Advancing the Net-Zero Agenda through Regional Cooperation in Green Hydrogen in Asia

Hydrogen Development in India

Kerala – Towards a leadership position

IGES Institute for Global Environmental Strategies

23 August 2023

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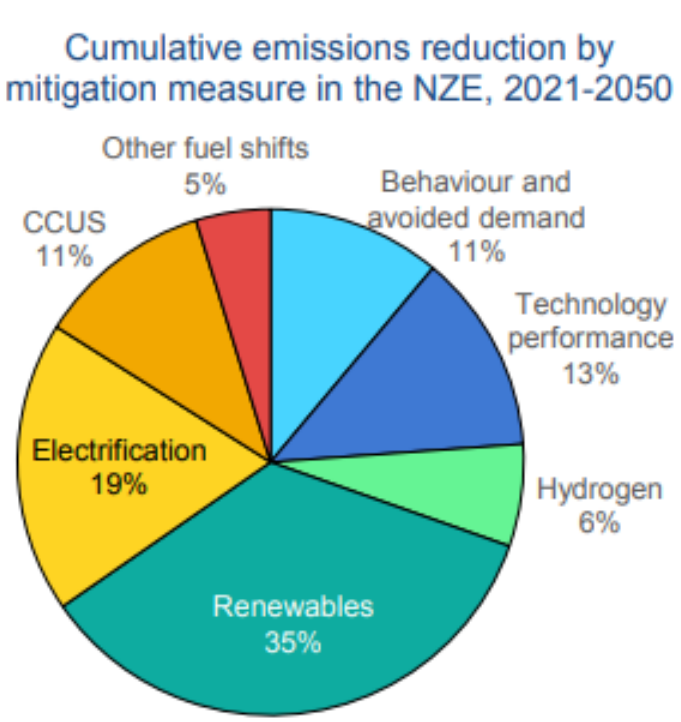
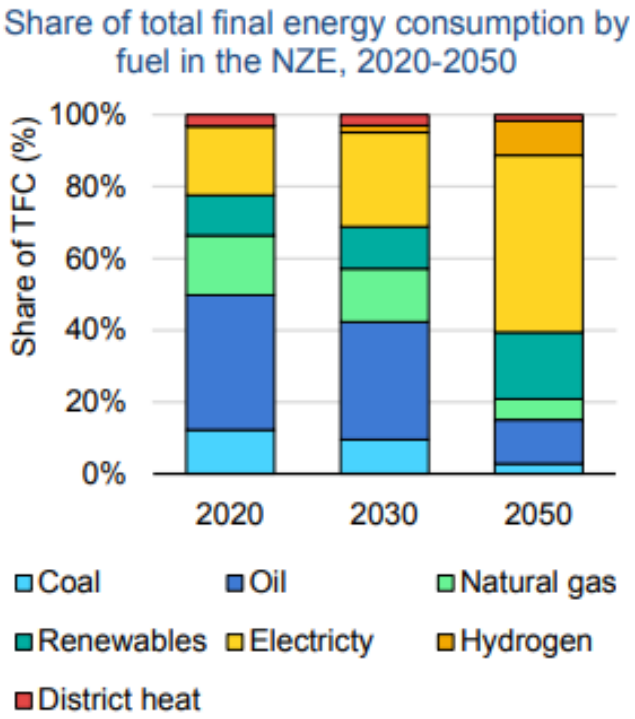
Role of H2 in Net Zero Emission 2050 pathway

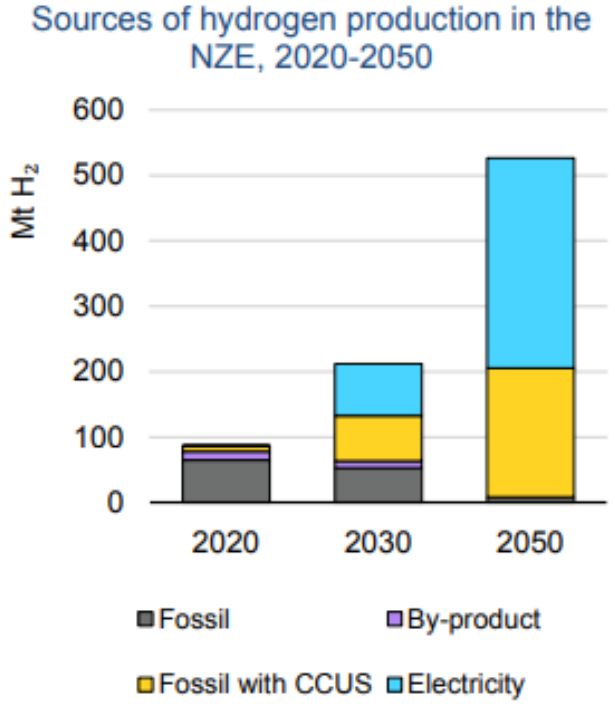
Hydrogen is estimated to contribute 6% in the cumulative emission reduction by 2050 in the Net Zero Emission 2021-2050 pathway (generated based on low-carbon technologies (such as electrolysis or fossil fuels with CCUS)

Hydrogen is estimated to contribute 10% in total final energy consumption by 2050

Global demand for hydrogen reached an estimated 87 million metric tons (MT) in 2020 and is expected to grow to 500–680 million MT by 2050. Electricity would be the major source of hydrogen production (~60%) in the Net Zero Emission 2050 pathway





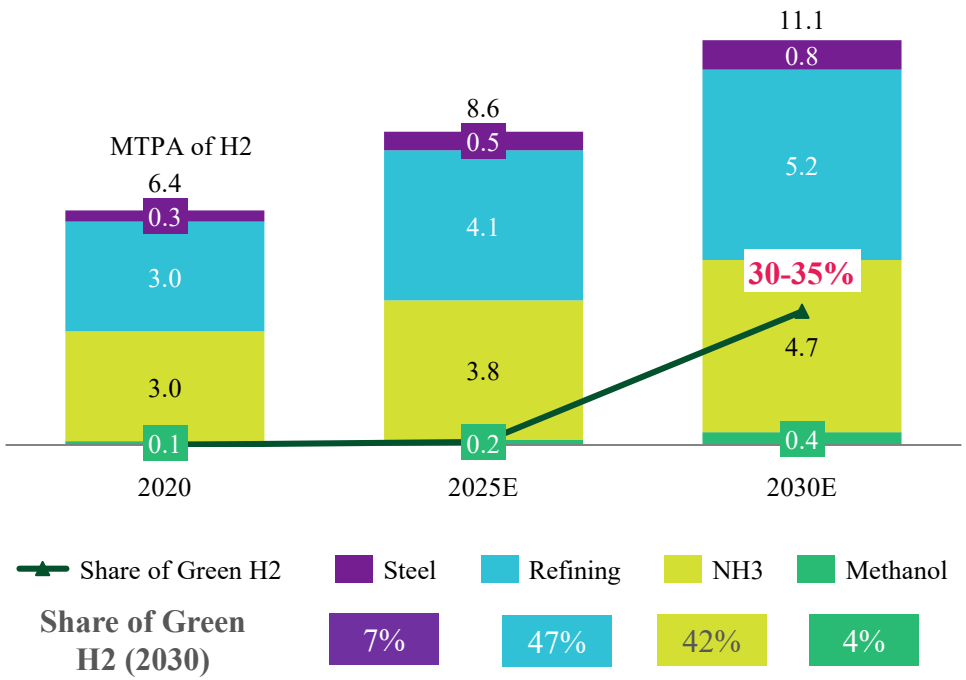


Source: IEA

India GH2 market projections

Indian Green H2 market expected to be 4-5 MTPA by 2030
..associated addition of 50 to 75 GW Renewables and 25 GW electrolyzer

Green H2 demand (est.) to be driven by large industrial use cases



1. GW market size considering 30-35% H_2 is supplied via electrolysis by 2030
Source: Niti Aayog, MNRE, IH2A, IRENA, H_2 usage per sector output, BCG analysis
Assumption: 57% CUF, balance ~40% grid

Several initiatives being assessed to drive Hydrogen adoption

Supply/ Cost-side initiatives

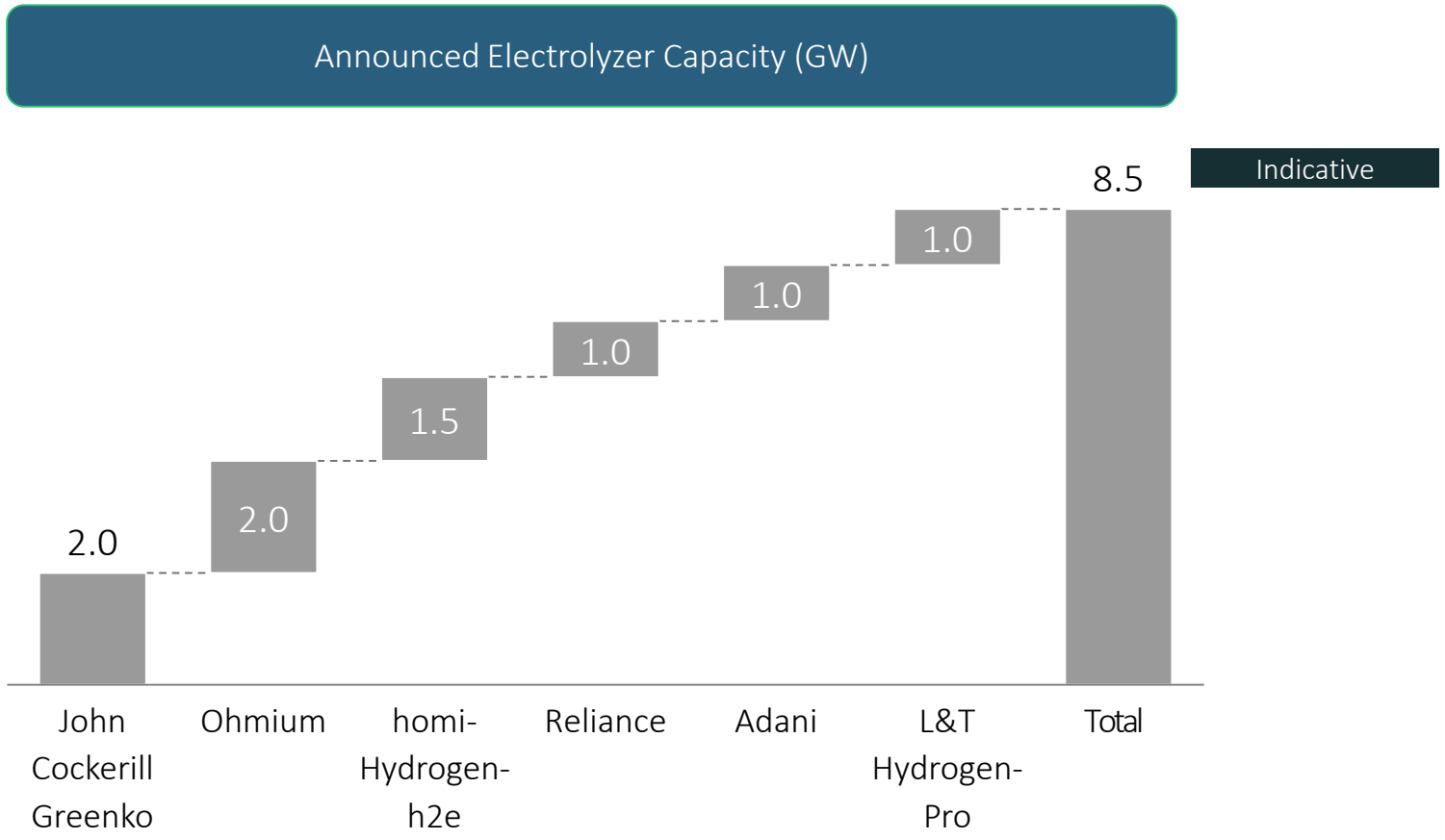
- Waiver on Import duty for electrolyzers
- Waiver on ISTS charges for 25 years
- PLI incentives (₹ 19,744 cr) for Green H2 (~est. ₹ 4590 cr for electrolyzer)

Demand-side initiatives

- Green hydrogen purchase obligation (GHPO) / consumption based model for fertilizers, steel, petchem etc.
- Demand aggregation model under consideration

