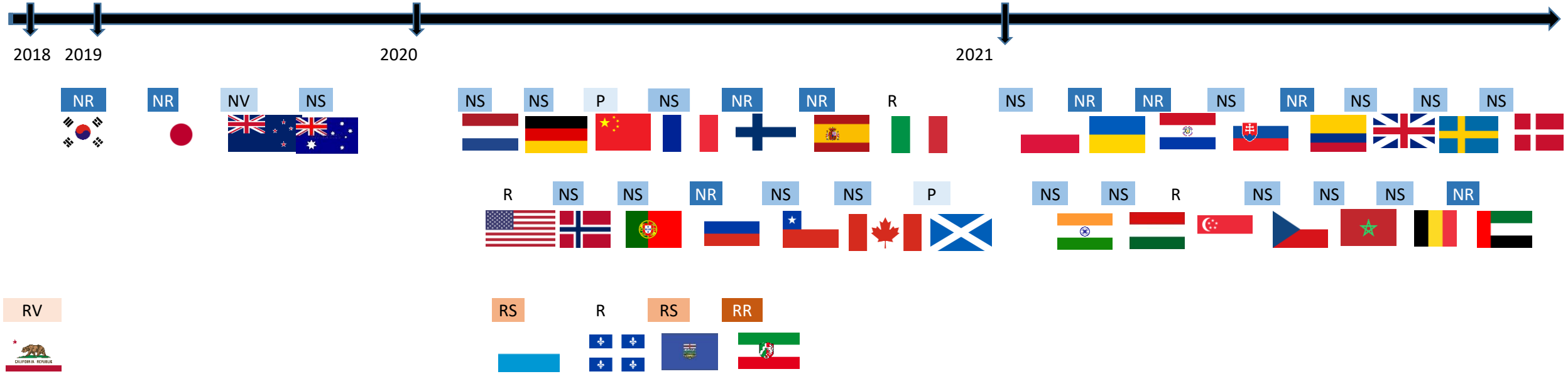


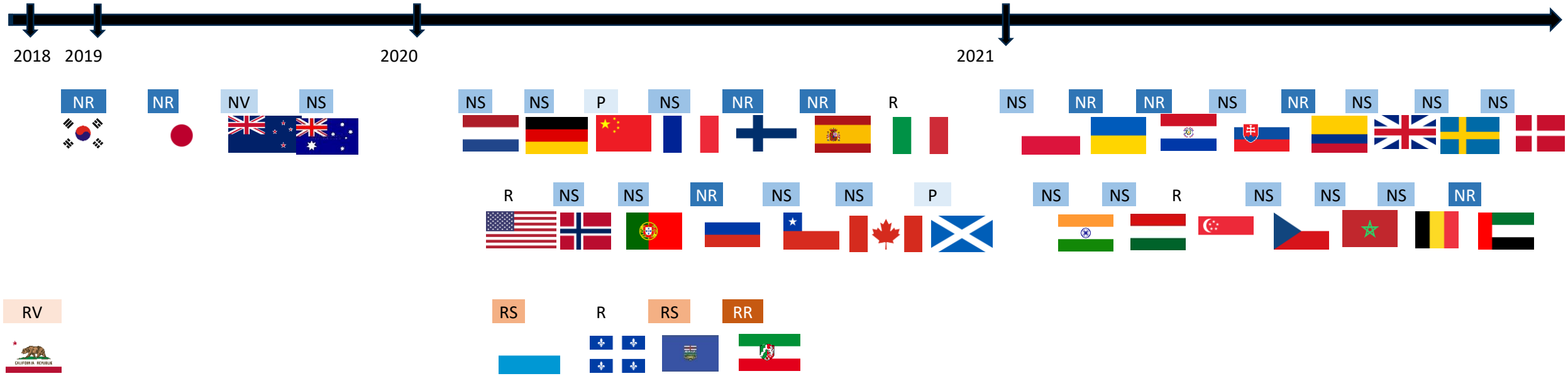
HYDROGEN IMPORT AND THE RISK OF SUPPLY, STUDY CASES FROM AFRICA

A. LAHNAOUI, IEK-STE

09 JUNE 2022

HYDROGEN ECONOMY,

MOMENTUM FOR GREEN HYDROGEN



R	4	Reports	P	2	Policies
RV	1	Regional visions	NV	1	National visions
RS	2	Regional strategies	NS	18	National strategies
RR	1	Regional roadmaps	NR	9	National roadmaps

HyResource, Policy international, 2022

FUEL OF THE FUTURE ?

- 1960 fuel cell development boosted by space programs
  1970 first use of the phrase “hydrogen economy,” by General Motors (GM).
  1973 fuel crisis gave a boost to scientific interest in hydrogen

- First cycle of interest in the hydrogen-based economy faded out in the mid-1980s
  oil prices dropped back down to historical lows

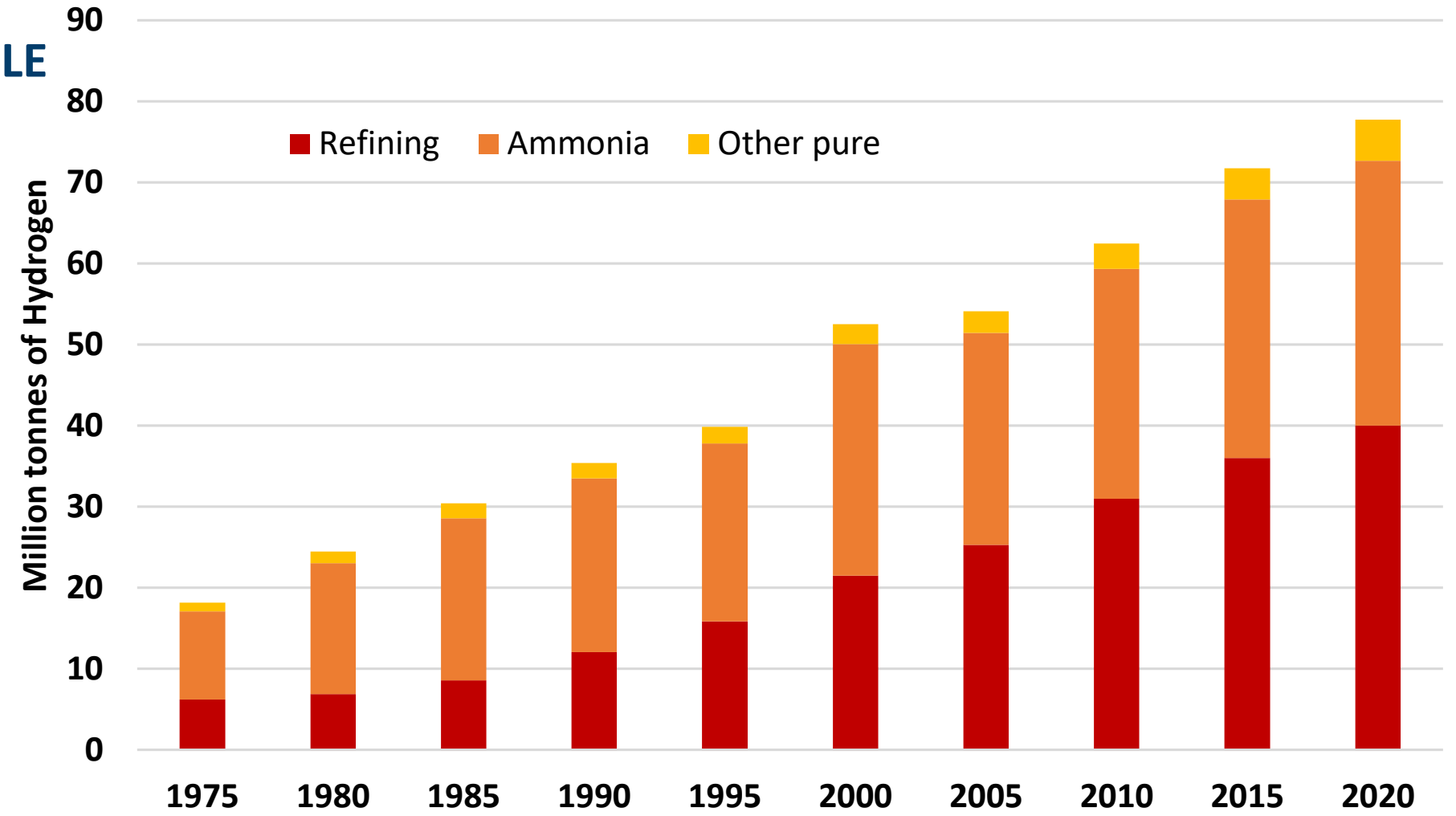
- Return of interest in hydrogen energy, stimulated by the popular book :
  Jeremy Rifkin, “The Hydrogen Economy,” 2002
  concept of ‘Peak Oil’ moving slowly to a new gas based energy sources

- 2010 combination of economic crisis
  success of lithium batteries ended the second cycle

HYDROGEN

AS PURE MOLECULE

Other: By products, Self consumed directly



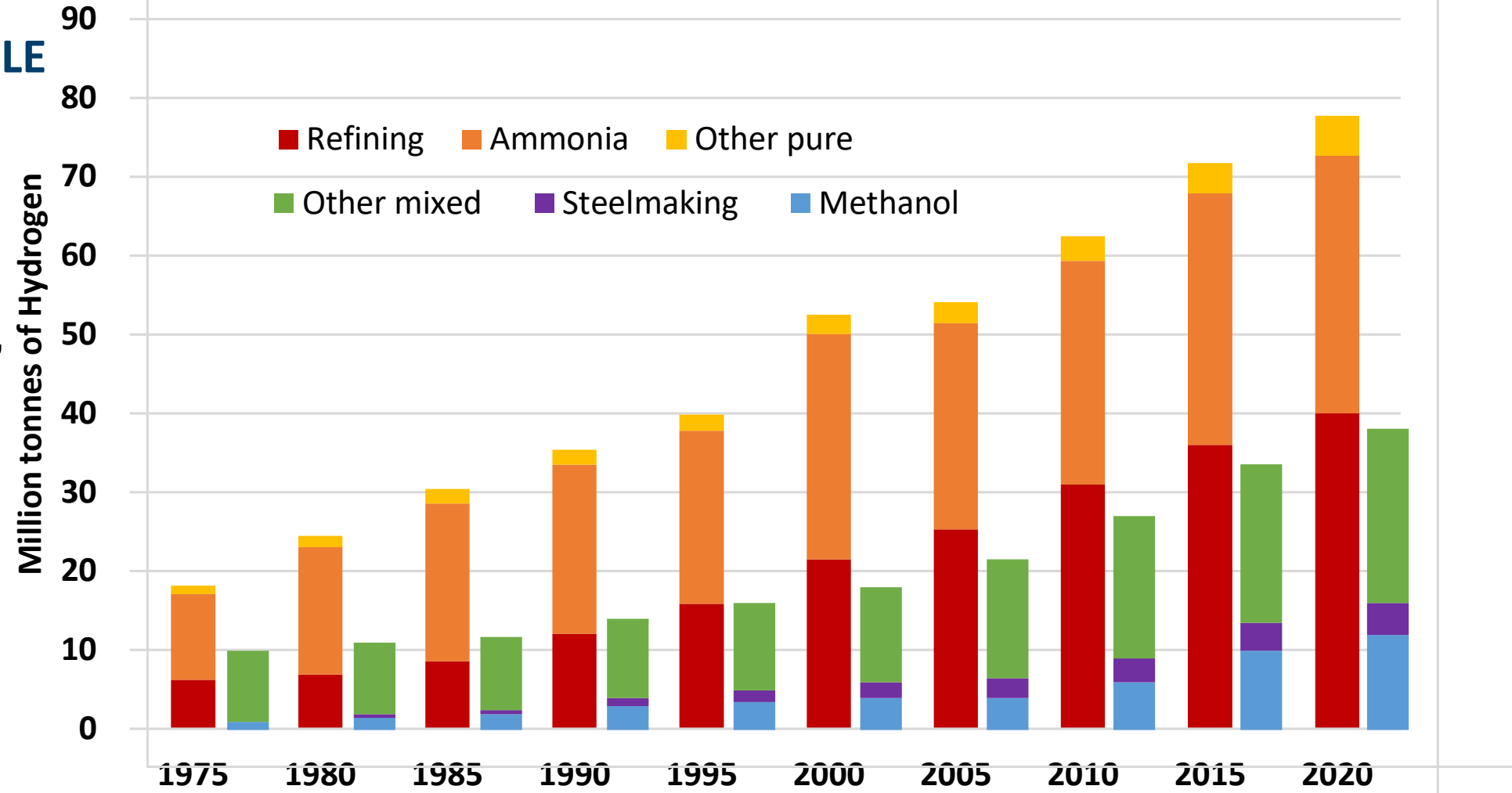
IEA (2019), *The Future of Hydrogen*, IEA, Paris

IEA (2021), *Hydrogen*, IEA, Paris

HYDROGEN

AS PURE MOLECULE AND MIXED

Other: By products, Self consumed directly



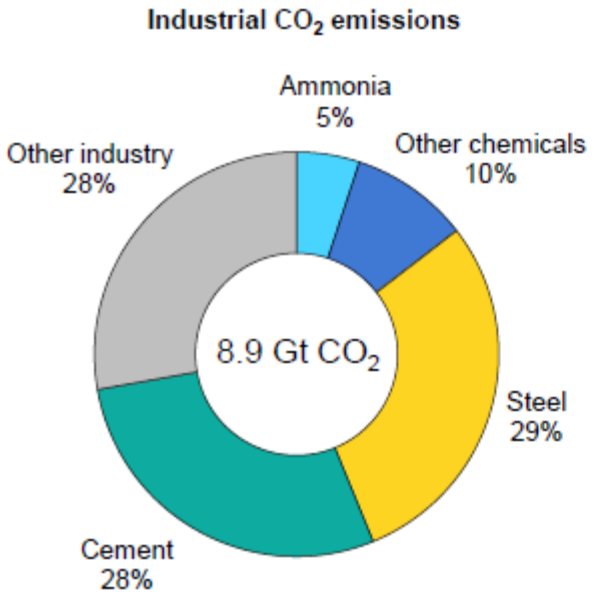
IEA (2019), *The Future of Hydrogen*, IEA, Paris

