

1974-2024: FRANCE'S HYDROGEN INDUSTRY, FRAMEWORK & GEOPOLITICS

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CLIMATE URGENCY + ENERGY SOVEREIGNTY + GEOPOLITICAL URGENCY

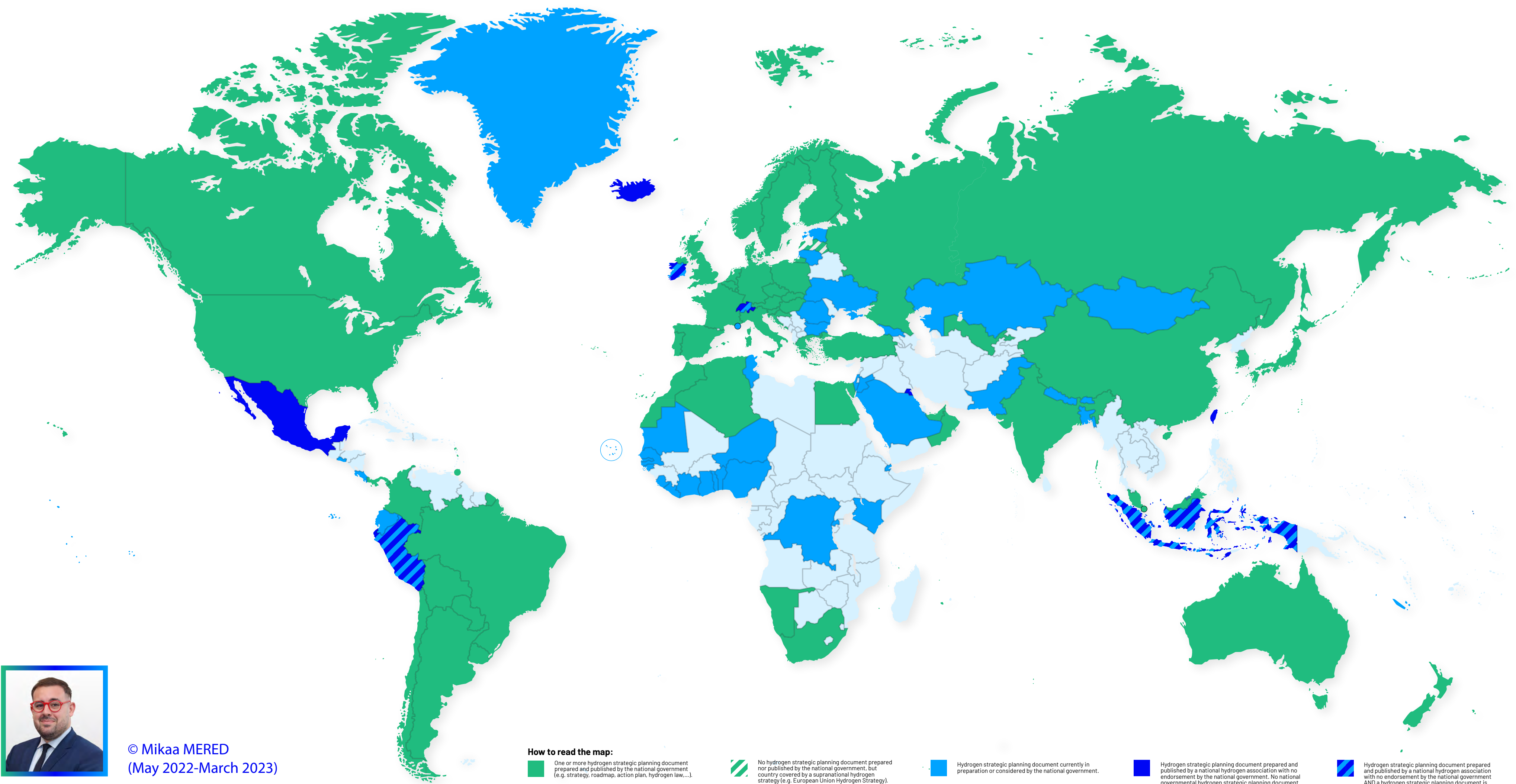
E.U. IMPORTED
FROM RUSSIA IN 2021 :

- **45% OF NATURAL GAS DEMAND**
- **25% OF OIL DEMAND**
- **45% OF COAL DEMAND**

REpowerEU
POLICY TARGETS
BY 2030 :

- **Reduce E.U. fossil fuels consumption by 155GM³**
(precisely the amount imported from Russia in 2021)
- **x4 domestic green H2 production target, to 10MT**
- **Hydrogen imports target set at 10MT**

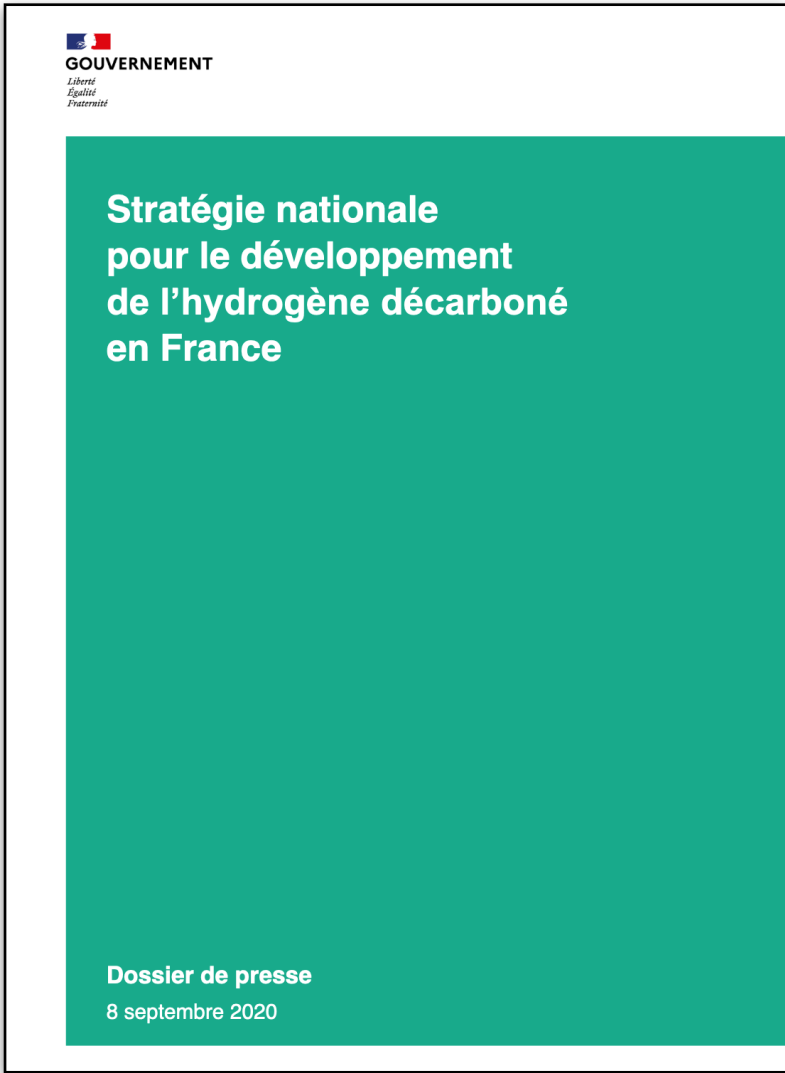
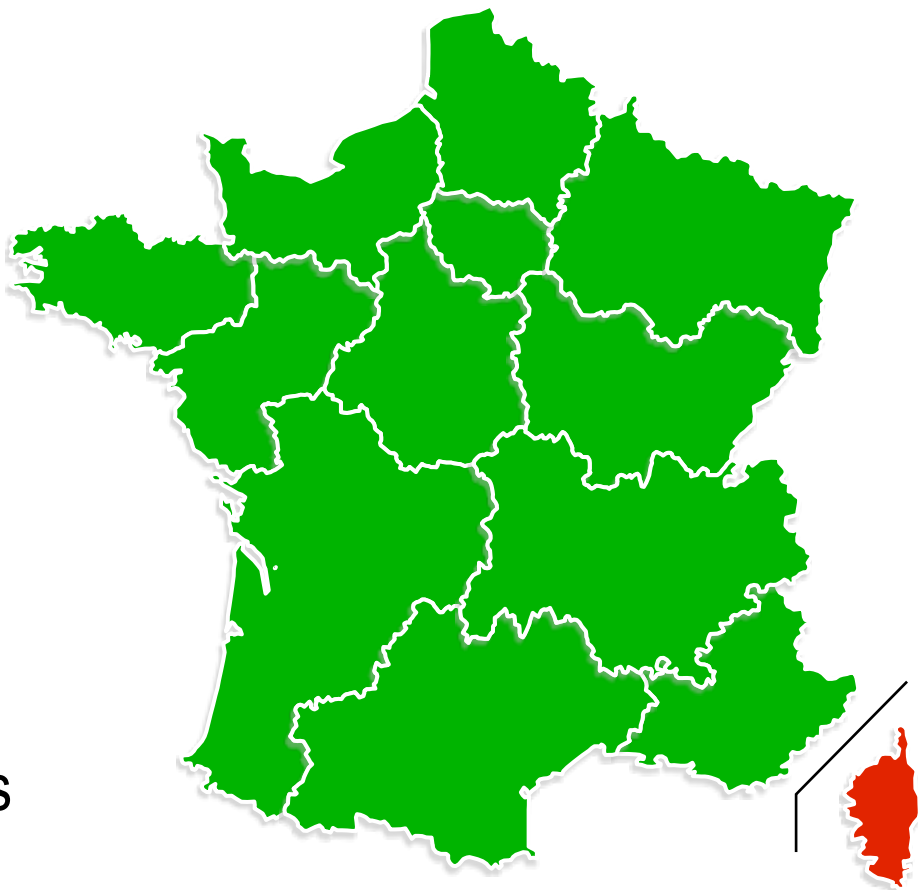
50 / 96 NATIONAL H2 STRATEGIC DOCUMENTS (as of 23.03.2023)