India GH2 market projections

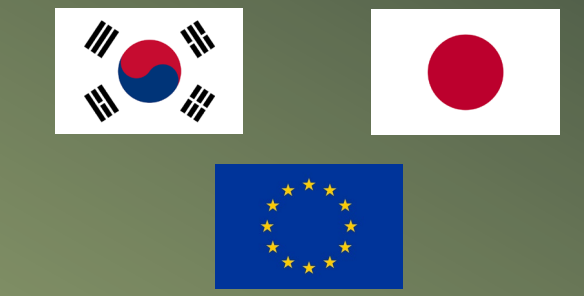
Significant momentum gearing up in announced Electrolyser 2025 capacity plans



Source: Niti Aayog, Rystad Energy Research

...Exports market will be key for Indian players

Net Importers



India GH2 market projections

India's competitiveness on price will depend on incentives; however, scale advantage to benefit India

2023 prices

	India	Australia	Oman & Saudi Arabia	USA
RE addition in last year (GW)	15.75 ↑	2.75	<1	~71 ↑
Total Renewable energy capacity (GW)	105	37	<2	~296

- India and USA well positioned in renewable energy adding capacities at a faster pace
- Other regions / countries like Australia, Oman and Saudi Arabia have announced large projects:
  - To match this, their capabilities to build evacuation infrastructure at GW level, availability of labour, environmental clearances and EPC skills sets needs to come at a faster pace

Source: IEA, IRENA & BCG Analysis

India GH2 market projections

Indian Corporates leveraging partnerships/ scale pilots to embark on Green H_2 journey

Non-exhaustive

RE Developers

Greenko uniper

Greenko to supply 250 ktpa to Uniper in EU from 2025

ACME Leading Through Innovation YARA Scatec

Yara, Scatec and Acme *signed term sheet for* Green Ammonia project in Oman with 1st phase of 100ktpa offtake

Infrastructure players

GAIL Cummins

Pilot to ***blend H_2 in NG network*** (MP) ***4.3TPD Green H2 plant*** by Nov 2023 using PEM electrolyzer by Cummins and EPC by Technimont

ऑयल इंडिया लिमिटेड Oil India Limited

100 kW AEM based green H2 plant with 10 kg / day *commissioned in Apr 2022 in Jorhat (Assam)*

GUJARAT GAS एनटीपीसी NTPC

5% H2 blending in CGD *at NTPC township in Hazira with 6.5 kW PEM electrolyzer with green power from floating solar plant*

End-use industries

Reliance Industries Limited ASHOK LEYLAND

H2-ICE truck (19-35 tonne) along with Ashok Leyland showcased in IEW; to be rolled out to 45000 trucks

JSL JINDAL STAINLESS

75TPA of green steel in Haryana in partnership with Hygenco

L&T commissions 800 kW electrolyzer (380 kW Alkaline and 420 kW PEM) to produce 45 kg / day in Hazira, Gujarat

EPC & technology

Hydrogen pro

JV with Norway's HydrogenPro to manufacture Alkaline electrolyzers

ohmium

Set-up 0.5 GW/ annum PEM ***electrolyzer mfg. facility*** in Bengaluru, to be expanded to 2 GW/ annum

Greenko John Cockerill

JV with John Cockerill to setup 2GW alkaline electrolyzer mfg. facility in Kakinada; *140 MW ordered for Una site in HP*

Emerging role of India and Kerala in global GH2 demand supply scenario

India Advantage

India – Emerging global hub for production and export of cost effective GH2

1. High RE potential
2. Low cost of generation of renewable energy
3. High availability of rainfall
4. Favorable manufacturing policies and ecosystem
5. Ease of doing business
6. Emerging R&D and skilling destination

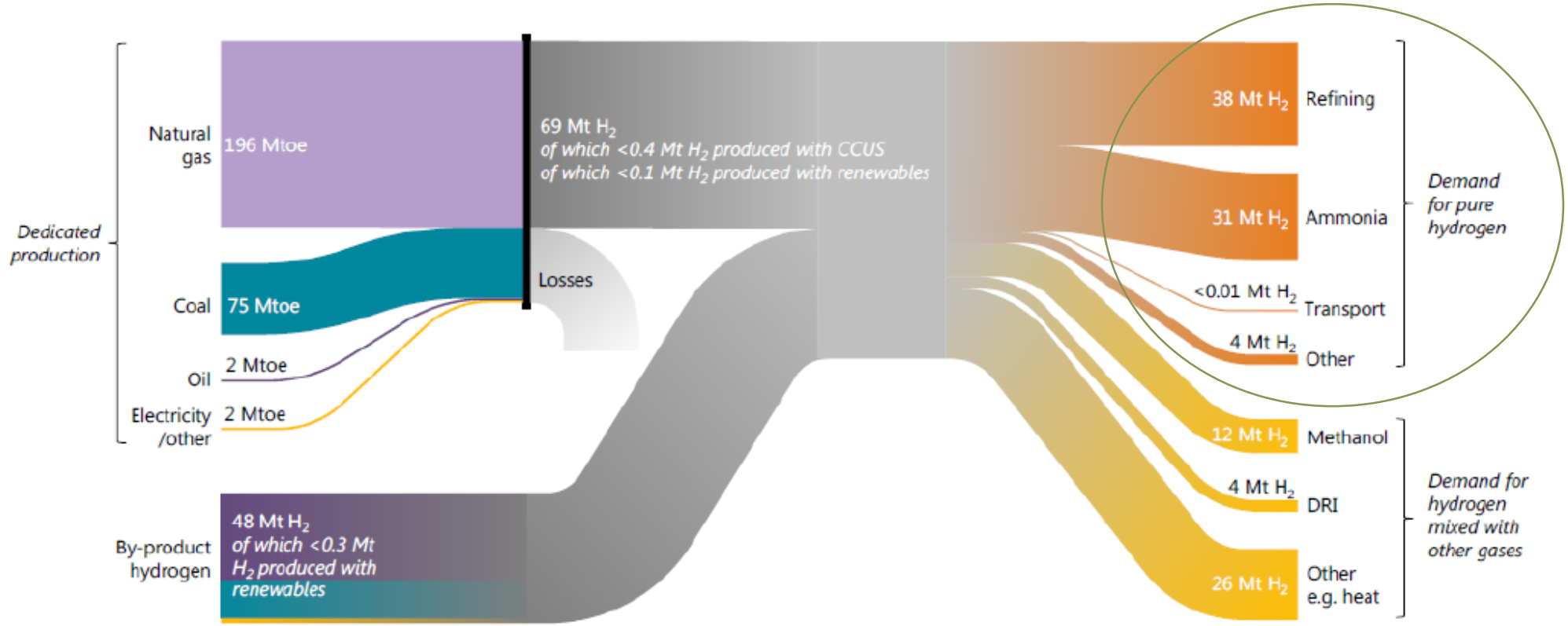
Kerala Advantage

Kerala – Emerging hub for production and export of cost effective GH2 in India

1. High RE potential- Solar (Ground mounted-6.1GW, Floating Solar- 6.5GW), Pumped Storage (9GW) in addition to Wind and Tidal potential
2. Availability of rainfall (>250 cm annual average)
3. 3000 TMC of water sources
4. Strategic location for export- access to 2 major ports at tip of sub-continent and 17 minor ports
5. Forward looking policies- ESG Industrial Policy, GH2 Policy, Floating Solar Policy, e Mobility Policy, Solar and Small Hydro Policy, PPP policy
6. Significant Domestic demand- FACT (~500 TPD), BPCL (~120 TPD), Petronet LNG Pipeline (~850 TPD*), CIAL, KMRL, KSRTC etc.
7. Discussions ongoing with Port of Hamburg for export of GH2 from Kochi GH2 Hub

*Assuming 25% blending in 5MMTPA pipeline capacity which is currently operating @25%

Supply and demand for hydrogen globally, 2018



- Refinery (30%) and Ammonia (Fertiliser) (25%) are the key demand sectors for pure Hydrogen globally with 38 MT and 31 MT respectively.
  - Of this, only <0.4 MT H2 is produced with CCUS
  - Only <0.1 MT H2 is produced with renewables
- Natural Gas and Coal are the major sources for production

Source: IEA

India: Annually 160 bn. US$ increasing imports of fossil fuels!

India: +8 Mn tons / year grey hydrogen consumption around 10 % of global demand

Crude Oil	Natural Gas / LNG	Coal	Petroleum Products*	Ammonia
				
• USD 112 Billion • 227 Million Tons	• USD 9.6 Billion • 27 Billion SCM	• USD 23.6 Billion • 243 Million Tons	• USD 16.2 Billion • 32.5 Million Tons	• USD 775Million • 2.6 Million Tons
Hydrogen potential				

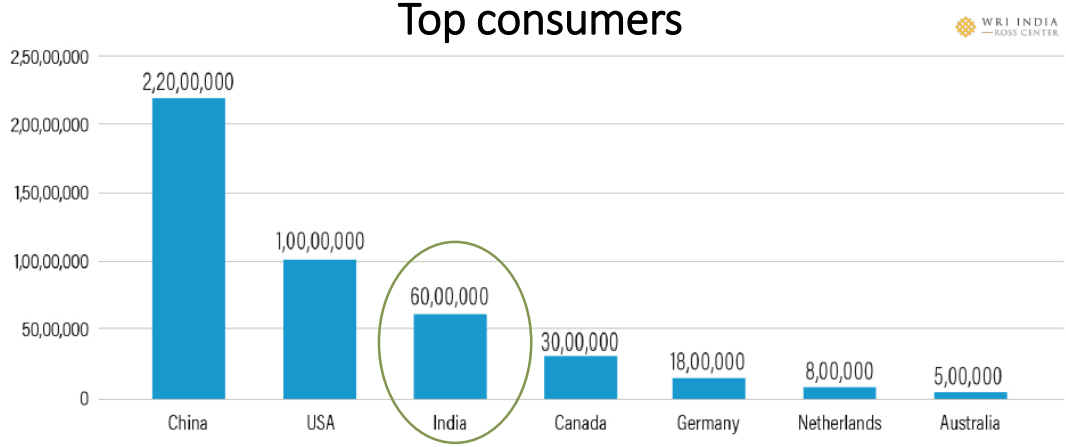
* India exports around 65 MT of petroleum products ($36 Billion USD)

Share of imports: 80% Oil; 50% Natural Gas; 25% Coal

- India's +8MT/annum demand for Hydrogen is around 10% of global demand
- Of this, +6 MTs annual production of grey H2 & +2 MTs imports (via fertilizer/Ammonia)

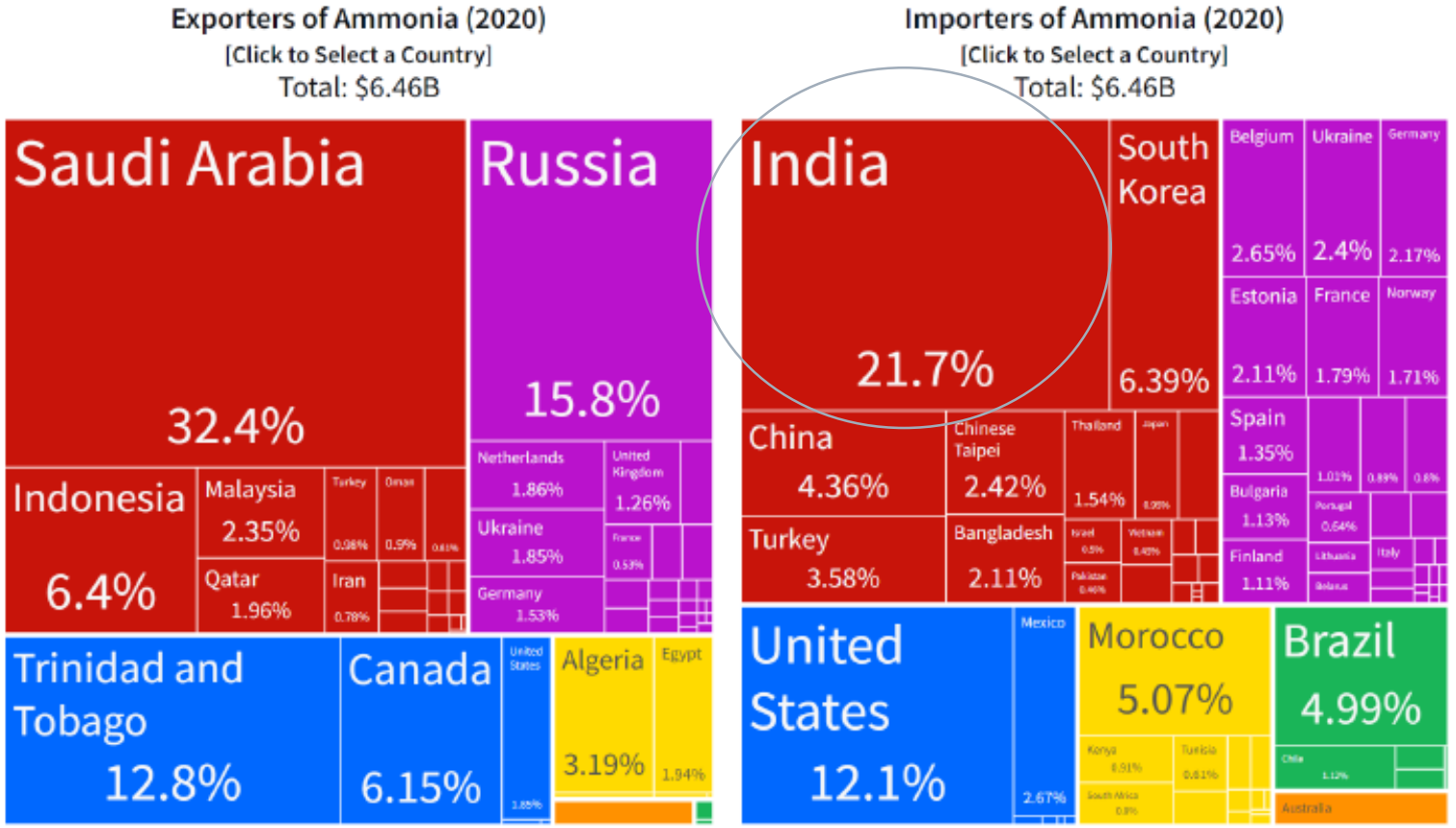
Goal: H2 produced based on natural gas (imports) to be replaced by Green H2