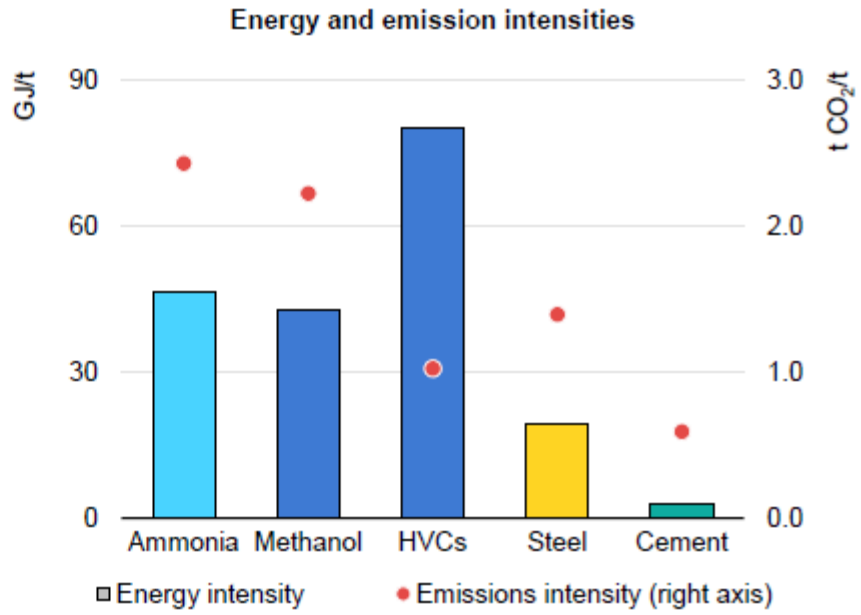
IEA (2021), *Hydrogen*, IEA, Paris

HYDROGEN

EMISSIONS

- Main production:
  - Natural gas
  - Coal in china
  - Produced next to the use point

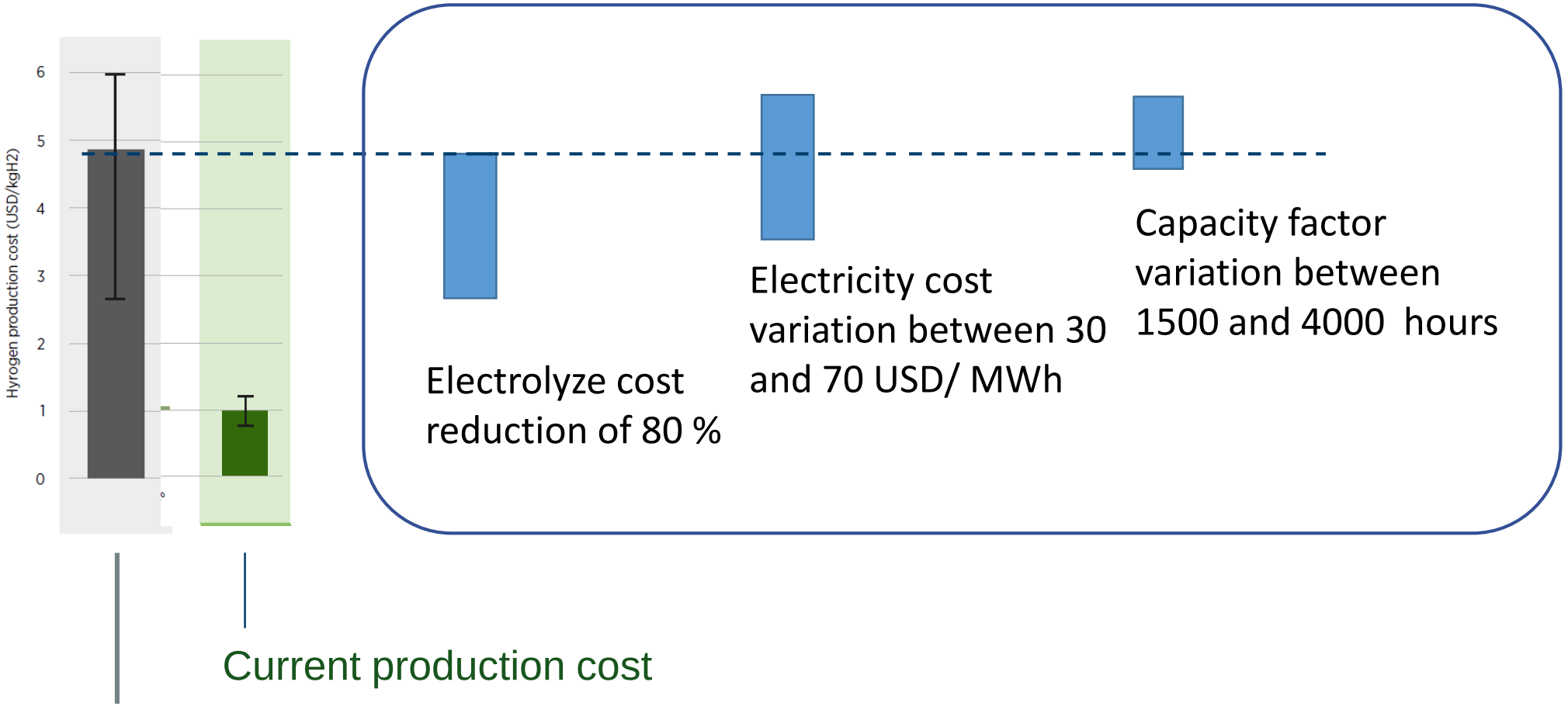




IEA (2021), *Hydrogen*, IEA, Paris

- Mainly produced from fossil fuels, resulting in close to 900Mt of CO_2 emissions per year.

GREEN HYDROGEN

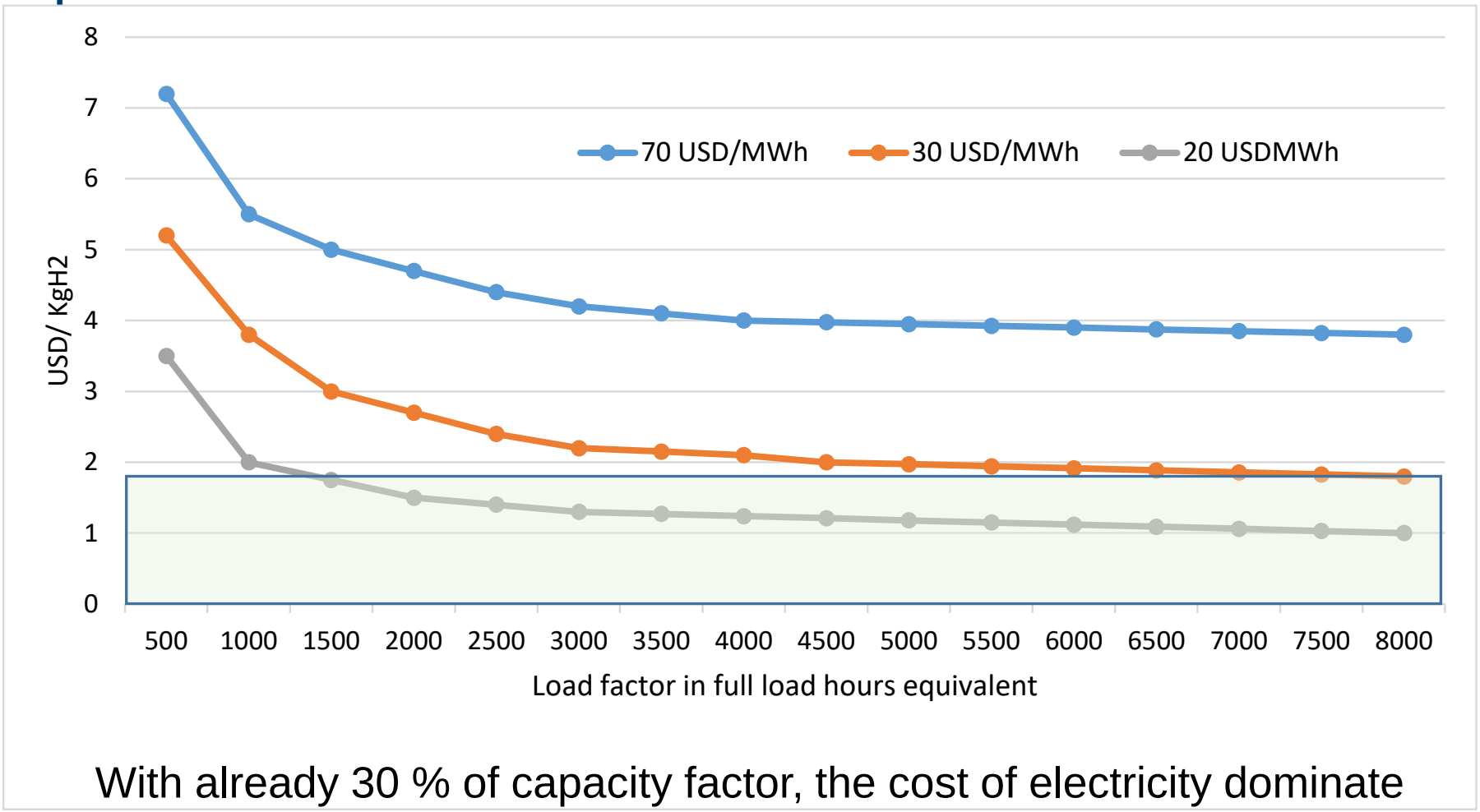


Investment of USD 770/kilowatt (kW), efficiency of 65% (lower heating value – LHV), an electricity price of USD 53/MWh, full load hours of 3200 (onshore wind)

Irena, Geopolitics of the Energy Transformation 2022

GREEN HYDROGEN

Electricity cost is important



With already 30 % of capacity factor, the cost of electricity dominate

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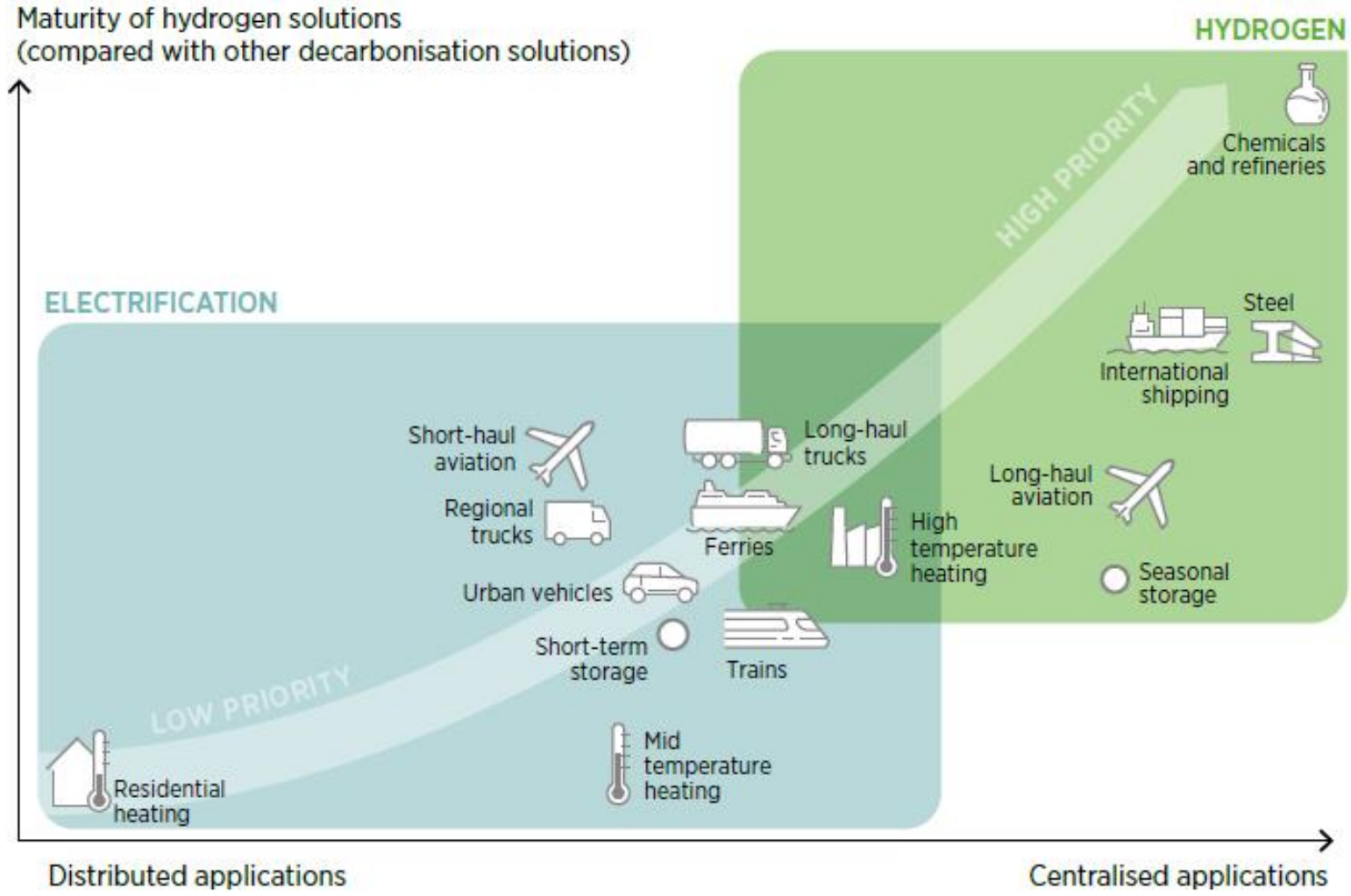
HYDROGEN DEMAND



