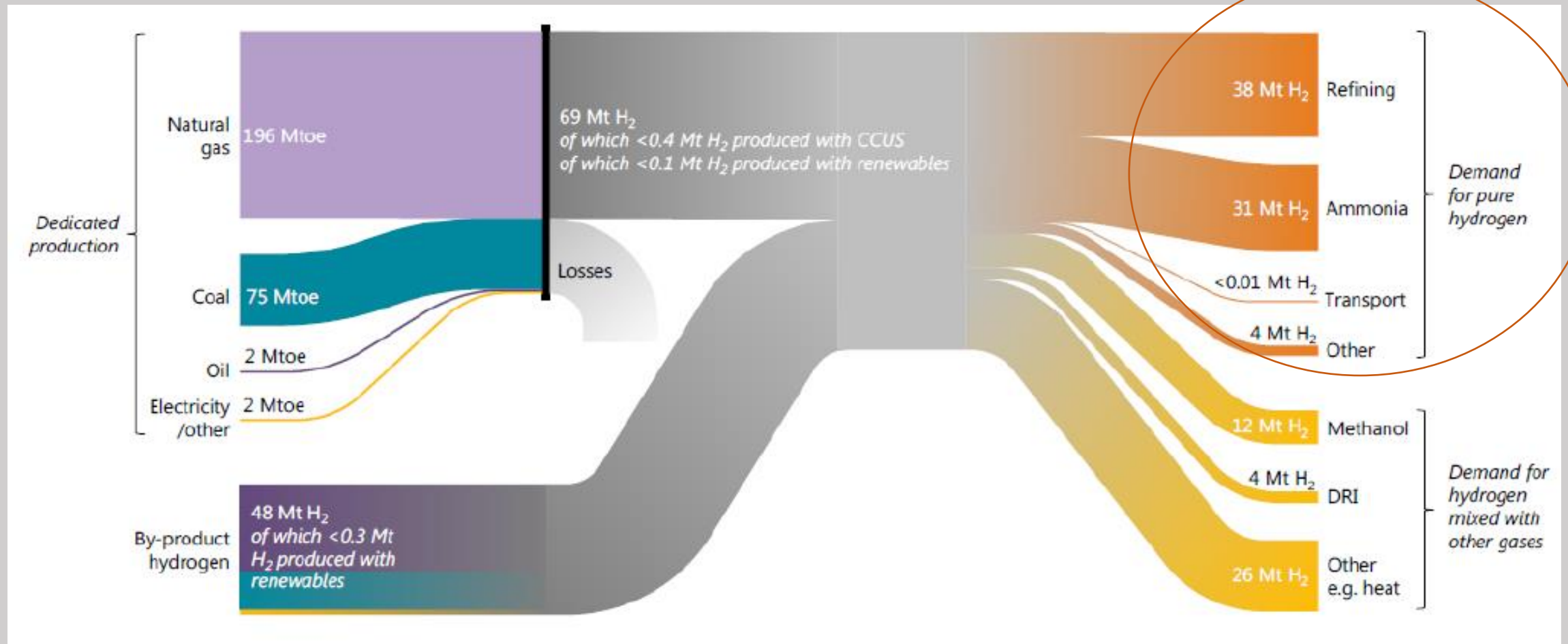


# Green Hydrogen Economy

## Kerala- Towards a leadership role

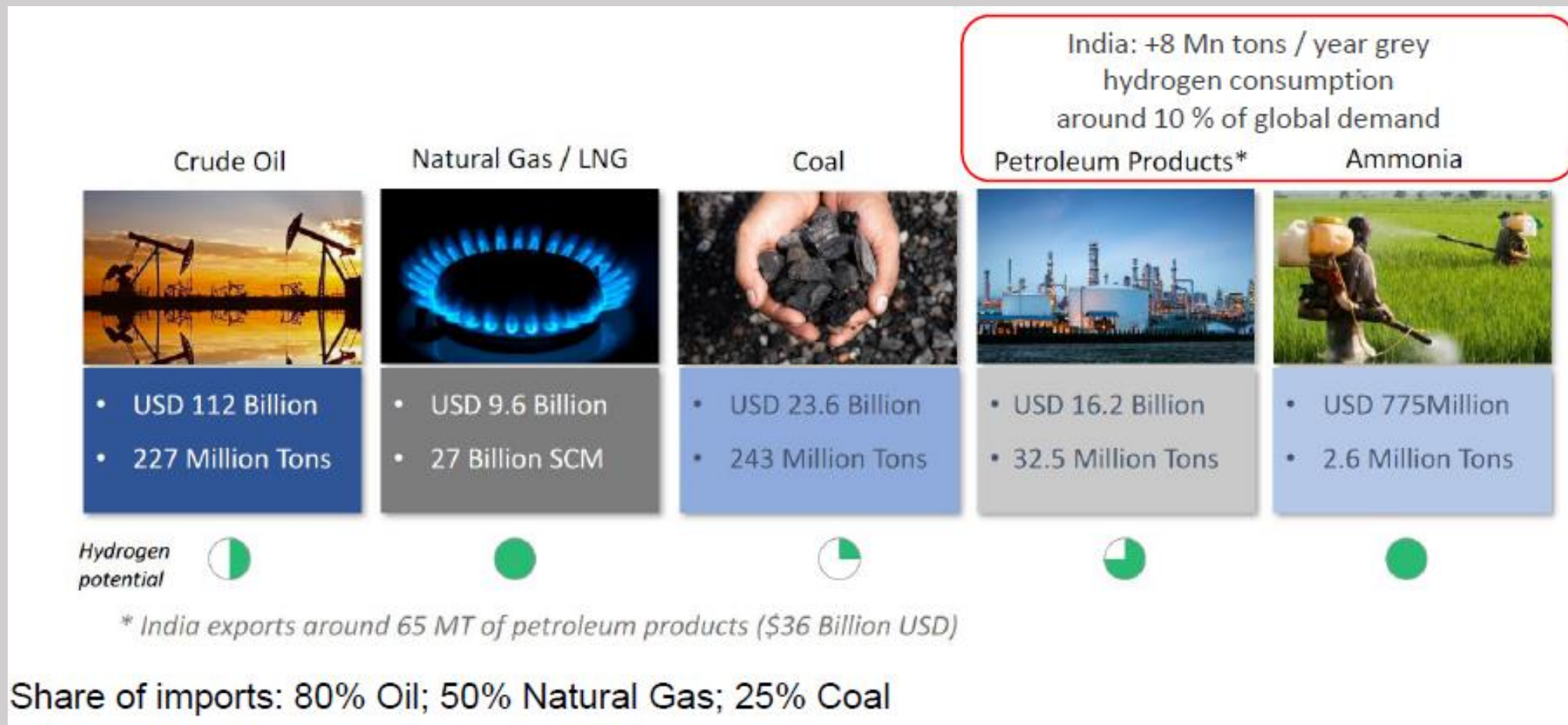


# Supply and demand for hydrogen globally, 2018



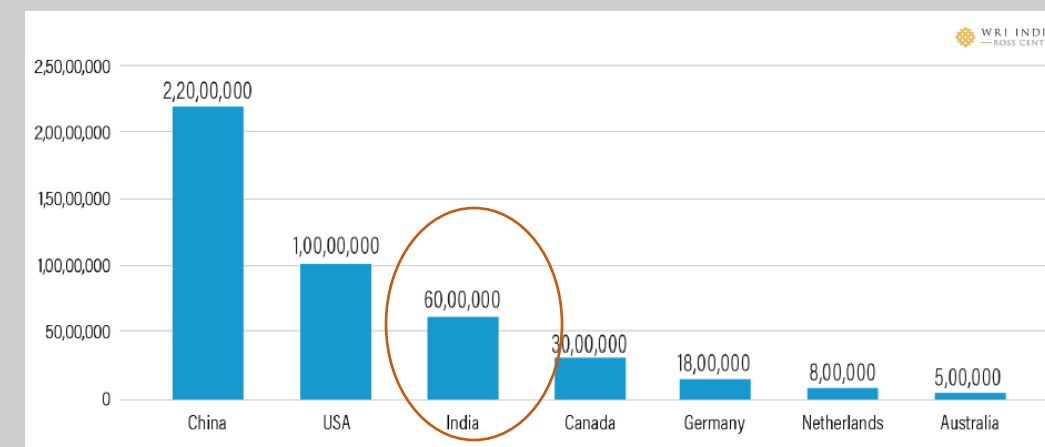
- Refinery (30%) and Ammonia (Fertiliser) (25%) are the key demand sectors for pure Hydrogen globally with 38 MT and 31 MT respectively.
  - Of this, only <0.4 MT H<sub>2</sub> is produced with CCUS
  - Only <0.1 MT H<sub>2</sub> is produced with renewables
- Natural Gas and Coal are the major sources for production