Top consumers



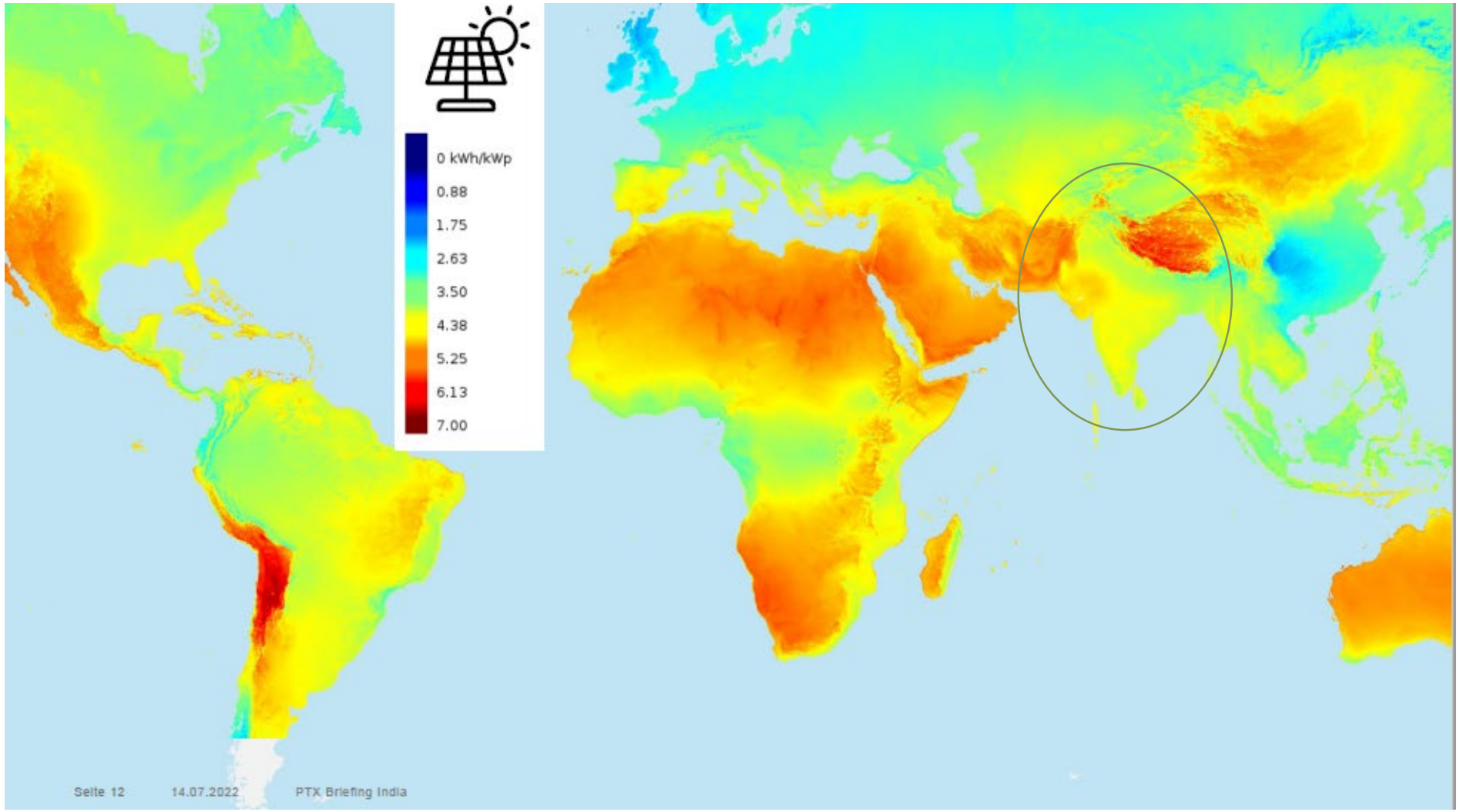
Source: PtX, NITI Aayog, WRI

India is the largest importer of grey hydrogen-based ammonia in the world



Source: Observatory of Economic Complexity

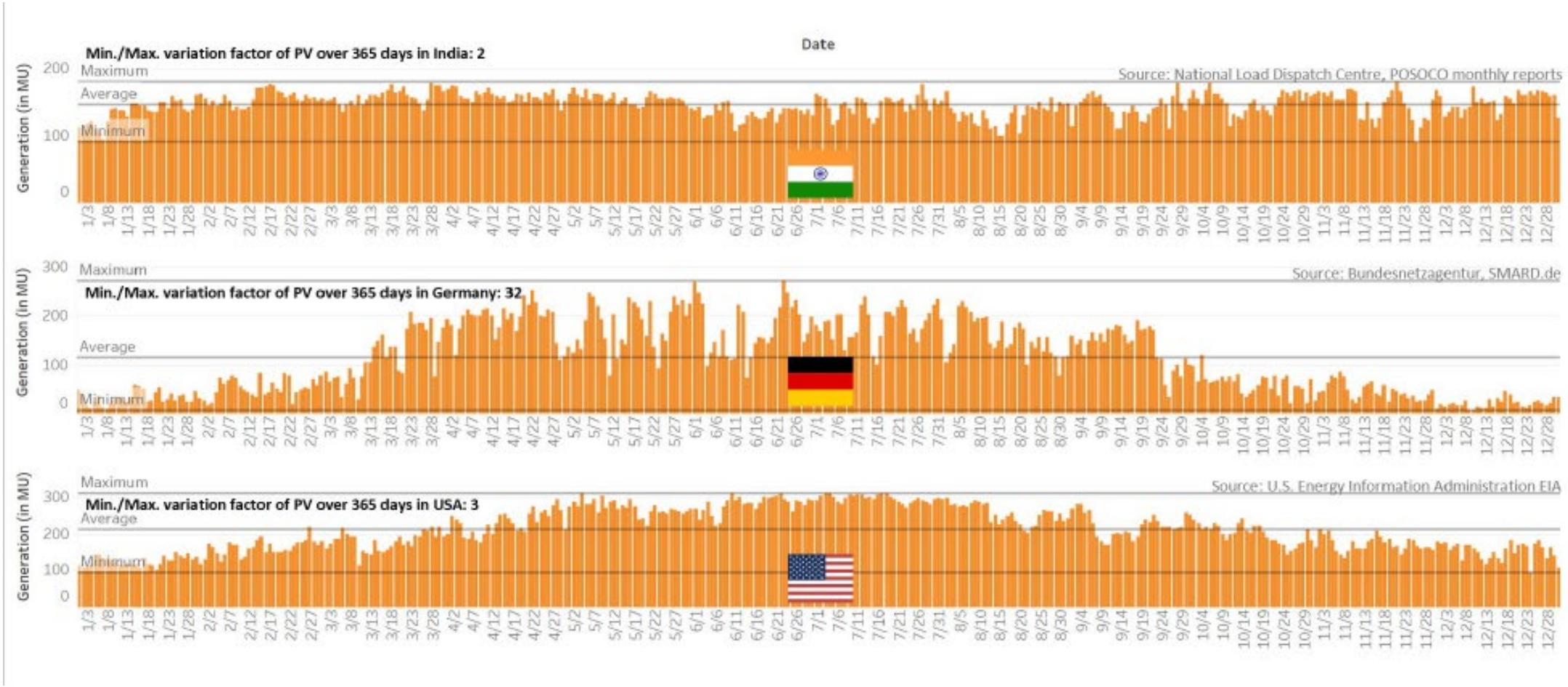
Excellent RE Resources in India



Source: PtX

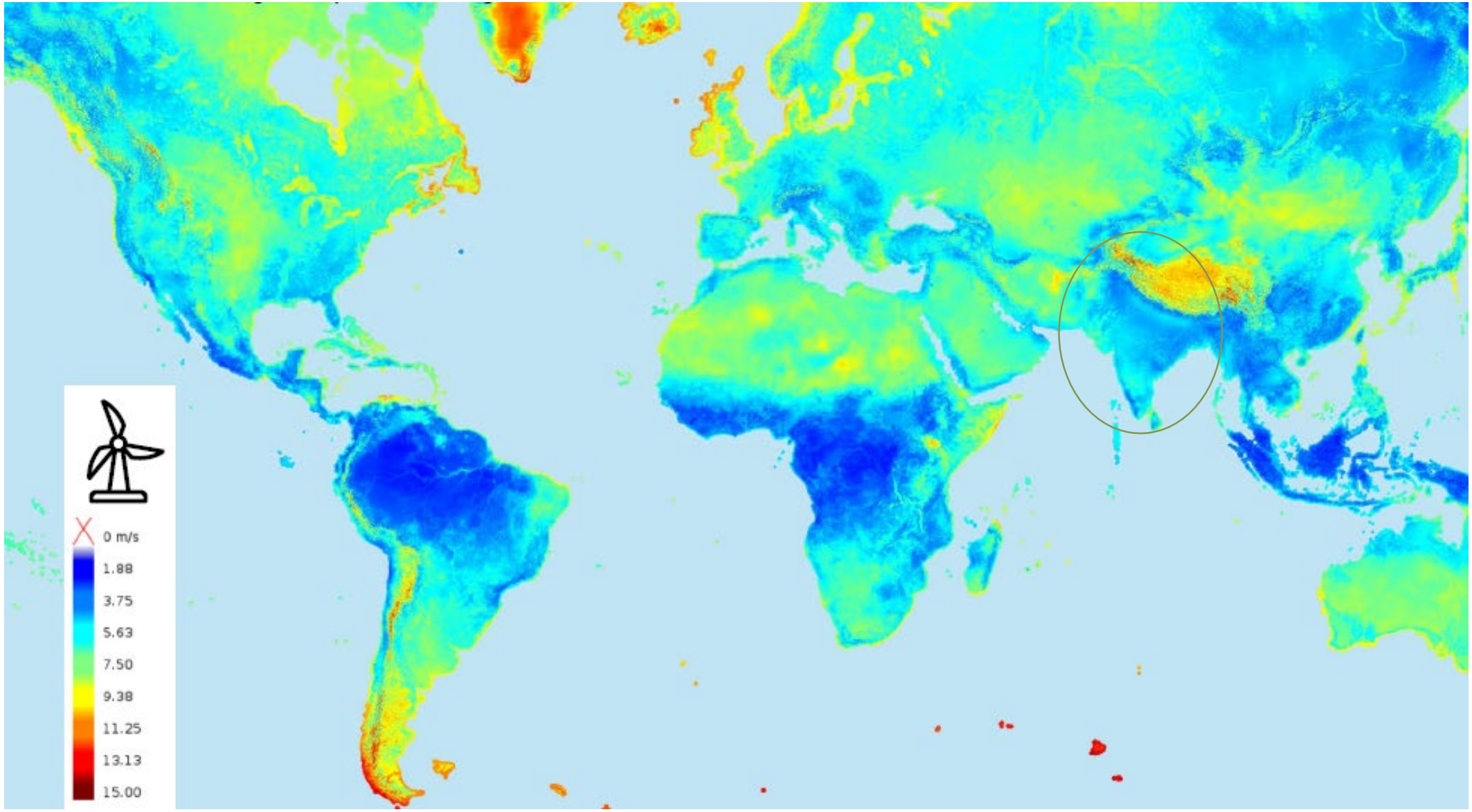
India has high solar energy security

Almost 365 days of higher PV generation in India in comparison to Germany and USA in 2020