Irena, Geopolitics of the Energy Transformation 2022

HYDROGEN DEMAND

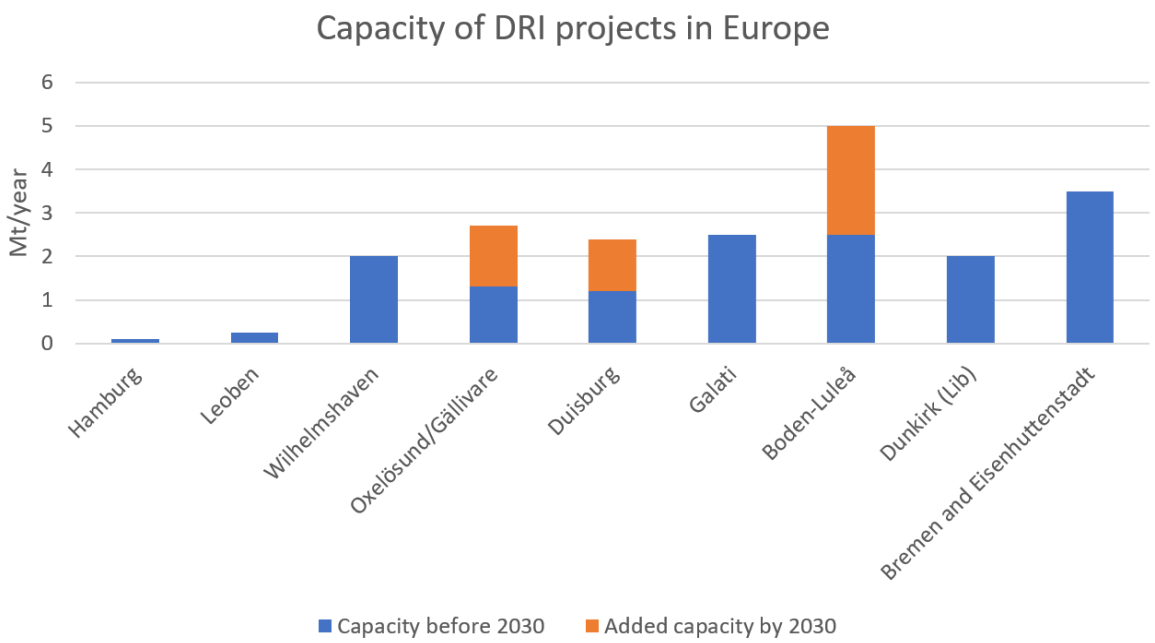
WHAT MAKES SENSE

Most relevant application for green hydrogen use.

- Decarbonize current production:
  - ammonia and methanol,
  - upgrade refineries
  - Still production is responsible of around 8 % of total emission:
    - Direct iron reduction
    - 20.45 Mt potential (from 159 Mt in 2019)

HYDROGEN DEMAND

DIR



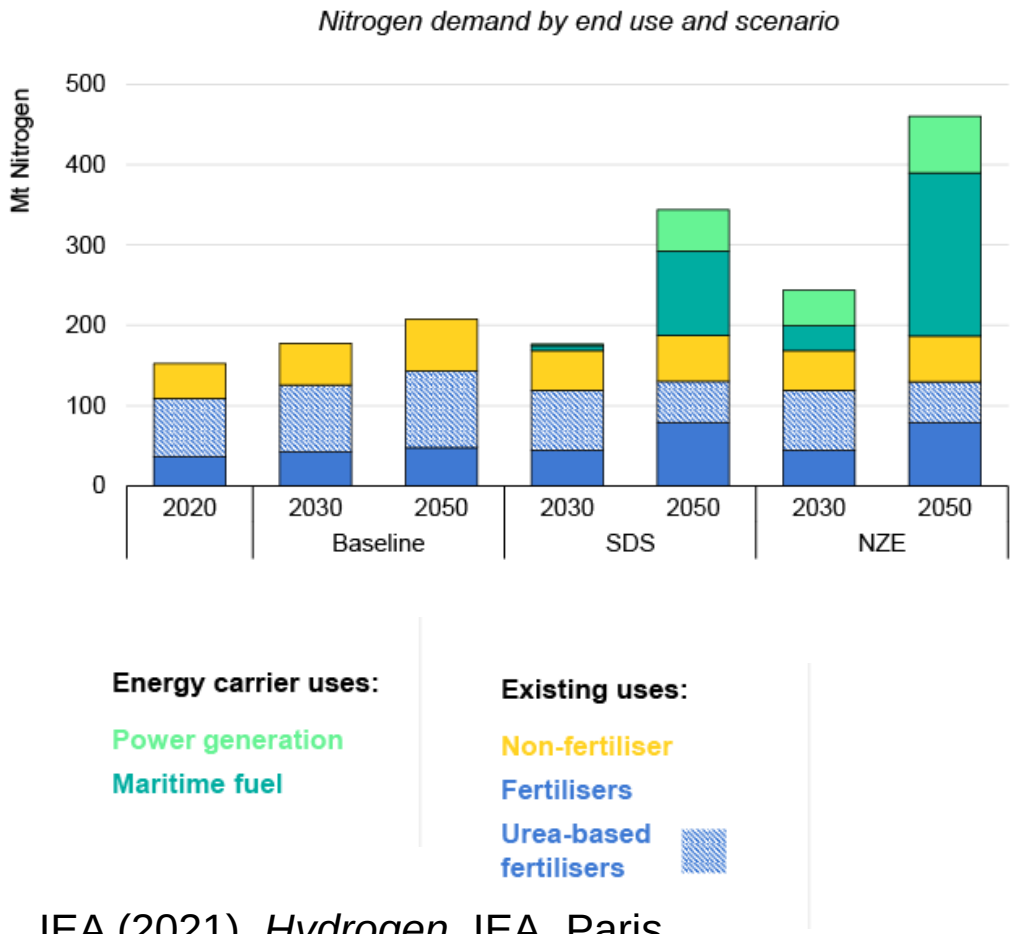
Bellona, Hydrogen in steel production, 2022

- 20.45 Mt potential (from 159 Mt total in 2019)

Hamburg, DE	Grey hydrogen
Dunkirk, FR	Natural gas
Taranto, IT	-
Eisenhuttenstadt, DE	Hydrogen from **electrolysis**
Bremen, DE	Natural gas -> hydrogen from **electrolysis**
Leoben , AU	Hydrogen
Salzgitter, DE	Natural gas and hydrogen
Wilhelmshaven, DE	Natural gas --> hydrogen from **electrolysis**
Gällivare-Oxelösund, SW	Hydrogen from **electrolysis**
Kiruna-Malmberget-Svappavaara, SW	Hydrogen likely from **electrolysis**
Duisburg, DE	Natural gas
Dunkirk, FR	Hydrogen and natural gas --> hydrogen from **electrolysis**
Boden-Luleå, SW	Hydrogen from **electrolysis**

HYDROGEN DEMAND

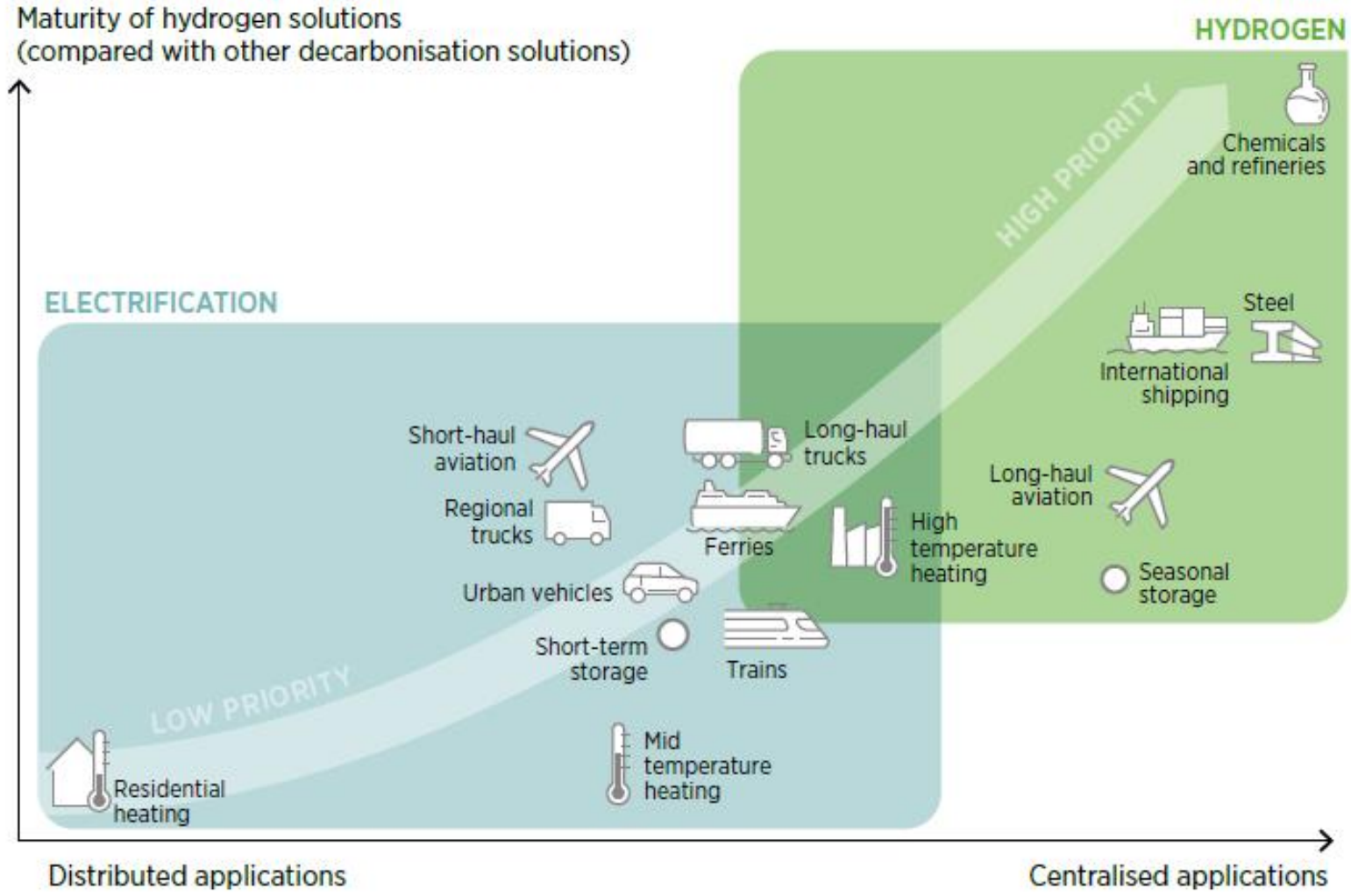
AMMONIA AND NITROGEN



IEA (2021), *Hydrogen*, IEA, Paris

- Ammonia
  - H2 / NH3 storable shippable fuels
  - Japan believe that green is too expensive: Need thermal plants
  - NH3 as fuels (shipping, industrial furnaces)
  - Chemical industry
  - Aviation (however need for short term decarbonization)
- Nitrogen
  - However nitrogen fertilizers are to pick than decline (ecosystems, zero growth policy in China/ India
  - Combining with the production of biofuels and synthetic fuels