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(May 2022-March 2023)

FRANCE = WORLD TOP-5 MOST-DEVELOPED H2 VALUE PROPOSITION, AMBITIOUS STRATEGY, GVT NOT KEEN ON IMPORTING BUT PRIVATE SECTOR IS

- National 2021 hydrogen demand : 860kT - 94% fossil fuels-based
- Basic national 2030 green hydrogen target : 475Kt/yr
- "Ambition2030 scenario" = 675Kt/yr "Ambition2030+" = 1090Kt/yr
- All regional governments have their own H2 strategy, aggregated funding of 600 M€ for projects all along the value chain.
- 19 "H2 ecosystems" across the country + 6 overseas territories with H2 demonstration projects of global technological significance.
- 7 "H2 basins" will concentrate 75% of the demand + 65% of investments & jobs
- 300 companies, from long-time H2 champions to world-scale disruptive start-ups able to unlock mass H2 production, storage & trade by 2028.
- Private sector collaboration and industry associations' activity at an all-time high



- First hydrogen R&D state programs : 1992, 1999 (40M€), 2004-2010 (100M€)
- June 2018 : 1st national "hydrogen plan" = 100M€ funding
- Sept. 2020 : National H2 strategy = 7 Bn€ funding, creation of the National Hydrogen Council, launch of two nationwide call for projects
- Jan. 2021 : appointment of an H2 inter-ministerial coordinator
- Feb. 2021 : Hydrogen law, defines national taxonomy discriminating "Renewable H2", "Low-carbon H2" and "Carbonated H2".
- Oct. 2021 : Strategic "France 2030" add-on = 1.9 Bn€ direct funding for green hydrogen technologies only
- Domestic ELX capacity target by 2030 = 6.5 GW
- CO2 emissions reduction unlocked thanks to H2, target by 2030 = 6MT/annum
- 3500 direct jobs nationwide today, 2030 target : up to 150k jobs
- H2 for mobility by 2030: 300k light vehicles, 5k heavy, 1000 refuelling stations
- 275 M€ funding for academic research and education programs

4 POLICY PRINCIPLES :
SOVEREIGNTY BEING THE MOST PREEMINENT DIMENSION VIS-À-VIS E.U. & INTERNATIONAL POLICY-BUILDING AND IMPLEMENTATION.

SCALABILITY

SALEABILITY

SECURITY

SOVEREIGNTY

- July 2022 IPCEI : 15 projects selected amongst 41 are French, #1 in EU
- NO FUNDING FOR CARBONATED H2 NOR DERIVATIVES
- H2 IMPORTS FROM OUTSIDE E.U. CLEARLY DISCOURAGED BY GVT, very little support for Germany-backed "H2Global" auction-based mechanism.
- NOW IN FAVOR OF INTRA-EU HYDROGEN PIPELINES but still a lot of skepticism from public decision-makers vis-à-vis the European hydrogen backbone (EHB).
- International H2 strategy chapter in preparation but NO OFFICIAL "HYDROGEN DIPLOMACY" at present nor planned for the near-future.
- Strategic disagreements between key ministries and private sector.
- Only 5 international bilateral H2 cooperation agreements
- Little international leverage of H2 innovations and world-firsts located in France's Overseas Territories despite clear regional potential.
- Private sector is developing its own international engagement capacity : "Hydrogen Task Force" by MEDEF International (foreign branch of the French Employers' Union) and France Hydrogène (main industry lobby)
- Strong resentment feeling against France's H2 policy in Germany, Spain & Portugal

FOR FRANCE, H₂ = ENERGY AUTONOMY BUT ALSO SOVEREIGNTY

STRONG LOCAL ECOSYSTEM(S)

SCALABILITY

*(needs investments +
de-risking mechanisms)*

SALEABILITY

*(needs proof that hydrogen is
clean + safe + accessible)*

SECURITY

*(of use, of supply + proof that
H2 contributes to energy
security)*

SOVEREIGNTY

*(means AUTONOMY &
RE-INDUSTRIALIZATION)*

S1 2022: LOW-CARBON H₂ STILL IS AN "MoU INDUSTRY"...

- **1066 low-carbon H₂ projects at MoU stage**
- **217 have reached Final Investment Decision (FID) = 20.36%**
- **119 FIDs are in Europe = 11.36% of total = 54.84% of FIDs**
- **30 FIDs are in USA & Canada = 2.81% = 13.82% of FIDs**
- **16 FIDs are in China = 1.50% = 7.37% of FIDs**
- **Rest of the world = 52 FIDs = 1.50% = 23.96% of FIDs**

...BUT A GREEN LEANING ONE WITH STRONGER STANDARDS

**80.65% of all FID'ed projects are
green hydrogen projects
(i.e. renewables-sourced electrolytic H₂)**

175 projects out of 217, worldwide

FRENCH PUBLIC-PRIVATE SUPPORT MECHANISMS WORK...