Source: www.energyforum.in

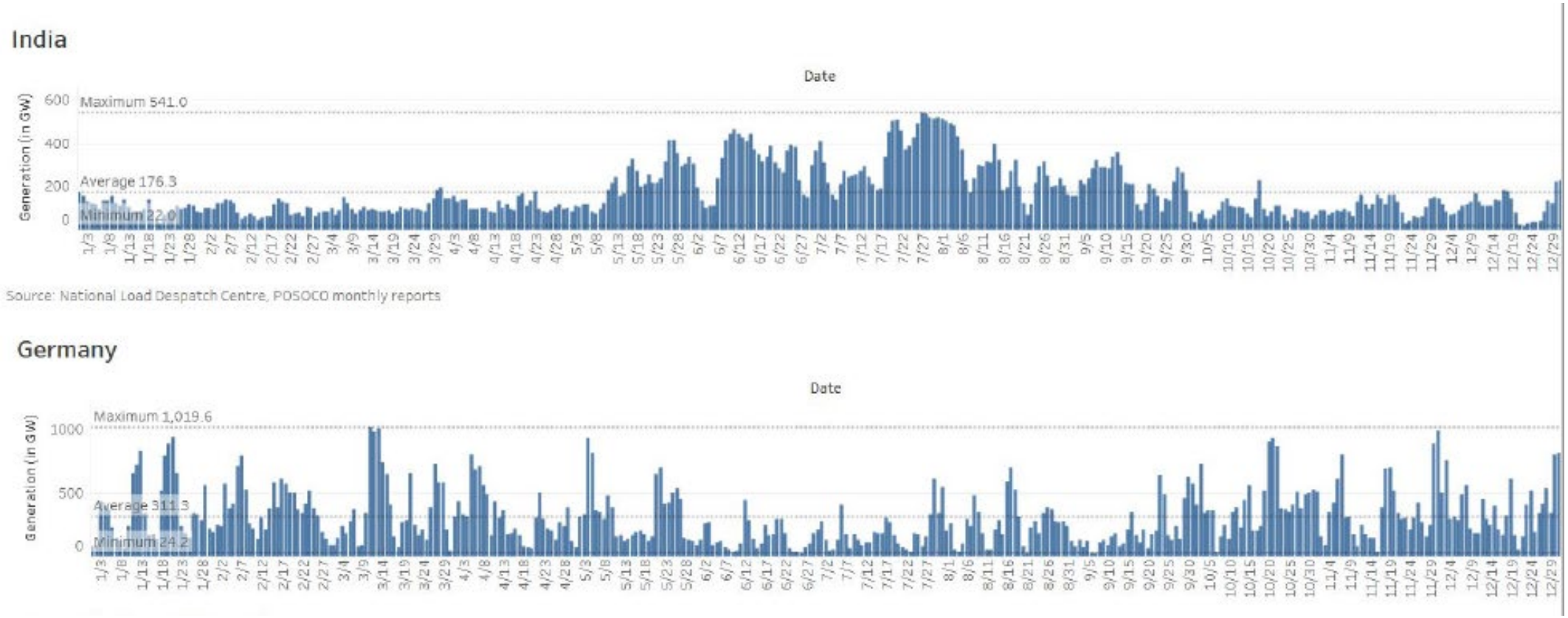
Global annual avg. wind speed, 100 m height



Source: Global Wind Atlas 1.0

Good wind conditions

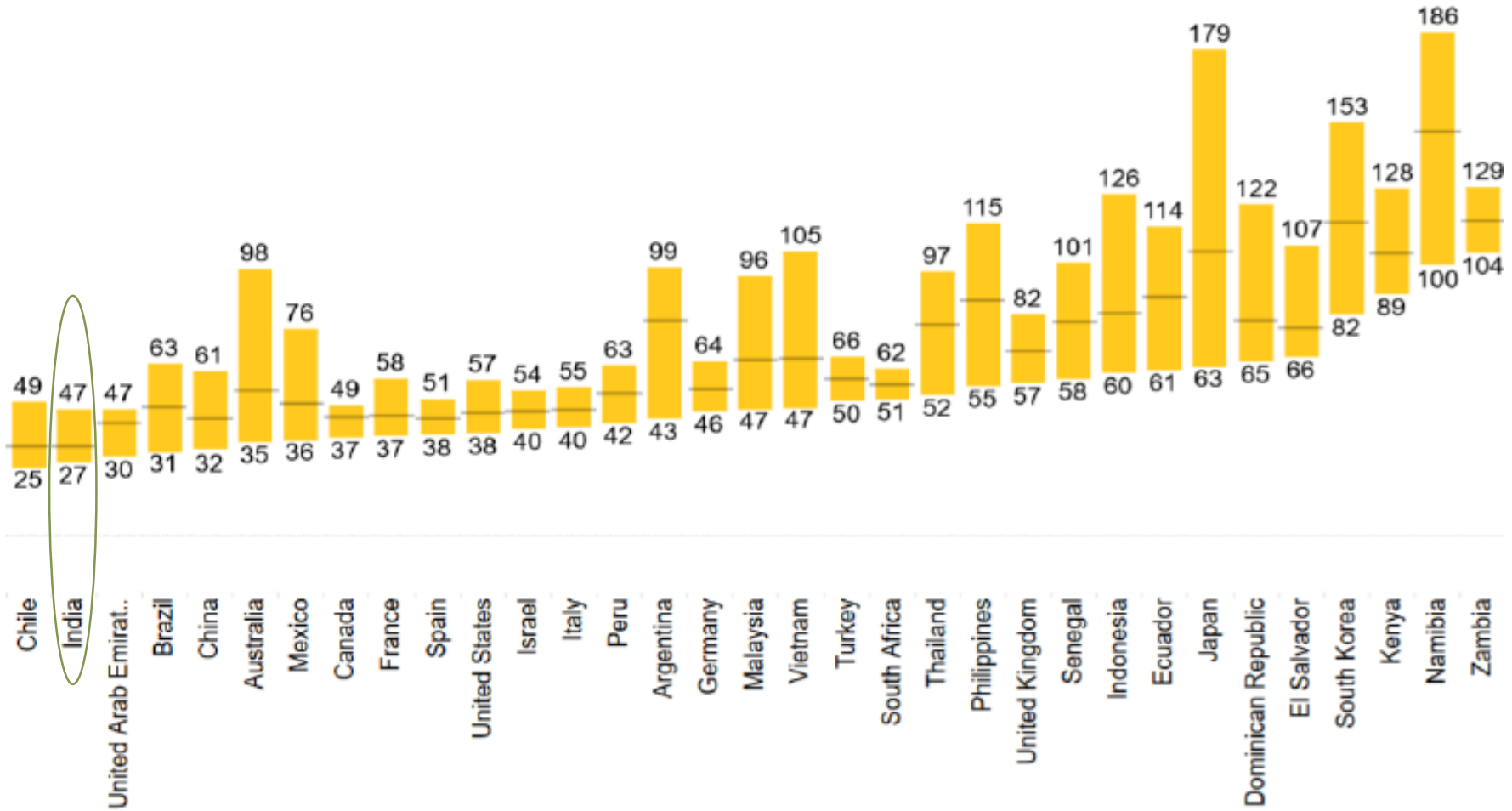
Good wind generation profiles over 365 days from wind in India Vs Germany



Source: PtX, NLDC, SMARD.de

India generates solar power at world record low cost

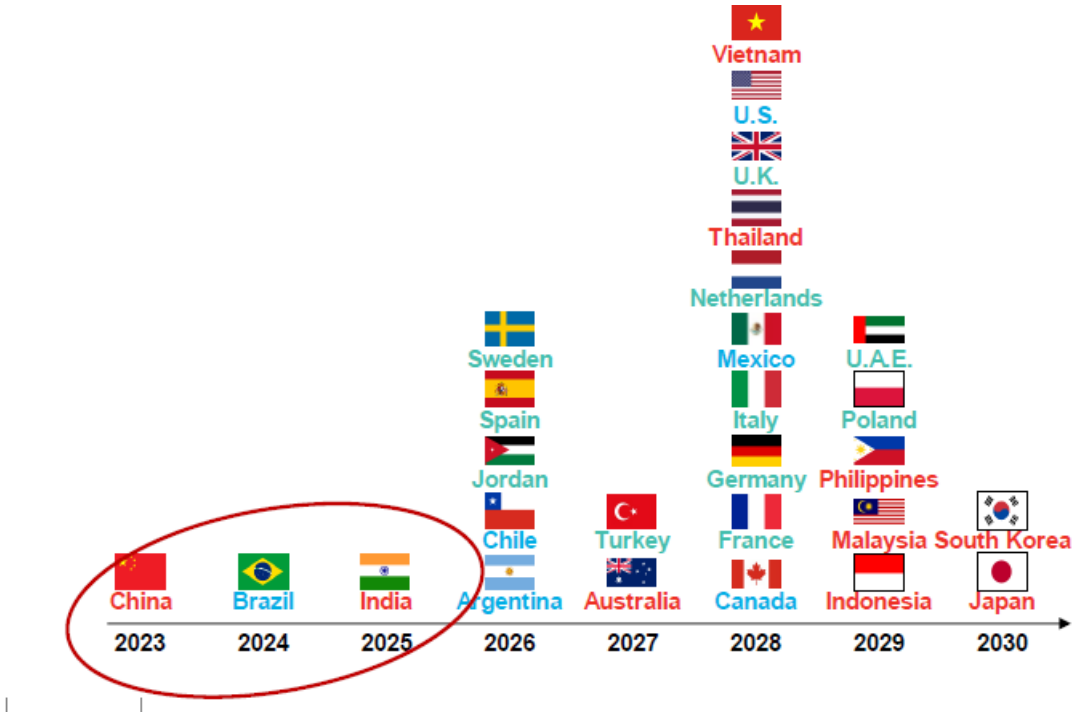
Comparison of cost (LCOE in USD/MWh) in 2022

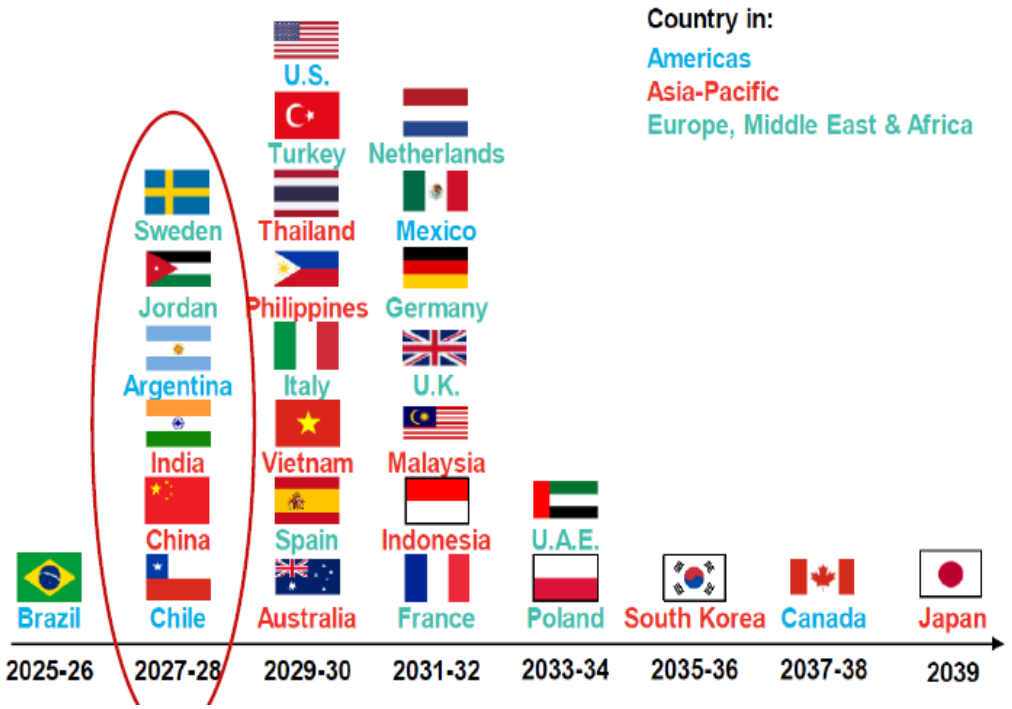


Source: PtX, Quelle: BNEF 2022

Green H2- Competitiveness

Green H2 from renewables to be competitive with blue H2 from gas in 2025 and grey hydrogen in 2027