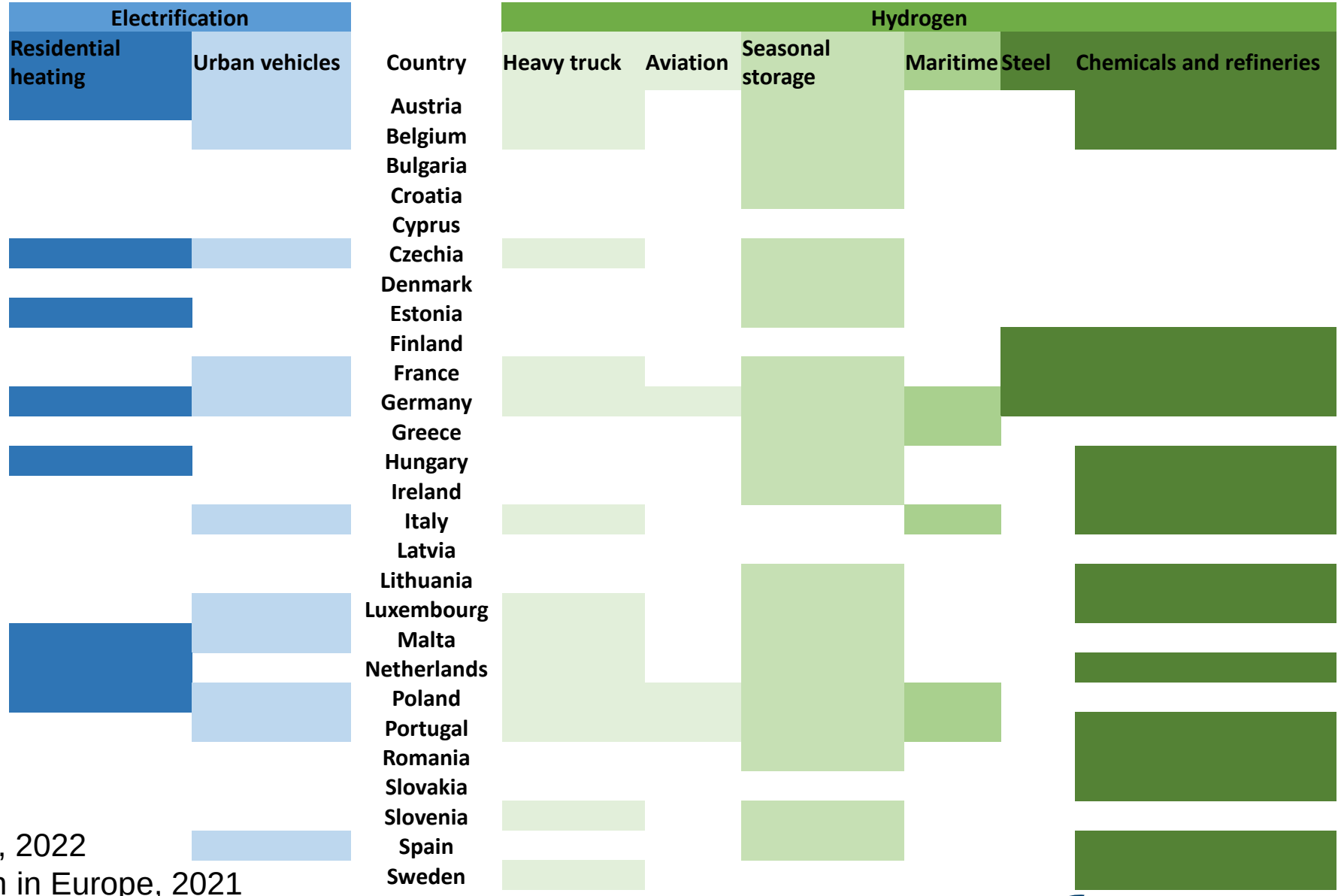
HYDROGEN DEMAND



Irena, Geopolitics of the Energy Transformation 2022

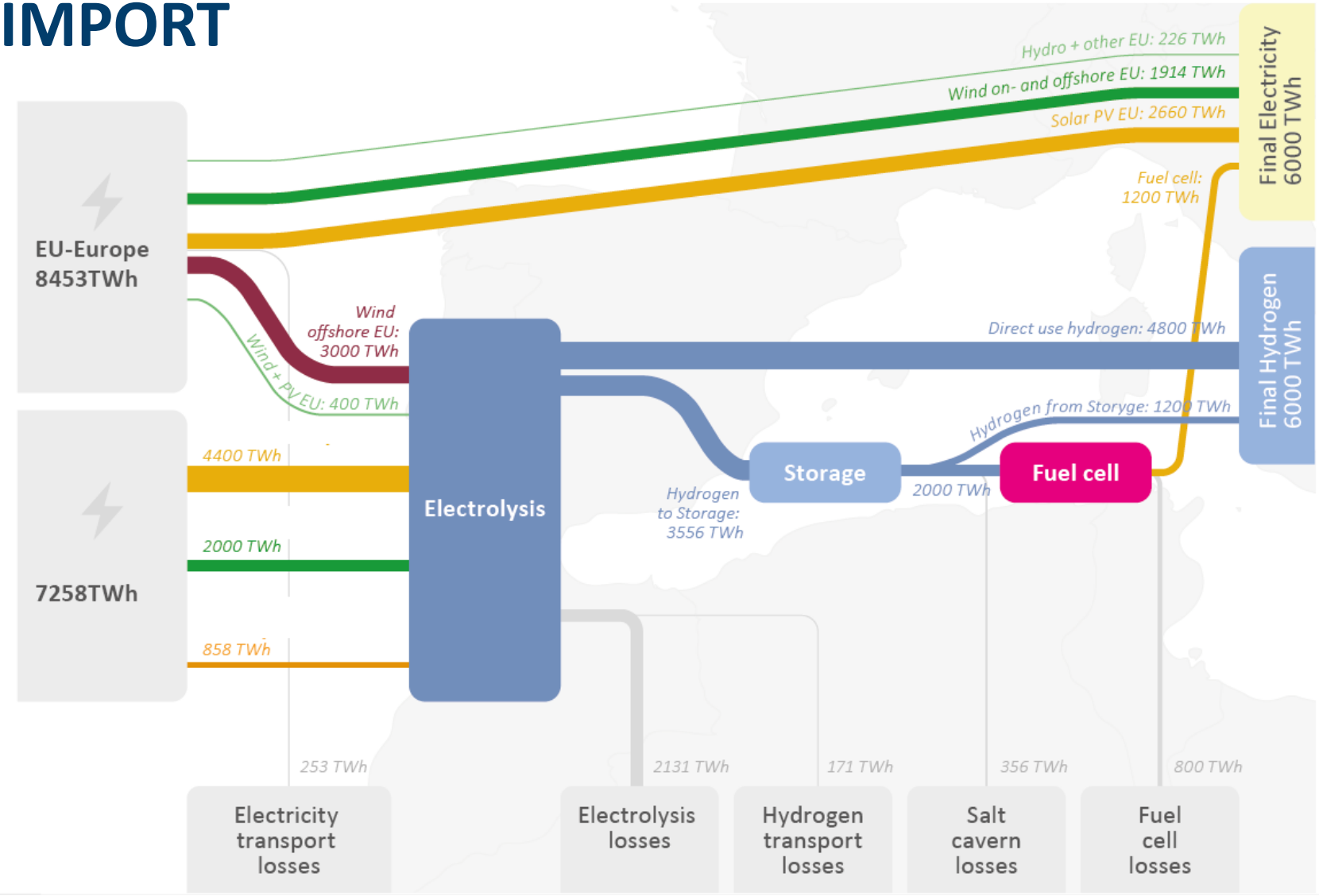
DEMAND IN EU

- Urban vehicles is as important as heavy truck
- Decarbonization of production (chemicals and refineries) along seasonal storage are the main hydrogen use focuses



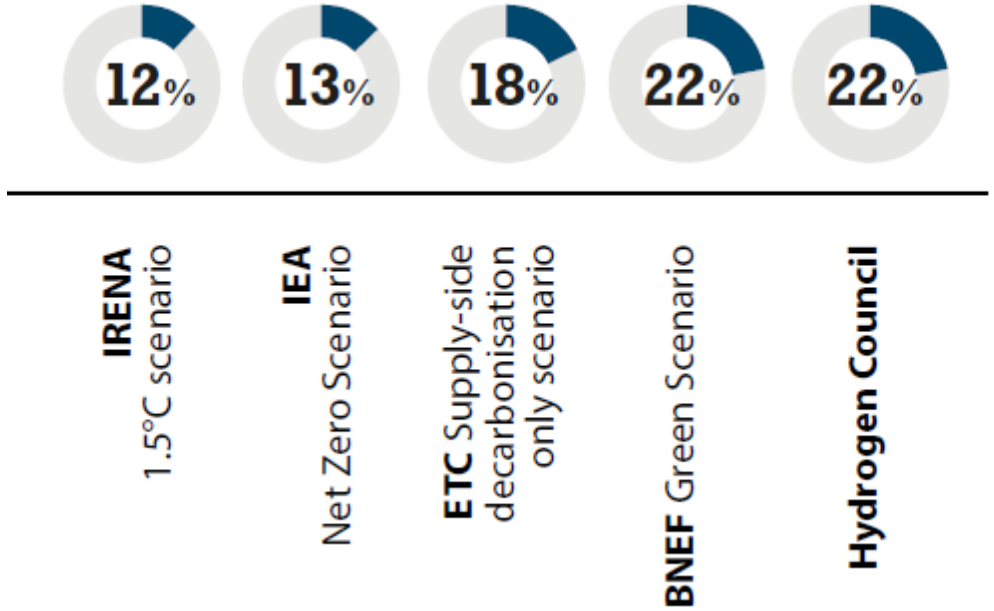
HyResource, Policy international, 2022
Intereconomics, Green Hydrogen in Europe, 2021

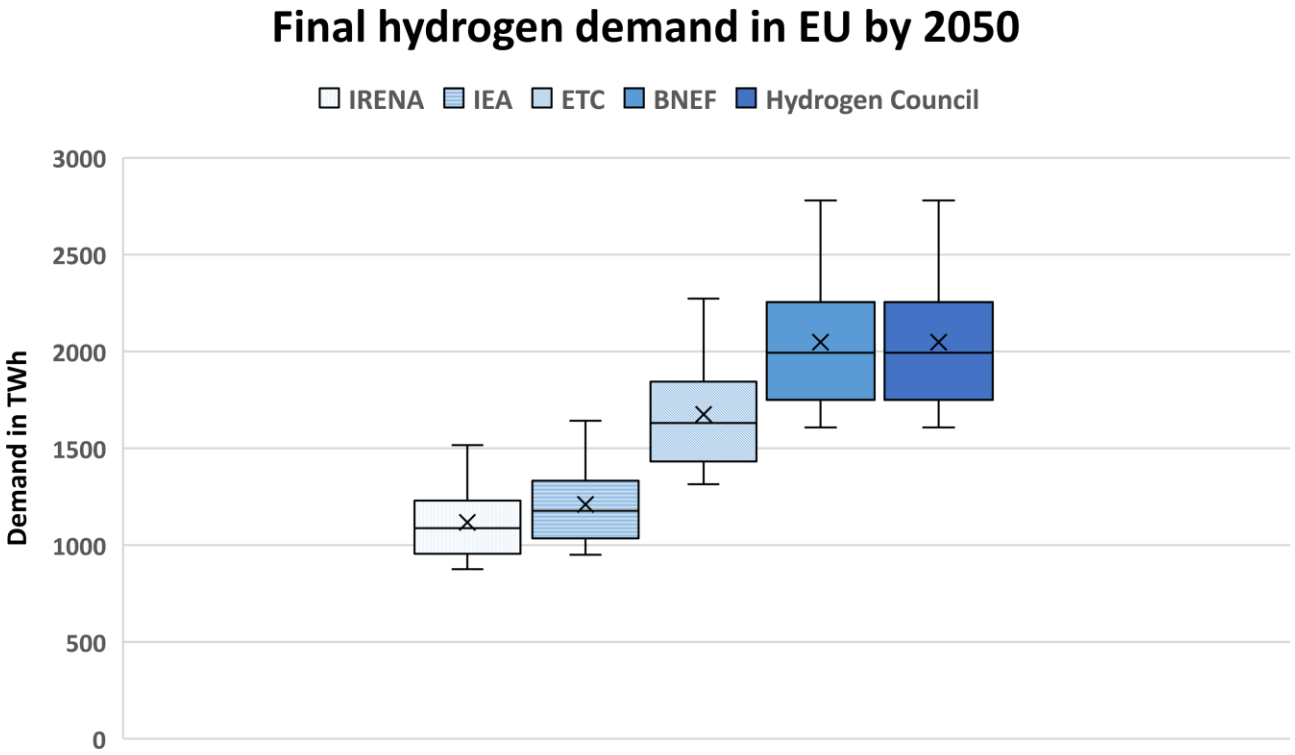
NEED FOR IMPORT



Dii Desert Energy, 2020

NEED FOR IMPORT



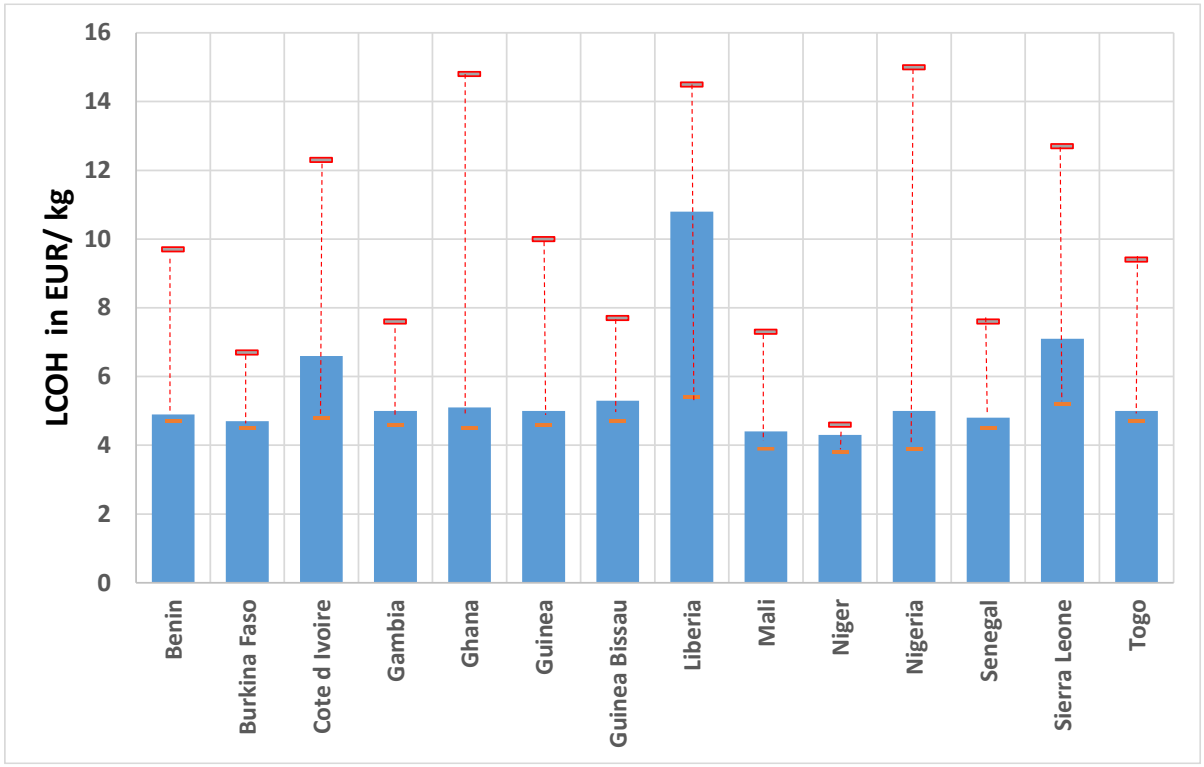


BloombergNEF (2021), ETC (2021), Hydrogen council (2021), IRENA (2021), IEA (2021)

