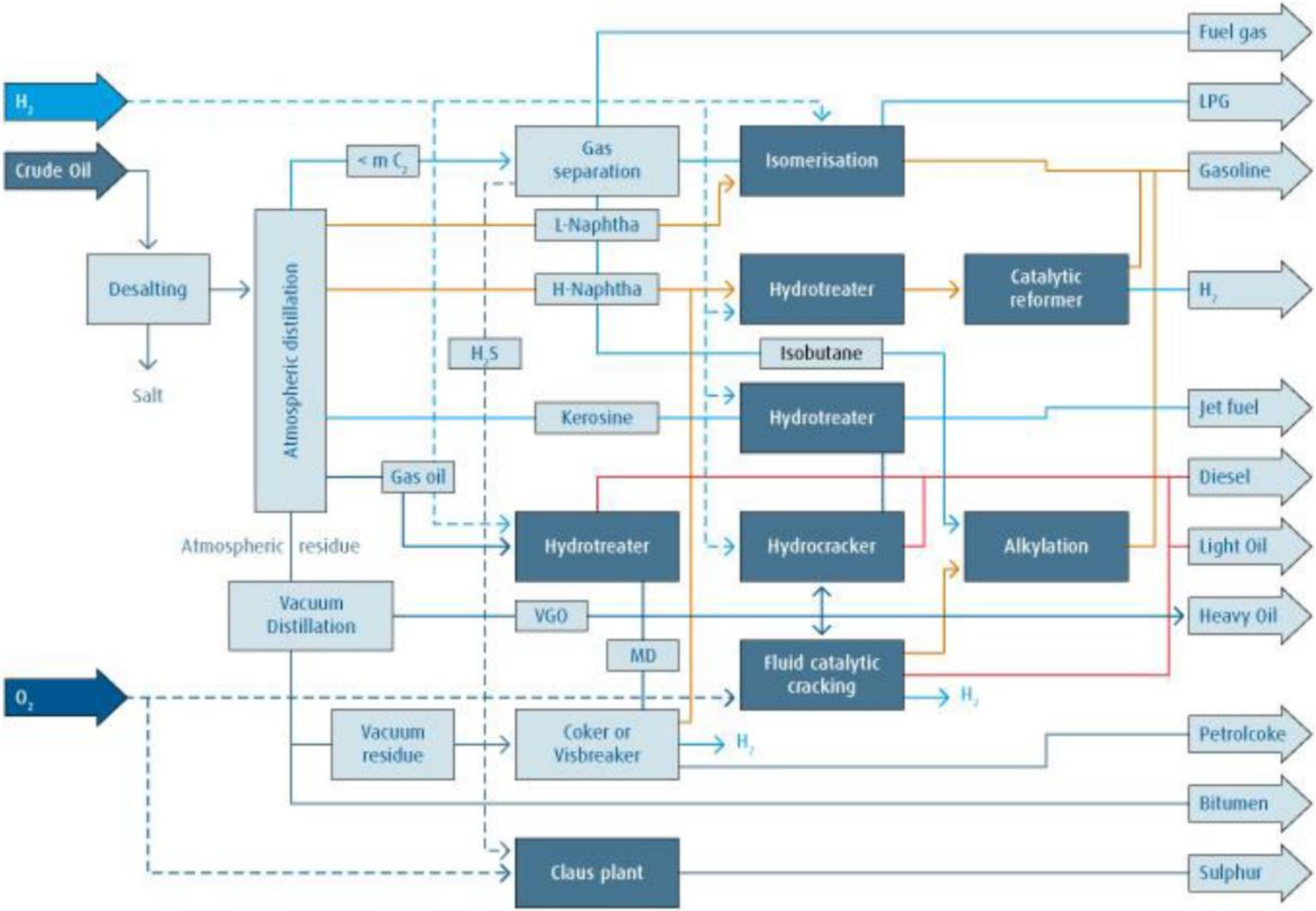
Source: Fuel Cells and Hydrogen Observatory

1. MERCADO ACTUAL DEL HIDRÓGENO

The oil refining sector is the biggest hydrogen producer and consumer in the EU. Hydrogen in refineries is used for the purpose of hydrotreating and hydrocracking processes.

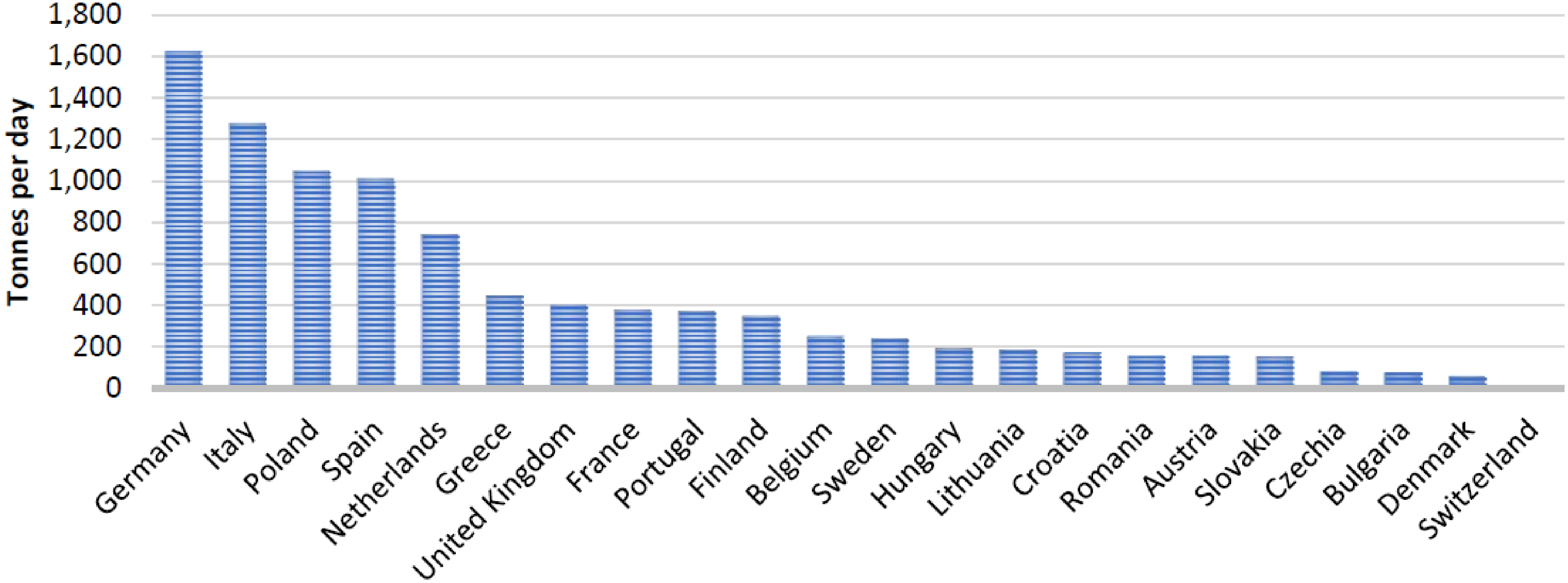
- Hydrotreatment is one of the key stages of the diesel refining process and relates to several processes such as hydrogenation, hydrodesulphurization, hydrodenitrification and hydrodemetalization. Hydrocracking involves the transformation of long and unsaturated products into products with a lower molecular weight than the feed.
- Hydrocracking is by far the most common hydrogen consuming process, needing around 300 Nm3 H2/t of product. Hydrotreating processes usually require only around 20-50 Nm3 H2/t of product. It is also important to note that refineries not only consume but also produce hydrogen at various stages of crude oil refining, with the most hydrogen yield being generated during catalytic reformulation which produces hydrogen at a rate of 200 Nm3 H2/t crude oil.

1. MERCADO ACTUAL DEL HIDRÓGENO



1. MERCADO ACTUAL DEL HIDRÓGENO

Figure 6. Captive hydrogen production capacity for refineries by country



Source: Fuel Cells and Hydrogen Observatory

1. MERCADO ACTUAL DEL HIDRÓGENO

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Next to refineries, the ammonia industry is the second largest hydrogen consuming sector in the EU. The ammonia production process involves a synthesis of hydrogen with nitrogen according to the following formula:

$$N_2 + 3 H_2 \rightarrow 2 NH_3$$

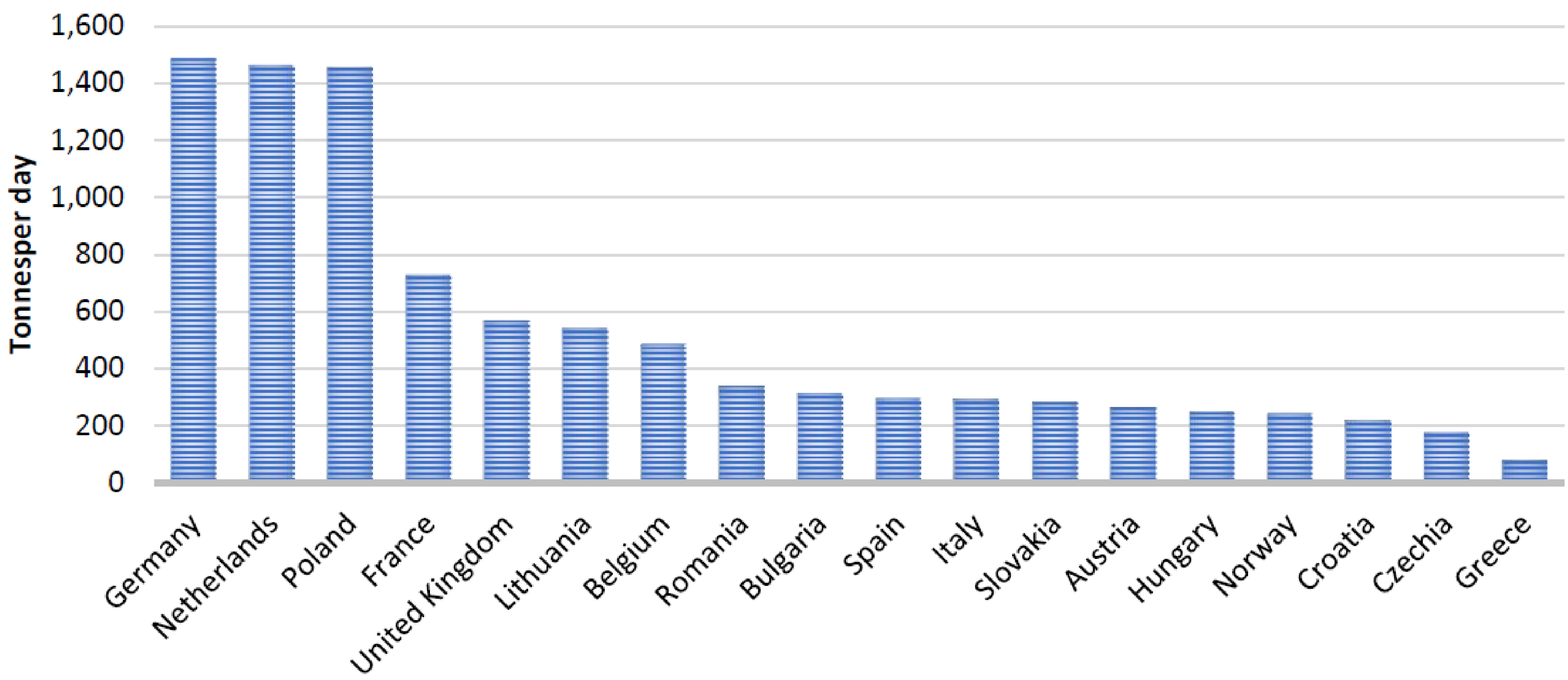
This process consumes about 175-180 kg of hydrogen per t of ammonia.

Total ammonia-related hydrogen production capacity in Europe was approximately 9,489 t per day split between 36 facilities. All of them were using either steam methane reforming or partial oxidation (POX) to generate hydrogen.

Similar to refining, Germany had the largest share with 16% of all Europe’s hydrogen production capacity dedicated to ammonia production, closely followed by the Netherlands (15%), Poland (15%), France (8%), and the United Kingdom (6%).

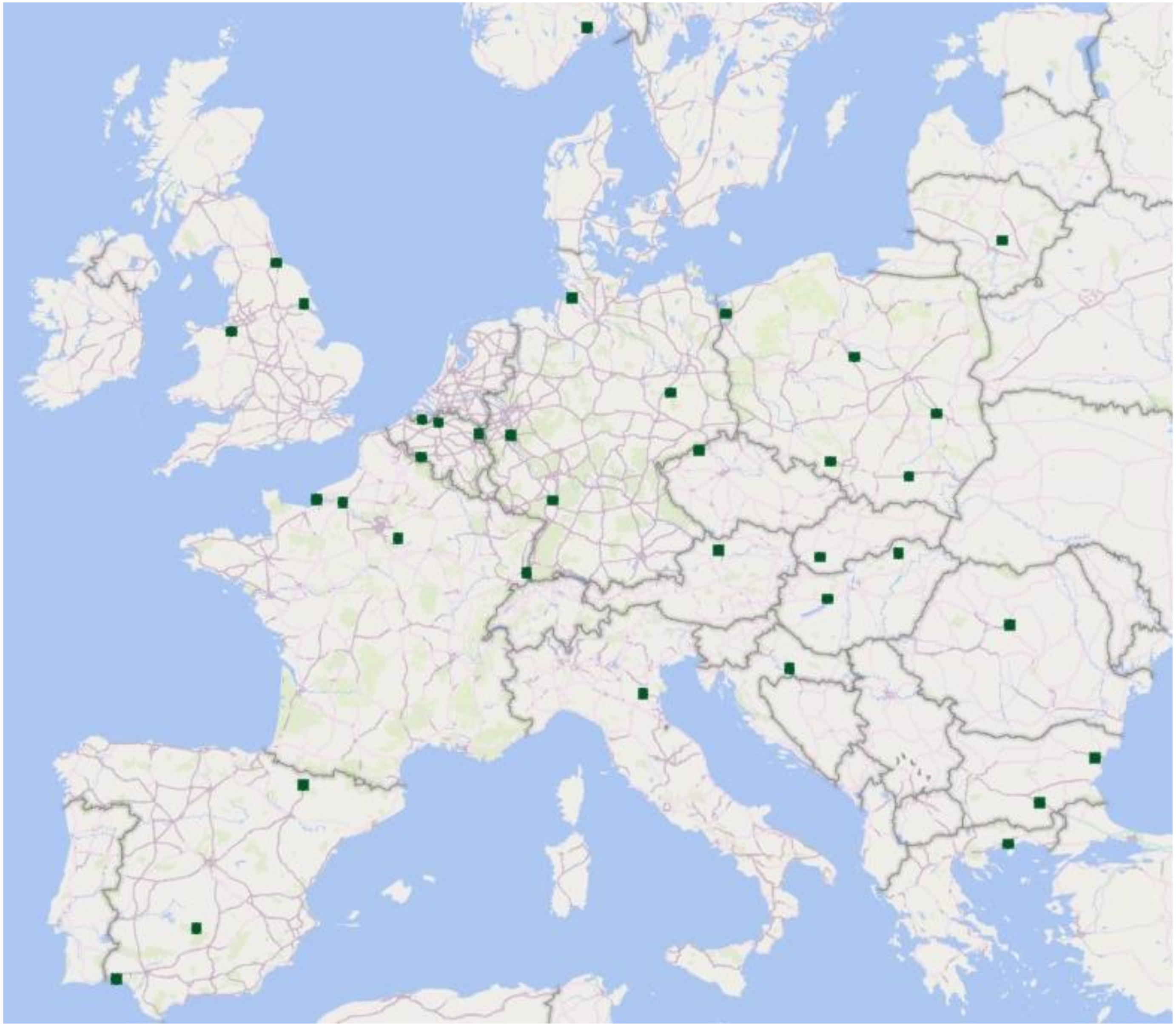
1. MERCADO ACTUAL DEL HIDRÓGENO

Figure 8. Captive hydrogen production capacity for ammonia by country



Source: Fuel Cells and Hydrogen Observatory

1. MERCADO ACTUAL DEL HIDRÓGENO



1. MERCADO ACTUAL DEL HIDRÓGENO

Refineries or ammonia plants comprise around 91% of total captive hydrogen production. Other than these processes, hydrogen is produced at scale also for the production of other chemicals, including methanol and hydrogen peroxide. The most common methanol production method is steam reforming of methane