**FRANCE = #1 E.U. COUNTRY FOR
IPCEI* SUPPORT AFTER THE FIRST
TWO 2022 WAVES = >5Bn€**

*(*Important Project of Common European Interest)*

...AND TRANSLATE INTO THE E.U. REGULATORY DEBATE

- **STRICT ADDITIONALITY**
- **TIME CORRELATION BY THE HOUR**
- **ZONING**
- **APPLICABILITY TO H₂ IMPORTS**

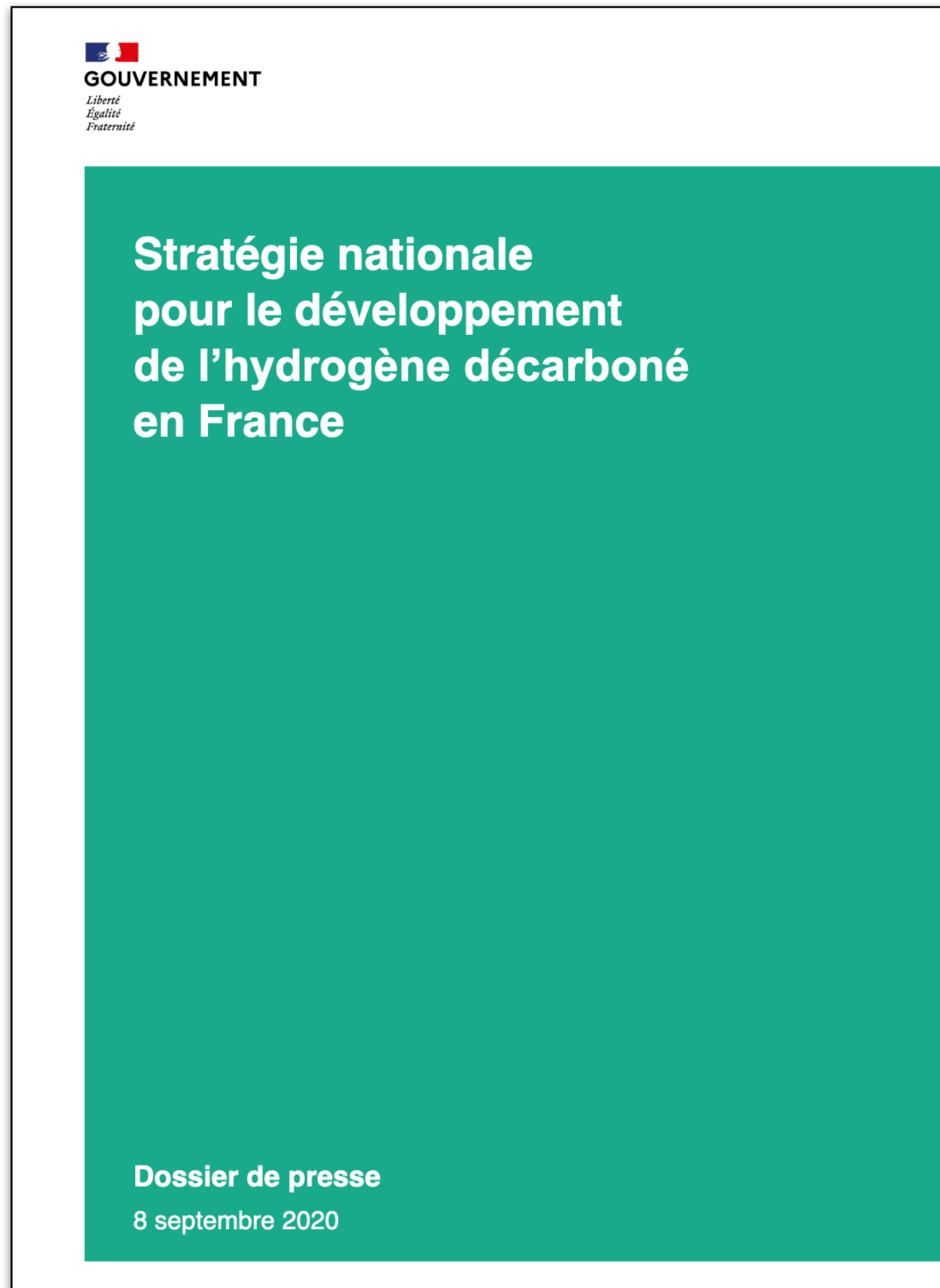
ADDITIONALITY FACTOR IS KEY, FAVORS BLUE H2 OTHERWISE

UK Governmental target = 10GW in 2030

**2030 H2 production pipeline = 17GW, supported
by the "H2 production business model" (HPBM)**

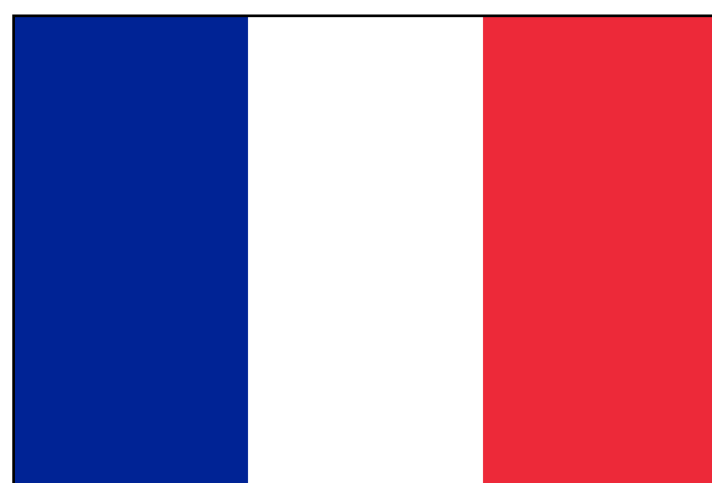
Results = 84% of UK H2 pipe is "blue" H₂

FRANCE'S H2 STRATEGY IS THE 3RD MOST AMBITIOUS IN EUROPE



- **SEPTEMBER 2020, BUILDS UPON 1ST H₂ PLAN (2018)**
- **8.9 Bn€ OF PUBLIC FUNDING FOR LOW-CARBON H₂**
- **MORE THAN 170 H₂ PROJECTS NATIONWIDE (AUG. 2022)**
- **CREATION OF A NATIONAL HYDROGEN COUNCIL**
- **APPOINTMENT OF A NATIONAL HYDROGEN COORDINATOR**
- **3 MAIN POLICY TARGETS BY 2030 :**
 - 1. 6,5GW of green H₂ production capacity**
 - 2. Save 6 million tons of CO₂ per annum**
 - 3. Create 50K to 150K new jobs nationwide**

FRANCE / GERMANY BATTLE FOR EUROPEAN H₂ LEADERSHIP ?



**H₂ = RENEWABLES
+ NUCLEAR**

**GVT: "NO EXTRA-EU H₂
IMPORTS, TRANSIT OK"**



**H₂ = RENEWABLES
+ FOSSILS w/ CCUS**

**GVT: "UP TO 70% IMPORTS,
EXTRA-EU ONES WELCOME"**

H₂ BASINS WITH COMPREHENSIVE & COMPLIMENTARY ECOSYSTEMS

LARGE GROUPS & ENERGY SUPPLIERS



2ND H₂ PRODUCER IN THE WORLD



LAUNCHED ITS OWN H₂ SUBSIDIARY IN 2018



SPECIALTY CHEMICALS & HIGH PERF MATERIALS. H₂ TANKS



H₂ TANKS AND FUEL CELLS WITH CEA

START-UPS & SMES



CARBON-FREE H₂ PRODUCTION



STATIONARY & MOBILE ENERGY STORAGE



H₂ MOBILITY



POWER TO GAS SERVICES

PUBLIC ACTORS (R&D, STRATEGY, LOCAL SUPPORT)



PUBLIC R&D CENTRES



NATIONAL AGENCIES



PROFESSIONAL ASSOCIATIONS & PLATFORMS



REGIONAL CLUSTERS

LIQUID H₂

RENEWABLE H₂

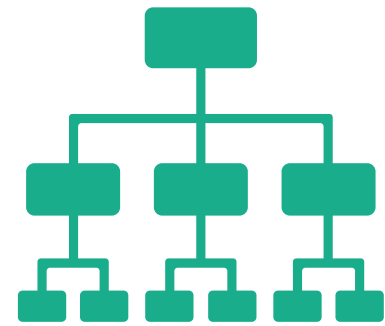
H₂ + CCUS

PYROLYSED H₂

NUCLEAR H₂

NATURAL H₂

NATIONAL AND SUB-NATIONAL H₂ GOVERNANCE



France hydrogène : nationwide business lobby, created in 2004

National Hydrogen Council : 15 corporate and public members, created in 2020

Inter-ministerial Hydrogen Task Force : created in 2020

H2 Task Force by MEDEF International & France hydrogène : created in 2021



Public support for "integrated hydrogen ecosystems" (research, education, business clustering, accelerators...) = 275M€ (2021-2023).