9 demand scenarios

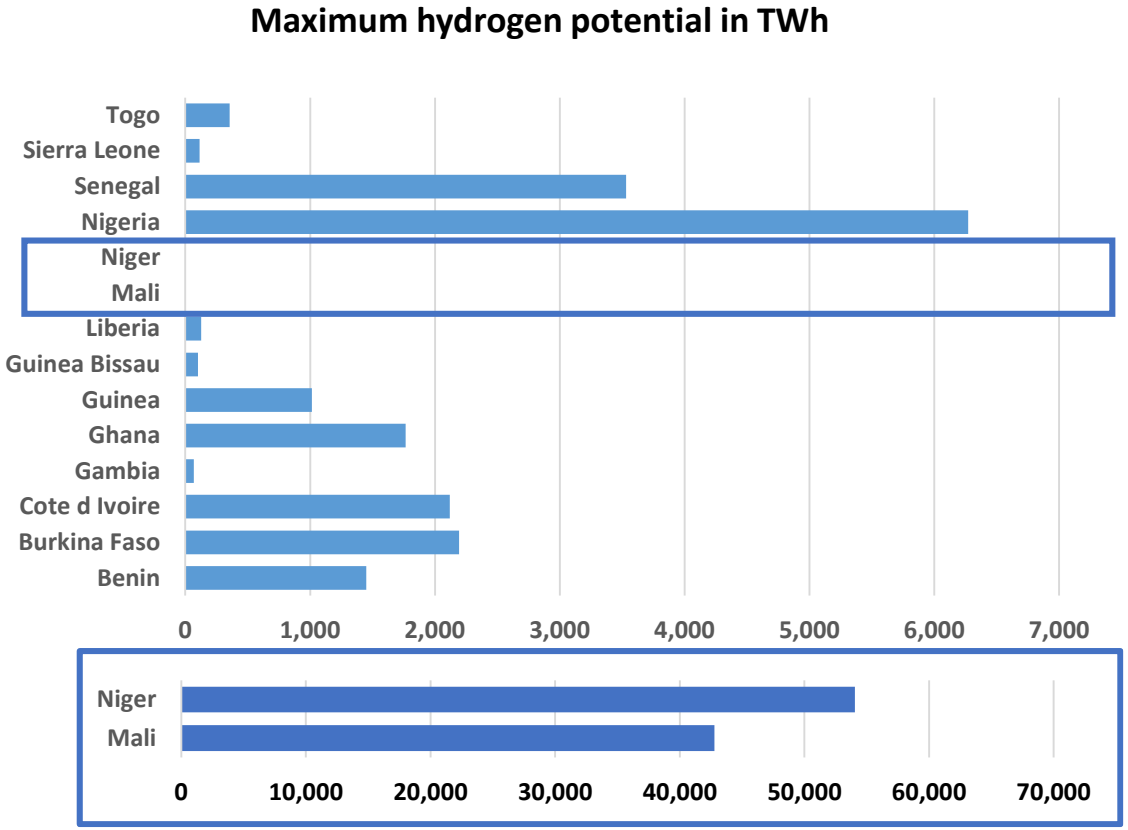
AFRICAN COUNTRIES CASES STUDY

Potential to already low cost



Costs by 2020

https://www.h2atlas.de/en/



5% of the Tech. Pot: 5,797 TWh

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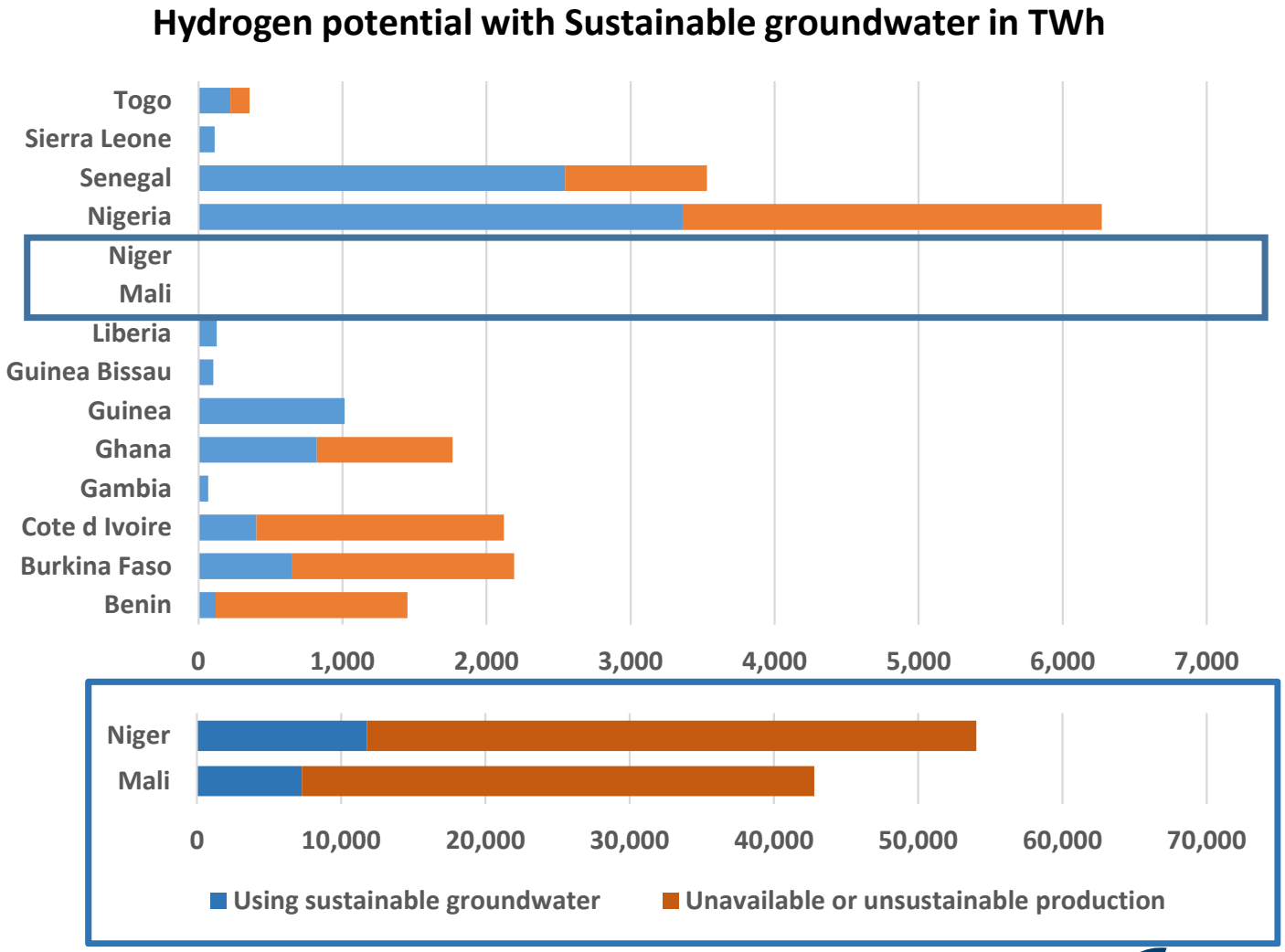
AFRICAN COUNTRIES CASES STUDY

Sustainability risk

Sustainable water available to maintain normal exploitation without adverse effects.

Take into account potential recharge and human and industrial use



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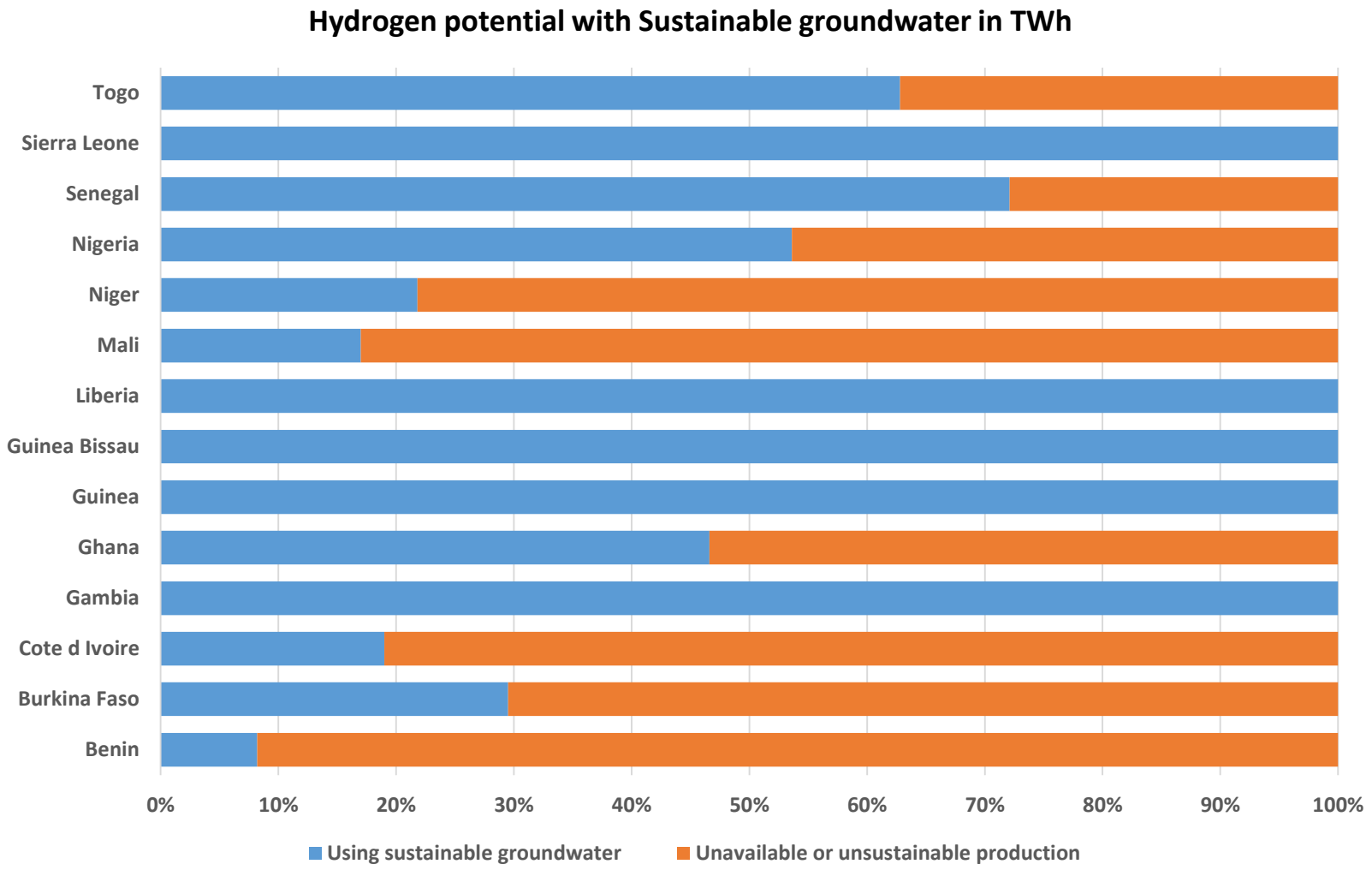
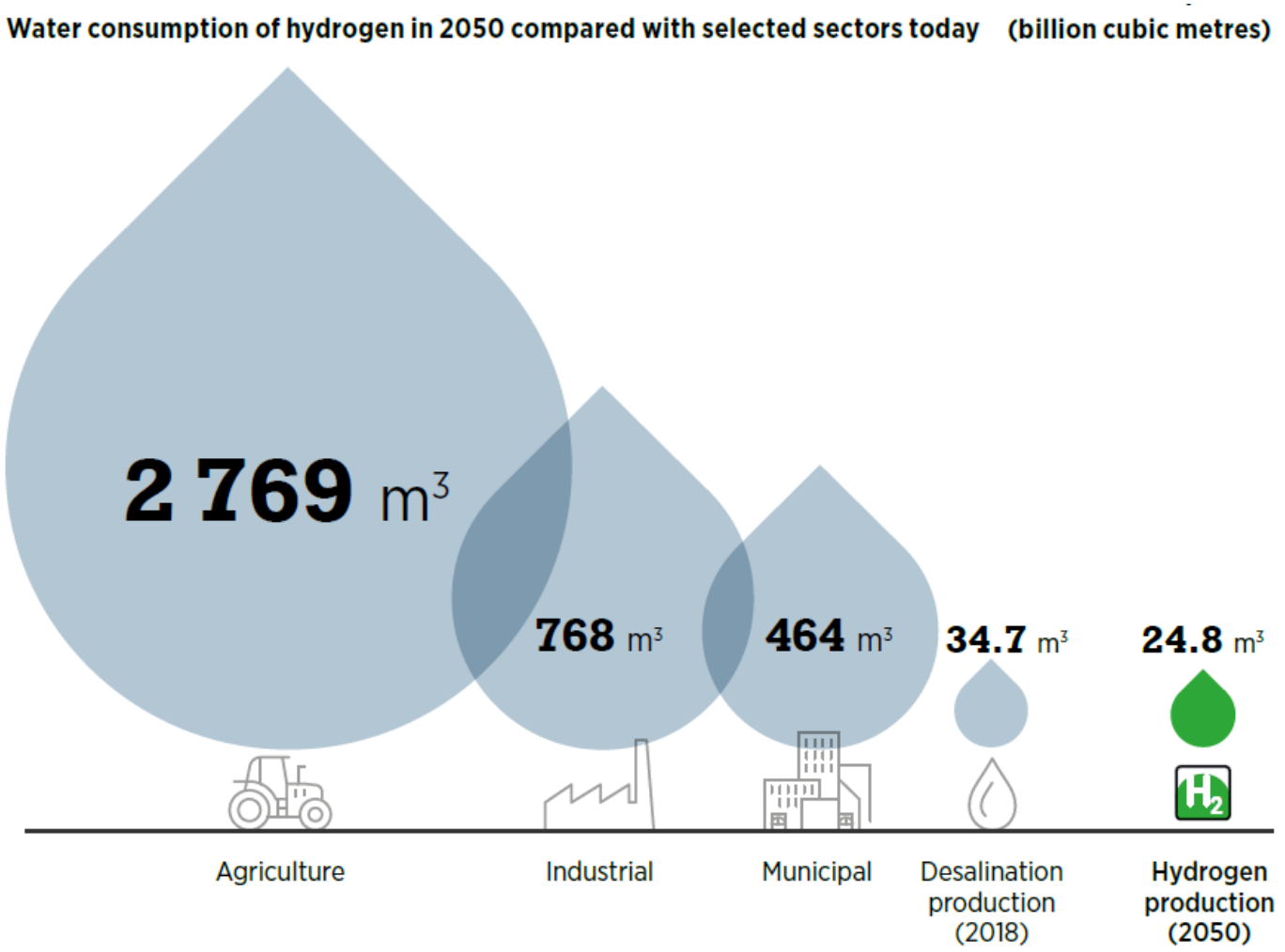


AFRICAN COUNTRIES CASES STUDY

Sustainability risk

- Hydrogen would reduce the Cost of desalination water
- however environmental impact should be carefully assessed
- Hardly would benefit to increase potential



Source: Blanco (2021).