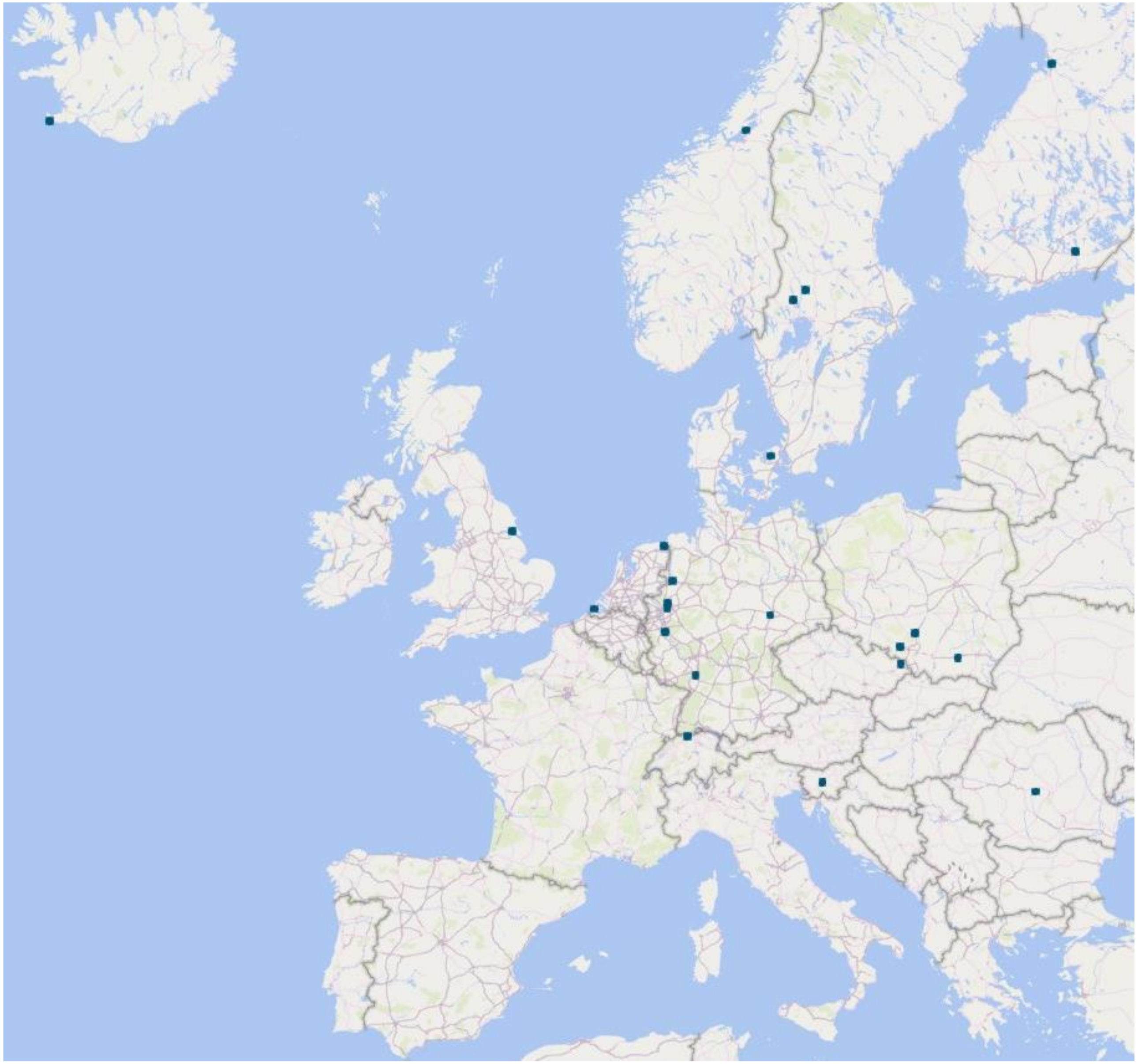
1st step: $CH_4 + H_2O \rightarrow CO + 3\ H_2$ and $CO + H_2O \rightarrow CO_2 + H_2$
2nd step: $3\ H_2 + CO_2 \rightarrow CH_3OH + H_20$

This production consumes about 1,400 Nm3 H2/t of methanol. Methanol is an important chemical raw material used for the production of formaldehyde, acetic acid and MTBE or fatty acid methyl esters (FAME), adhesives and solvents.

Other uses of hydrogen include the production of such high-volume chemical products as hydrogen peroxide, for which hydrogen consumption is approx. 735 Nm3 H2/t, hydrogen chloride, aniline, cyclohexane, TDI and oxo-alcohols. Production of those chemicals takes place at large integrated chemical or petrochemical plants.

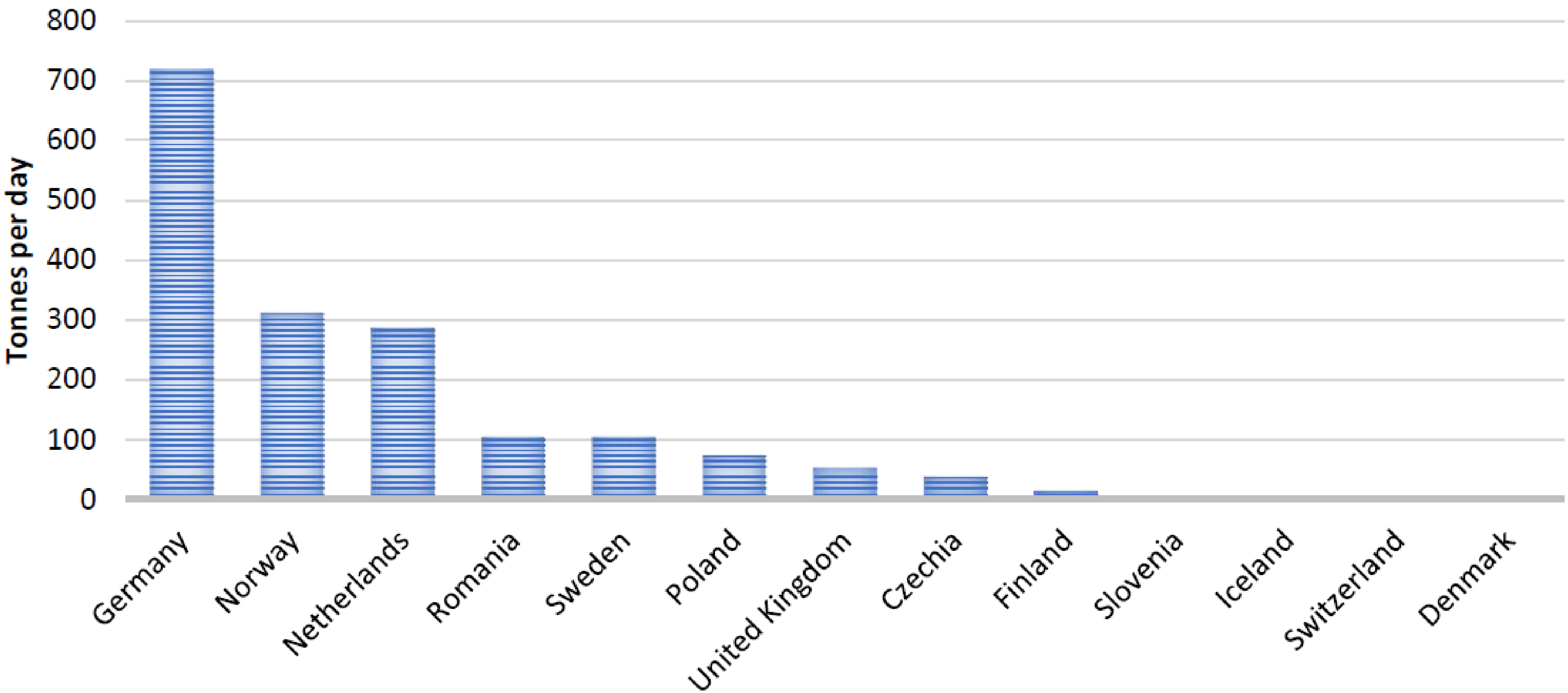
Total captive hydrogen production capacity in Europe dedicated to methanol and other chemicals is approximately 1,707 t per day split between 23 facilities.

1. MERCADO ACTUAL DEL HIDRÓGENO



1. MERCADO ACTUAL DEL HIDRÓGENO

Figure 10. Captive hydrogen production capacity for methanol or other chemical plants, excluding ammonia.



Source: Fuel Cells and Hydrogen Observatory

1. MERCADO ACTUAL DEL HIDRÓGENO

The merchant hydrogen plants can be divided into two main categories:

- Plants dedicated to supply a single large-scale consumer with only excess capacity available to supply the retail hydrogen market; and
- Small and medium scale hydrogen production sites designed for the purpose of supplying mostly retail customers.

While the first type can be comparable in scale to the largest captive hydrogen production facilities, the installations designed with the hydrogen retail market in mind are an order of magnitude smaller in terms of their maximum capacity.

The report identified 108 merchant hydrogen plants operational in Europe in 2019. Total capacity of those plants has been estimated at 3,865 t per day.

The merchant hydrogen market in Europe is dominated by 4 groups: Linde Gas, Air Liquide, Air Products and Messer, that own a combined 81% of plants and 90% of total merchant hydrogen production capacity.

1. MERCADO ACTUAL DEL HIDRÓGENO

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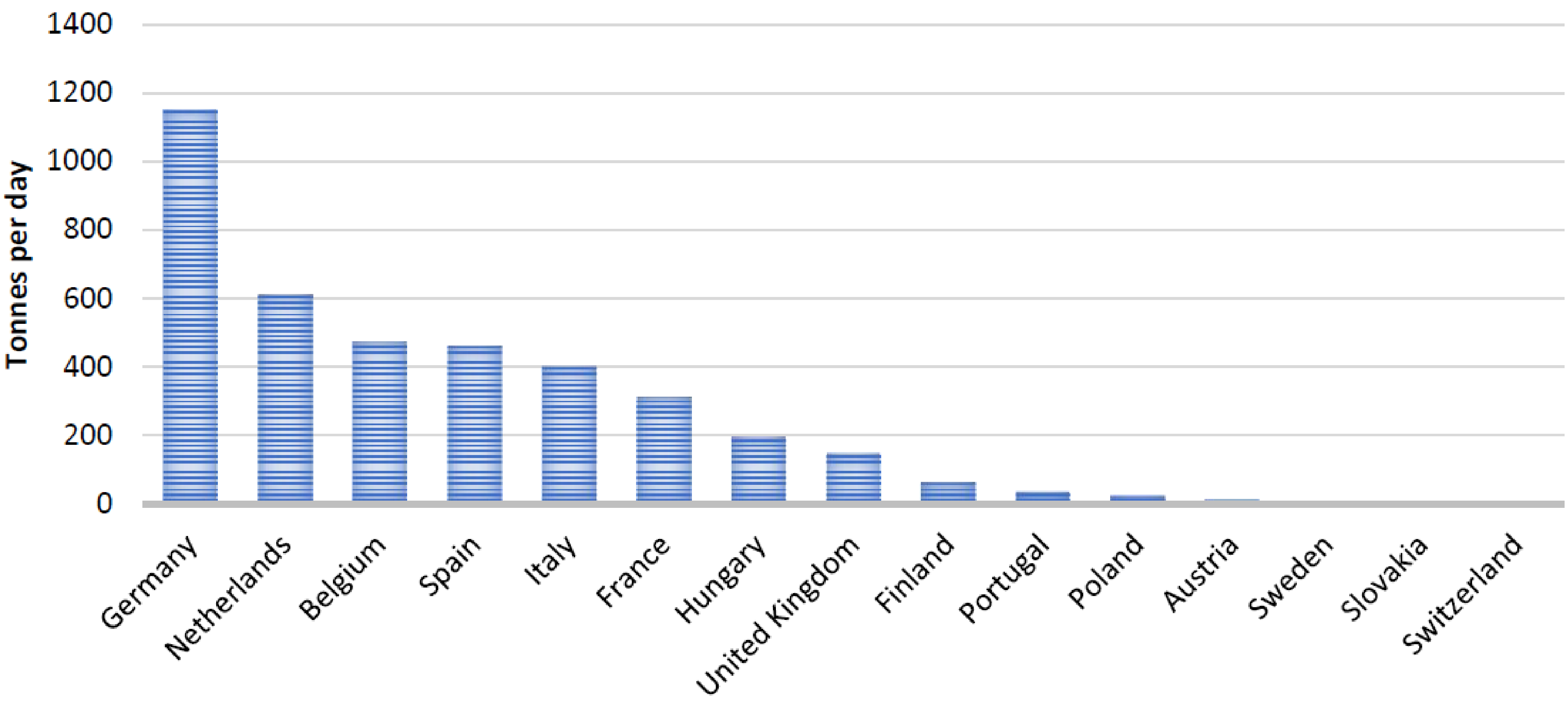
Figure 12. Merchant hydrogen production capacity.



Source: Fuel Cells and Hydrogen Observatory

1. MERCADO ACTUAL DEL HIDRÓGENO

By-product hydrogen production capacity, by which we mean hydrogen produced as a by-product of other processes, has been estimated at 8,523 t per day, including:

- 4,541 t per day of hydrogen mixed in coke oven gas,
- 1,777 t per day of hydrogen as by-product from refining operations7,
- 581 t per day of hydrogen produced by the chlor-alkali process,
- 108 t per day of hydrogen produced by the sodium chlorate process,
- 1,105 t per day of hydrogen produced during ethylene production,
- 412 t per day of hydrogen produced during styrene production.

The hydrogen production rate for ethylene and styrene production processes is around 190 Nm3 H2/t ethylene and 220 Nm3 H2/t of styrene. By-product hydrogen from those industries is almost universally used on site as a feedstock for other chemical or petrochemical processes further downstream.

The by-product production rate from the chlor-alkali industry is around 300 to 270 Nm3 H2/t chlorine. On average, the industry vents around 15% of produced hydrogen into the atmosphere with the remaining 85% usually burned for heat or used in a CHP unit to generate both heat and power.

1. MERCADO ACTUAL DEL HIDRÓGENO

The biggest potential source of by-product hydrogen is coke oven gas (COG), where the hydrogen production rate is about 450 Nm3 H2/t of product. In this case though, the output gas is not pure hydrogen but rather a mixture of hydrogen (55%-65%) and methane, carbon monoxide, CO2 and nitrogen.