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



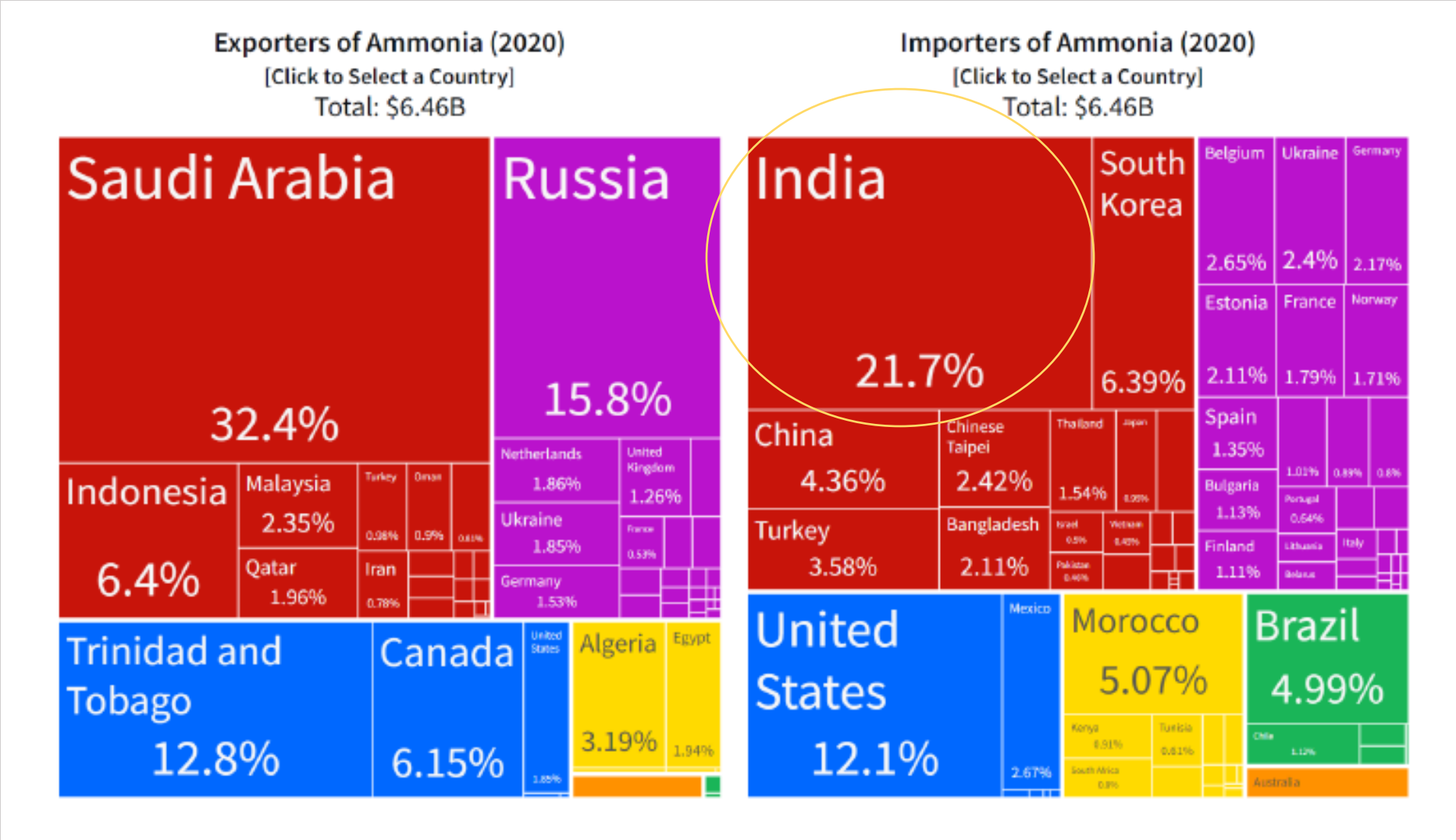
- India's +8MT/annum demand for Hydrogen is around 10% of global demand
- Of this, +6 MTs annual production of grey H<sub>2</sub> & +2 MTs imports (via fertilizer/Ammonia)