AFRICAN COUNTRIES CASES STUDY

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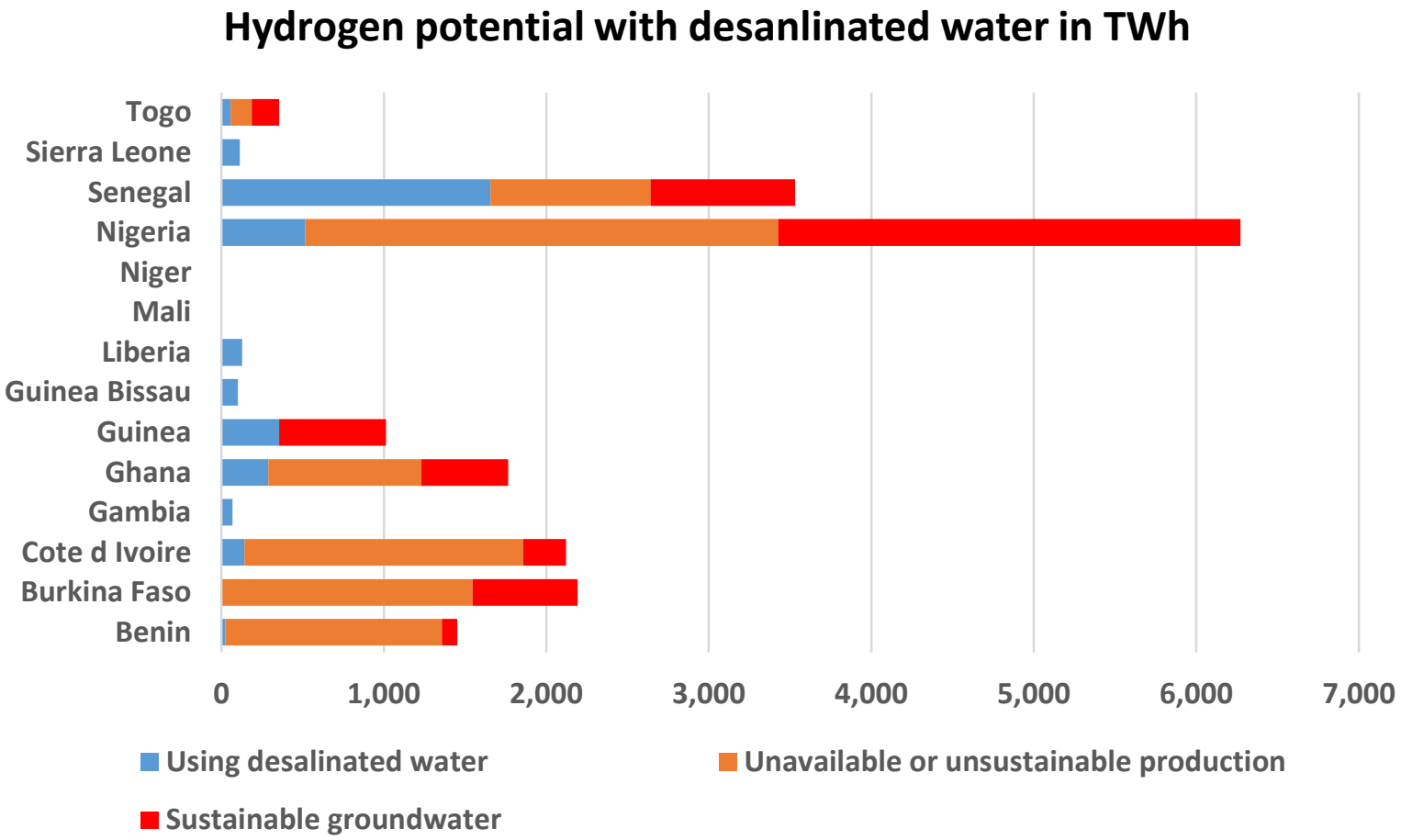

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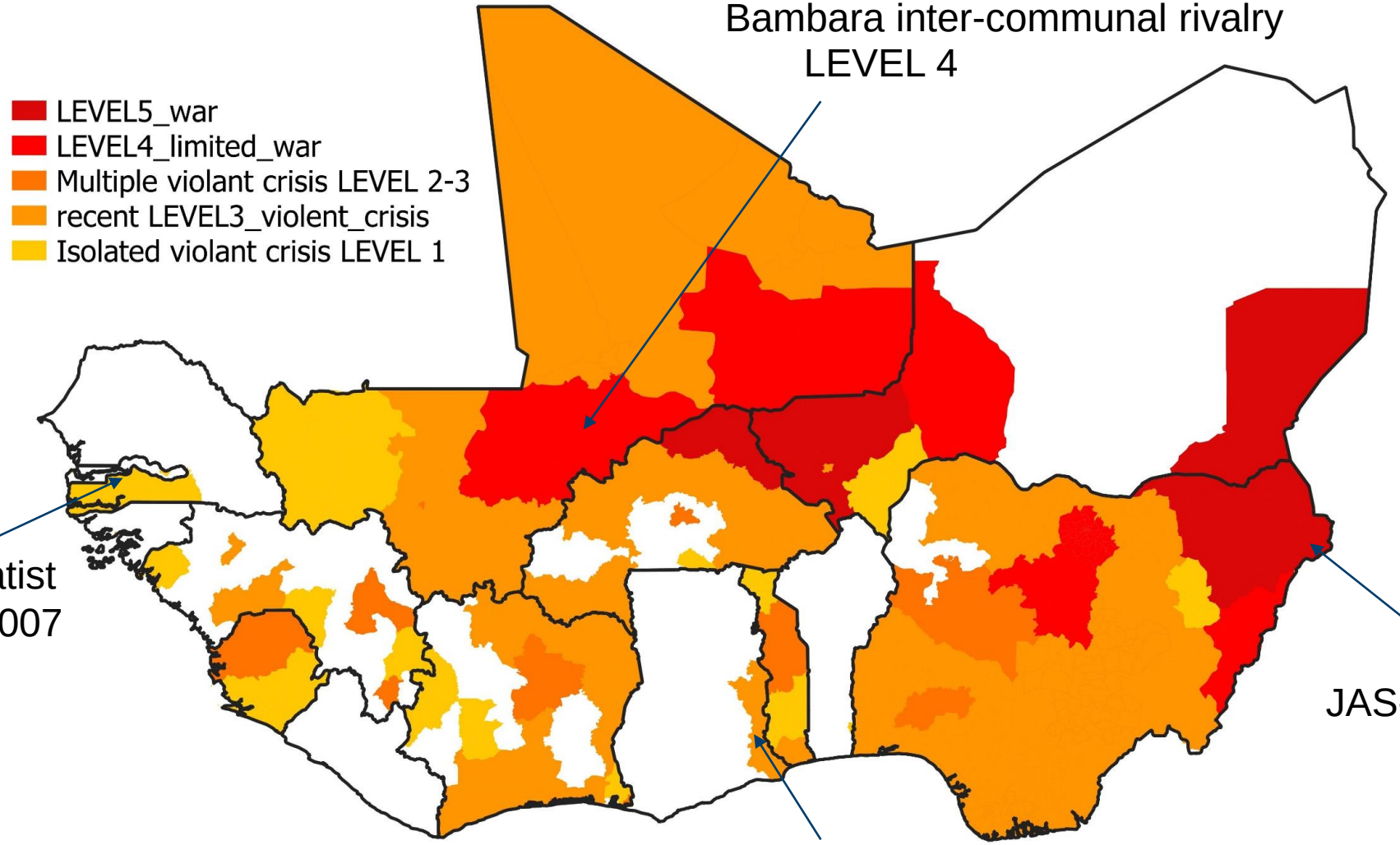
AFRICAN COUNTRIES CASES STUDY

Conflict risk



Bambara inter-communal rivalry
LEVEL 4

Casamance separatist
peace agreement 2007
LEVEL 1

JAS-Boko Haram
LEVEL 5

Western Togoland 2020 LEVEL 3

Based only on historical events from HIIK, 2020

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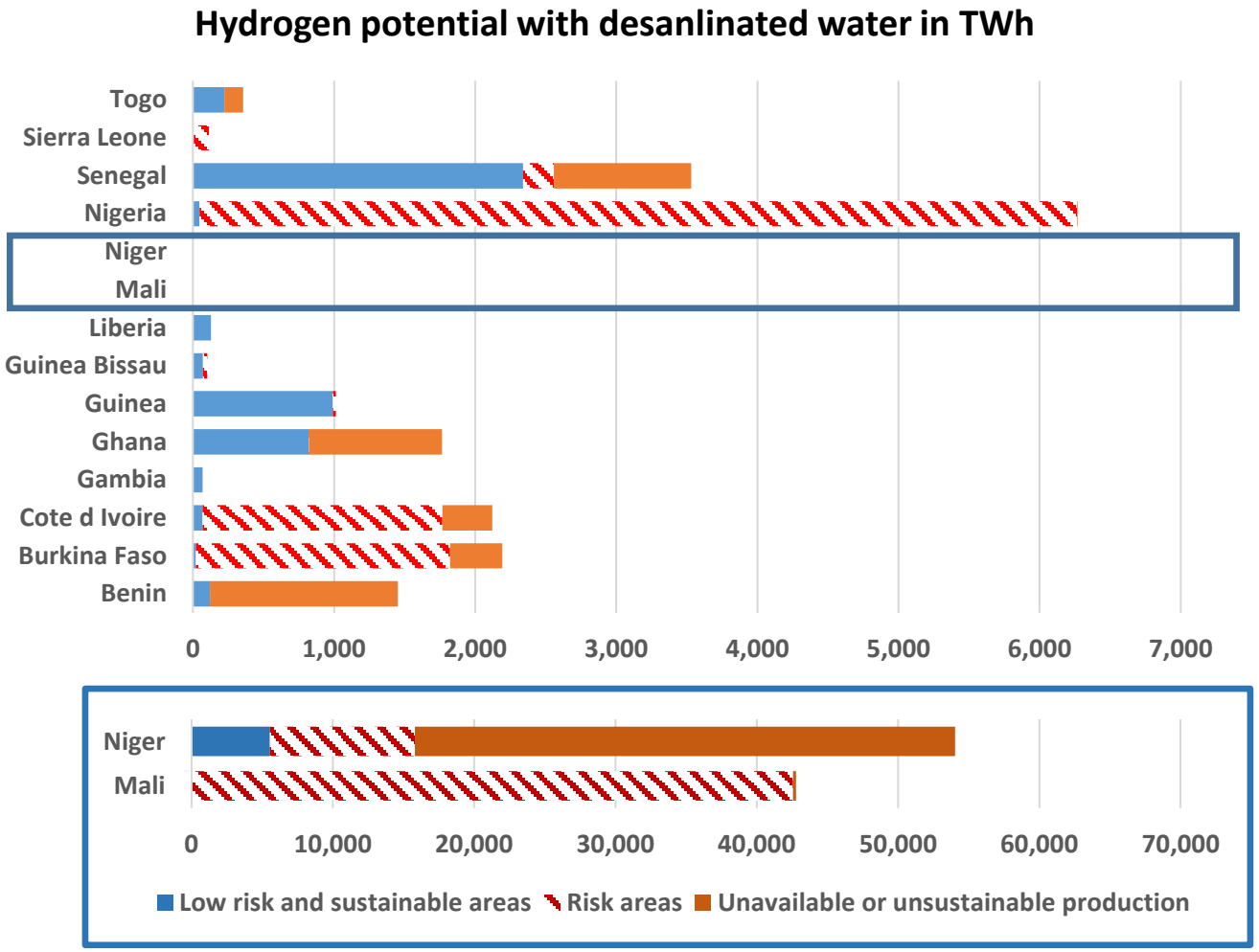
AFRICAN COUNTRIES CASES STUDY