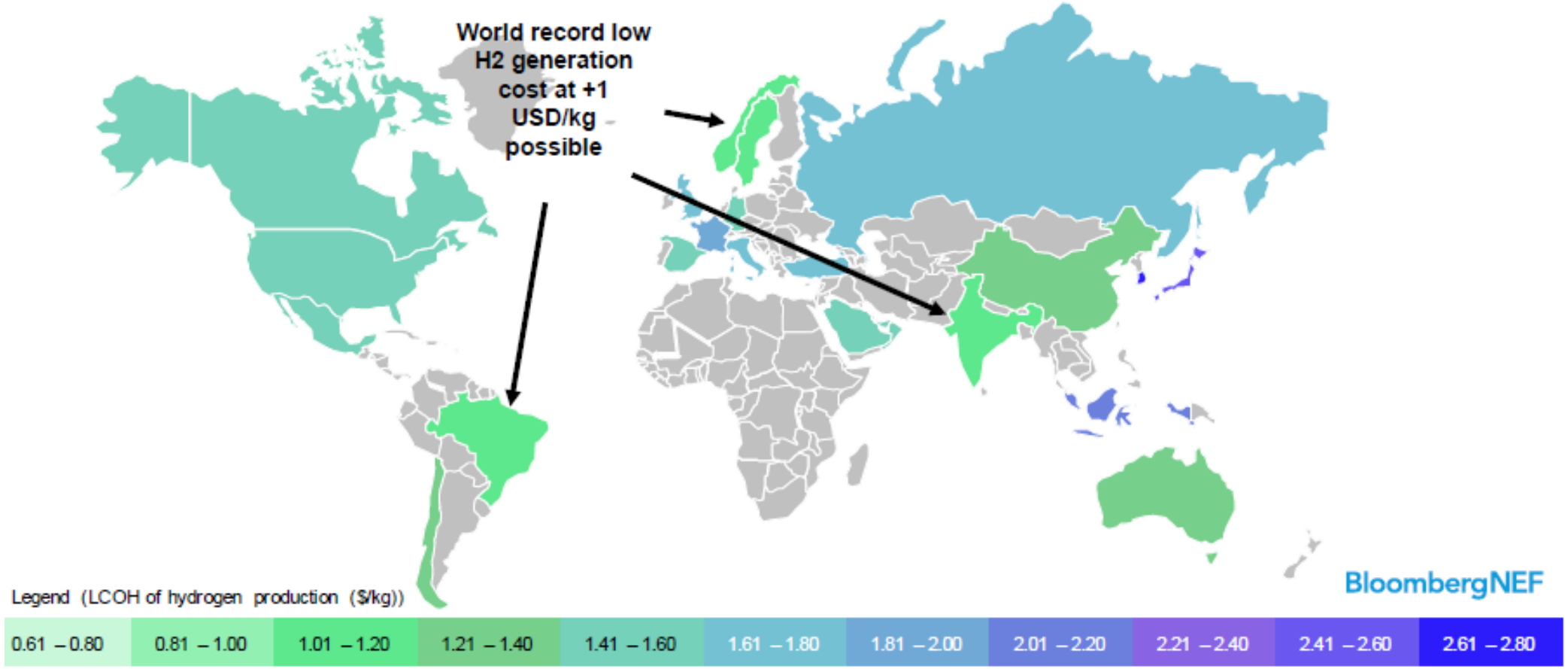


Bloomberg NEF: from 2027, Green H2 from renewables to be competitive with H2 from natural gas and from 2032 then competitive with gas combustion

Source: PtX

Will India be able to export lowest cost green hydrogen to the world?

Global cost advantage for green hydrogen from India is ~1 USD/kg in 2030.



Opportunities emerging from global demand

EU ambition: 10 Mtons import & 10 Mtons production of green H2 in 2030

Number of ships, based on EU import ambition

Investment for 10 million tons green H2 production annually: € 160 billion

https://global.kawasaki.com/en/corp/newsroom/news/detail/?f=20220422_3378

10 million tons of H2 =
880 H2 ships annually

H2 Ship		
160.000	m^3	LH2
11.360	tons	LH2
443.040	MWh	energy
equivalent CH4		
443.040	MWh	energy
44.304.000	m^3	CH4 1bar
34.080	heating homes 1 yr	

Pros and Cons- H2 carriers

Complete overview: energy density of hydrogen & related carriers

Carrier	Pros	Cons	When to use
LH2	Low weight	Large volume	e - costs high
LOHC	Easy to transport, non-toxic	Half the H2 content than ammonia	When e- costs low, intercontinental shipping
Ammonia	High H2 content	Toxic & weight	Intercontinental shipping
Methanol	Many applications, high energy content per volume	Very flammable, high production costs	Intercontinental shipping, when toxicity an issue is
H2 pipe (gaseous)	Very low CAPEX and OPEX	Only feasible by large quantities	Under 10000 km

Note that colour coding is purely for indication and alignment with next slides & has *no* value judgement (e.g. green being the most optimal)

National Green Hydrogen Mission

EXPECTED OUTCOMES OF THE MISSION BY 2030

India's Green Hydrogen Production Capacity will Reach at Least
5 MMT Per Annum

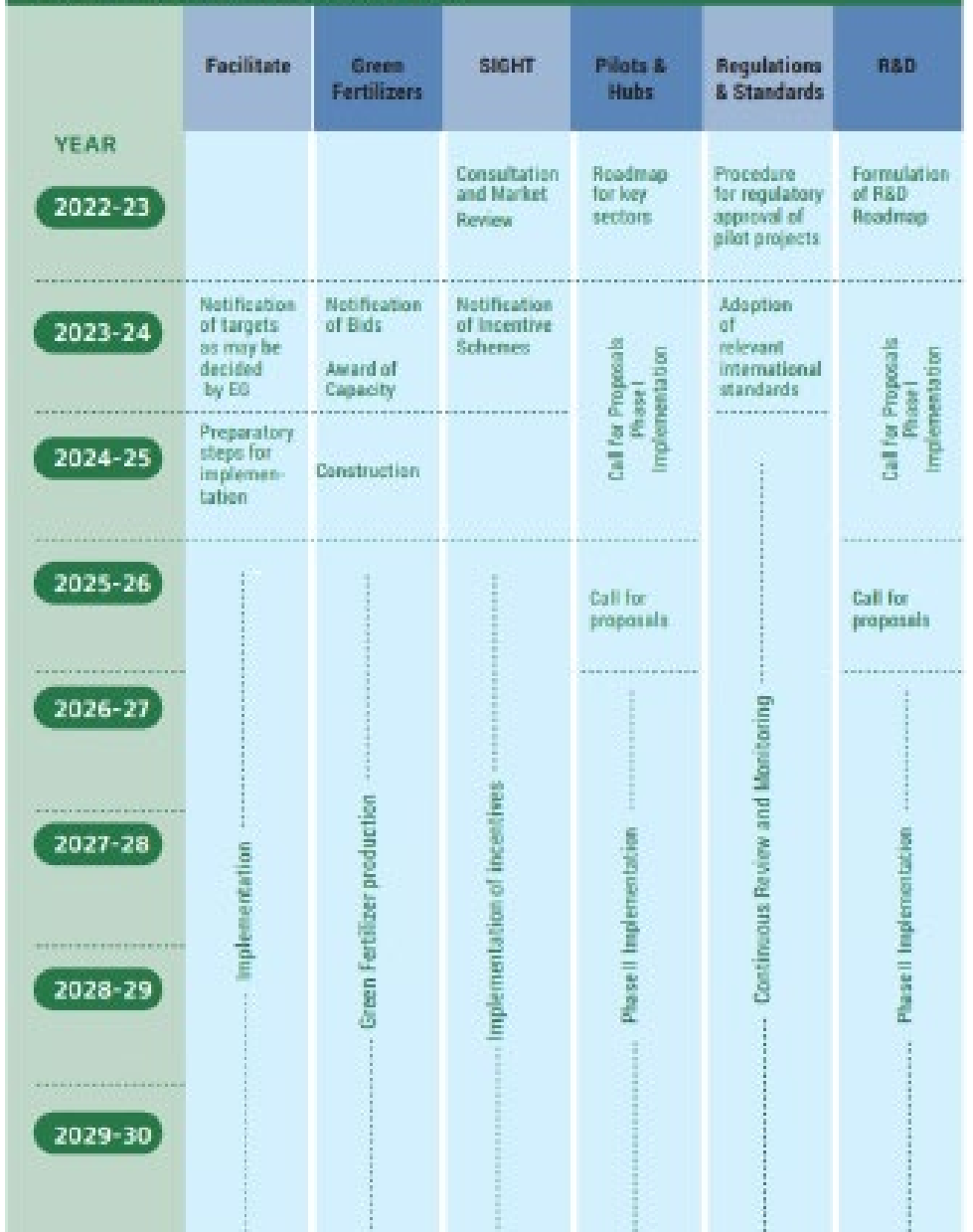
Renewable Energy Capacity Addition of
~125 GW

Over
₹8 lakh crore
in Total Investments

Create Over
6 lakh
Full Time Jobs

50 MMT per annum
of CO_2 Emissions are Expected to be Averted

MISSION IMPLEMENTATION TIMELINE



NetZero: Vision of the State

Government of Kerala aspires to become No.1 State in the country in clean energy adoption and achieving NetZero emission targets.

The vision set by Kerala towards achieving NetZero are following;

1. Net Carbon Neutral State by 2050- Announced in the State Budget 2022-23
2. 100% Renewable Energy based State by 2040
3. A Green Power exporting State utilizing Floating Solar and Pumped Storage Hydro potential
4. A Green Hydrogen Production Hub and a strategic export hub
5. Robust and dynamic State Electricity Utility
6. Adequate CTU and STU capacity for import and export of power
7. A mature Carbon Credit market by 2030
8. A destination for knowledge-based green and quality jobs and green skilling

Emission profile of Kerala and focus sectors

GHG Inventory (base year 2018-2019)

As per Intergovernmental Panel on Climate Change (IPCC) of UN, Greenhouse gas emission and removal estimates are divided into four major sectors;

Sectors	Emissions (Million tCO2 eq.)	%
Energy	74.7	91 %
Industry- Industrial Processes and Product Use (IPPU)	0.6	1%
Agriculture, Forestry and Other Land Use (AFOLU)	2.6	3%
Waste	3.9	5%
Total	**81.96**	

Of the 74.7 MtCO2;
- Transportation sector- 61%
- Energy industries- 39%

Road Transport - 92% of Transportation sector
Electricity Generation- 72% of Energy sector

Transport and Electricity generation requires major focus in the decarbonization efforts towards NetZero

e-mobility (Battery and Fuel Cell based EVs) and Renewable Energy are the immediate solutions to decarbonize transport and electricity generation sectors

- The net carbon emissions in the state - **54.27 Million tCO2 eq. (**accounting for the sequestration by tree cover, by 34% of emission)
- The net per capita emission is **1.5 tCO2 eq.**

India- 2.9 GtCO2 (~7% of global emission) and 1.8 tCO2 (per capita) respectively-2019; 3rd largest emitter
India's per capita emissions are seven times lower than that of the United States, 3.4 times lower compared to China's and three times lower compared to the EU

Emission mitigation strategies- Kerala State Action Plan on Climate Change (KSAPCC)

- The Kerala SAPCC V.2 is based on the Common Framework suggested by the MoEF&CC.
- Proposed mitigation strategies of KSAPCC could reduce around **57 MtCO2 during** 2022–30 time period, with an investment of around INR **52,231** crores.
- Of the proposed investment, **State's share is 5% (INR 2,611 Crs)** and Centre's share as **23%.** The remaining investment will be the industry/consumer's share.