Alliances et joint ventures

REGIONAL GOVERNMENTS + PRIVATE SECTOR : HYmpulsion (Auvergne-Rhône-Alpes), Hynomed (Région SUD), HyPort & Genvia (Occitanie), Dinamhyse (Grand Est), HYPA Corsica, GRHYD (Hauts-de-France), Lhyfe (Pays de la Loire), ISTHY & VHYCTOR (Bourgogne-Franche-Comté),...

CROSS-BORDER ALLIANCES : Bourgogne-Franche-Comté + Rhineland-Palatinat (2017), MosaHyc (Moselle + Sarreland + Luxembourg, 2020),...

LOCAL H₂ HUBS STRATEGY

SMART SPECIALIZATION IN H₂

- 2 research centres: LAVOISIER, BERHY
- 1 major project: Methycentre
(Power-to-Gas, 1GWh/yr, online by 2022)
- 2 H₂ stations
- Vibrant SME ecosystem: Storengy, Ataway, H2V, McPhy...



last one
(2021):
**CENTRE-VAL
DE LOIRE**

first one (2017):
**AUVERGNE-
RHÔNE-ALPES**

Major "hydrogen valley"

- 2nd most-populated region
- 2nd largest regional economy
- 80% of H₂ jobs in France
- 70% of H₂ investments in France
- 3 major H₂ ecosystems
(Lyon, Grenoble, Clermont-Ferrand)



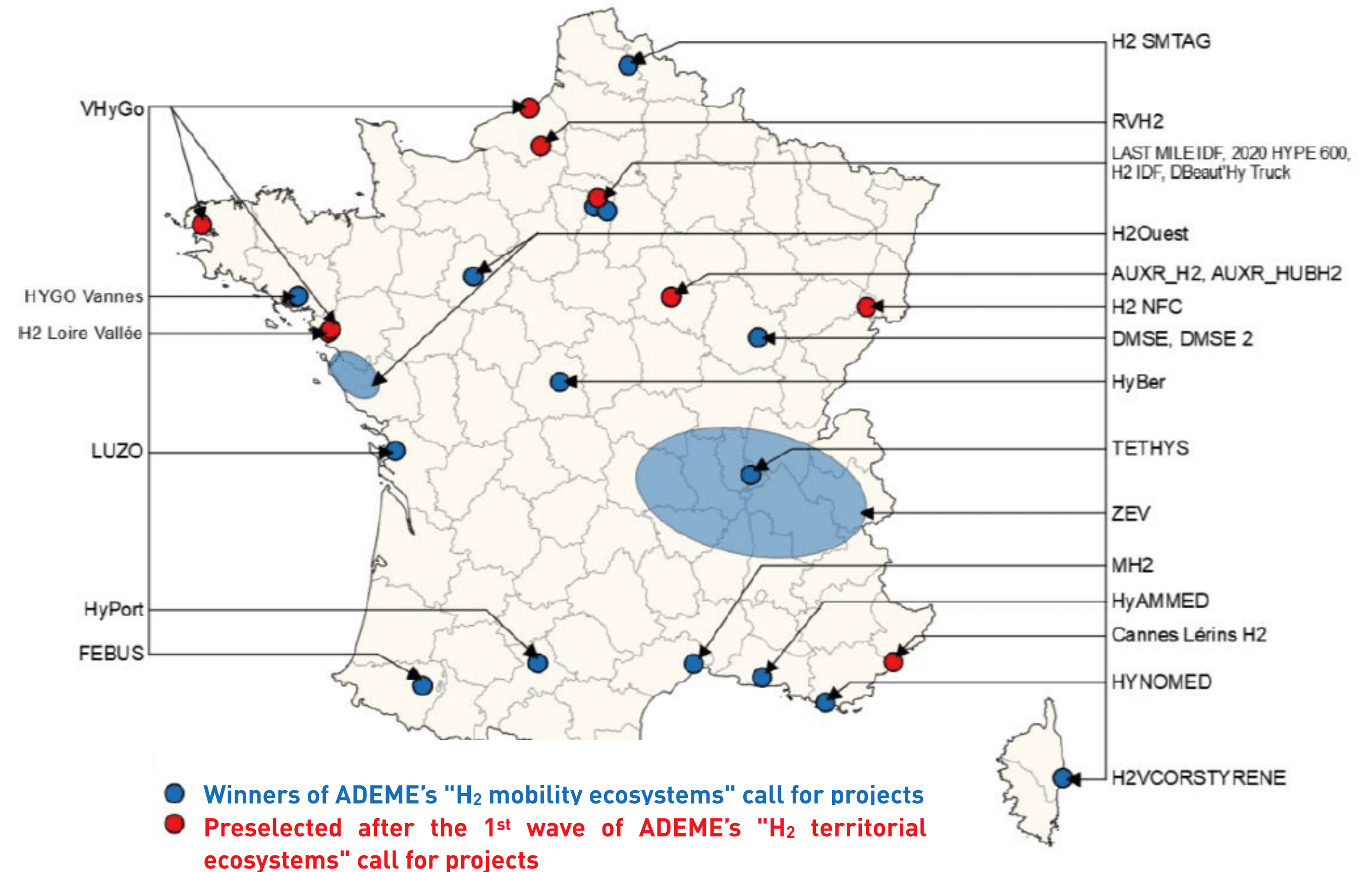
Corsica

- 1 research centre: MYRTE
- 1 major project: HYPA Corsica
- 0 H₂ stations
- GTT, CEA

19 "HYDROGEN ECOSYSTEMS" ACROSS FRANCE ACT AS MODELS

PROGRESS SINCE FRANCE'S 1ST NATIONAL H₂ PLAN IN 2018 :

- 57 H₂ refuelling stations
- 21.6MW of installed H₂ electrolysis capacity (= 3,100 tons/year), based at 99% on renewable electricity
- 2,300 lightweight commercial vehicles
- 160 heavy-duty vehicles