**Goal: H<sub>2</sub> produced based on natural gas (imports) to be replaced by Green H<sub>2</sub>**



Source: PtX, NITI Aayog, WRI

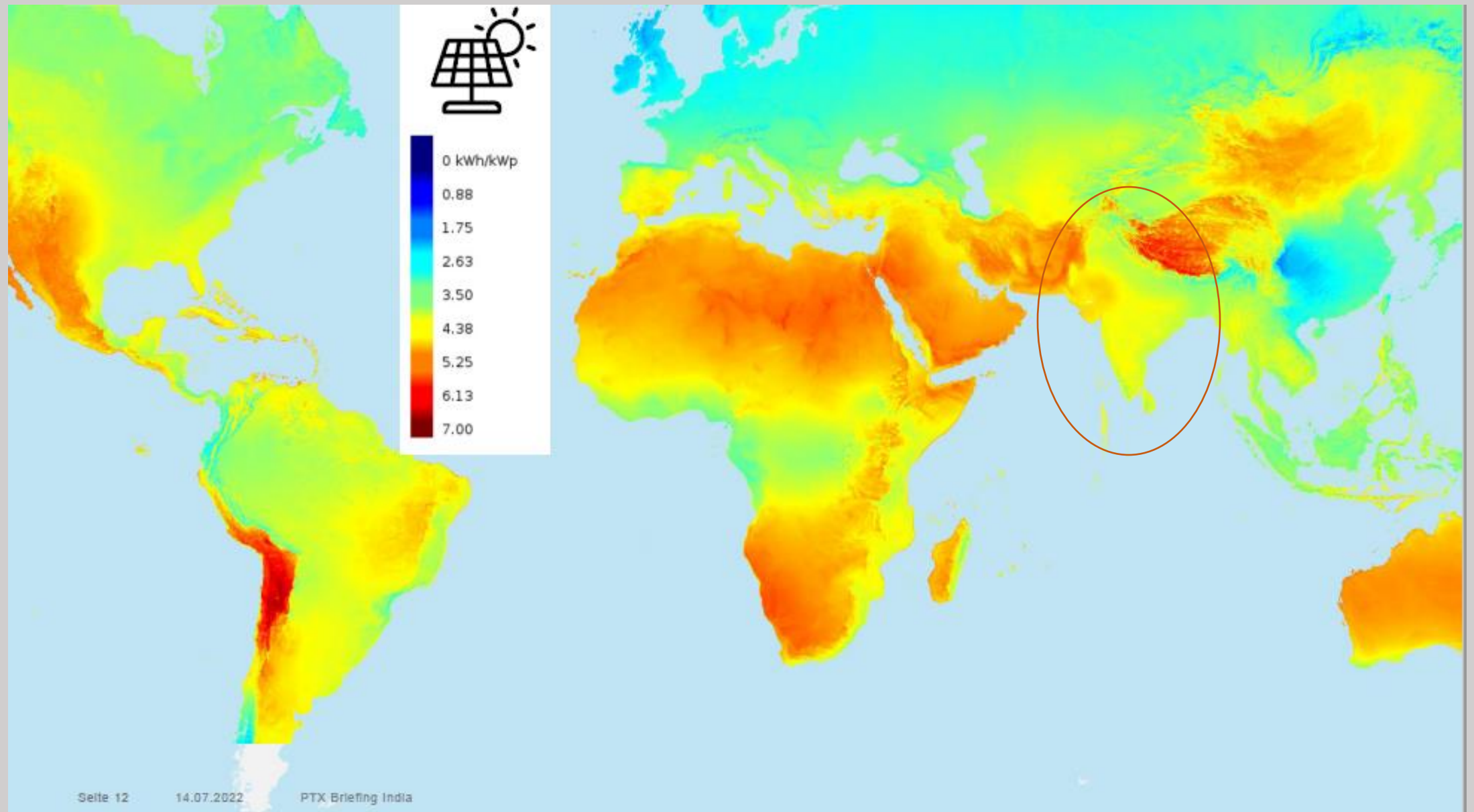
# India is the largest importer of grey hydrogen-based ammonia in the world