Mitigation actions	Target	Total investment (INR Crore)
Rooftop Solar PV-based electricity generation	1.1 GW by 2030	5,712
RE-based electricity generation	2.36 GW by 2030	15951
Improving T&D loss infrastructure	T&D loss% is 8.8% by 2030	600
Improving the energy efficiency of TPPs	Heat rate within 5%–7.5% of design heat rate	529
Energy efficiency improvements in 2 major Industries	Improvement in specific energy consumption as per IESS level 3 in fertilizer and at a CAGR of 0.2% in refinery between 2022 and 2030	311

Mitigation actions	Target	Total investment (INR Crore)
Solar pumps	58,000 solar pumps by 2030	2,385
Solar feeder connected to EE pumps	1.5 lakh EE pumps	584
Efficient lighting	53% of lighting points in the residential sector	18
Efficient appliances	Penetration of efficient appliances	785
Adoption of ECBC	10% of commercial floor area by 2030	1828
Adoption of EV	Adoption of about 4.75 lakh vehicles by 2030	23,021
	Charging stations 51,000 by 2030	514
	Total	**52,238**

Solar Rooftop, Utility scale Solar projects and adoption of EV are top 3 investment areas

Priority infrastructure projects of the State with significant green attributes for private participation

Priority projects of the State with high PPP potential

1. Floating Solar Power Projects with storage
2. Kochi Green Hydrogen Hub (KGH2)
3. Green Hydrogen Valleys
4. Green Transport Corridors- West Coast Canal, Coastal and Hill Highways

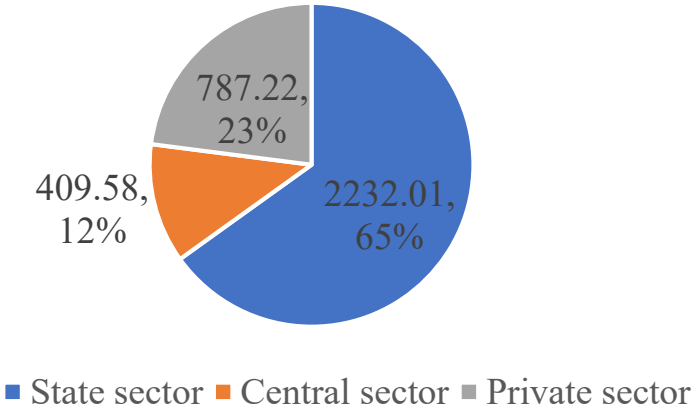
1. Floating Solar Power Projects (FSPP)

Kerala Power system

- Total Installed Capacity of the State is **3428.81 MW** whereas Peak Demand (FY21) is **4284 MW**
- Though 65% of the share of Installed Capacity in MW terms is of State, State generation in MU terms is only 28% and rest 72% of energy is purchased, largely from CGS station
- State is highly dependent on Central share of Power and availability of CTU/STU capacity leading to a vulnerable demand supply state

Total Installed Capacity*	3429 MW
Peak Demand (FY21)	4284 MW
Annual Energy Requirement (FY21)	25,144 MU
Own generation(FY21)	7,057 MU (28%)
Purchase (FY21)	18,912 MU (72%)
Major share of installed capacity by sector	State, 65%
Major source of power generation	Hydro, 54%

Installed Capacity (MW), Sector wise

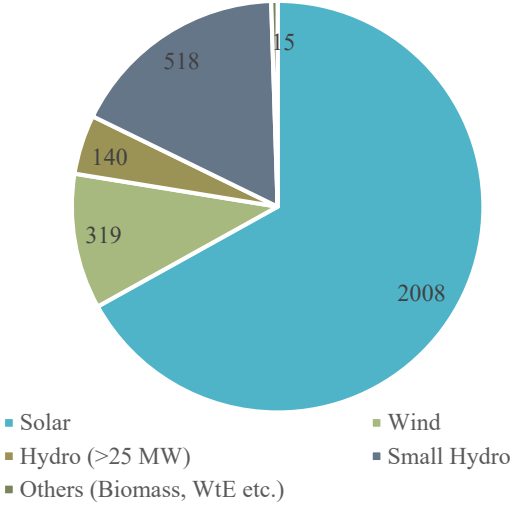


Renewable Energy Potential

- **Kerala has 8,600 MW of estimated RE potential.**
- Additional potential of **>9000 MW of Pumped Storage** and **>6,500 MW of Floating Solar Projects**
- At present only about **10% of the total RE potential** is utilized.
- **KSEB and ANERT** proposes to achieve **3000 MW** of Renewable Energy Installed capacity in the state **during 2022-27.**

RE Source	Potential (MW)	Achievement (MW)
Solar	6,150	**493**
Wind	1,700	**62.5**
Hydro		
SHP	650	**266.52**
Others	100	**5**
TOTAL	**8,600**	**825.20#**

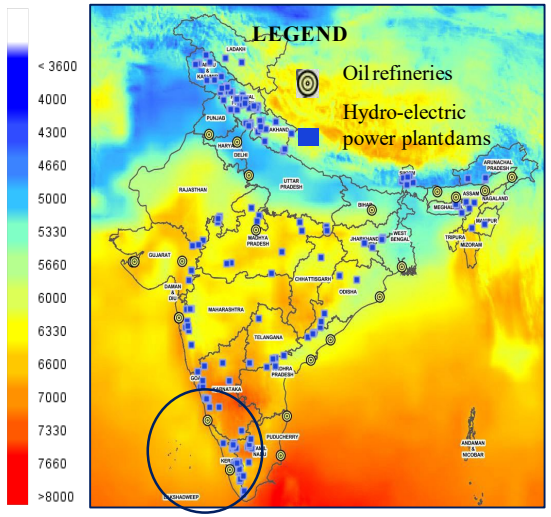
3000 MW by 2027, breakup by source



1. Floating Solar Power Projects (FSPP)

Significance of Floating Solar Power Plants

- Kerala has high annual average **solar insolation (> 6600 MJ/m2)**
- 2 prominent refineries (BPCL Kochi and MRPL Mangalore) are in proximity to 15 Hydro electric Power Plants (>25 MW) which can be ideal locations for hybridizing with floating solar or Pumped storage projects for Hydrogen generation
- Considering the high cost of limited land available in Kerala, **Floating Solar Power with storage** is a likely solution to localized generation of power to meet energy security.



Large potential for Floating Solar Power Plants

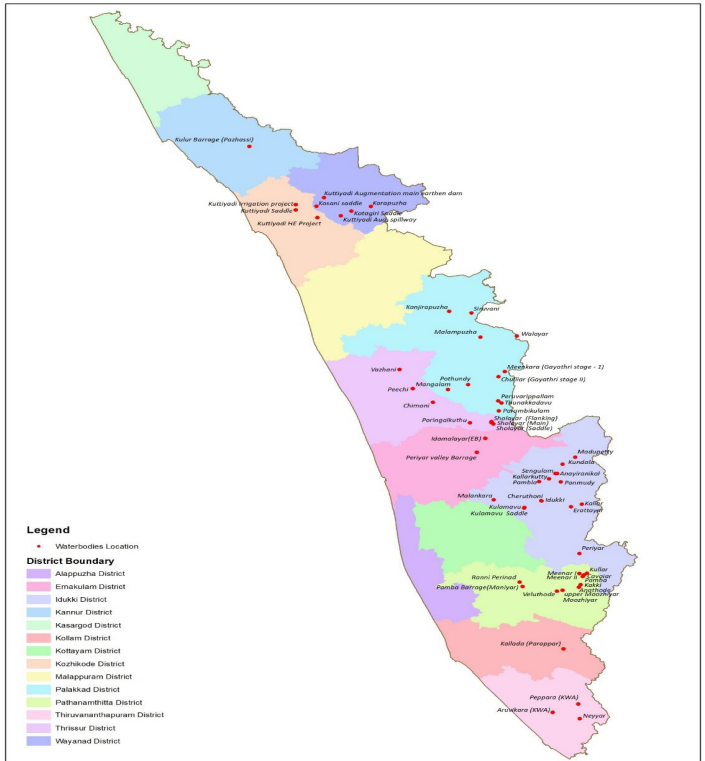
- **61 Large Dams* of Kerala** can help to generate power in space-challenged state like Kerala through FSPPs

Large Dams

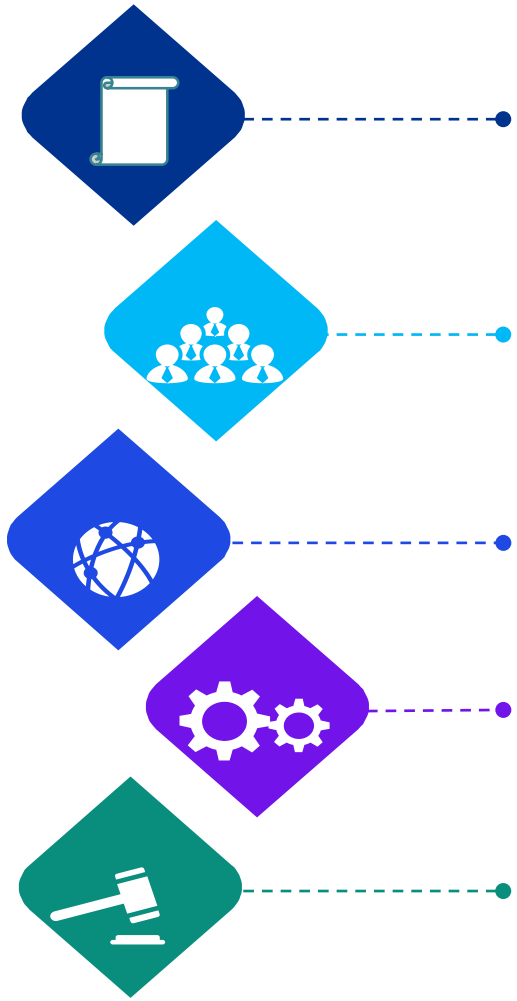
- **As per National Registry of Large Dams (NRLD) 2019;**
  - Total Reservoir Area (m2) (At Maximum Water Level) of 61 dams: **1,218 km2**
  - **10%** of reservoir area: **121 km2** (30,092 acres)
  - MW capacity that can be installed (assuming 6 acres/MW): **~5,000 MW**

Fallow/ brackish water bodies

- In addition, it is estimated that Kerala has about **20,000 hectares (49,400 acres)** of land lying fallow or brackish without rice or fish cultivation.
- **10%** of such area has potential to develop **~1,500 MW** of additional solar power.



1. Key features of the proposed FSPP Policy



Clear guidelines for installing Floating Solar Projects in the state (on Reservoirs, Backwaters, Water bodies formed of sand mining, quarrying, fallow land unsuited for farming)

Applications for FSPPs shall be initiated by Developers by providing developer led proposals on owned/leased lands/water bodies (approx. 20,000 Ha for leasing to private investors)

An online single window clearance system to facilitate private developers and investors to install FSPPs- thereby cutting down implementation delays.

DISCOM (KSEB) has right of first refusal giving opportunities for developers to look for the best option of power tie-up.

Transparent Lease Rental fixing and Lease Agreement for waterbodies

Surplus STU capacity shall be provided by DISCOM for Captive and Open Access transaction

2. Kochi Green Hydrogen Hub (KGH2)

Kerala's unique enabling ecosystem for GH2 Projects

High Renewable Energy Potential

- Ideal location for green hydrogen production with high rainfall (>250 cm annual average), solar insolation, wind potential
- Presence of waterbodies for floating solar power generation

Vibrant Power Sector

- 2nd in India, as per rating of NITI Aayog-2022
- Enabling Policies, Regulations

A front runner in Green H2 adoption

- Kickstarted International partnerships, research and pilot projects - TuDelft-NL, IIT Chennai, etc.

Presence of Potential demand centres

- Refineries, Fertiliser and Chemical industries as potential demand centres

Strong ecosystem of infrastructure

- Natural Gas
- LPG pipelines
- CGD infrastructure
- Land Banks along West Coast Canal and Transport corridors

Strategic export locations

- 2 major and 17 intermediate /Minor ports
- 1 LNG Terminal

Proposed incentives for investors

- Draft GH2 Policy is prepared and under public consultation
- Working Group for industry collaboration
- Separate GH2 development Company- SPV

Research projects and proposed global partnerships

- Global research partnerships

First State to announce a scheme of ₹2 Billion in the State budget 2023-24, for V.G.F/Grant/Equity support to set up Green Hydrogen hubs in Kochi and Thiruvananthapuram over the next 2 years.