Conflict risk

Nigeria and Mali are mainly impacted

Senegal with highest potential to risk zones



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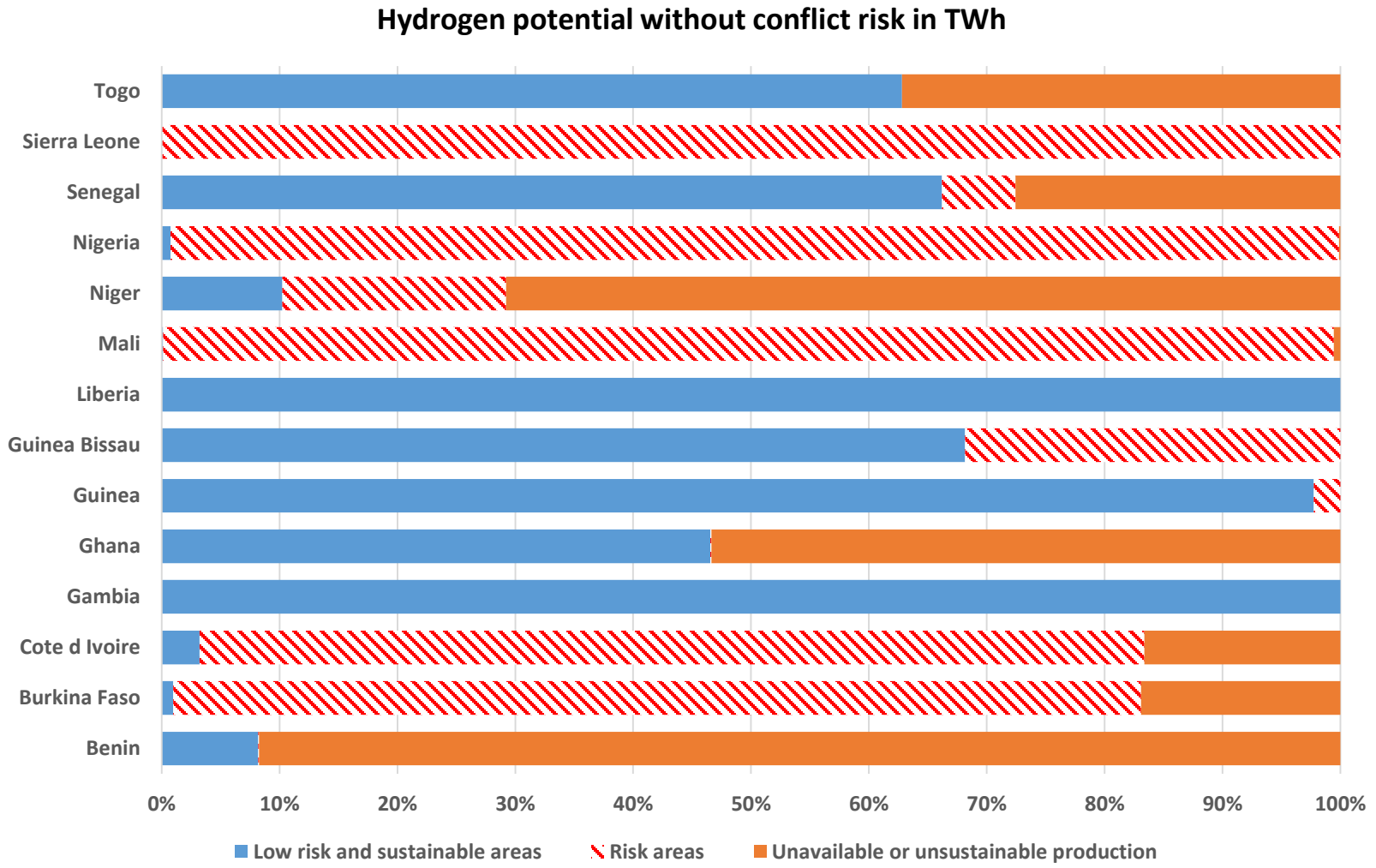
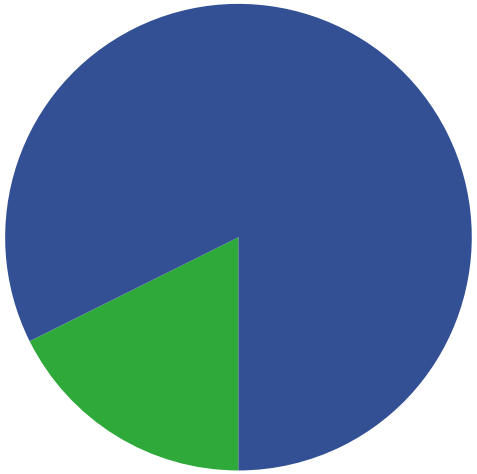


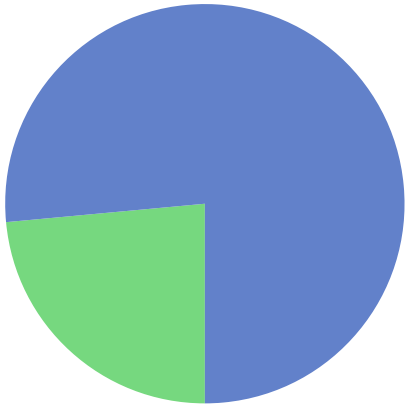
AFRICAN COUNTRIES CASES STUDY

Social risk



More than 50% of Energy for Hydrogen

Less than 50%



Hydrogen Export

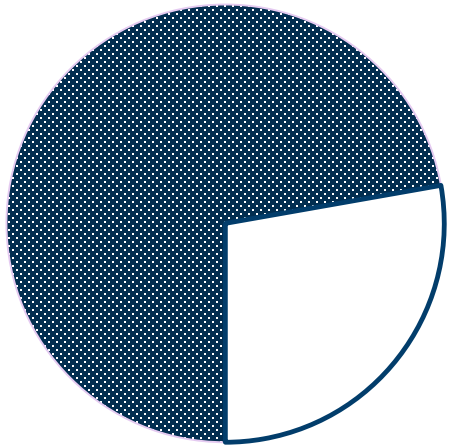
Electricity Access

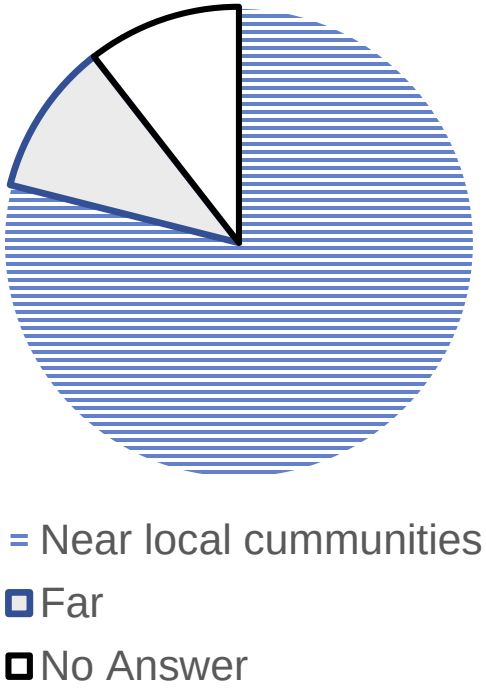
Less than 50% of new Renewable Energy should be used for Hydrogen Production/Export

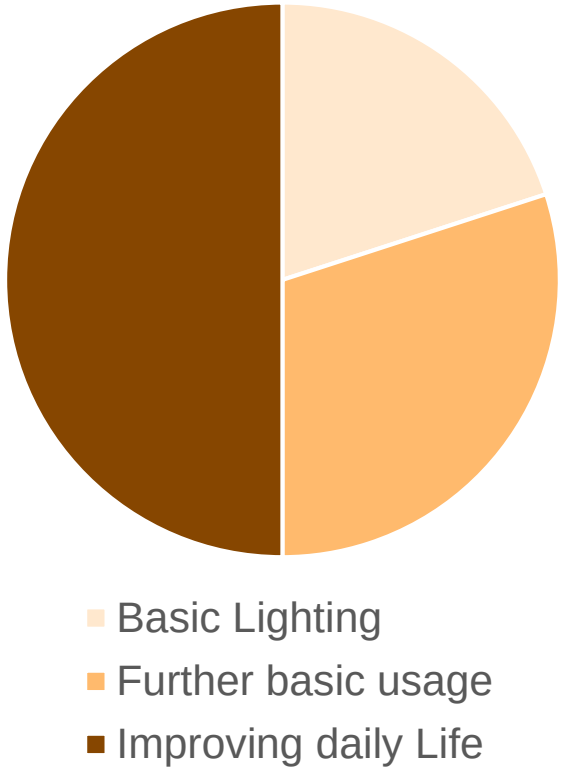
Based on surveys with WASCAL partners

AFRICAN COUNTRIES CASES STUDY

Social risk







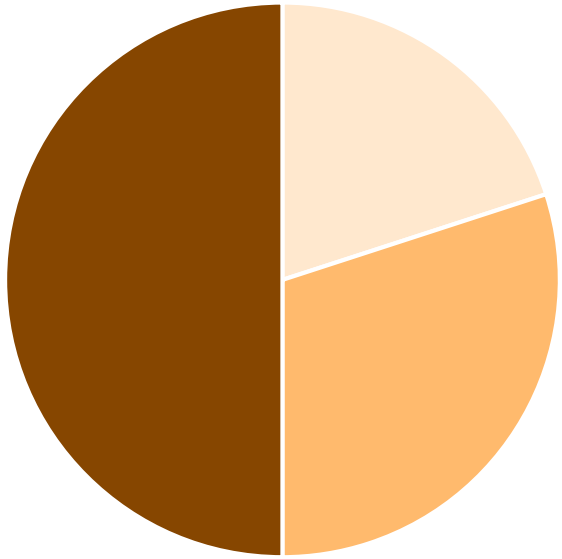
- Promote off-grid solutions
- Acceptance of RE

Based on surveys with WASCAL partners

AFRICAN COUNTRIES CASES STUDY

Social risk

Indicative services made possible by specified kilowatts of electricity	Task lightning + phone charging or radio	Tier 1 + General lightning + air circulation + television	Tier 2 + Light appliances
LEVEL OF ACCESS	**TIER-1**	**TIER-2**	**TIER-3**
Consumption per Household per Person	22 kWh	224 kWh	696 kWh



138 kWh/ household

Based on surveys with WASCAL partners

AFRICAN COUNTRIES CASES STUDY

Local use

- **High Interest** in Domestic Hydrogen Use

- Examples Domestic Hydrogen Use
  - Energy security (e.g. Energy Storage)
  - Reduce dependency on traditional biofuel