Source: Observatory of Economic Complexity



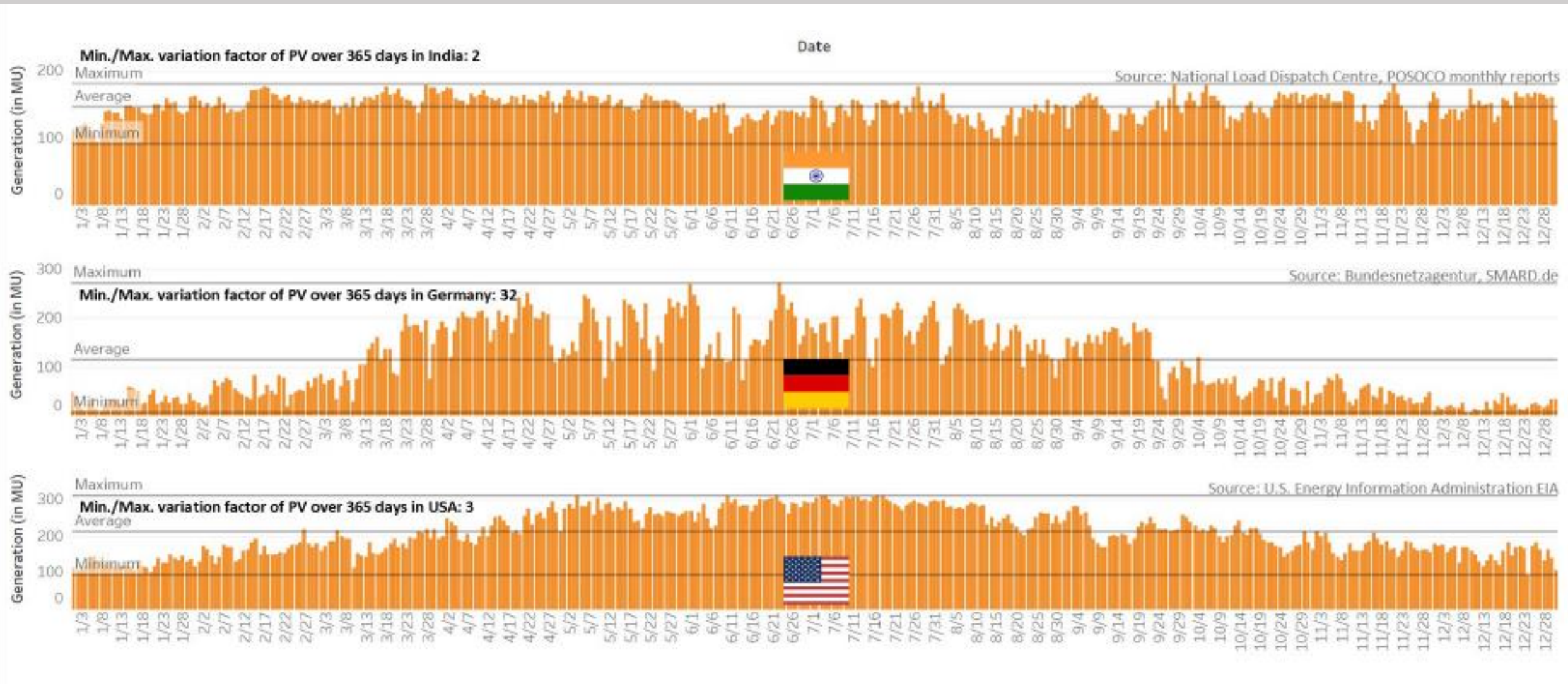
## Excellent RE Resources in India



Source: PtX

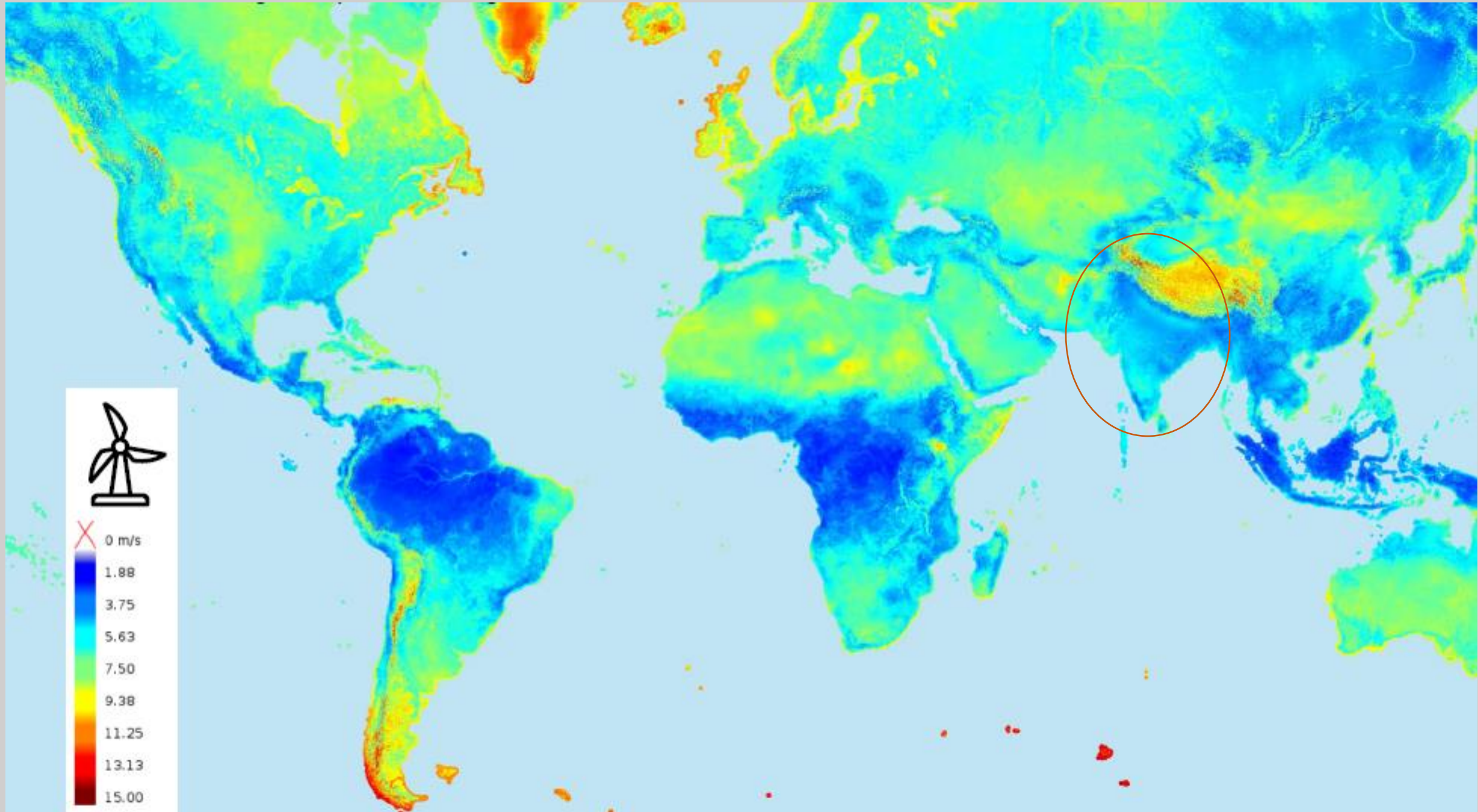
# India has high solar energy security

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