FRANCE IS TRYING TO ADDRESS GLOBAL H₂ BOTTLENECKS

**COMPETITION FOR
CRITICAL METALS
SUPPLY**

**LIMITED TALENT
POOL & TRAINING
PROGRAMS**

**COMPETITION FOR
METALLURGICAL
ENGINEERS**

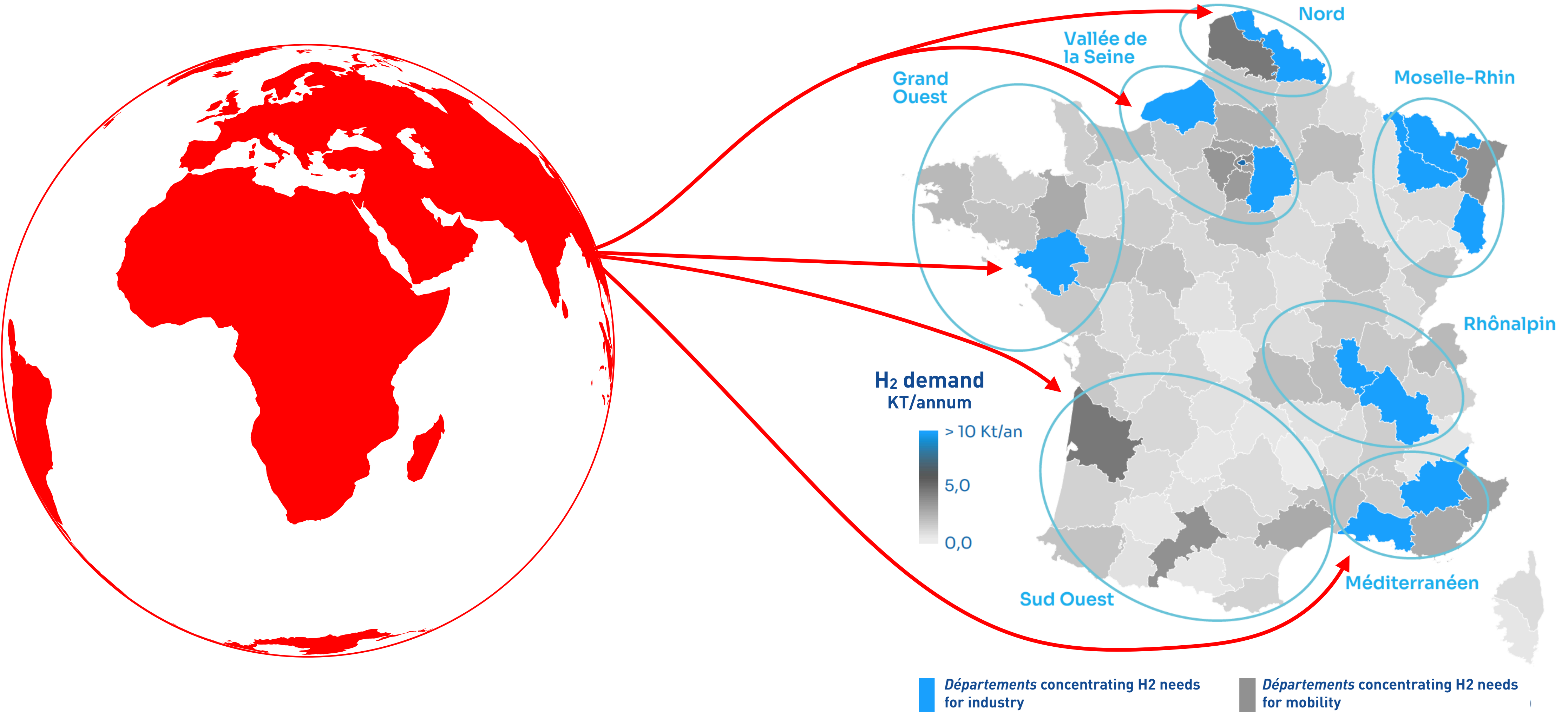
**HARD SECURITY OF
INFRA & FACILITIES
IN HIGH-INTENSITY
CONFLICT**

**MARKET-MAKING
MECHANISMS,
STANDARDS &
CERTIFICATION**

**PERMITTING TIME +
EMERGING NIMBY &
NEO-COLONIALISM
NARRATIVES**

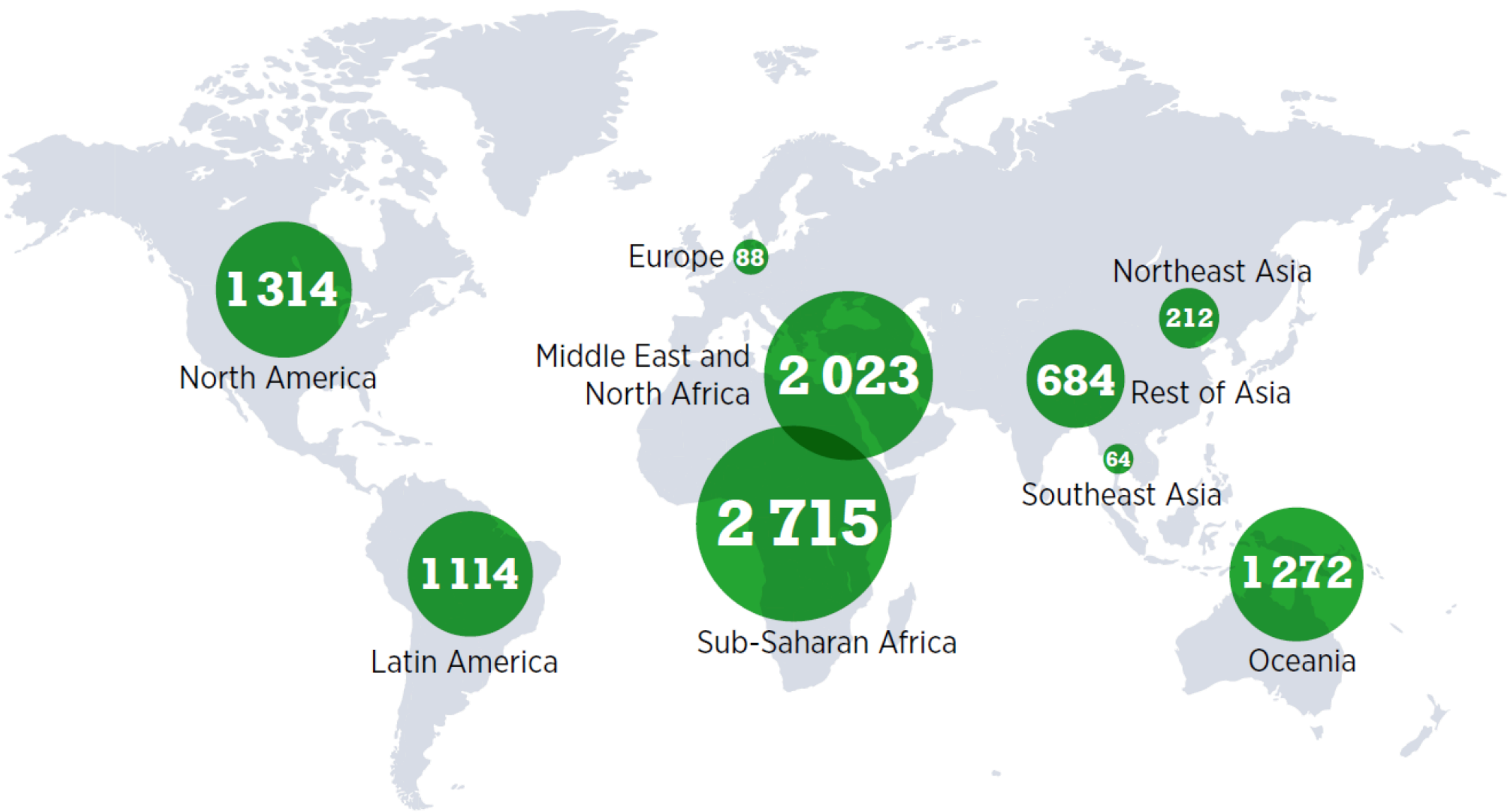
CLIMATE IMPACT OF HYDROGEN LEAKS (TECH + NORMS + CONTROL / AUDIT)