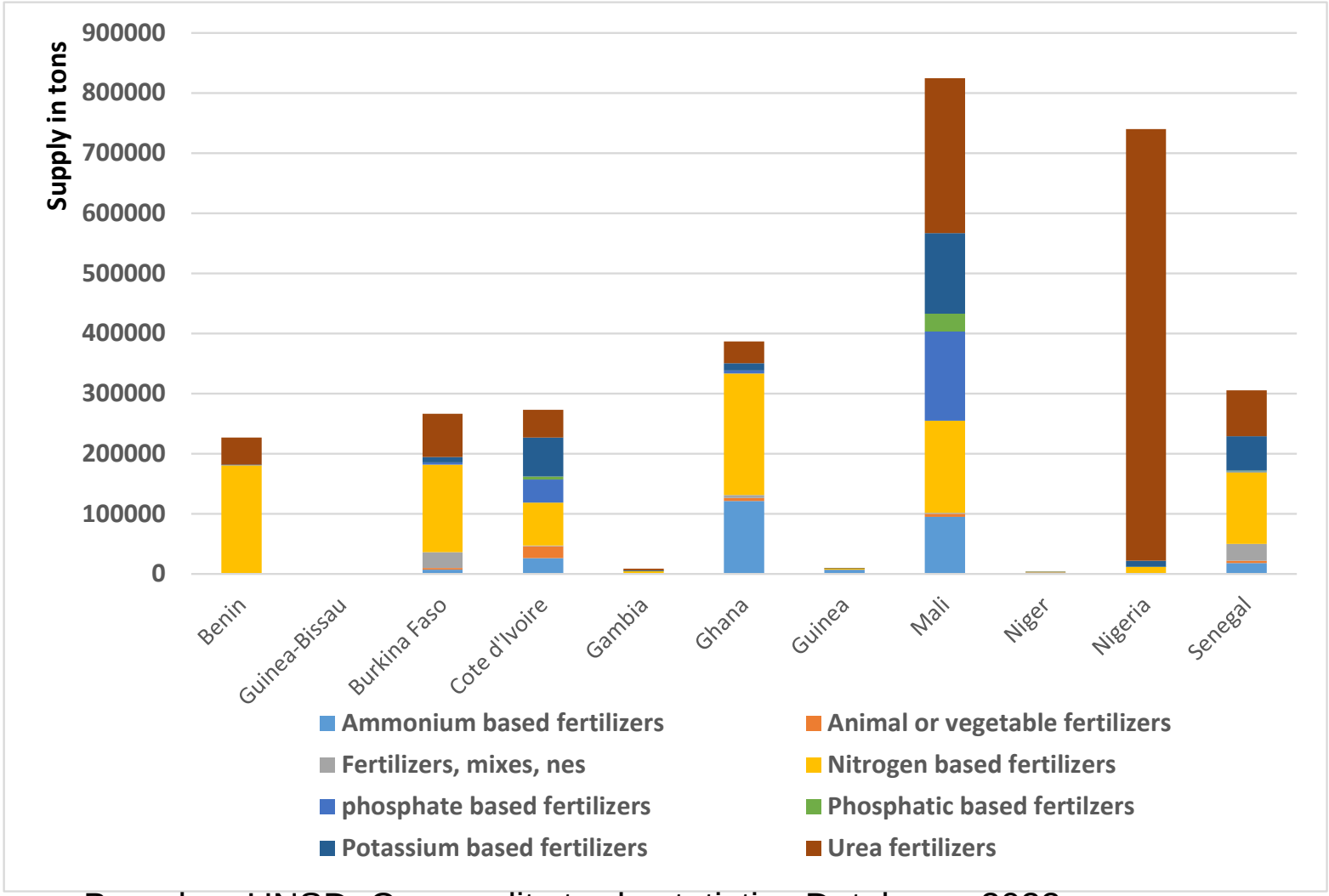
Based on surveys with WASCAL partners

AFRICAN COUNTRIES CASES STUDY

Local use

Fertilizer is mainly imported

Ammonia (nitrogen) based fertilizers mainly in use in Mali and Ghana

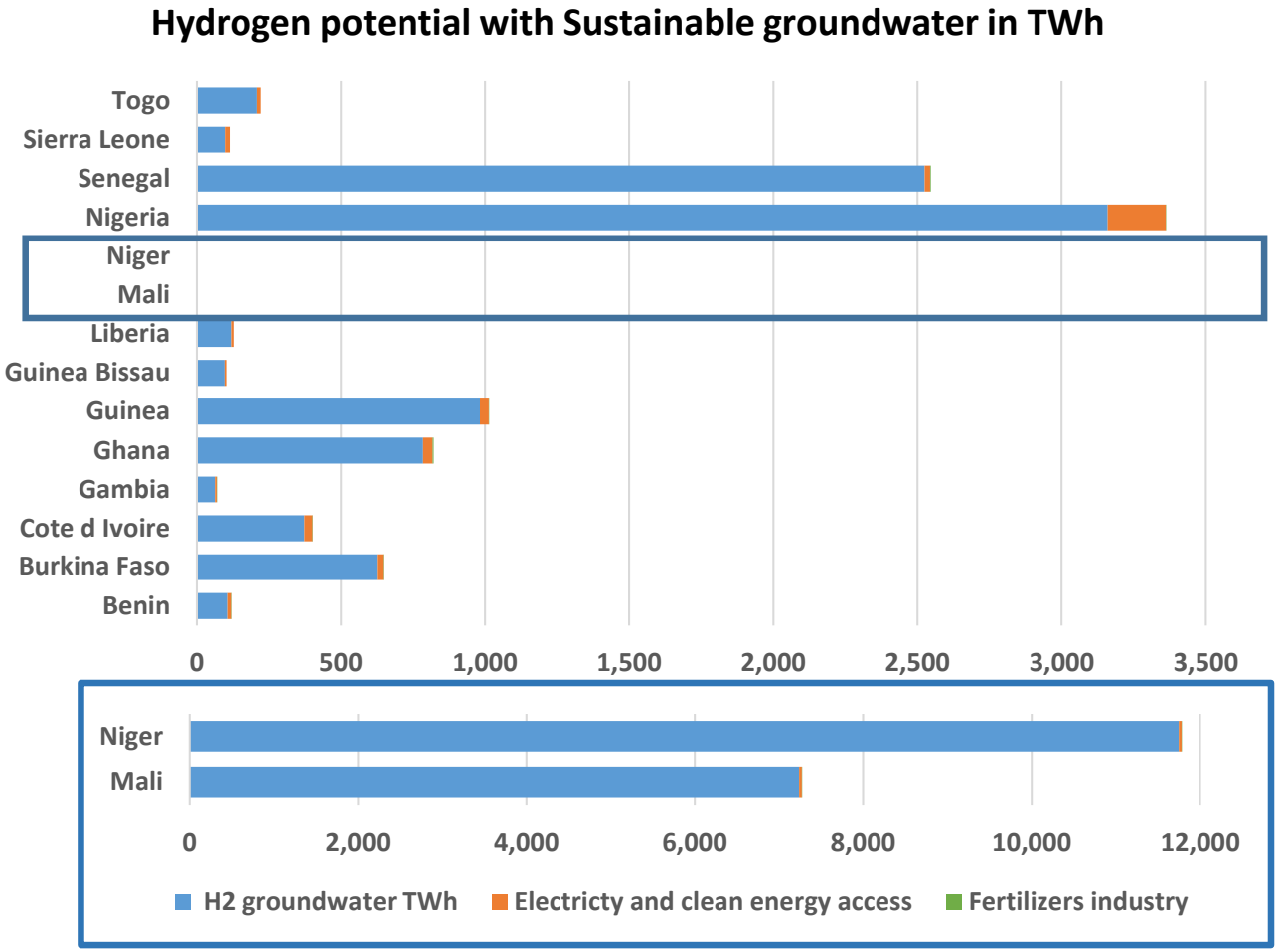


Based on UNSD, Commodity trade statistics Database, 2022

AFRICAN COUNTRIES CASES STUDY

Local use of electricity and green hydrogen

- Electricity and clean energy access is based on a direct use of electrification to promote universal access at a level of 696 kWh / household/ capita
- Fertilizers industry is based on hydrogen content equivalent of different types
- Both usage are based on recent imports and population counts



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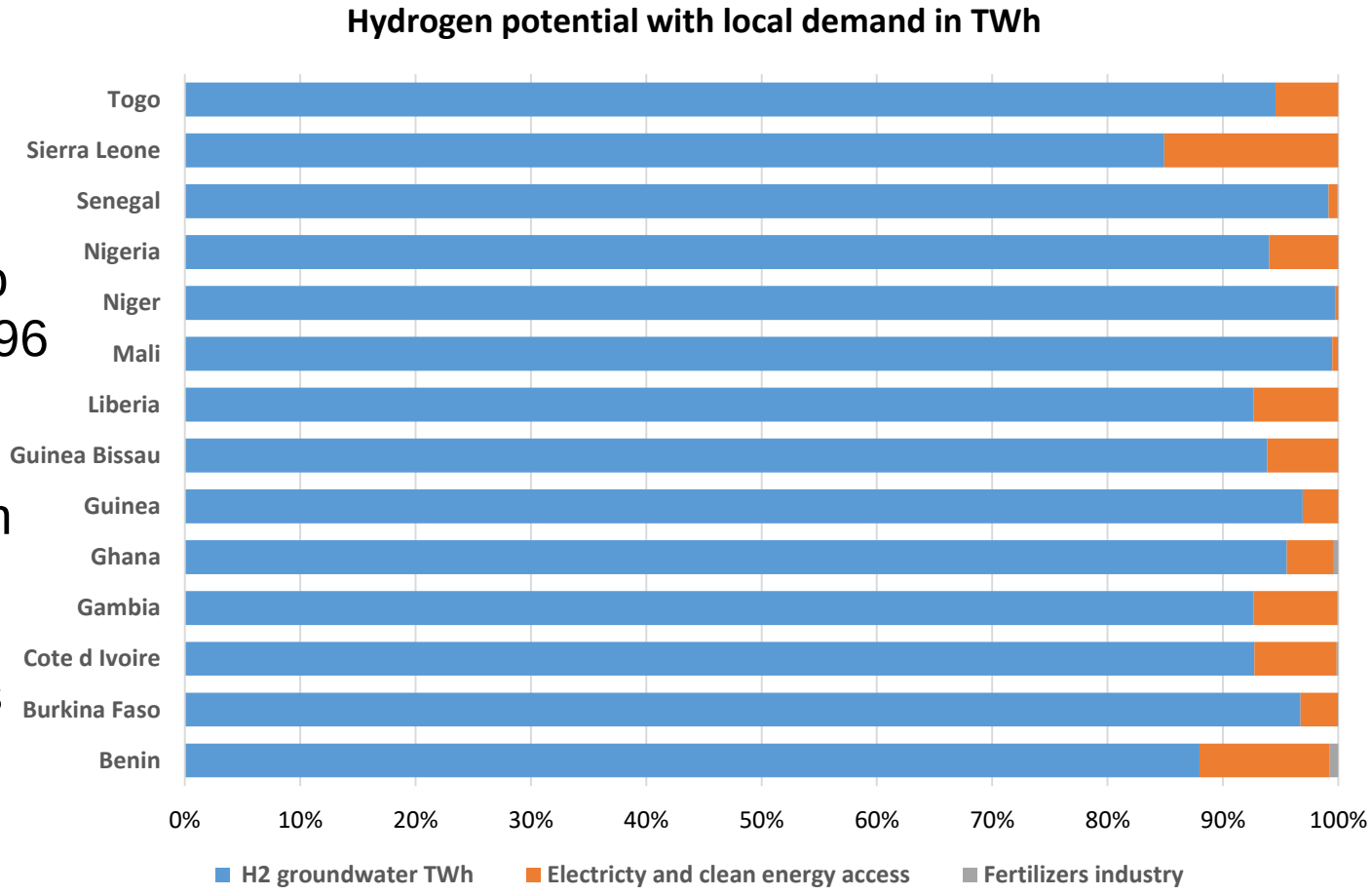
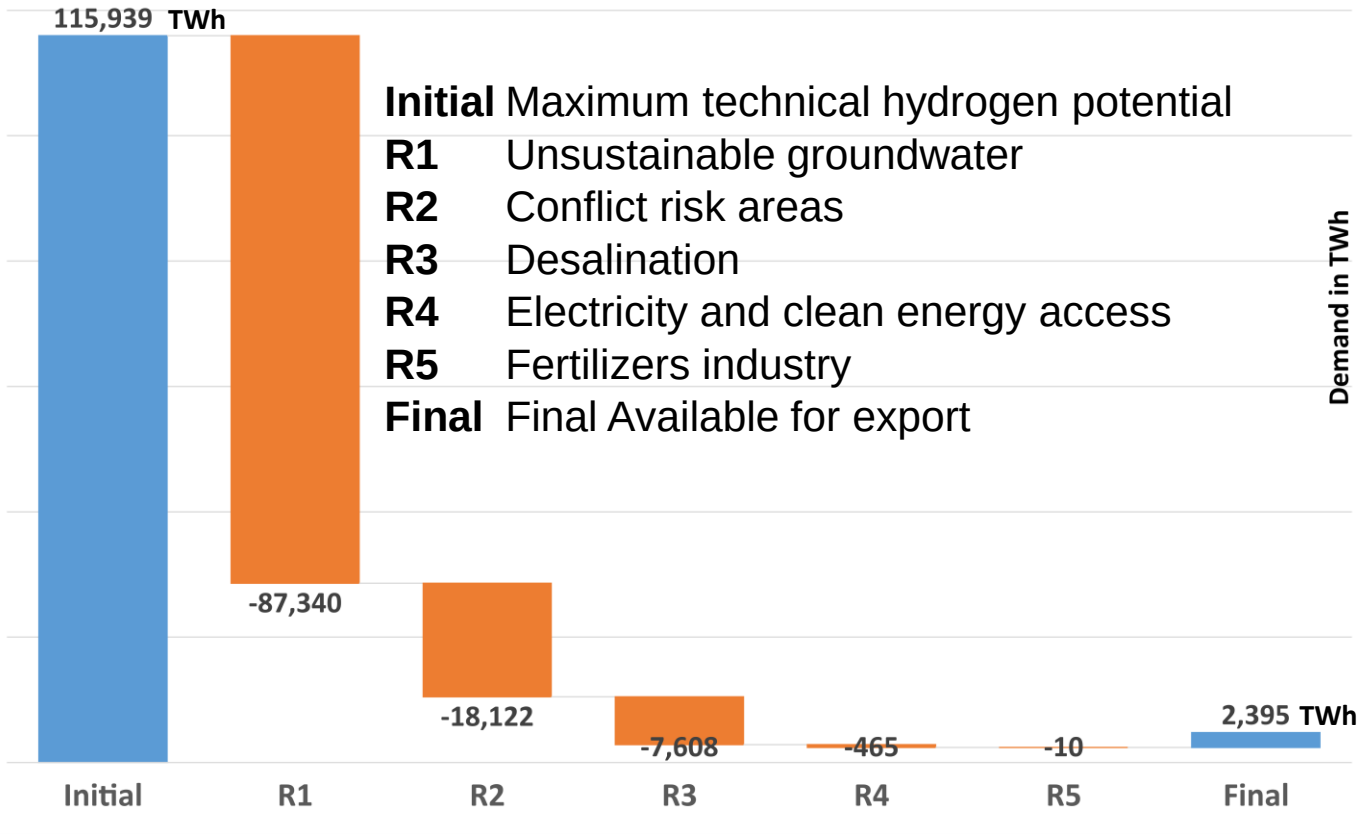
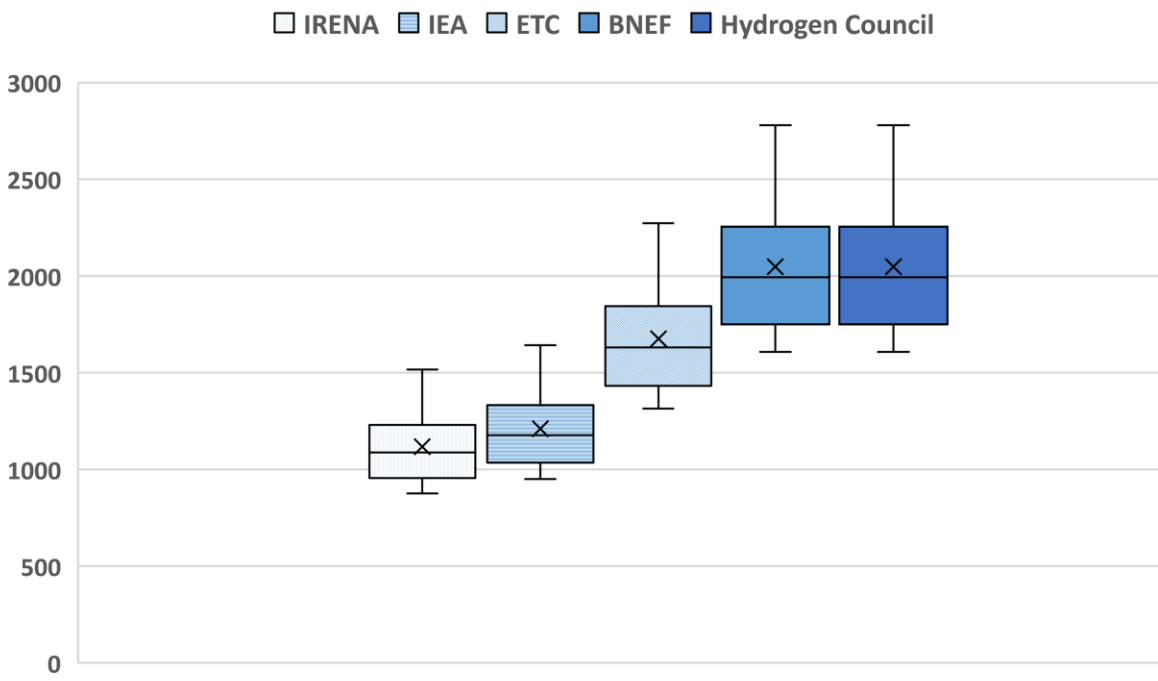


CONCLUSION

Final green hydrogen import potential from 14 African countries



Final hydrogen demand in EU by 2050



- Transport risk
- Other industries: Cement
- Energy policies conflicts

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