## Global annual avg. wind speed, 100 m height

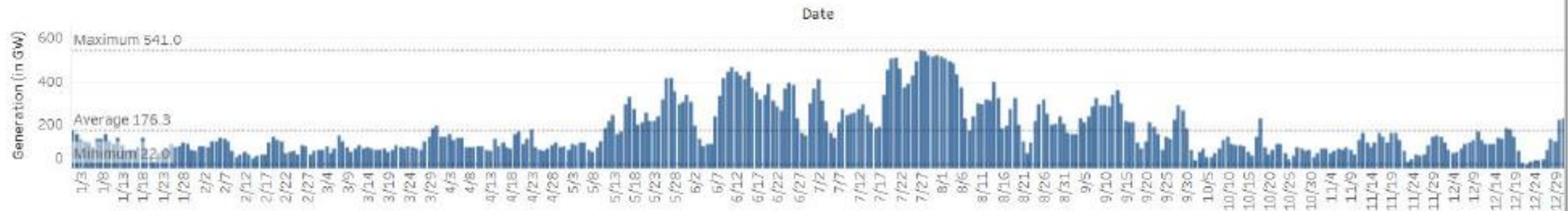


Source: Global Wind Atlas 1.0

# Good wind conditions

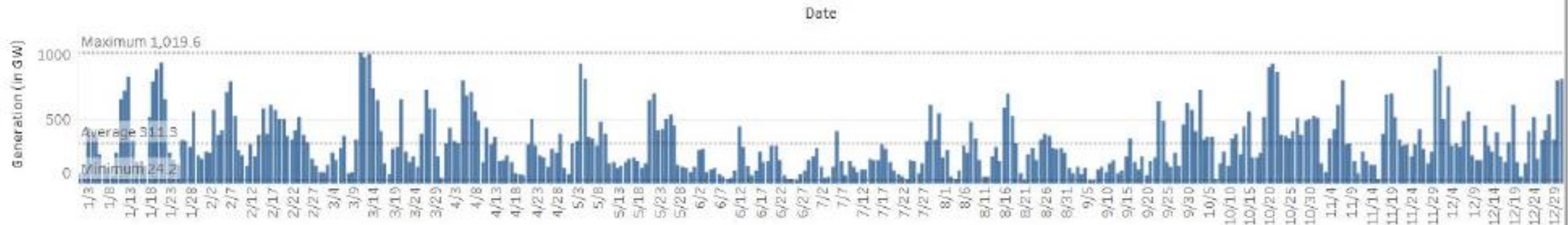
Good wind generation profiles over 365 days from wind in India Vs Germany