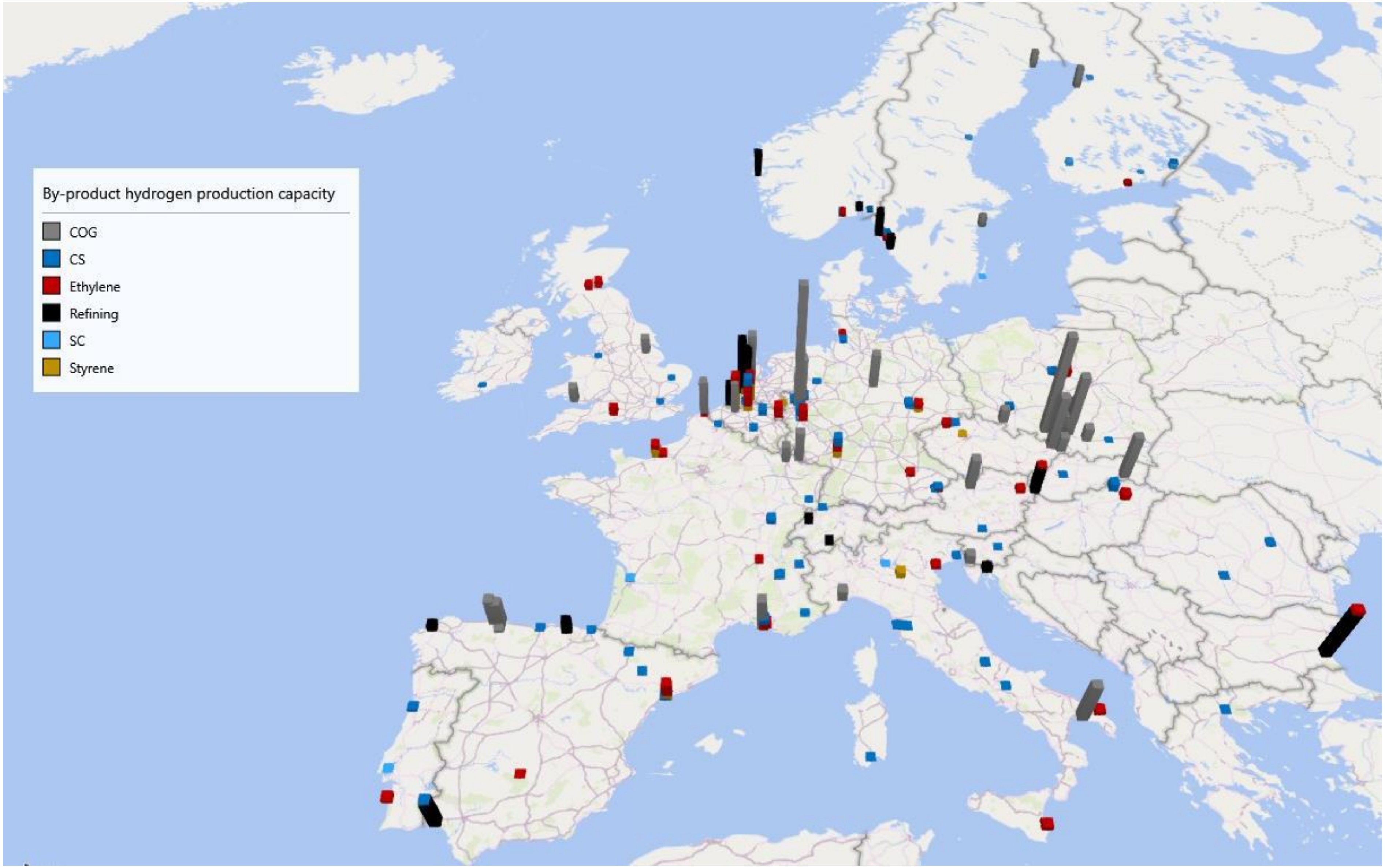
Coke oven gas is used to enrich the calorific value of the other process gases for use in blast furnace stoves, the reheating furnaces of hot strip mills, for other high temperature processes, or for the under-firing of coke ovens.

The surplus COG may be utilised at the blast furnace as an alternative reducing agent and is also used in power plants.

Other, smaller by-product hydrogen sources include:

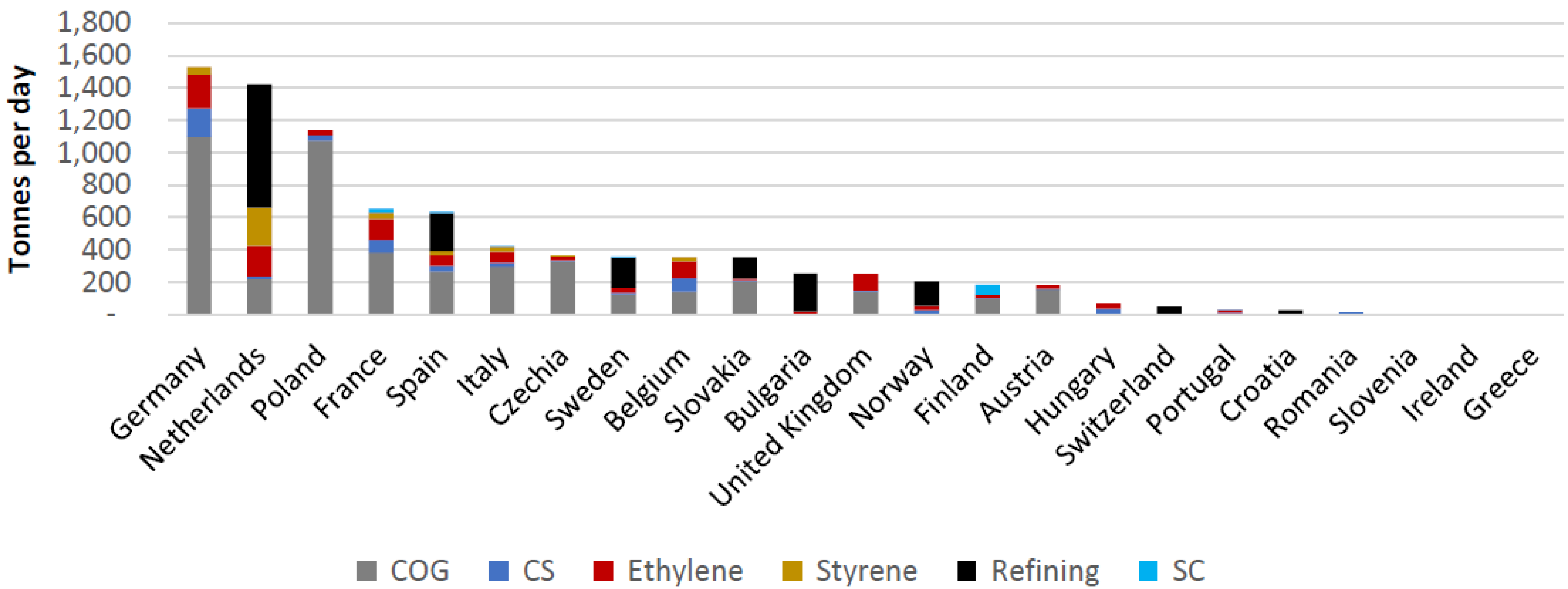
- Acetylene production: 3,400 – 3,740 Nm3 H2/t product.
- Cyanide production: 2,470 Nm3 H2/t of product.

1. MERCADO ACTUAL DEL HIDRÓGENO



1. MERCADO ACTUAL DEL HIDRÓGENO

Figure 14. By-product hydrogen production capacity[8]



Source: Fuel Cells and Hydrogen Observatory

1. MERCADO ACTUAL DEL HIDRÓGENO

The most common method of producing hydrogen is steam reforming of natural gas (SMR). Less common are partial oxidation (POX) and autothermal reforming (ATR). SMR and natural gas is widely used for all applications including oil refining, ammonia synthesis, or any other bulk hydrogen production. Even though natural gas is the most common feedstock, steam reforming is also used with other feedstocks, which include also liquid hydrocarbons like LPG or naphtha.

Out of the 326 identified hydrogen production plants which were using fossil fuels as feedstock, only three were using carbon capture technologies:

- Grupo Sappio hydrogen production unit in Mantova, Italy with a capacity of around 1,500 Nm3/h that started operating in 2016.
- Air Liquide Cryocap installation in Port Jerome, France, capturing CO2 from hydrogen supplied to an Exxon refinery, with a capacity of around 50,000 Nm3/h that started operating in 2015.
- Shell refinery in Rotterdam, Netherlands where CO2 from hydrogen production is captured and sold for agricultural use as part of the OCAP project since 2004.

The total share of hydrogen production capacity from fossil fuels with CCS/CCU is ~0.5% equating to 131 tonnes per day.

1. MERCADO ACTUAL DEL HIDRÓGENO

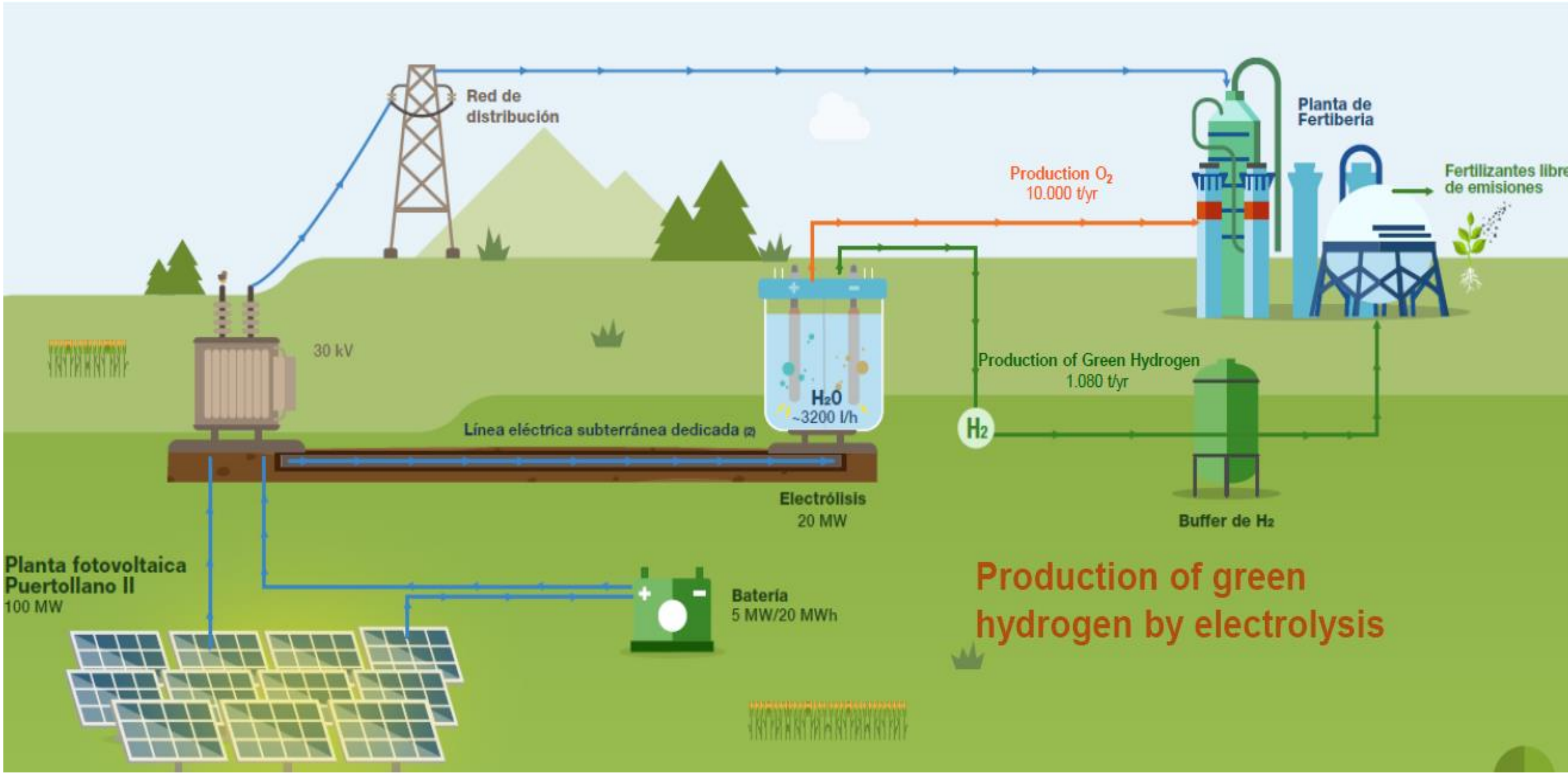
Hydrogen can, of course, also be produced with electricity by splitting water via water electrolysis. There is a significant number of electrolysers installed in Europe.

Beyond the established hydrogen use cases mentioned above, there is increased activity in development of power-to-hydrogen projects, where electricity is used to produce hydrogen via water electrolysis. By the end of 2019, the authors identified 95 operational power-to-gas (water electrolytic) projects. Total power of those electrolysers was around 92 MW equalling a hydrogen generation capacity of ~41 t of electrolytic hydrogen per day (0.14% of total production capacity).9 Compared to 69 MW in 2018, this represents a 33% increase in operational power-to-hydrogen capacity between 2018 and 2019.

Most of them produce electrolytic hydrogen for merchant sales, on-site industrial consumption, mobility applications, or energy storage for renewable energy grid balancing.

Countries with the largest number of installations are Germany (28), United Kingdom (13), France (9).