2. Kochi Green Hydrogen Hub (KGH2)

Ongoing project for global cooperation

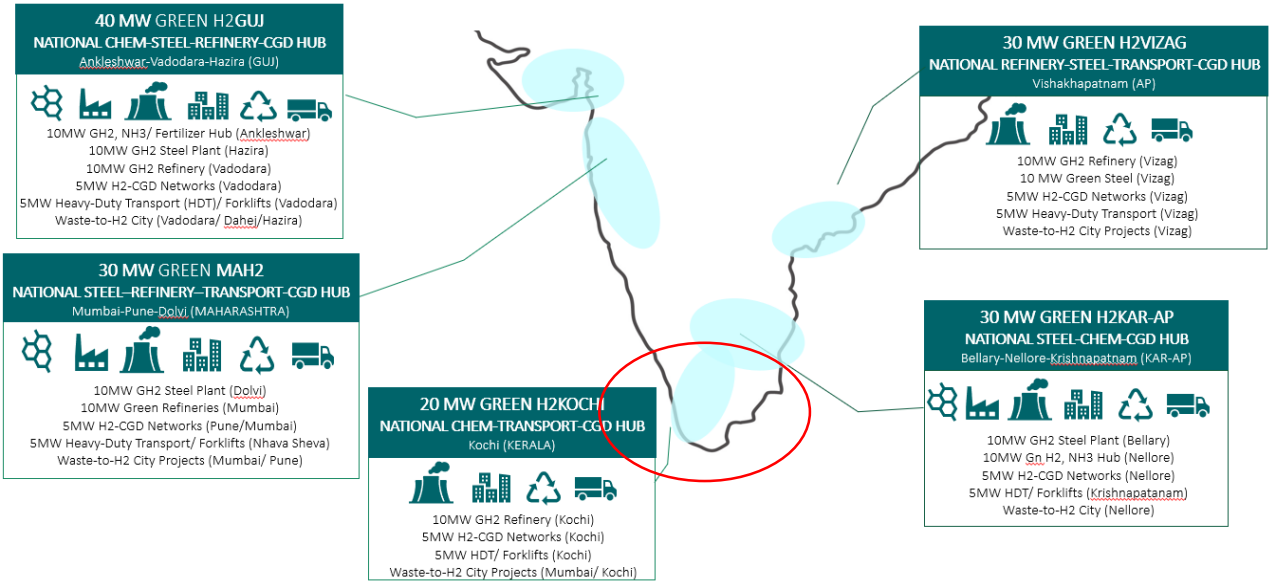
- The **India H2 Alliance** is an industry coalition of global and Indian companies committed to the creation of a hydrogen value-chain and economy in India. IH2A member firms include Chart Industries, RIL and JSW.
- IH2A proposes 5 GH2 Hubs by 2025, via Public-private partnerships. Kochi is one among them. DPR is being prepared by MEC Intelligence

Project:

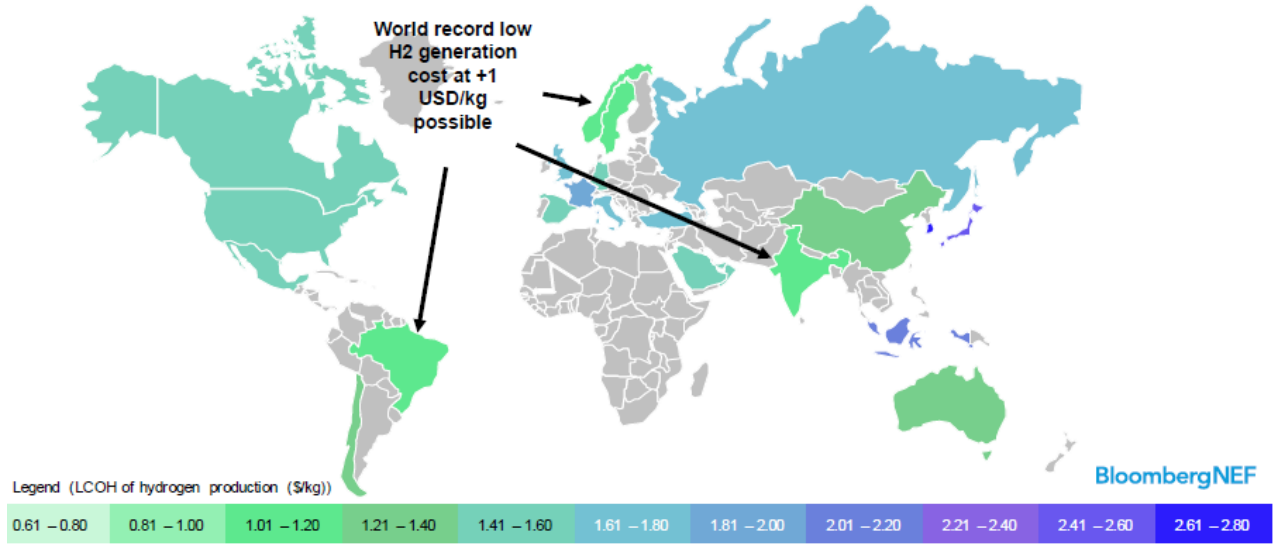
A capital expenditure of **USD 468 million**, to build **a 60-tonnes per day** (TPD) green hydrogen plant with a **150 MW** Electrolyser, Storage and Infrastructure.

Demand centres:

The plan focusses on refineries, fertilizer and transport uses in the first phase, aligning with the state government's plans for zero-emission transport, to power Hydrogen-ICE retrofitted bus fleets and build the required infrastructure.



Global cost advantage for green hydrogen from India- ~1 USD/kg in 2030



2. Kochi Green Hydrogen Hub (KGH2)

A strong ecosystem of demand centres for Green H2 adoption

Demand Centers

End usage	Purpose	Potential Customer
Refinery	• De-sulphurisation of diesel and petrol.	• BPCL, Kochi • MRPL Mangalore
Ammonia production	• Production of nitrogen-based (urea), complex fertilizer- diammonium phosphate (DAP). • Use of ammonia as a hydrogen carrier and fuel for shipping	• FACT Kochi
Methanol and Chemical production	• Hydrogen is a main feedstock in the production of methanol • Methanol- for chemicals and solvents, as fuel for transport in the form of various blends, marine fuel, and cooking.	• Cochin Petromins Pvt. Ltd. (CPPL) • Hindustan Organic Chemicals Ltd.-HOCL (Phenol and Acetone)- 5TPD
Transport	• **HICE Engine- 1000** Trucks, **3000** buses, **100** ferry boats • Potential demand of **30 Kg Hydrogen per day per Bus/Truck**	• KSRTC • KMRL • Kochi Water Metro
Heat and Power generation	• Blending with Natural Gas • Power-H2-Power as another form to provide storage and flexibility using Fuel Cells	• GAIL Kochi-Mangalore LNG Gas Pipeline • CGD operators in 14 districts • IOCL- Kochi, KSEB
Export infrastructure	• Port access for storage/liquefaction cum export facilities	• Port of Hamburg • Rotterdam Port

2. Key features of the proposed Green H2 Policy

Following benefits/incentives shall be granted to the producer of Green Hydrogen and Green Ammonia for the projects commissioned **before 30th June 2025;**

Aggregation of Green Hydrogen demand by nodal agency	Open Access for sourcing of Renewable Energy within 15 days of receipt of application	50 percent exemption from wheeling charges
50 percent exemption from intra-state transmission charges	100 percent exemption from cross-subsidy surcharge	Banking shall be permitted for a period of 30 days
INR 200 Crs for V.G.F/Grant/Equity	Grid Connectivity	RE used for GH2 or Ammonia shall be counted for RPO of consuming entity
Creation of Land Banks: INR 300 Crs for land acquisition along West Coast Canal; INR 1000 Crs for Vizhinjam Port for PPP investments-State Budget 2023-24	Additional incentives for green investments from 'Kerala Industrial and Commercial Policy 2023-28'	High Level Committee for monitoring, implementation and dispute resolution with Chief Secretary as the Chairman, ACS (Power Department) as Convenor

3. Green Hydrogen Valley- Kochi and Vizhinjam

Department of Science and Technology (DST), Ministry of Science and Technology, Government of India has invited proposal from agencies to set up **Hydrogen Valleys** under **Mission Innovation**

- Kerala is planning to develop 2 Green Hydrogen Valleys in **Kochi** and **Thiruvananthapuram (Vizhinjam).**
- **Shortlisted by DST for one of the 7 Valleys in India. Preparation of DPR is ongoing for Kochi and Vizhinjam GH2 Valleys**
- **ANERT is** spearheading activities in Kerala region

What is Hydrogen Valley?

1. Defined geographical area where hydrogen serves more than one end sector or application in mobility, industry and energy.
2. Covers steps in the hydrogen value chain, from production to storage and its transport & distribution to various off-takers.

Objective

1. To strengthen research, innovation, knowledge and capacity of scientific and industrial actors in the valley, demonstrate clean hydrogen solutions with the view to local, regional and nation-wide deployment

Mission Innovation

1. A global initiative of 23 countries and the European Commission (on behalf of the European Union) catalyzing action and investment in research, development and demonstration to make clean energy affordable, attractive and accessible for all.

Funding

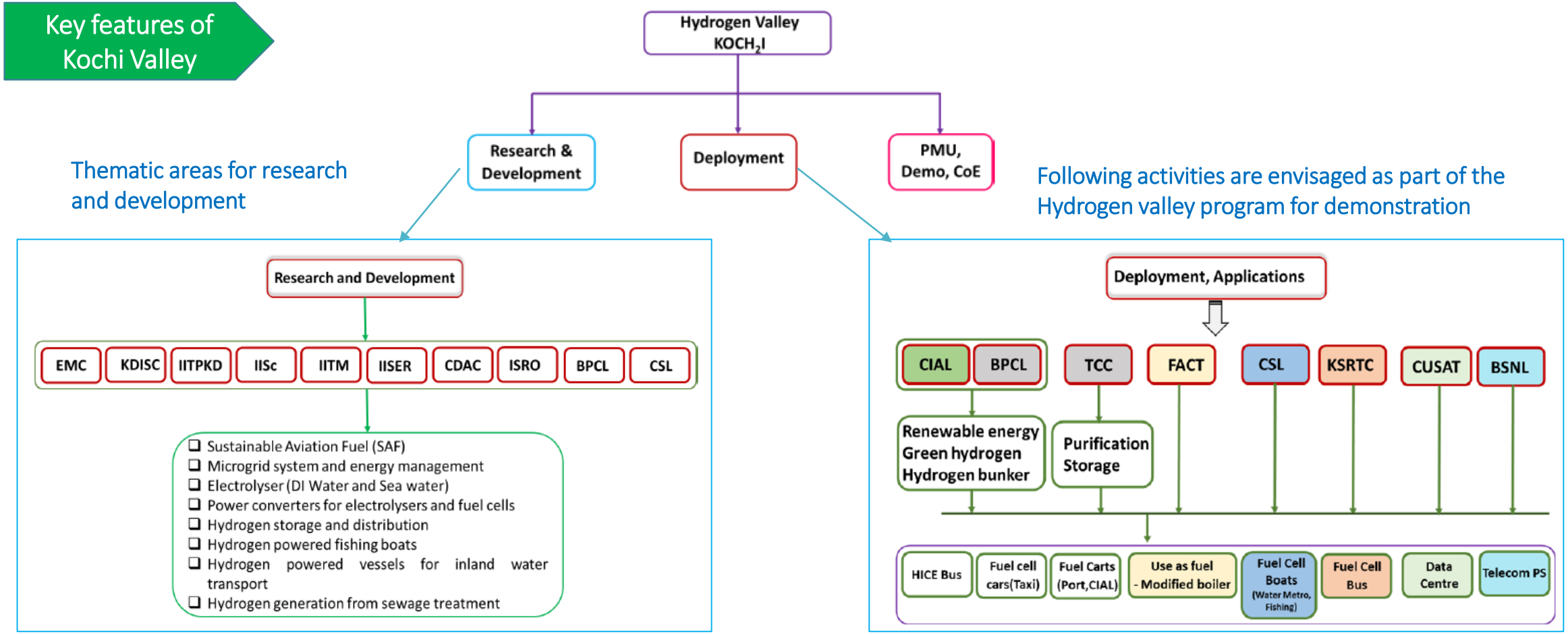
1. For Phase I, the allocated budget **is Rs. 90 Cr.** for setting up of **three Hydrogen Valley Platforms.**
2. The allocated budget will be distributed among the entire hydrogen value chain (production, distribution and transportation).

3. Green Hydrogen Valley- Kochi

The activities involved in the proposed hydrogen valley can be broadly divided into three;

a) Research and Development
b) Deployment of technologies available to meet the needs projected
c) Establish a technology dissemination centre cum PMU to co-ordinate the overall activity and to ensure the sustenance of the development activity.