## India



Source: National Load Despatch Centre, PDSOCO monthly reports

## Germany

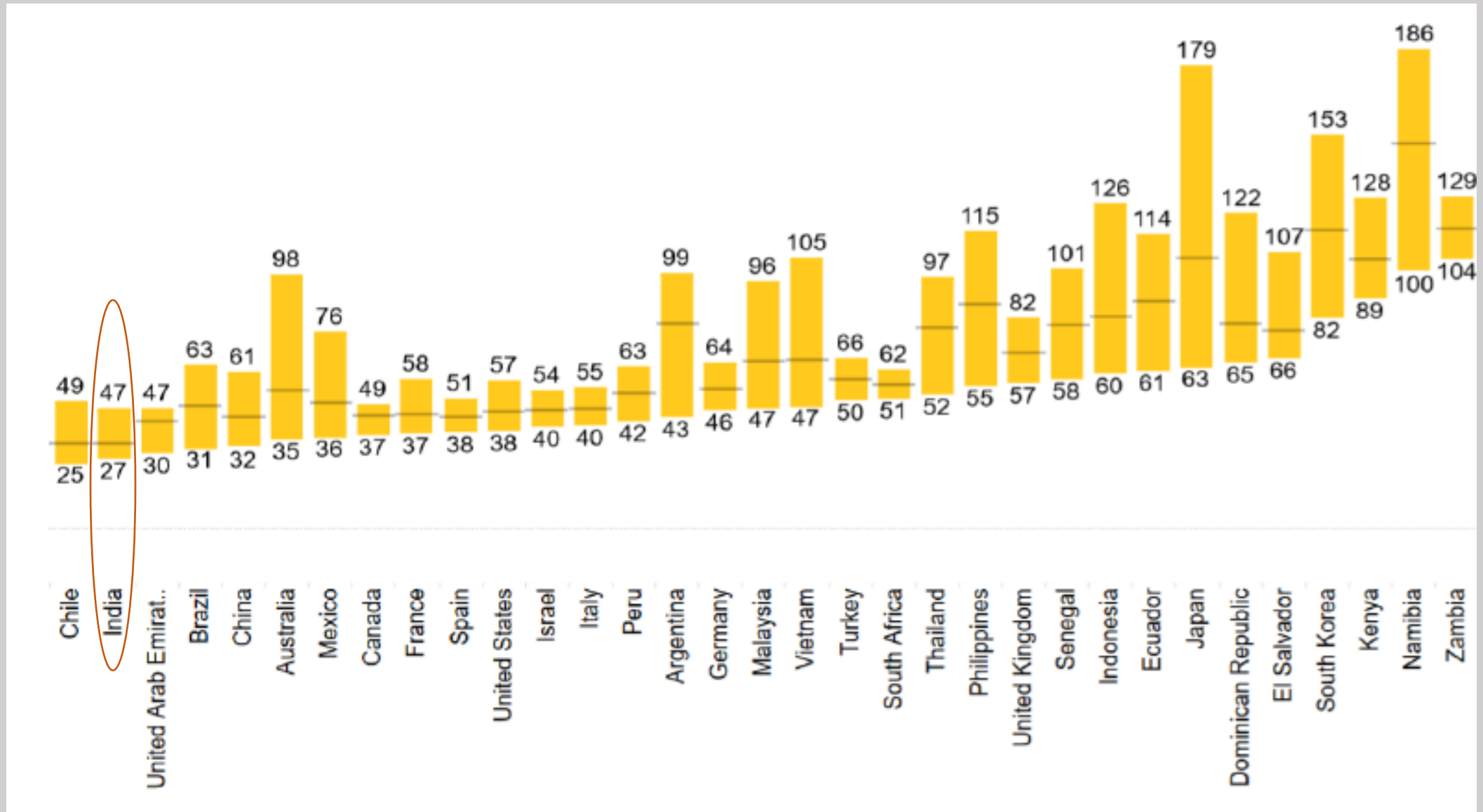


Source: PtX, NLDC, SMARD.de



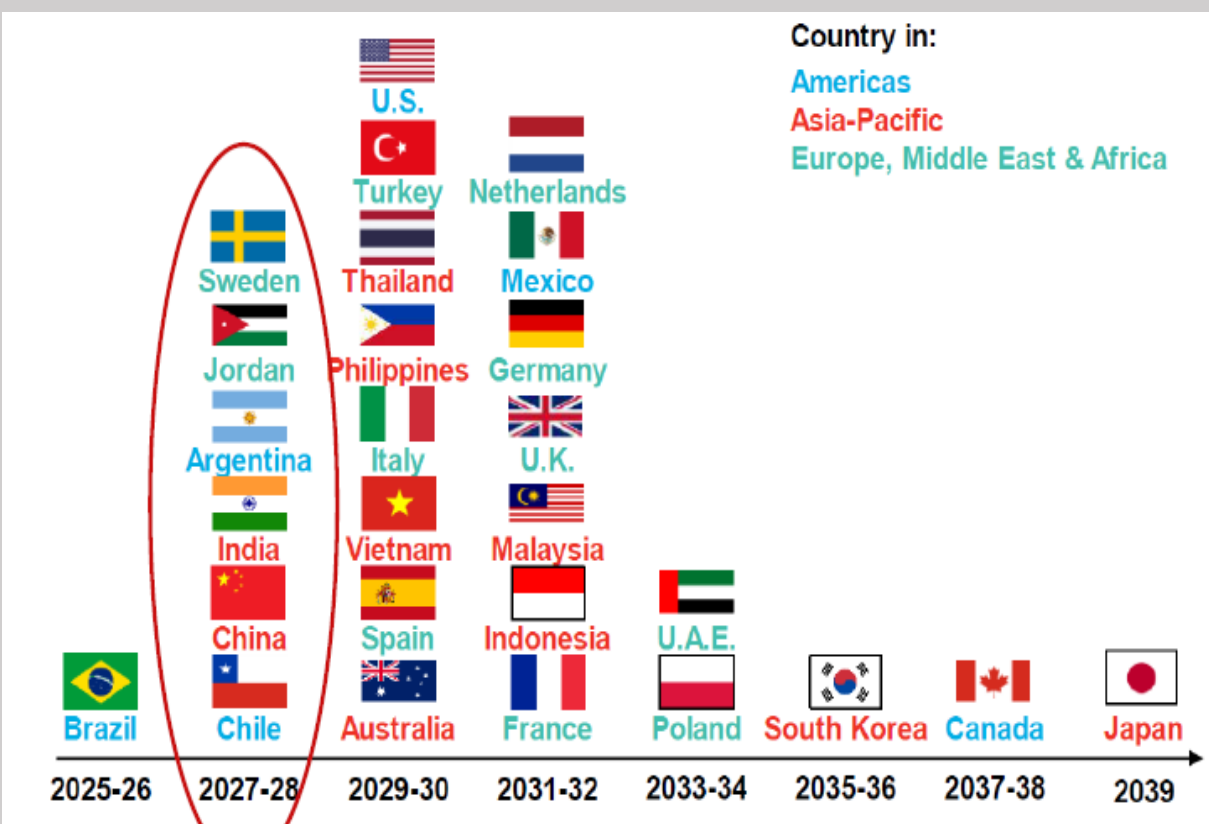