1. MERCADO ACTUAL DEL HIDRÓGENO



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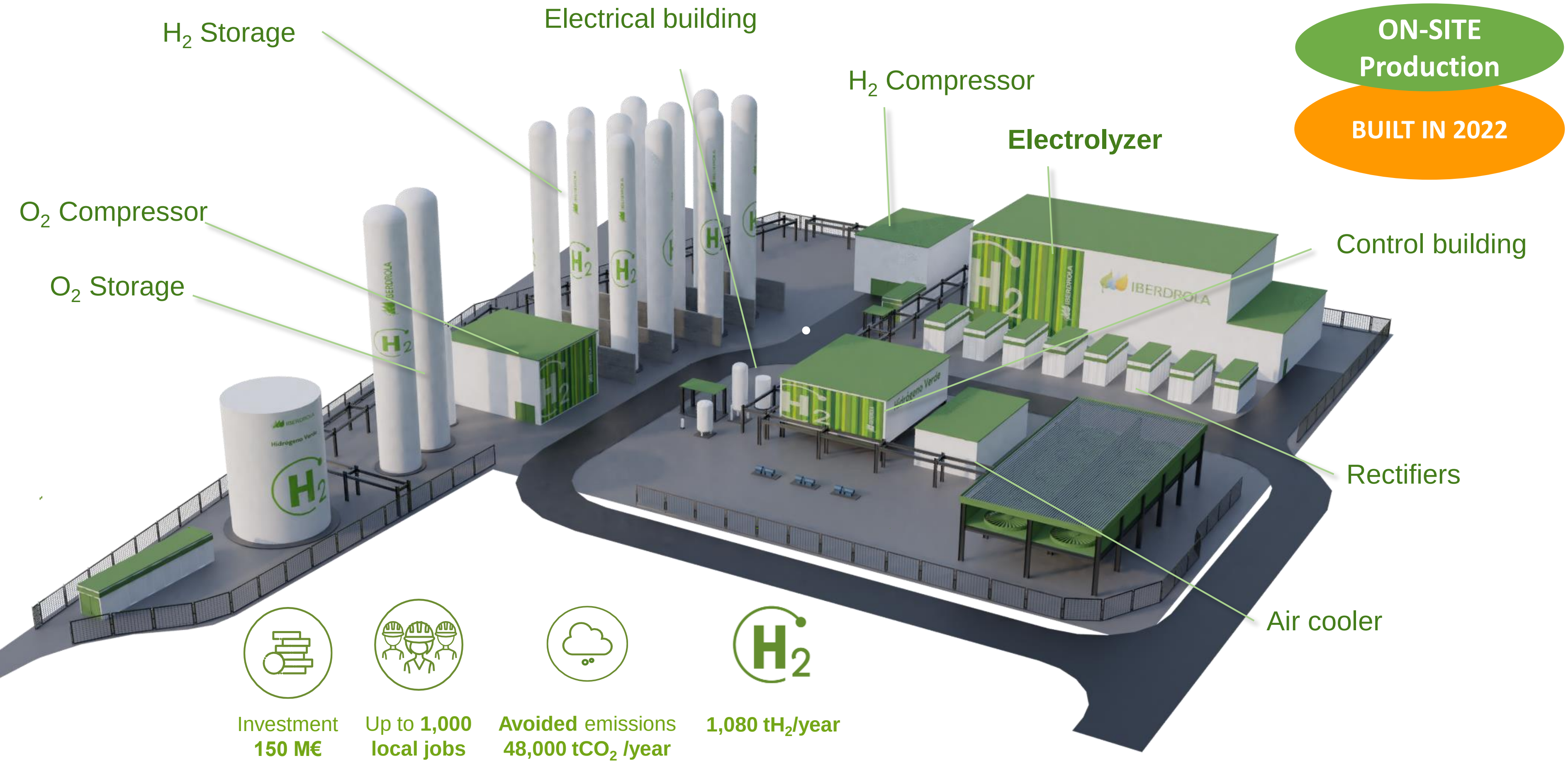


1. MERCADO ACTUAL DEL HIDRÓGENO

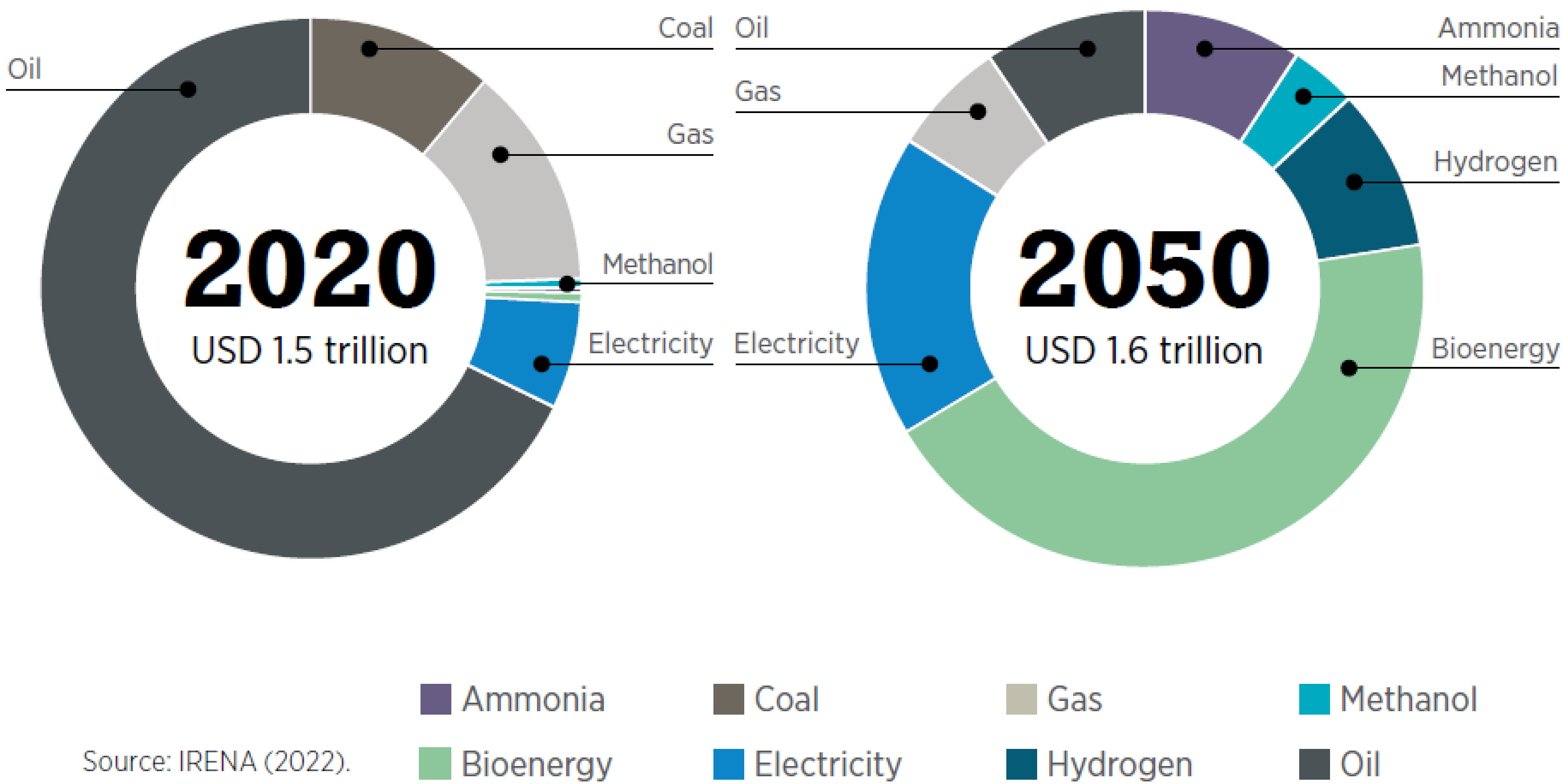
[Inauguración de la Planta de Hidrógeno Verde de Puertollano (Ciudad Real) - YouTube]

ÍNDICE

1. MERCADOS ACTUALES DEL HIDRÓGENO
2. MERCADOS FUTUROS DEL HIDROGENO
3. QUE ESTA PASANDO EN URUGUAY

2. MERCADOS FUTUROS DEL HIDROGENO

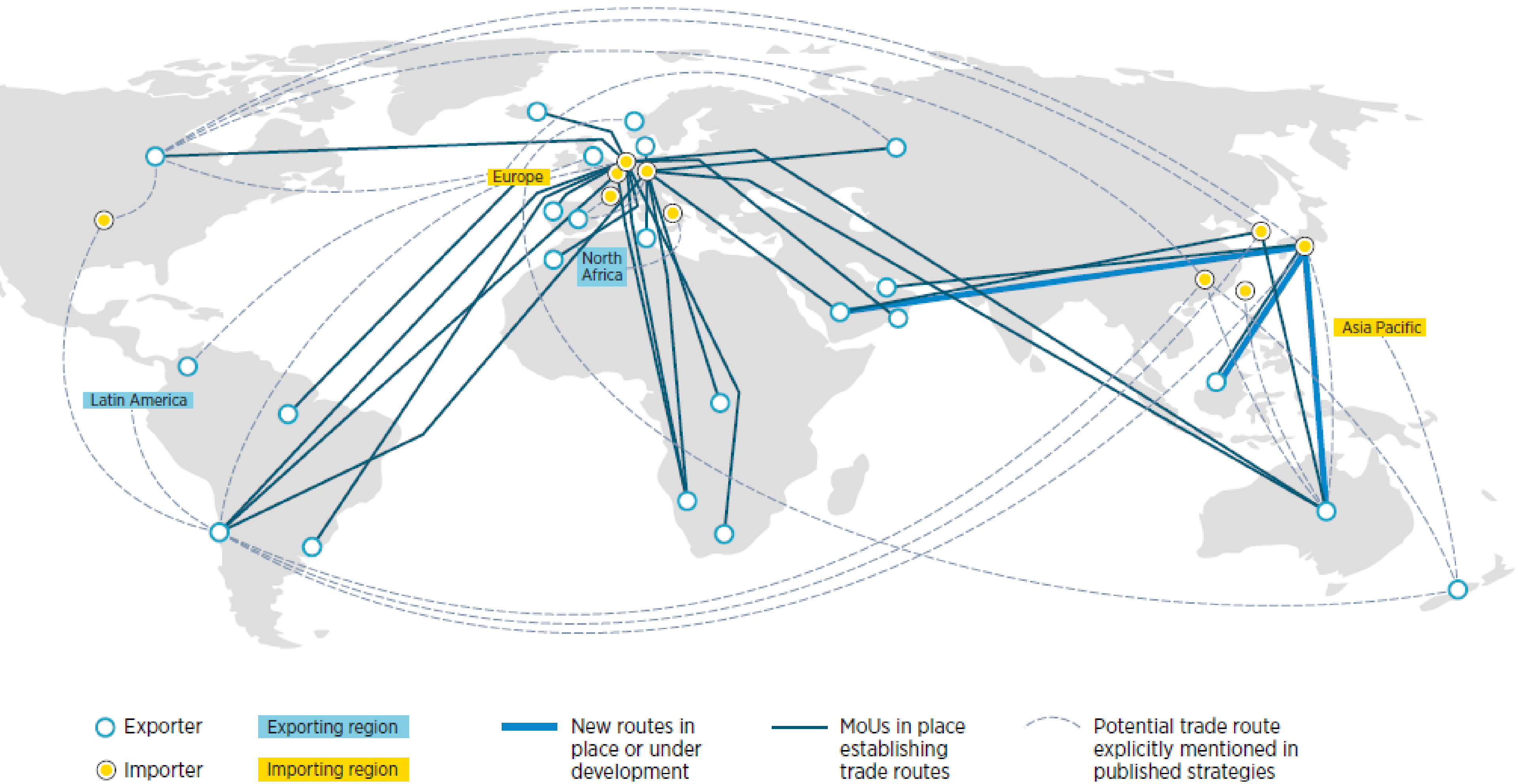
Figure S.1 **Shifts in the value of trade in energy commodities, 2020 to 2050**



Source: IRENA (2022).