GOVERNMENT WANTS LOCAL H₂ / COMPANIES AIM FOR GLOBAL H₂

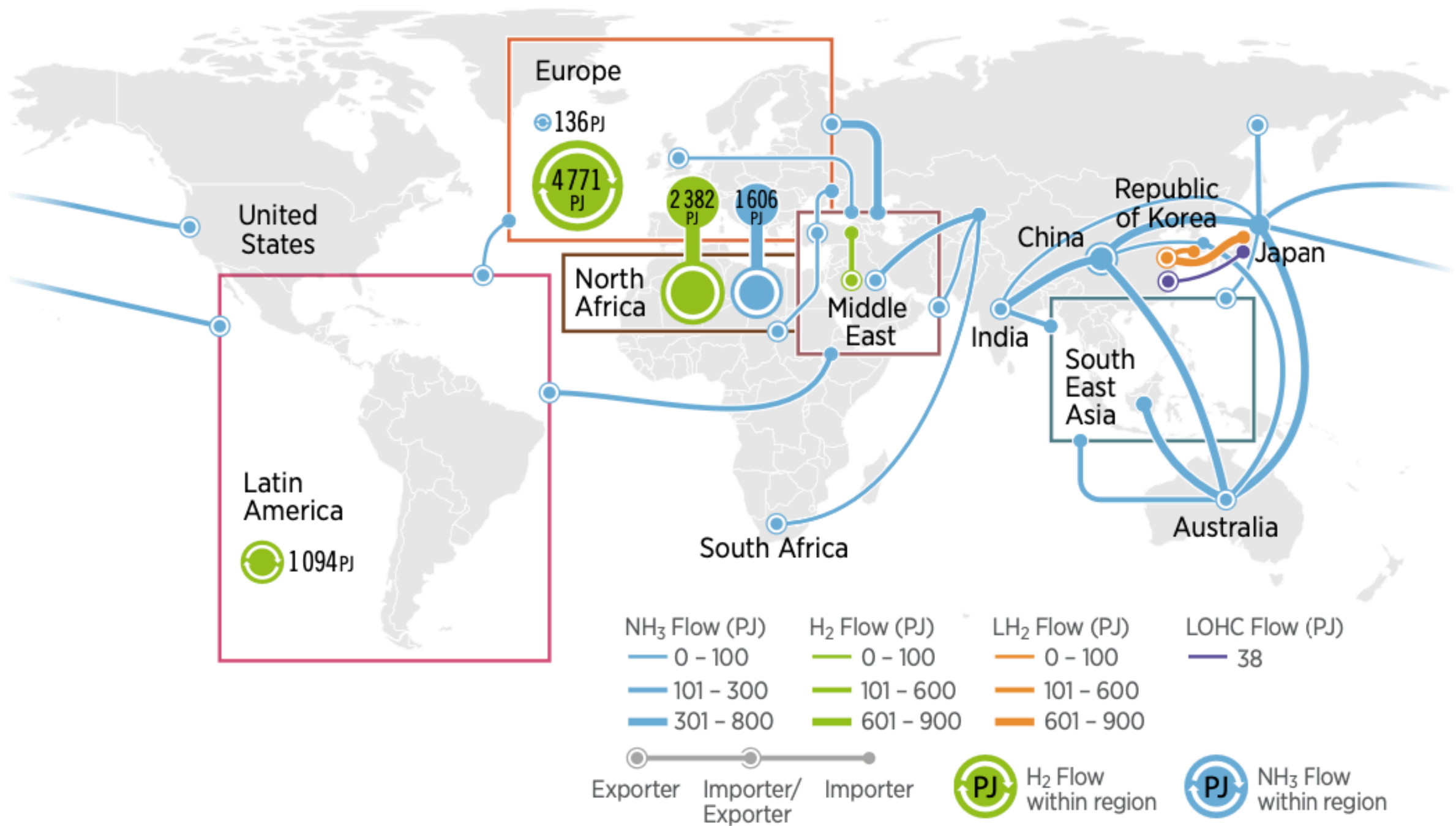


FRANCE = KEY IN THE EURO-AFRICAN H₂ MARKET DEVELOPMENT?

Global green hydrogen production map by 2050 under 1,5 USD/kg (in EJ)