Key features of Kochi Valley



4. Green Transport Corridors- West Coast Canal, Coastal and Hill Highway

- Government of Kerala aspires to transform the major transport corridors of Kerala- the West Coast Canal, Coastal and Hill Highways, into **green economic trade corridors**
- Mapping of ESG based Economic Development Opportunities (EDO) along the West Coast Canal (WCC) and Coastal Highways are being undertaken for **creation of Land Banks** for attracting investments under PPP mode

Concept Planning for **Transit Oriented Development** along the corridors are being undertaken

Economic Development Opportunities (EDOs) of **e-mobility, industry, renewable energy, transport, tourism, trade and agriculture** sectors are being assessed along the transport corridors

West Coast Canal

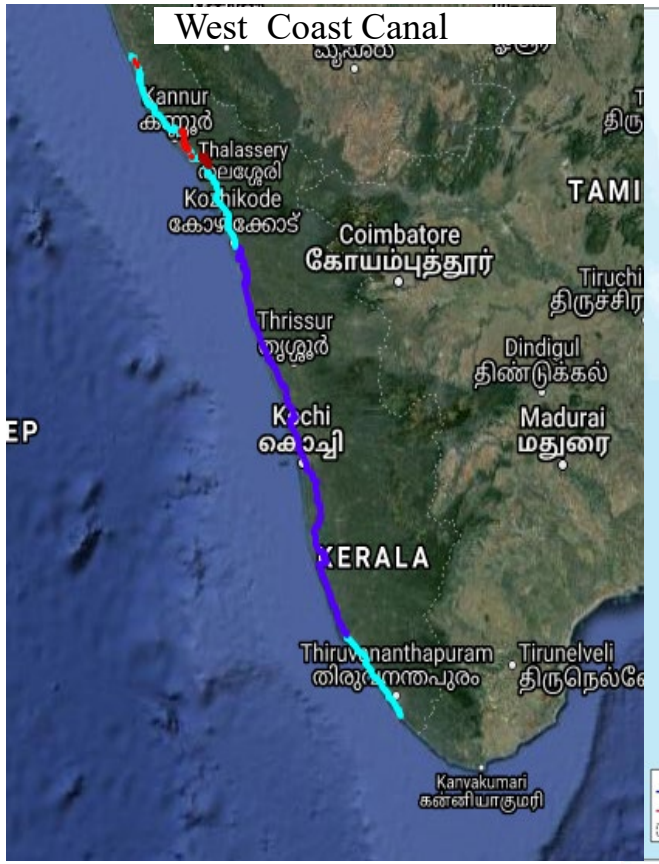
- Overall Project Cost is INR 24 Billion.
- INR 3 Billion is earmarked for land acquisition based on EDO study
- The total length of the **Inland Waterways** in the state is 1687 km.
- The main arterial Waterway in the state is the **West Coast Canal** (WCC) (~ 560 Km.)

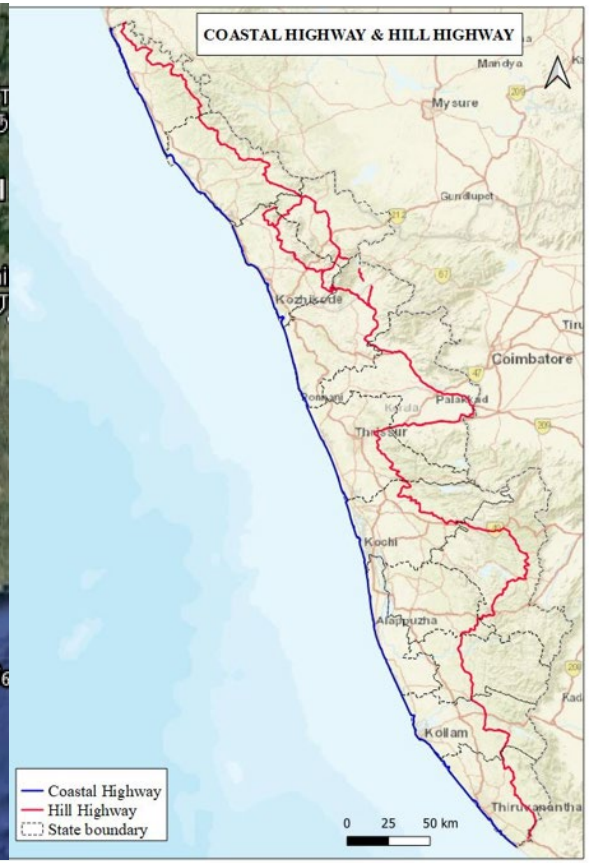
Coastal Highway

- Project Cost: INR 65 Billion
- Total length: 625 km
- Completion Target Date: 2027

Hill Highway

- Project Cost: INR 35 Billion
- Total length: 1251 km
- Completion Target Date: 2026





4. Green Transport Corridors-Coastal Highway

EDO Assessment along Coastal Highway for land bank creation

- The Coastal Highway is aimed at improving the road connectivity of the coastal belt of the state
- Starts from Poovar in Thiruvananthapuram and ends at Thalapady in Kasaragod district
- Connecting major ports at Kollam, Vizhinjam, Vallarpadam, and several other smaller ports.

It is planned to set up Beach Promenade, Cycling tracks, Tourist Facilitation amenities, Walking Track, EV charging stations etc. along the Coastal Highway.

Following land parcels are being acquired;

a) Every 25th km - 50 cent parcel
b) Every 50th km - 1 acre land parcel
c) Every 75th km - 50 cent land parcel
d) Every 100th km - 2 to 5 acre land parcel

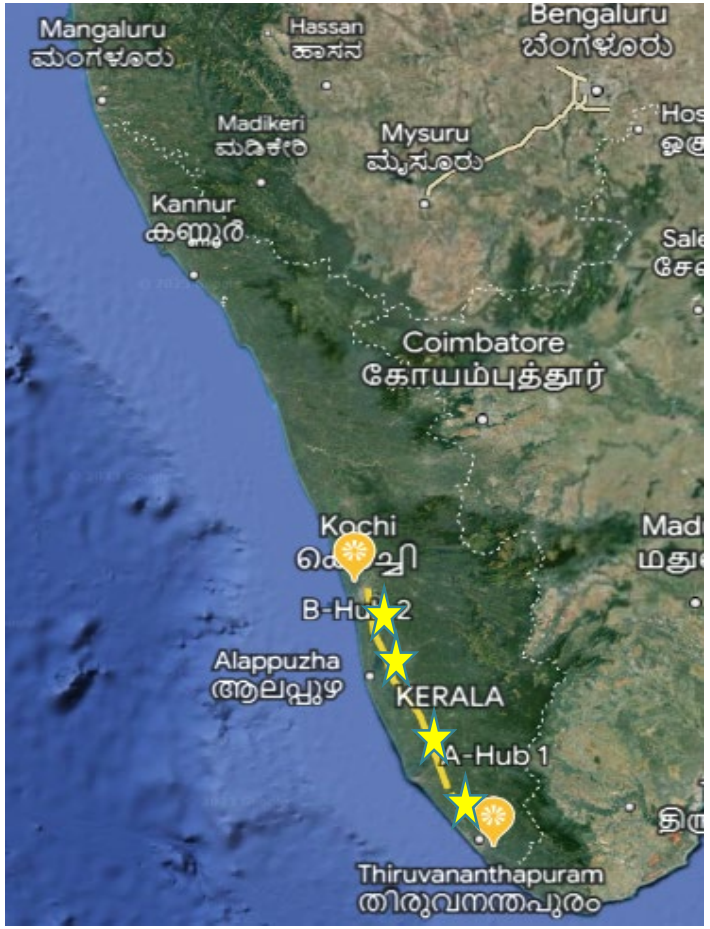
68 land parcels having a total area of 181 acres have been identified along the coastal highway stretch, and land acquisition process has started.

Sl No	District	No: of Land Parcels	Area (in Acres)
1	Trivandrum	6	18.3091
2	Kollam	8	24.3484
3	Alappuzha	5	3.7797
4	Ernakulam	4	43.965
5	Thrissur	9	32.95
6	Malappuram	1	0.46
7	Kannur	11	10.7
8	Kasargod	24	46.62
		68	**181.1322**

4. Green Transport Corridors- West Coast Canal, Coastal and Hill Highway

Developing ‘e-Mobility Hub & Spokes’ along converging points of transport corridors (WCC, Hill and Coastal Highway) and procurement of EVs for converting the fleet of Government Departments and Agencies

Network of Hydrogen & EV Charging Infrastructure along Vizhinjam to Kochi Corridor integrated with Hydrogen generation and Floating Solar Power Projects



HYDROGEN & EV CHARGING STATIONS

- **Vizhinjam- Hub A**
- **Kochi- Hub B**
- **Hubs-** Catering end users in transport (Kochi Water Metro, KSRTC HICE buses, Trucks), shipping (CSL, Kochi Port), fertilisers (FACT), aviation (CIAL), refineries (BPCL) sectors
- **Clusters in between-** Catering limited end users

FACILITIES

- **Hydrogen Refueling Stations:** For fuel cell Vessels, HICE trucks and buses, Fuel Cell vehicles
- **EV Fast Charging stations:** Off-grid and grid charging for battery EV vehicles.
- **Rest stations and accommodations.**

PROMOTING EV FLEET

- **Procurement of EVs for Government departments and Agencies through appropriate business models**

4. Green Transport Corridors- West Coast Canal, Coastal and Hill Highway

Green Capacity building for transport corridors

A capacity building program by IFC is being undertaken to incorporate ESG and climate resilience elements in key infrastructure projects including WCC, Coastal and Hill highways on following themes;

ESG framework	Climate Resilience	Green Financing framework
1. Environmental, Social Management Plan (ESMP) and Environmental, Social Management Systems (ESMS) are prepared, and training is going on for key sectors	1. Climate resilience policy is under review 2. Training for inclusion of climate resilience in DPRs of WCC, Coastal highway and Power projects being undertaken	1. Green Financing framework document is approved and adopted by KIIFB

Tentative scope of Parties in PPP project structuring

Tentative scope of Government in the projects to facilitate Private investments

Priority Projects	Scope		Intended benefits for NetZero	Tentative Project Cost (INR Billion)
	Private Party	Government		
1. Floating Solar Power Projects	• Project Development under DBFOT/BOOT etc. • Operation& Maintenance (say 25 years)	• Project and site allocation as per FSPP Policy • Minimum power purchase obligation by Utility if any • Provide common infrastructure including; ✓ STU and CTU availability with pooling station ✓ Road connectivity ✓ Water allocation ✓ Construction power ✓ Telecommunication facilities ✓ Warehouse and housing facility wherever possible	Renewable energy generation for electrification of various sectors	80*
2. Kochi Green Hydrogen Hub (KGH2)	• Project Development under DBFOT/BOOT etc. • Operation& Maintenance (say 35 years)	• Project and site allocation as per GH2 Policy • Facilitate demand aggregation of Government entities • Provide common infrastructure including; ✓ STU and CTU availability with pooling station ✓ Road connectivity ✓ Water allocation ✓ Construction power ✓ Telecommunication facilities ✓ Warehouse and housing facility wherever possible	Green H2 generation for decarbonization of Transport, Refineries, Fertilizers, Power, Marine and Aviation sectors	33

* @4crs/MW for 2000 MW;

* Two GH2 valleys, 50:50 funded by Centre and State

Tentative scope of Parties in PPP project structuring

Tentative scope of Government in the projects to facilitate Private investments

Priority Projects	Scope		Intended benefits for NetZero	Tentative Project Cost (INR Billion)
	Private Party	Government		
3. Green Hydrogen Valleys	• Participation of private Research and Development players • Deployment of technologies for demonstration by private players	• Valley conceptualization and development • Common facility development	R&D, Technology development and demonstration for GH2 generation and consumption	1.2*
4. Green Transport Corridors- West Coast Canal, Coastal and Hill Highways	• Project development of EDOs* under DBFOT/BOOT etc. • Operation & maintenance	• Land acquisition for identified EDOs • Project and site allocation as per PPP Policy • Provide common infrastructure including; ✓ Road connectivity ✓ Water allocation ✓ Construction power ✓ Telecommunication facilities ✓ Warehouse and housing facility wherever possible	Greener transport corridors	124
Total				**238.2**

*EDO- Economic Development Opportunities in Renewable energy, Transport, Logistics, industry, agriculture, tourism and trade sectors

Thank you