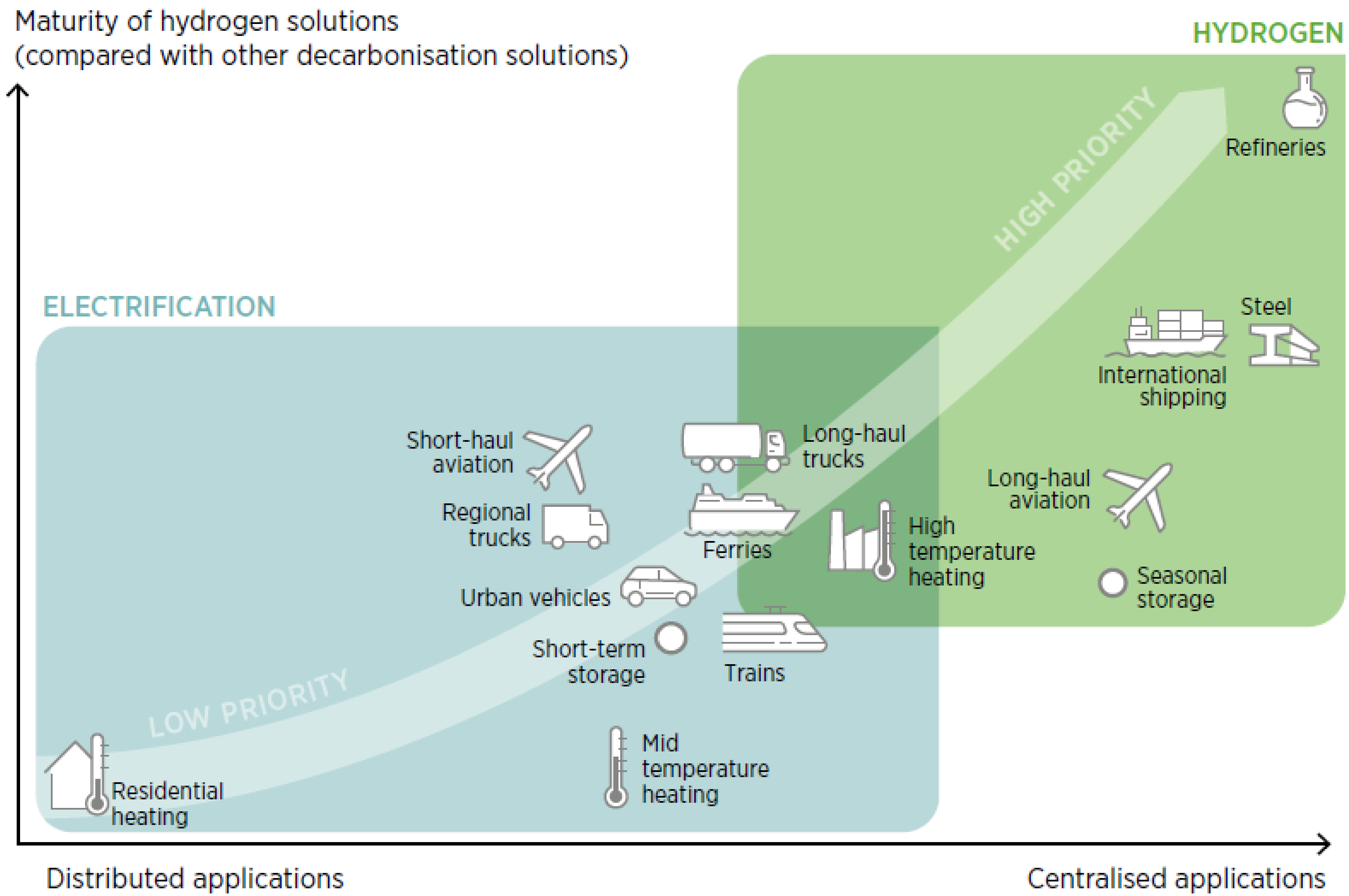
2. MERCADOS FUTUROS DEL HIDROGENO

Figure S.2 An expanding network of hydrogen trade routes, plans and agreements

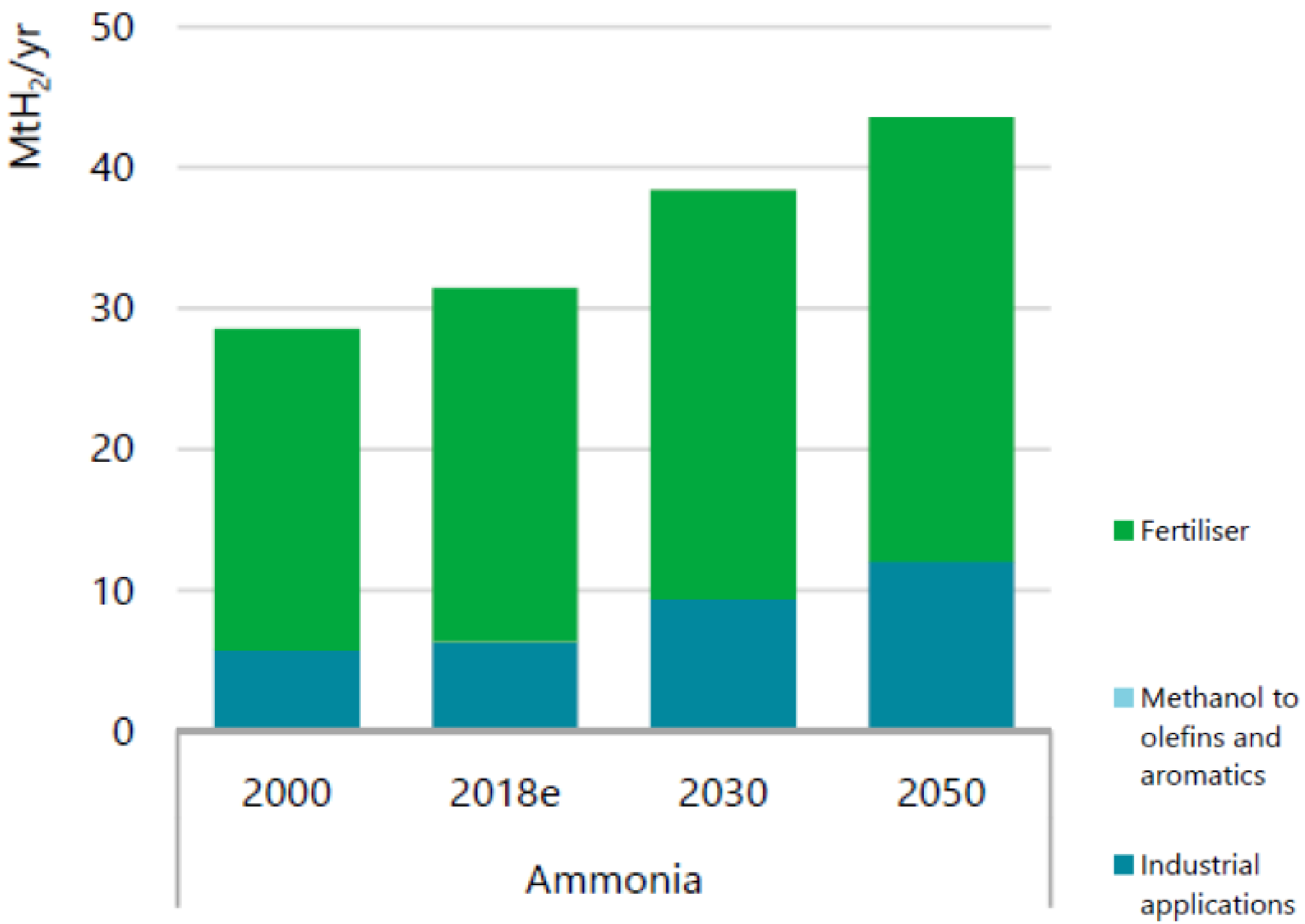


2. MERCADOS FUTUROS DEL HIDROGENO

Figure S.3 Clean hydrogen policy priorities

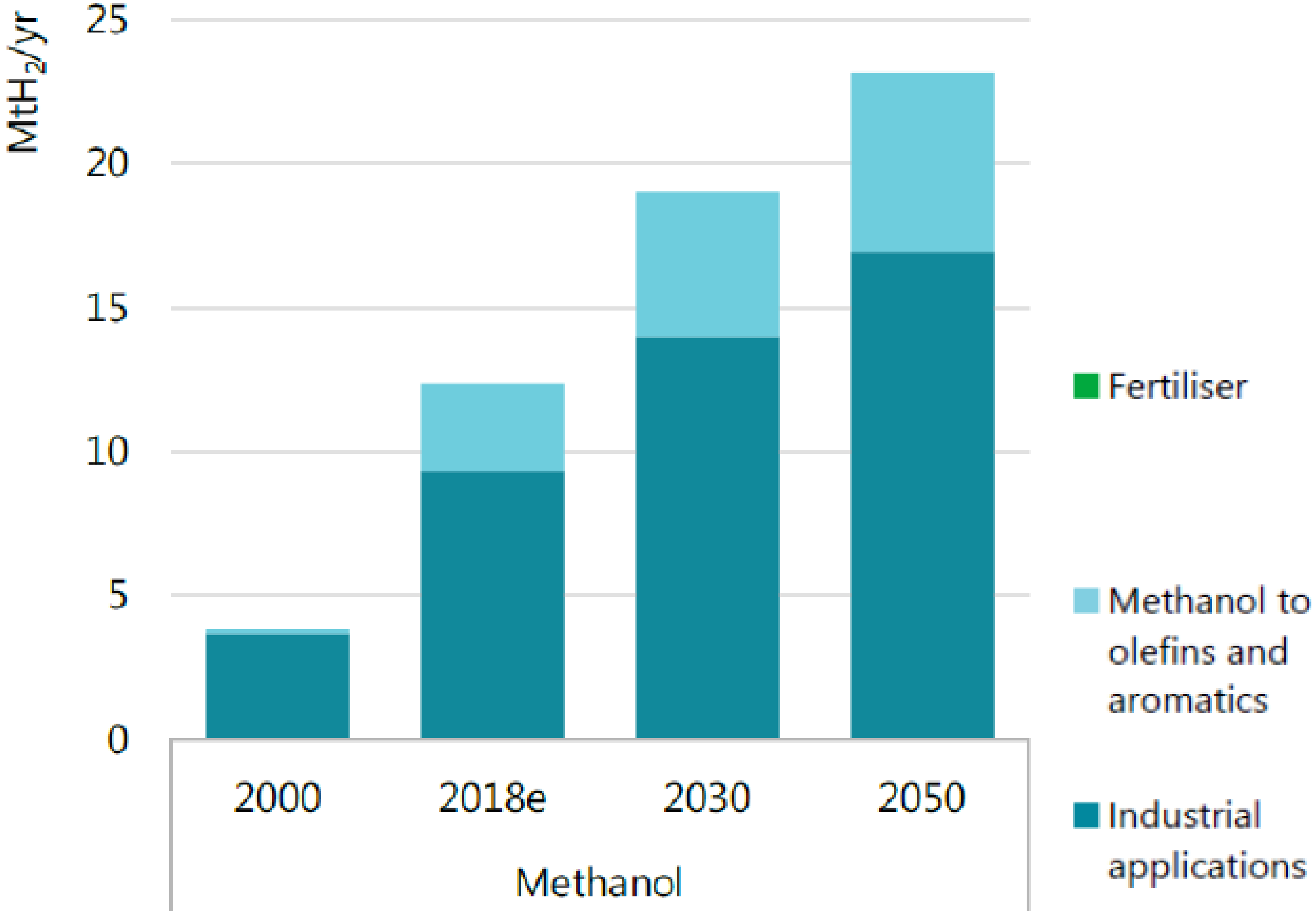


2. MERCADOS FUTUROS DEL HIDROGENO



Previsiones crecimiento demanda de amoniaco, IEA, 2019

2. MERCADOS FUTUROS DEL HIDROGENO

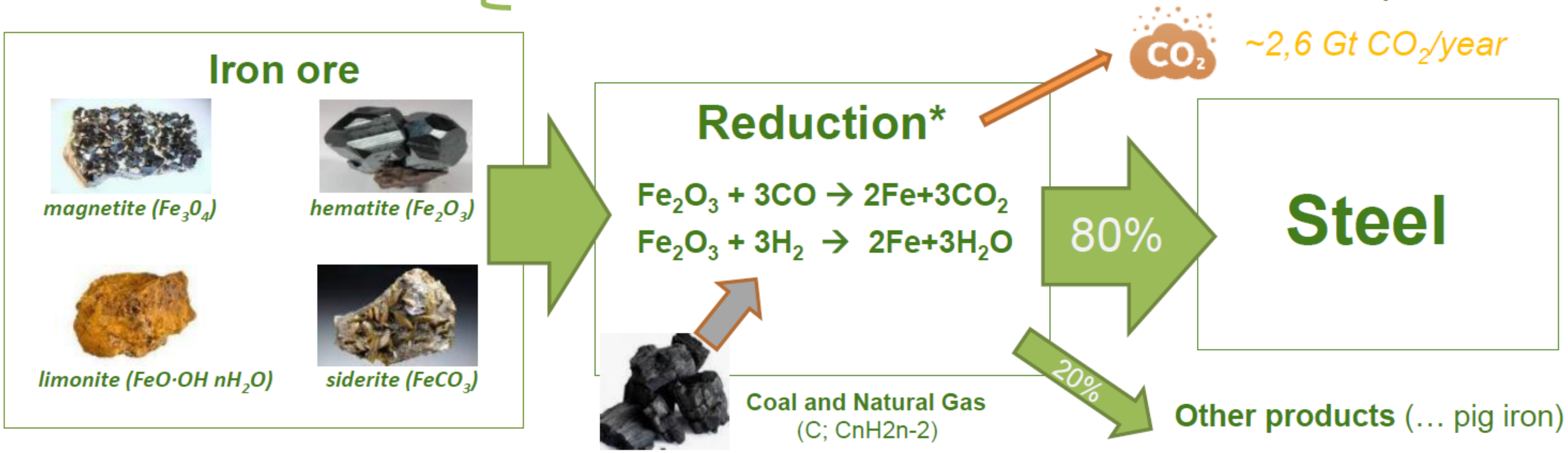


Previsiones crecimiento demanda de metanol, IEA, 2019

2. MERCADOS FUTUROS DEL HIDROGENO

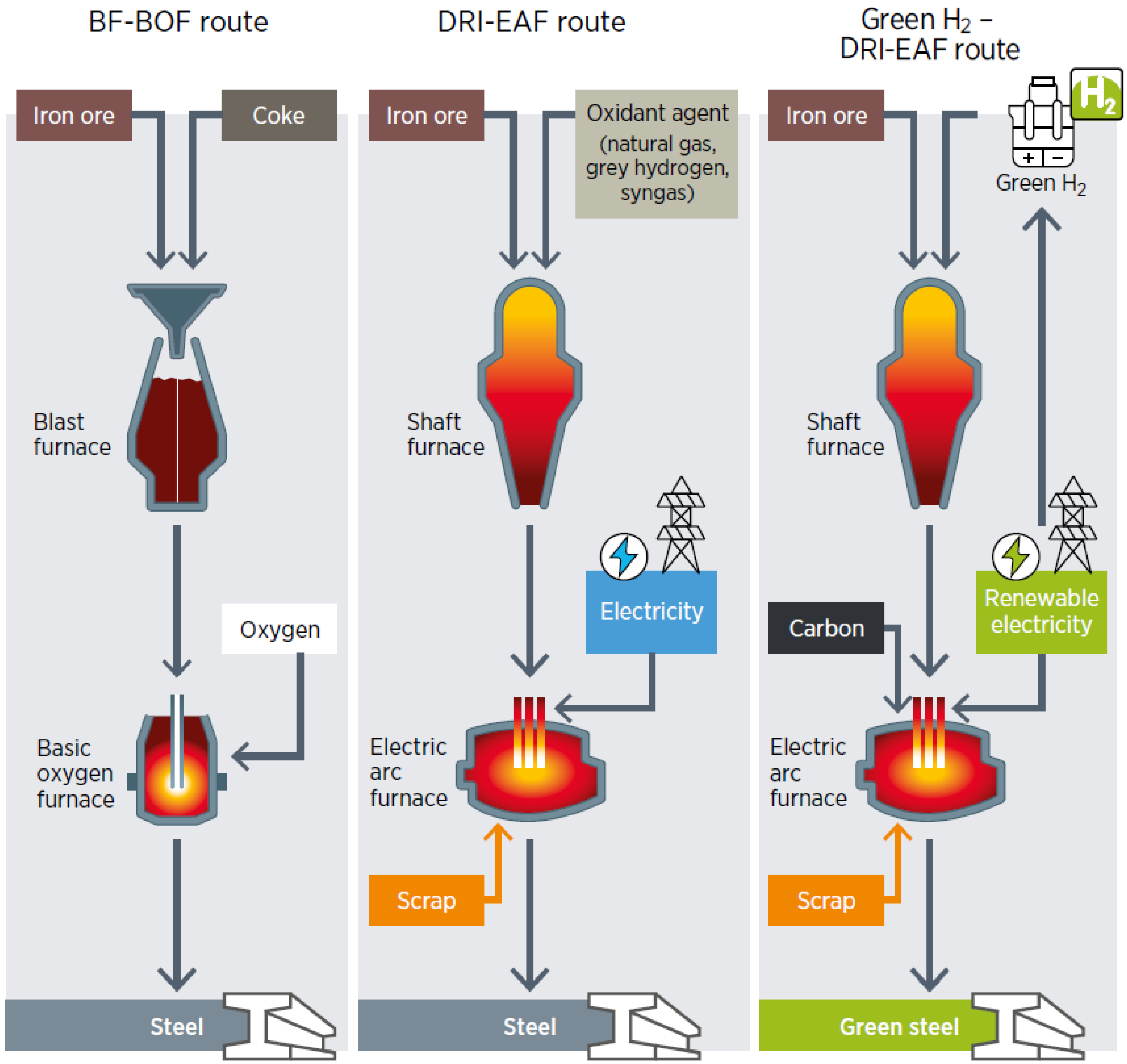
Iron and steel industry: Iron ore reduction to obtain different alloys

Reduction process:
- Blast Furnace + Basic Oxygen Furnace- BF-BOF **72% of production**
- Direct Reduction + Electric Arc Furnace- DR+EAF **6% of production**



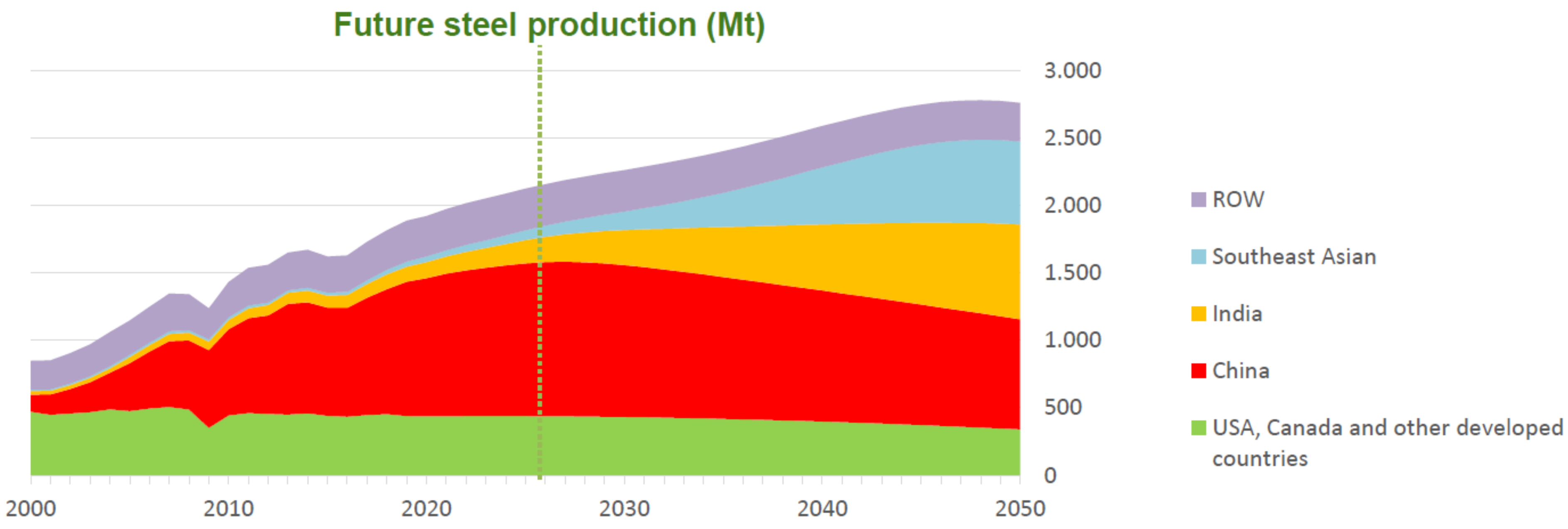
Other manufacturing processes: Steel recycling + Electric Arc Furnace (EAF) **26% of production**