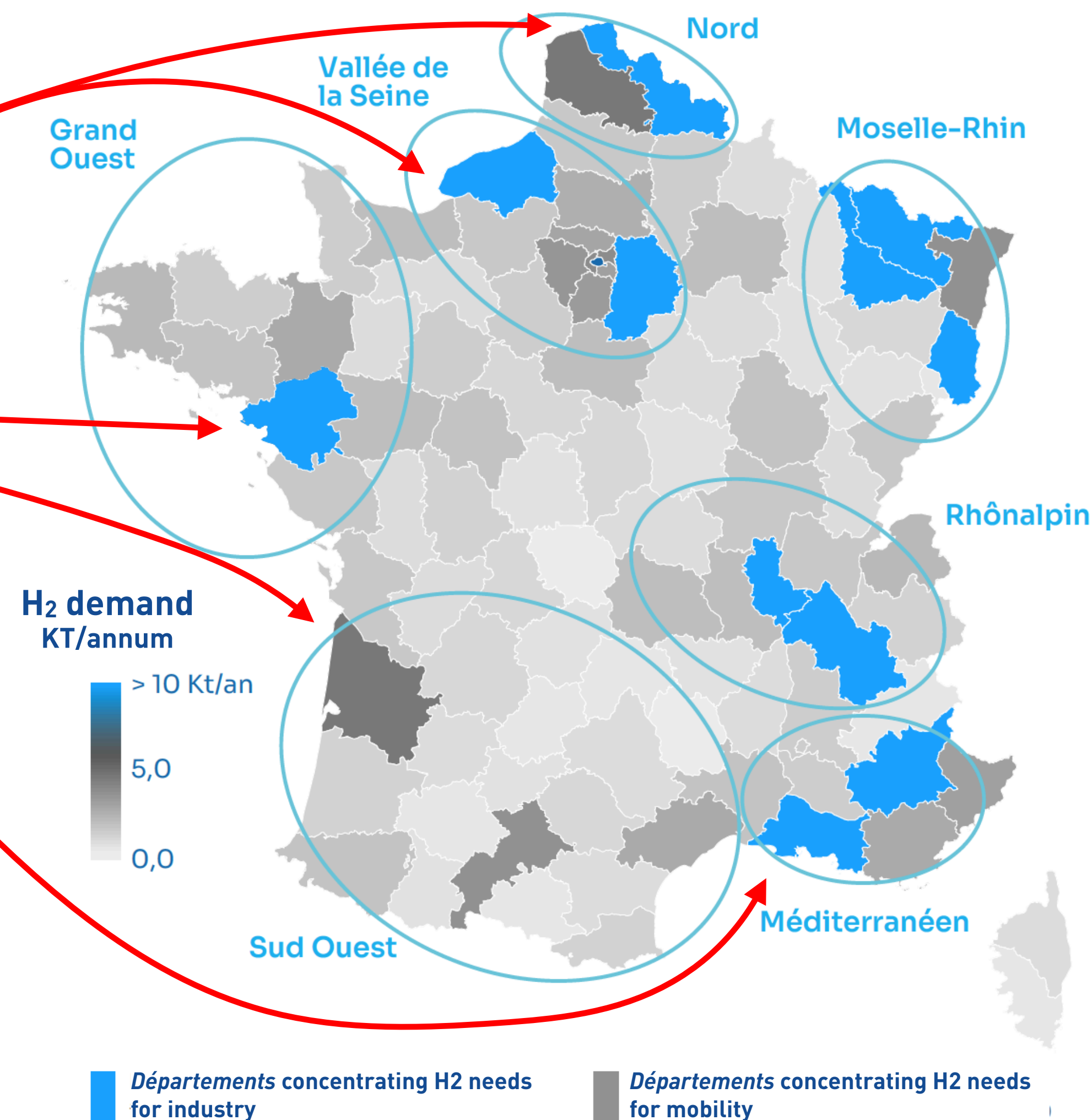


Global hydrogen trade map in 2050 under optimistic technology assumptions

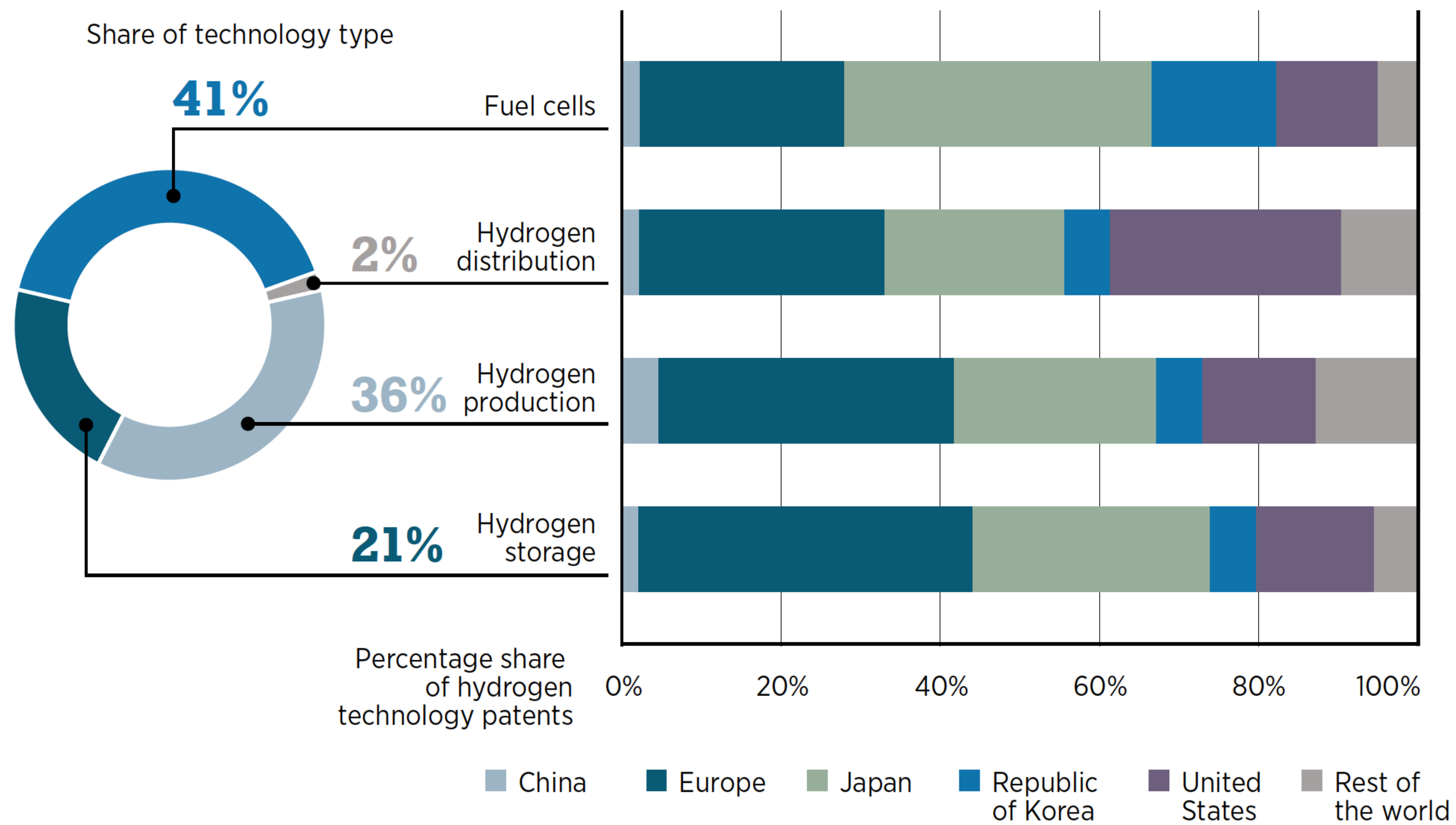


FRENCH LEADERS IN R&D FOR UNLOCKING H2 TRADE/BUNKERING

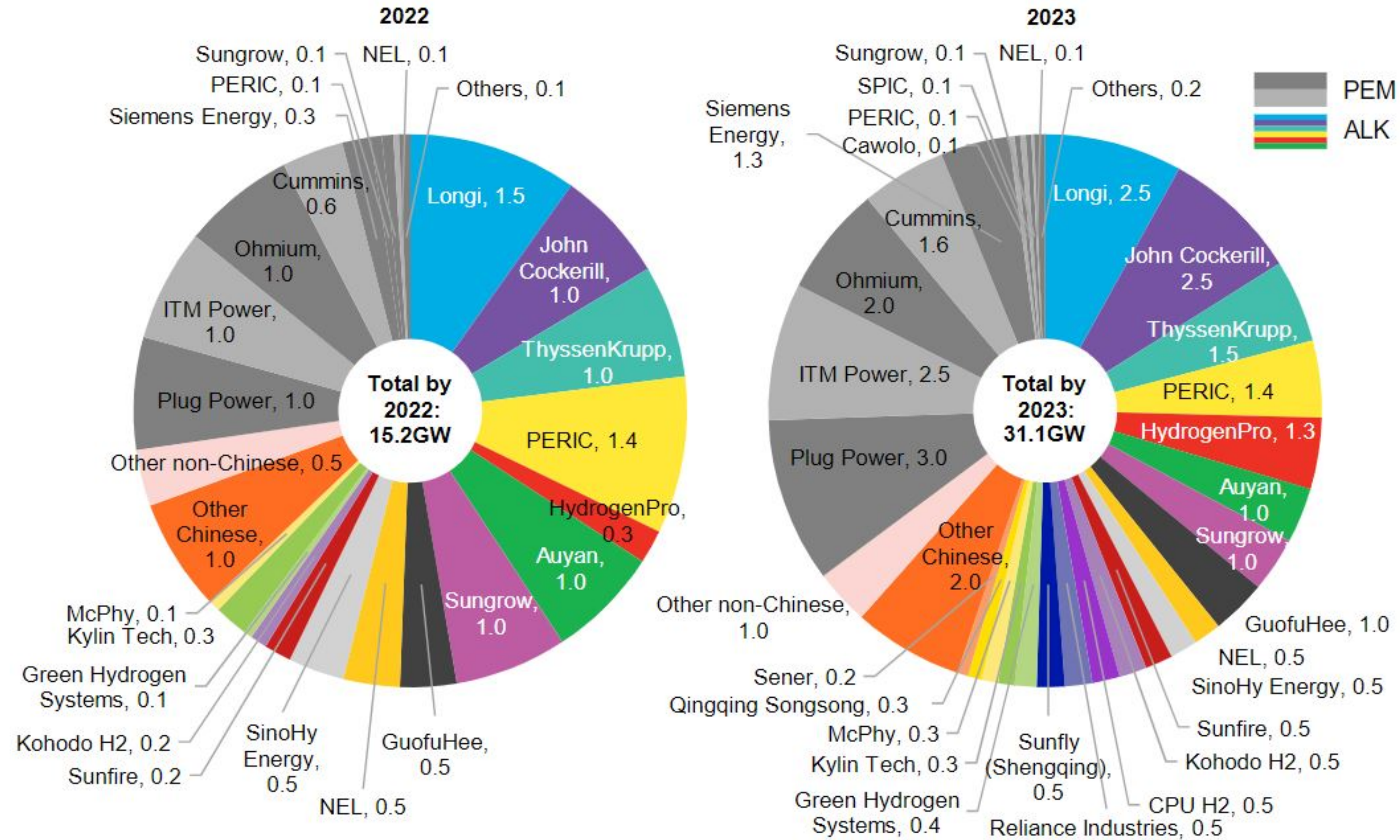
- **PURE GAZEOUS HYDROGEN IN DEDICATED PIPELINES (EHB)**
- **AMMONIA**
- **E-METHANOL / E-LNG / SAFs**
- **LIQUID ORGANIC H2 CARRIERS (TOLUENE/MCH...)**
- **LIQUID NON-ORGANIC H2 CARRIERS (HySiLabs's Hydrosil)**
- **SOLID H2 CARRIES (Bore...)**
- **SEMI-FINITE PRODUCTS (H2-green steel, aluminum, ciment...)**