2. MERCADOS FUTUROS DEL HIDROGENO



2. MERCADOS FUTUROS DEL HIDROGENO

In a BAU* scenario, steel production could increase 40% by 2050



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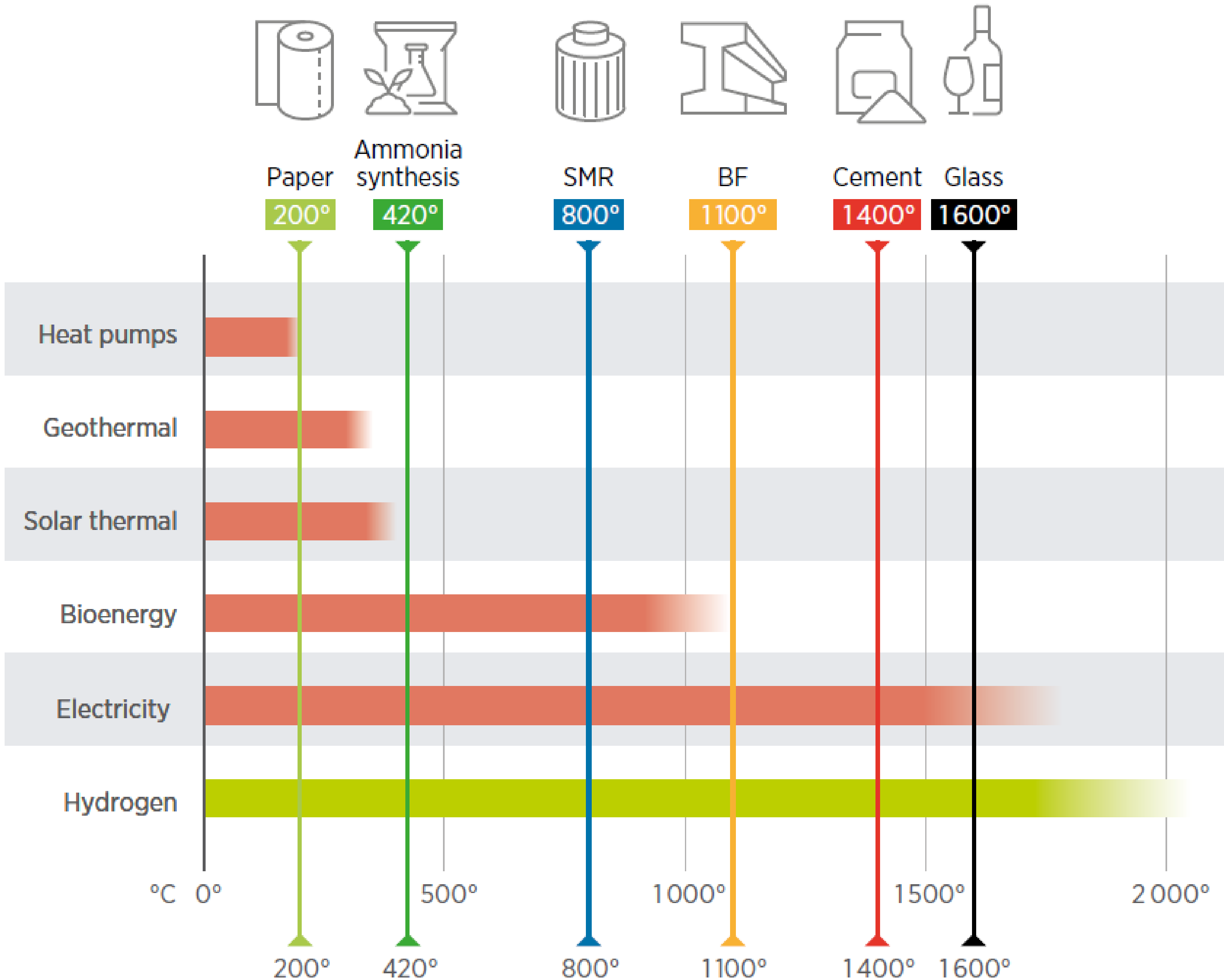

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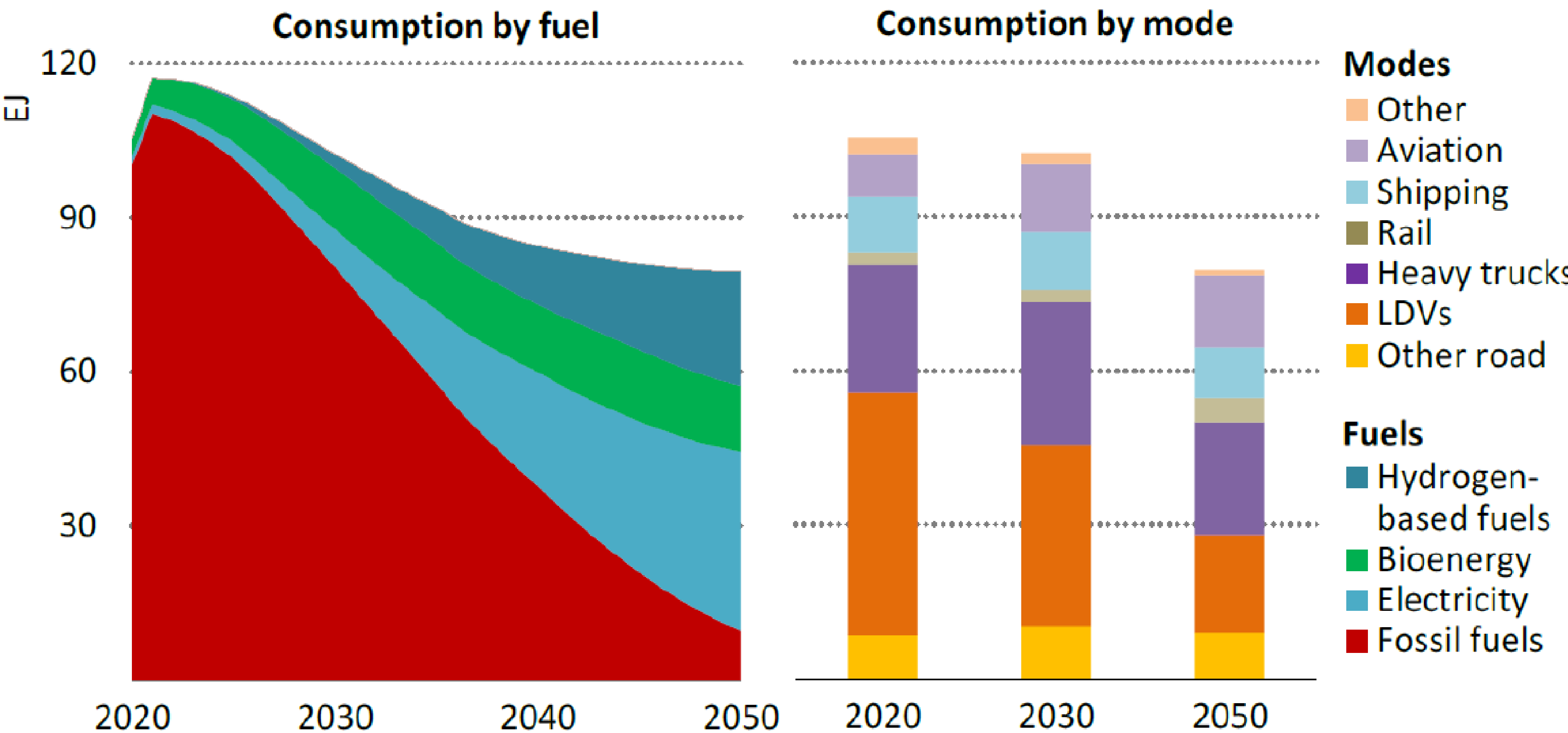
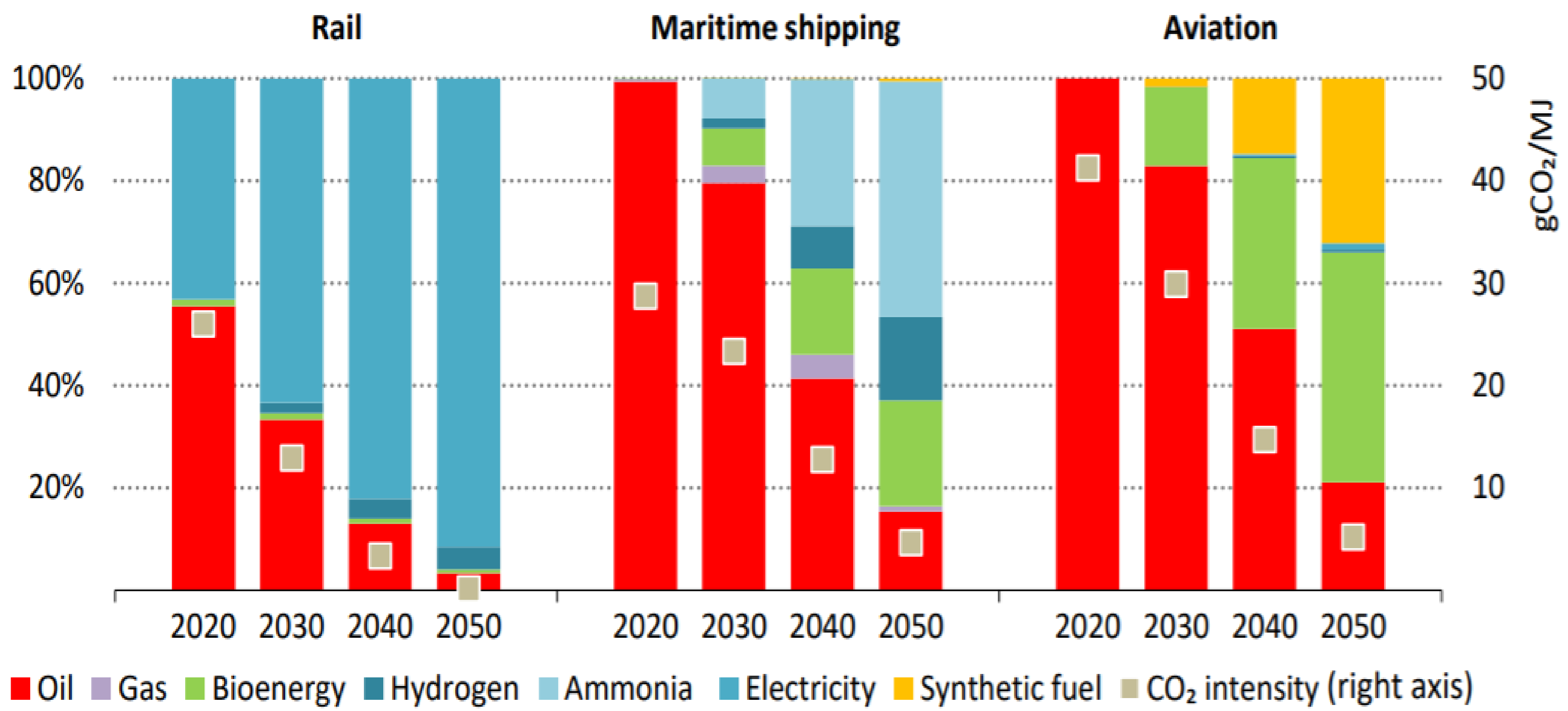


Estimación de los consumos según el tipo de combustible y segmento de transporte, IEA 2021

2. MERCADOS FUTUROS DEL HIDROGENO

Figure 3.25 ▹ Global energy consumption by fuel and CO_2 intensity in non-road sectors in the NZE



2. MERCADOS FUTUROS DEL HIDROGENO

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REPowerEU and RFNBOs Delegated Acts, two documents for kickstarting the rise of hydrogen and its derivatives in the coming decade.

junio 19, 2022 Carlos Lopez Sin categorizar 0 comentarios

In May, the EU Commission presented two long-awaited documents:

- the "REPowerEU" plan aims to rapidly reduce the EU dependency on imported fossil fuels from Russia and accelerate the energy transition
- the Renewable Energy Directive Delegated Acts sets out the framework for the production of renewable hydrogen and derived fuels (RFNBOs)

Both publications are amending major EU legislations, including the Fitfor55 package presented last summer, and will therefore play a decisive role in shaping the energy transition landscape, including in kickstarting the rise of hydrogen and its derivatives in the coming decade.

2. MERCADOS FUTUROS DEL HIDROGENO

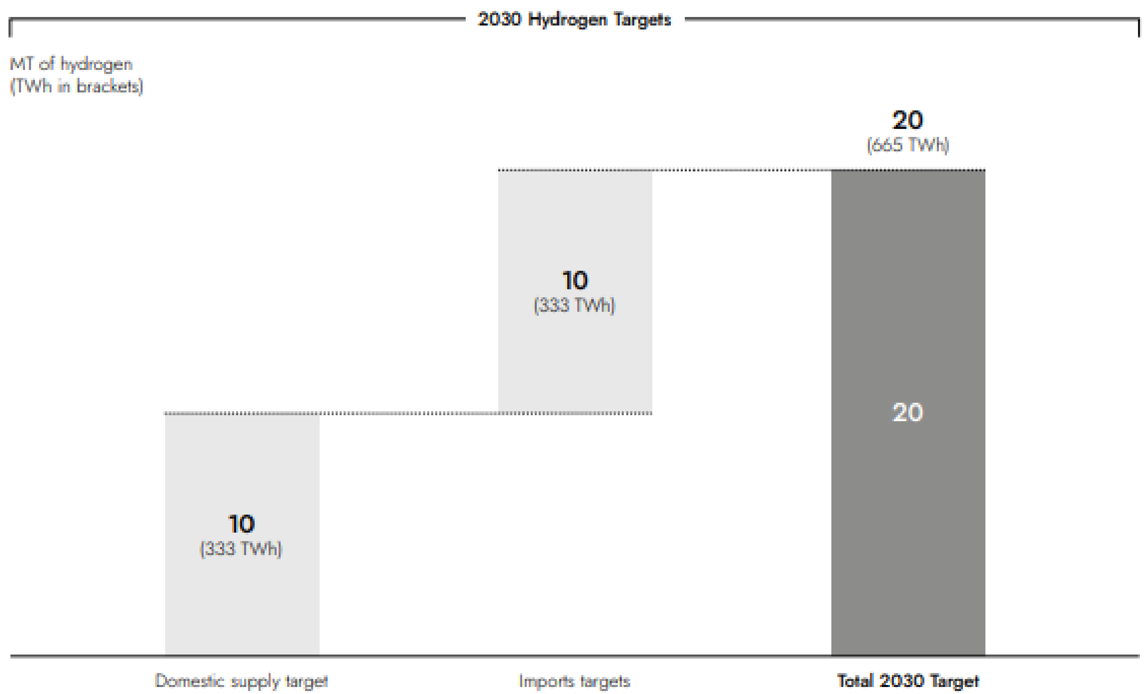
Europe's accelerated 2030 climate targets define an aggressive role for hydrogen

Europe has defined a **bolder and more ambitious hydrogen target of 20 MT** by 2030 in response to the **RePowerEU plan** to phase out Russian fossil fuel imports well before 2030

This includes a **10 MT target of domestic EU hydrogen supply**, as well as a **10 MT target of hydrogen imports** from outside the EU.[1]

These targets are strengthened by accelerated **national climate ambitions** as well as the accelerated development of the **European hydrogen market**.

Note: This study's underlying analysis was largely completed prior to the publication of the detailed RePowerEU plan and its 2030 hydrogen targets. As such, this study's supply and demand estimates were not intended to align with the 20 MT target by 2030.



2. MERCADOS FUTUROS DEL HIDROGENO

Delegated Acts

The European Commission has published two official drafts of the RED Delegated Acts on the definition and production of renewable transport fuels (RFNBOs), such as renewable hydrogen.

- The first proposal sets the electricity sourcing criteria for producing RFNBOs such as renewable hydrogen and its derivatives
- The second one defines the calculation methodology that shall be used to assess the lifecycle emissions of RFNBOs against the 70% GHG emissions reduction threshold set forth in RED2.

These Delegated Acts have been put to consultation before adoption and are expected to enter into force in autumn 2022 with immediate effect.

2. MERCADOS FUTUROS DEL HIDROGENO

Five supply corridors are key to the EHB vision and can deliver access to abundant and low-cost hydrogen supply by 2030

To deliver the 2030 hydrogen demand targets set by the RePowerEU plan, **five large-scale pipeline corridors are envisaged**.

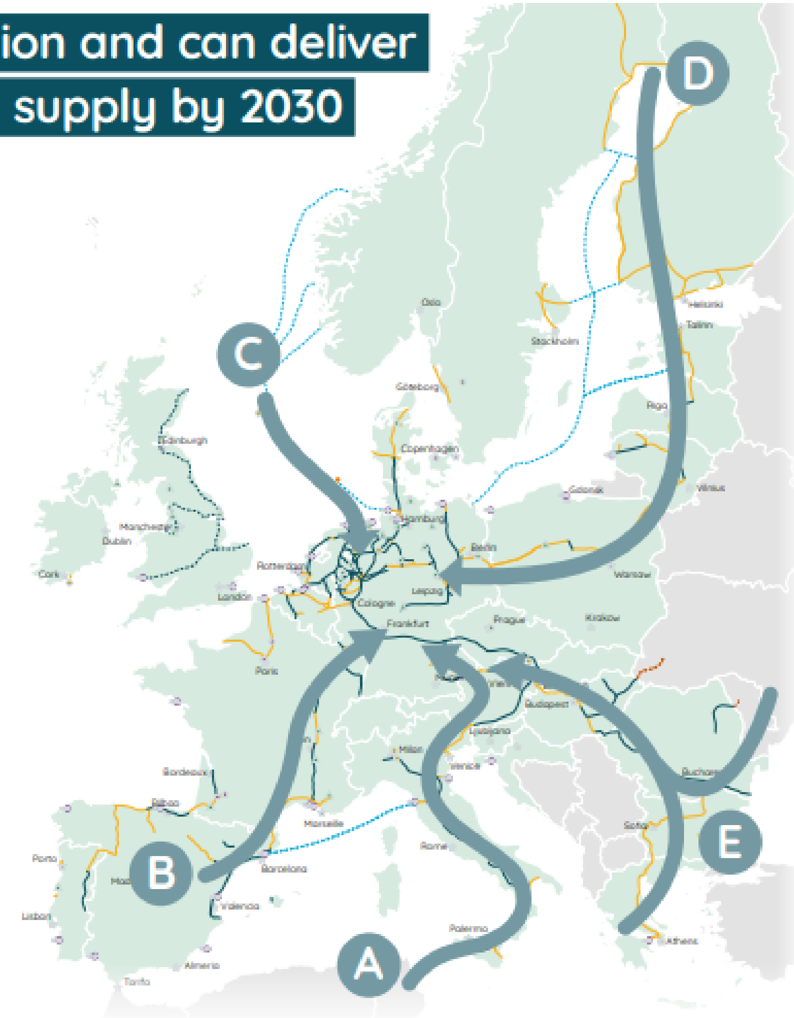
The corridors will **initially connect local supply and demand** in different parts of Europe, before expanding and **connecting Europe with neighboring regions** with export potential.

Certainty about the deployment of this infrastructure will **enable market actors to develop** supply and demand more rapidly

The five hydrogen supply corridors are:

- Corridor A: **North Africa & Southern Europe**
- Corridor B: **Southwest Europe & North Africa**
- Corridor C: **North Sea**
- Corridor D: **Nordic and Baltic regions**
- Corridor E: **East and South-East Europe**

These five corridors **span across both domestic and import supply markets**, consistent with the **three import corridors** identified by the RePowerEU plan, including a corridor via the **Mediterranean** (Corridors A and B), via the **North Sea** (Corridor C) and via **Ukraine** (Corridor E)



2. MERCADOS FUTUROS DEL HIDROGENO

Each corridor has a unique regional role in enabling the scale up of low-cost hydrogen supply and the decarbonisation of energy demand

Corridor A
North Africa & Southern Europe

Corridor A would transport **large quantities of cost-competitive green hydrogen potential from Tunisia and Algeria** through Italy to central Europe leveraging existing gas infrastructure.

Corridor A would decarbonise **existing industries along the route in Italy and Central Europe as well as in Germany**.

Corridor B
Southwest Europe & North Africa

Corridor B would transport **green hydrogen supply from the Iberian peninsula and North Africa**, and gain **access to underground storage sites in France** to deliver stable hydrogen supply.

Corridor B would decarbonise **regional industry and transport clusters in Portugal, Spain, France and Germany**.

Corridor C
North Sea

Corridor C includes hydrogen supply from ongoing and planned **offshore wind, blue hydrogen and large-scale integrated hydrogen projects in the North Sea**.

Corridor C would meet **demand from industrial clusters and ports in the UK, the Netherlands, Belgium and Germany**.

Corridor D
Nordic and Baltic regions

Corridor D would transport green hydrogen supply potential from **onshore and offshore wind from countries surrounding the Baltic Sea**.

Corridor D would be built around **regional networks around industrial clusters**, serving numerous new **green steel, e-fuel, fertilizer and green chemicals projects in the Nordics** as well as decarbonizing existing industry in the Nordics, Baltics, Poland and Germany along the corridor route.

Corridor E
East and South-East Europe

Corridor E would connect **high supply potential regions such as Romania, Greece, and Ukraine**[1] – leveraging vast land availability and high-capacity factors for solar and wind.

Corridor E would deliver hydrogen to **off-takers in Central Europe and Germany**.

2. MERCADOS FUTUROS DEL HIDROGENO

Since some corridors transit through the same countries, key metrics – like corridor length, supply and demand – overlap

In this study, **when a corridor transit through a given country**, even if only partially, **it becomes part of the analysis of the corridor**, including its hydrogen demand, supply and transport infrastructure.

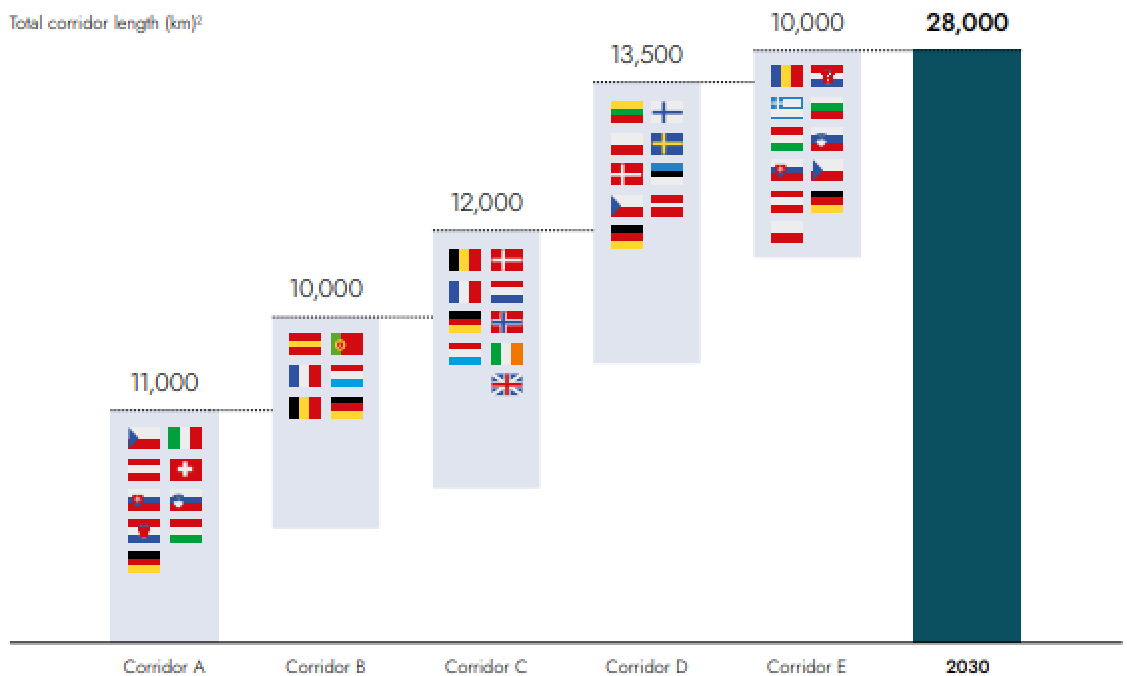
All five corridors of this study either: **(1) transit through some of the same countries, or (2) terminate in the same country**[1].

For example:

- **Corridor B** (Southwest Europe and North Africa) and **Corridor C** (North Sea) both transit through sections of **the Netherlands, Belgium and Germany**.
- **Corridor D** (Nordic and Baltic regions) and **Corridor E** (East and South-East Europe) both transit through section of **Germany, Czechia and Poland**.

This means that **all corridors partially overlap with other corridors. As a result, key metrics – like corridor length, supply and demand – overlap and are not mutually exclusive**.

This is illustrated on the right for corridor lengths.