FRENCH AMONGST WORLD #3 PATENTING FORCES IN H₂

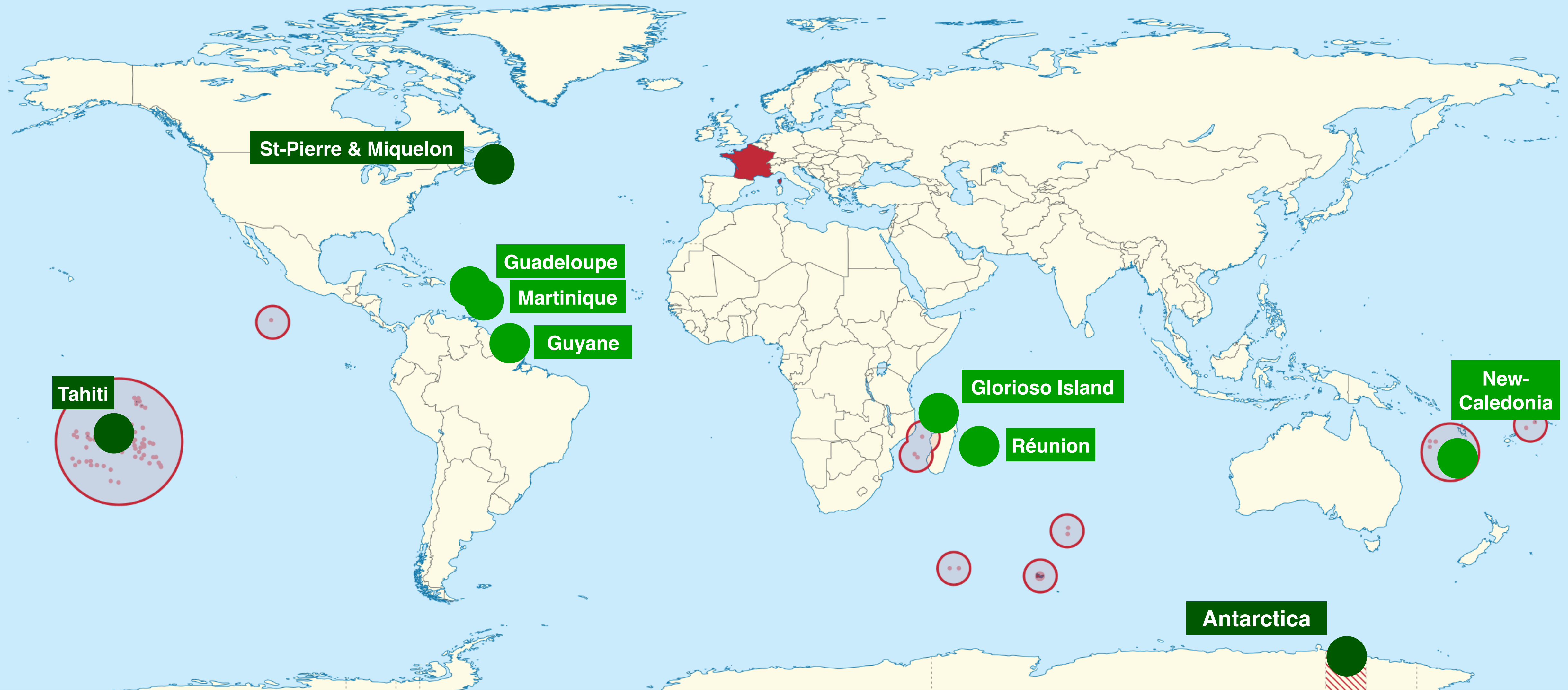


ELX MANUFACTURING CAPACITY & PROCUREMENT (IPCEI)



Source: Company filings, industry sources, BloombergNEF. Note: The values refer to year-end capacities.

FRANCE'S "OUTRE-MER" AS H₂ PRODUCERS & TECH TESTBEDS



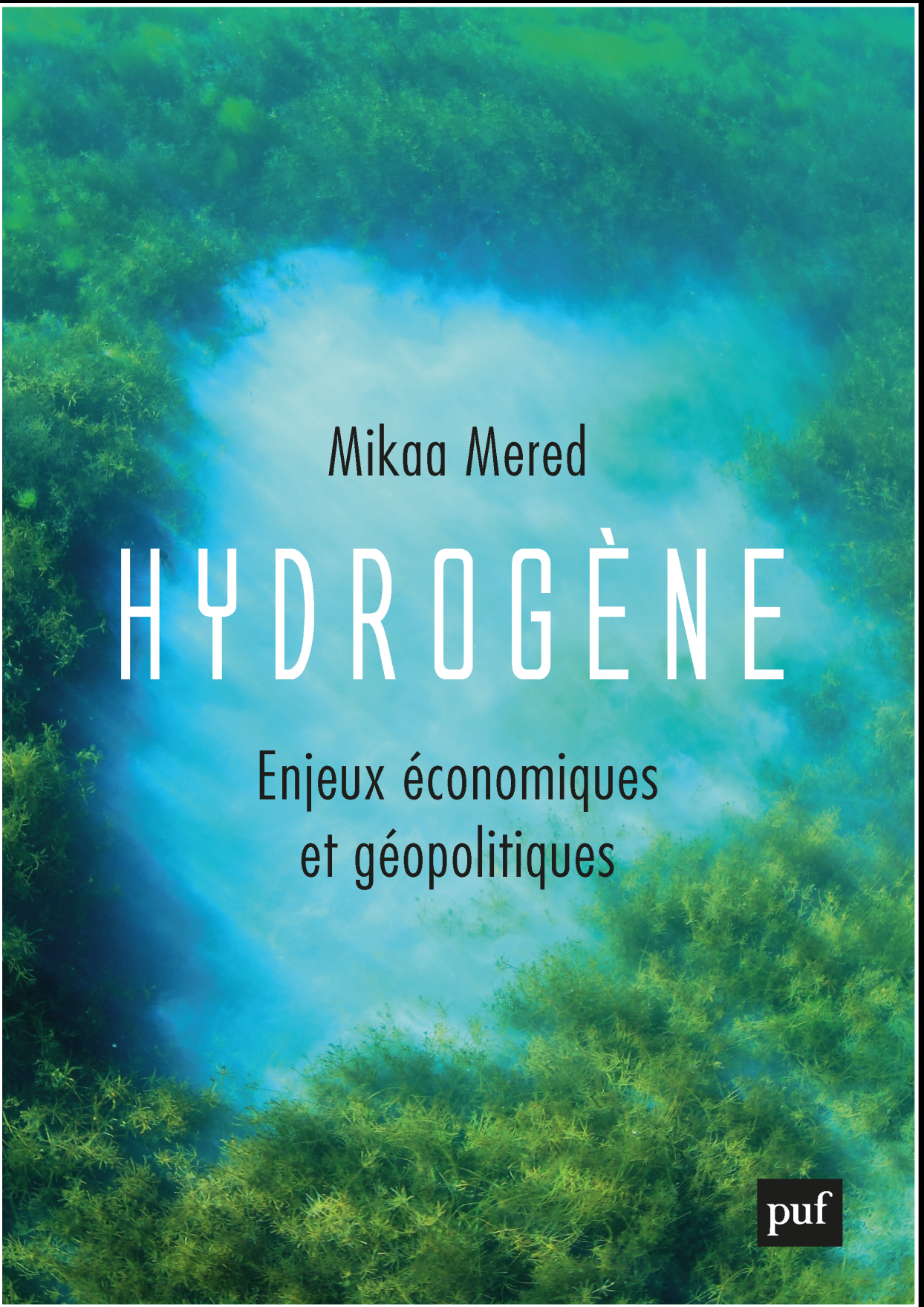
IF YOU READ FRENCH AND WANNA GO FURTHER, READ THIS!



Out Dec. 7th, 2022



Out Dec. 7th, 2022



Available in September 2023

Thank you for your invitation and your attention. Let's keep in touch!

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