1 Since the largest demand clusters in Europe are concentrated in and around Germany,

ÍNDICE

3. QUE ESTA PASANDO EN URUGUAY

METAS y SECTORES

2025

Primeros pilotos

150 - 300 MW
Electrolizadores

200 - 500 MW
Energías renovables

Transporte pesado doméstico y exportación derivados

2030

1 - 2 GW
Electrolizadores

2 – 4 GW
Energías renovables

Expansión a nivel nacional, exportación de derivados

2040

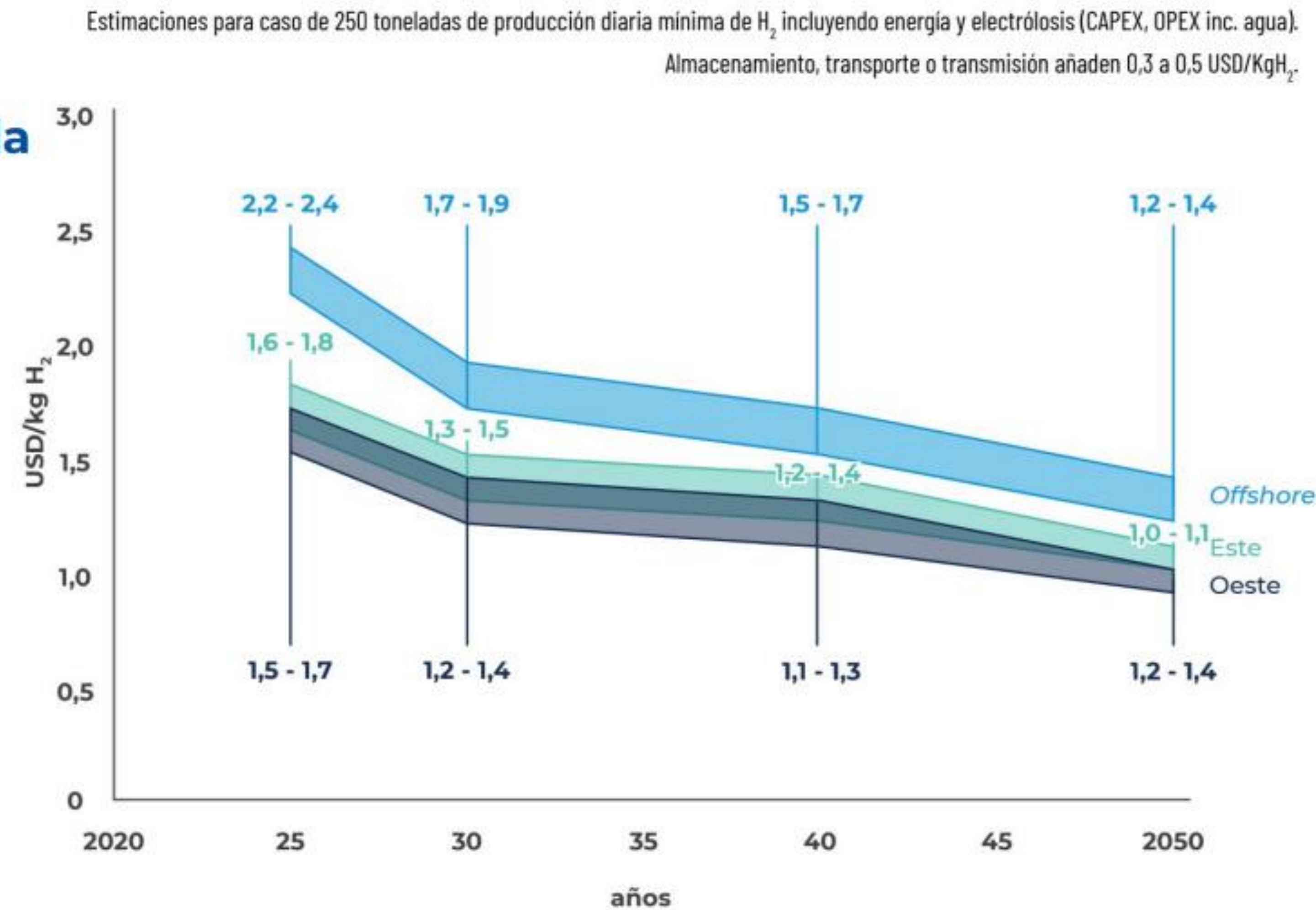
10 GW
Electrolizadores

20 GW Energías renovables

Combustibles sintéticos, hidrógeno, amoníaco

3. QUE ESTA PASANDO EN URUGUAY

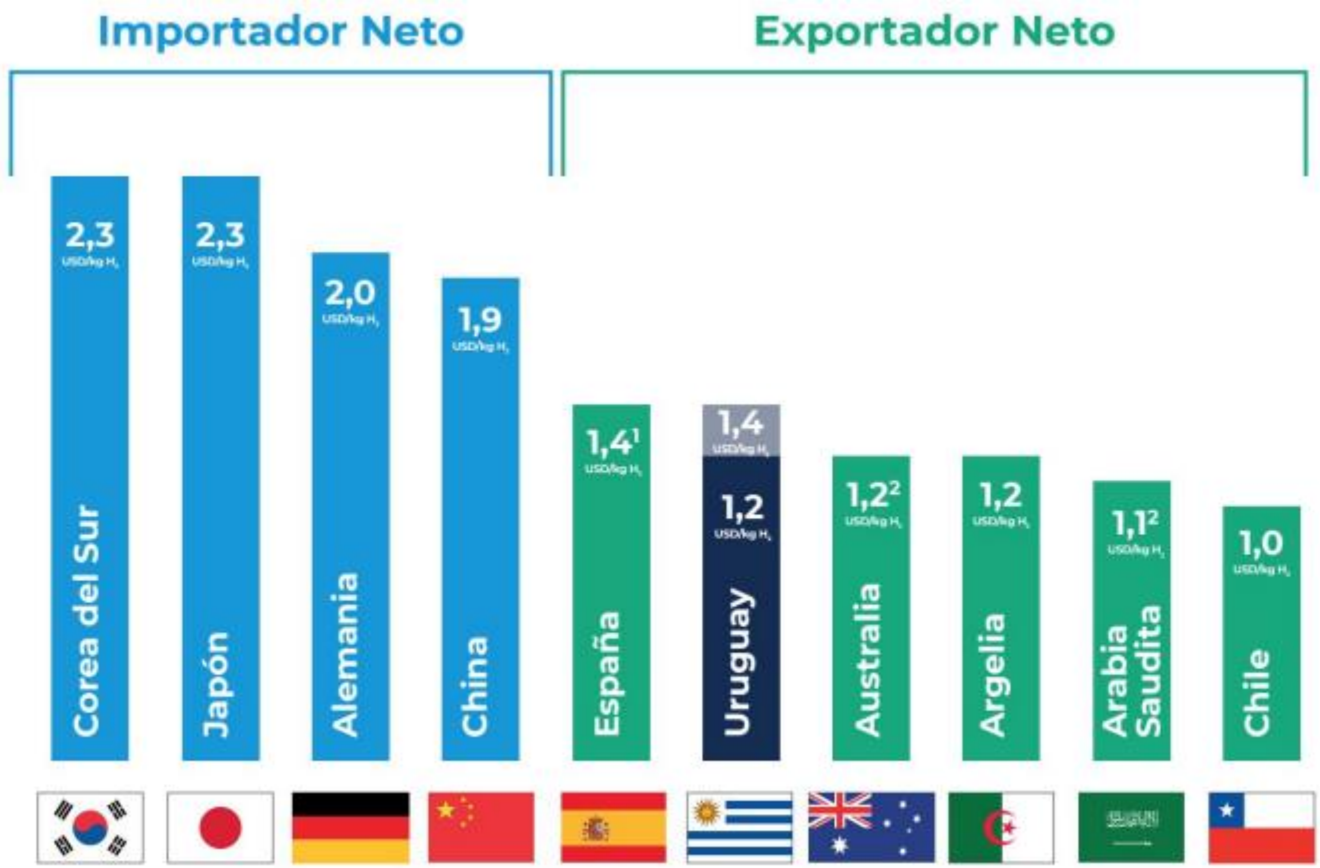
Los costos de producción de hidrógeno a escala pueden llegar a ~1.2-1.4 USD/kg para 2030



Fuente: Adaptado de McKinsey & Company, 2021, de acuerdo con contrato # :C-RG-T3777-P001 concluido con el BID.

3. QUE ESTA PASANDO EN URUGUAY

Uruguay se encuentra en una posición competitiva a nivel mundial



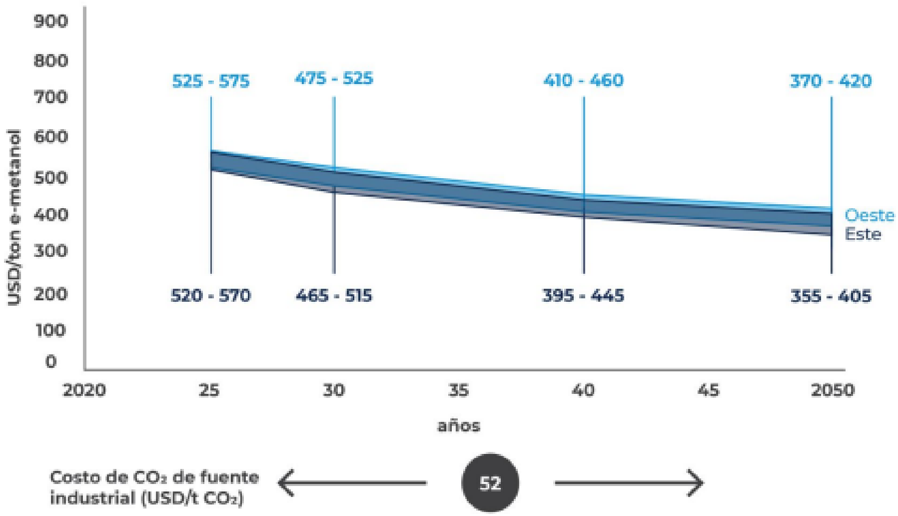
Fuente: Adaptado de McKinsey & Company, 2021, de acuerdo con contrato # :C-RG-T3777-P001 concluido con el BID.

1. *Benchmark* tomado del anuncio HyDeal para costos de producción a escala, excluye cosots de transporte y distribución.

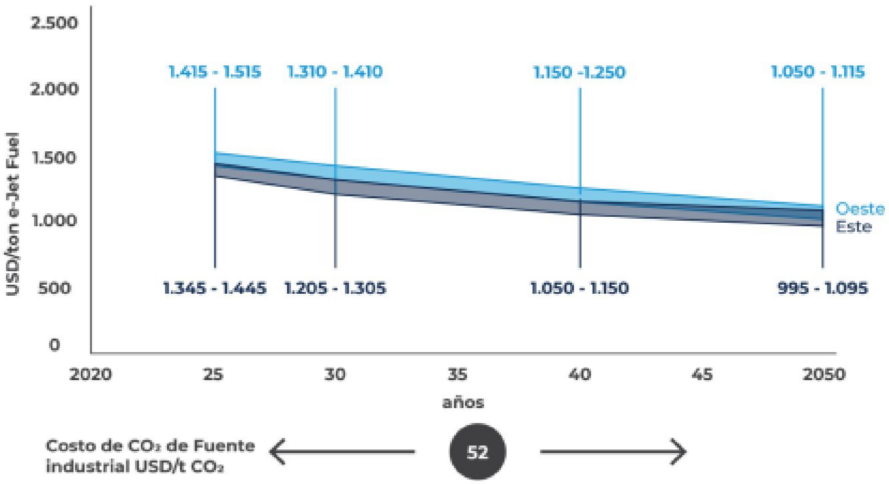
2. *Benchmark* tomado de las producciones del Consejo de Hidrógeno; excluye costos de transporte y distribución.

3. QUE ESTA PASANDO EN URUGUAY

Proyección de costos de e-metanol



Proyección de costos de e-Jet Fuel



Fuente: Adaptado de McKinsey & Company, 2021, de acuerdo con contrato # :C-RG-T3777-P001 concluido con el BID.

3. QUE ESTA PASANDO EN URUGUAY

H_2U PROGRAM: PRIVATE INVESTMENT WITH GOVERNMENT SUPPORT

Onshore

Power supply

- Existing capacity of national utility UTE
- New capacity (dedicated)

Pilot scale

Local (green) H_2 production, small-scale & mobility focused
Led by public-private initiatives

in progress

Local

H_2U Pilot ANCAP

Commercial scale

Local (green) H_2 production, medium-scale & industry focused
Centered around a few large off-takers as "anchor-load", smaller mobility off-taker as add-on
Mostly led by private sector

Local

Distribution ESTACIONES ANCAP

Export

Production and logistics
- Carrier products (ammonia, methanol, LOHC, CGH2, LH2, e-fuels)
- Logistics: piers, tanks, future dolphin
- Geological storage

ANCAP

Local Market

- Transport
- Ammonia
- Methanol
- E-fuels
- Other green chemicals
- Industry
- Natural gas pipeline
- Other

Offshore

Power supply

- New capacity (dedicated)

Commercial scale

Large-scale projects with low-cost (green) H_2 production. Focus on connecting supply and demand globally.
Led by private or large sovereign investors

in progress

Export

Knowledge and experience in offshore (oil and multi-client E&P contracts, operations, HSE, metocean data, geotechnical information). Coordination with relevant stakeholders (ANP, DNA, DINARA, DINAMA, NGOs)

ANCAP

International Market

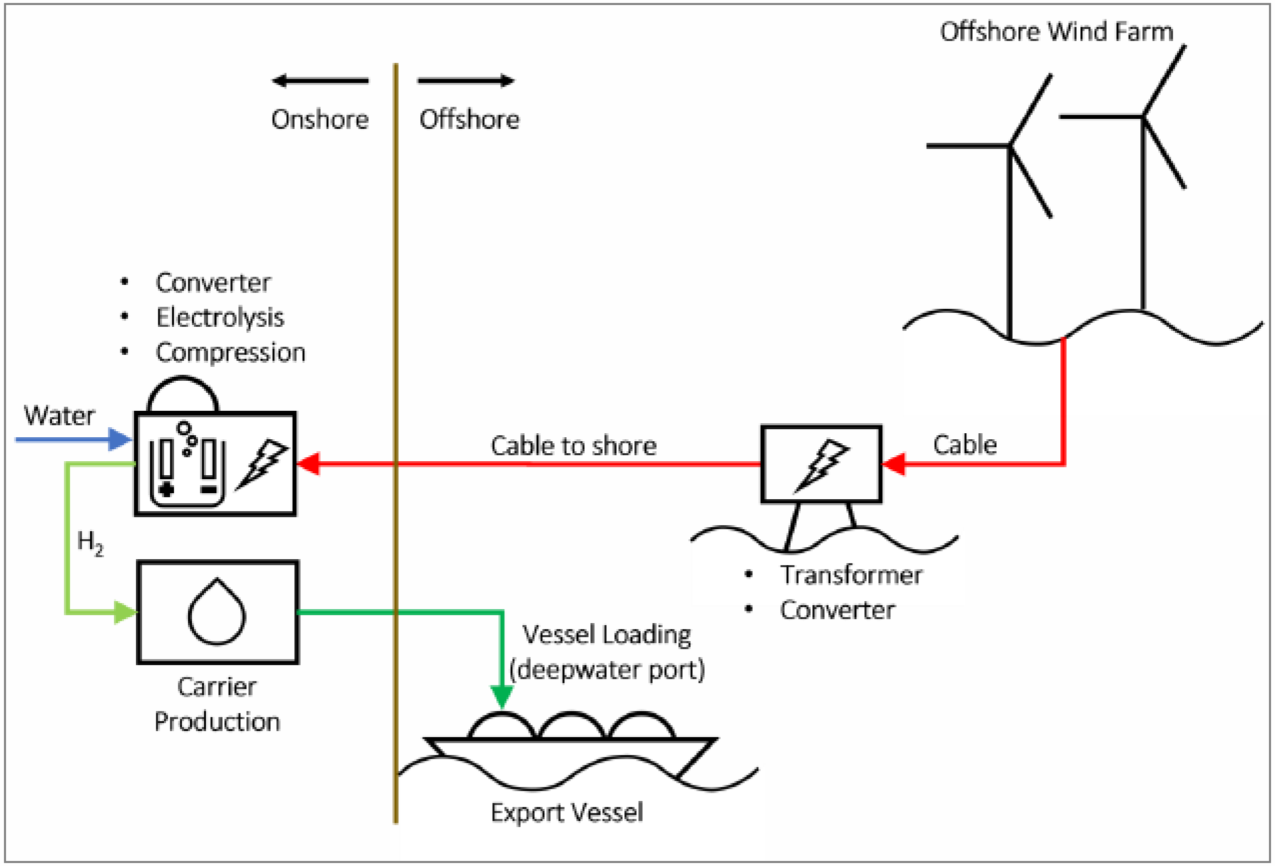
Regional
Europe
Asia
Other

Demand

H2 URUGUAY Offshore   ANCAP

3. QUE ESTA PASANDO EN URUGUAY

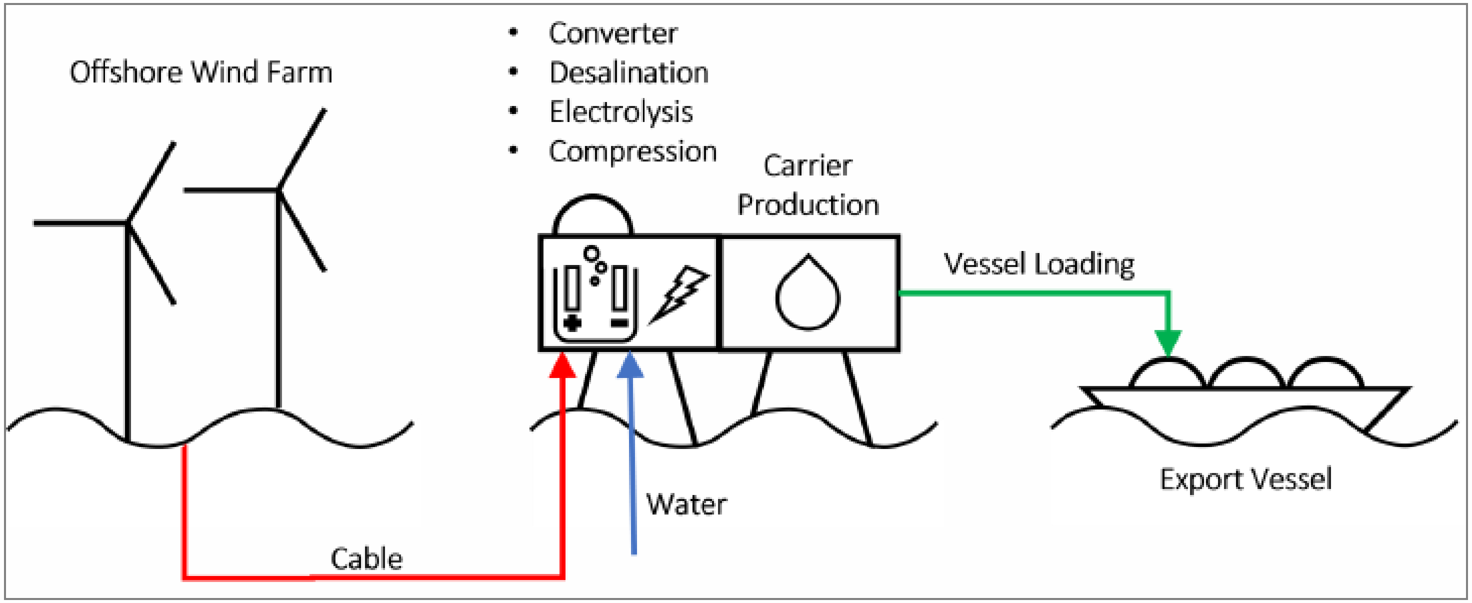
DEVELOPMENT CONCEPTS – ONSHORE ELECTROLYSIS



URUGUAY Offshore ANCAP

3. QUE ESTA PASANDO EN URUGUAY

DEVELOPMENT CONCEPT – OFFSHORE ELECTROLYSIS



MUCHAS GRACIAS POR VUESTRA ATENCION.