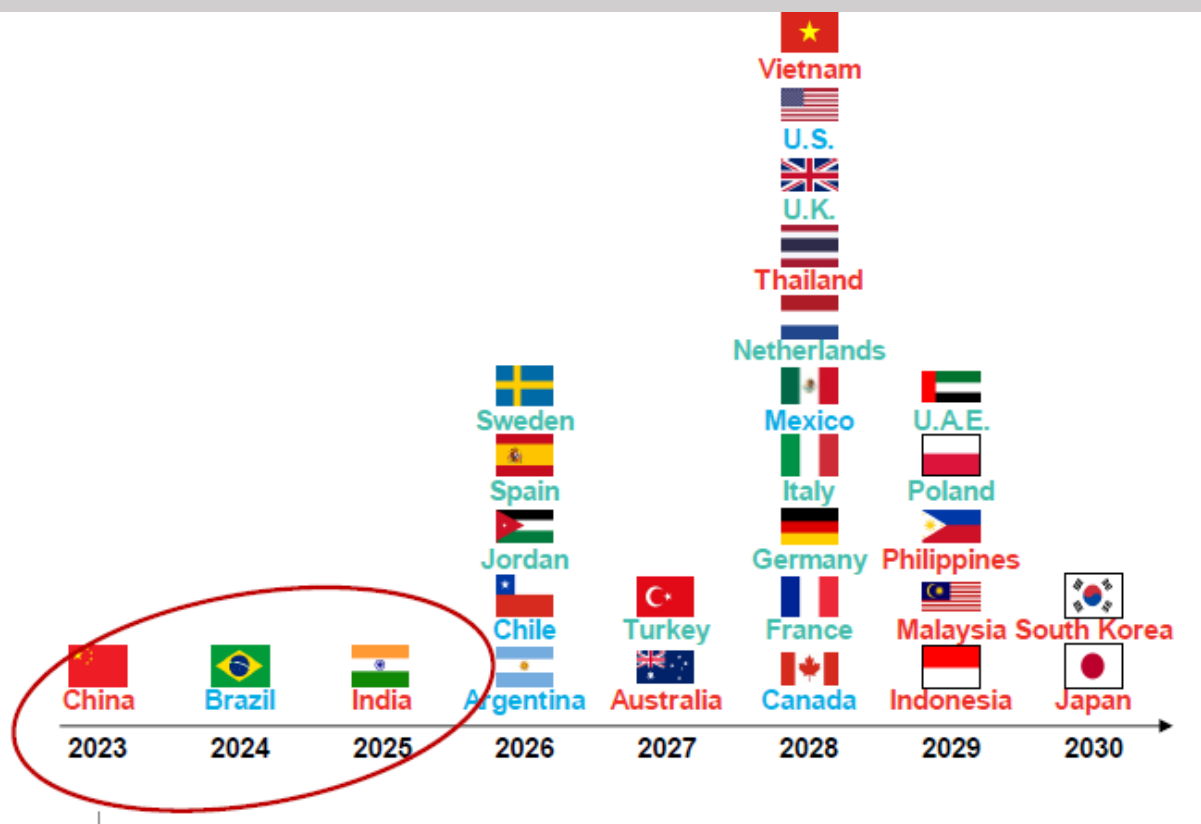
# India generates solar power at world record low cost

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



Source: PtX, Quelle: BNEF 2022

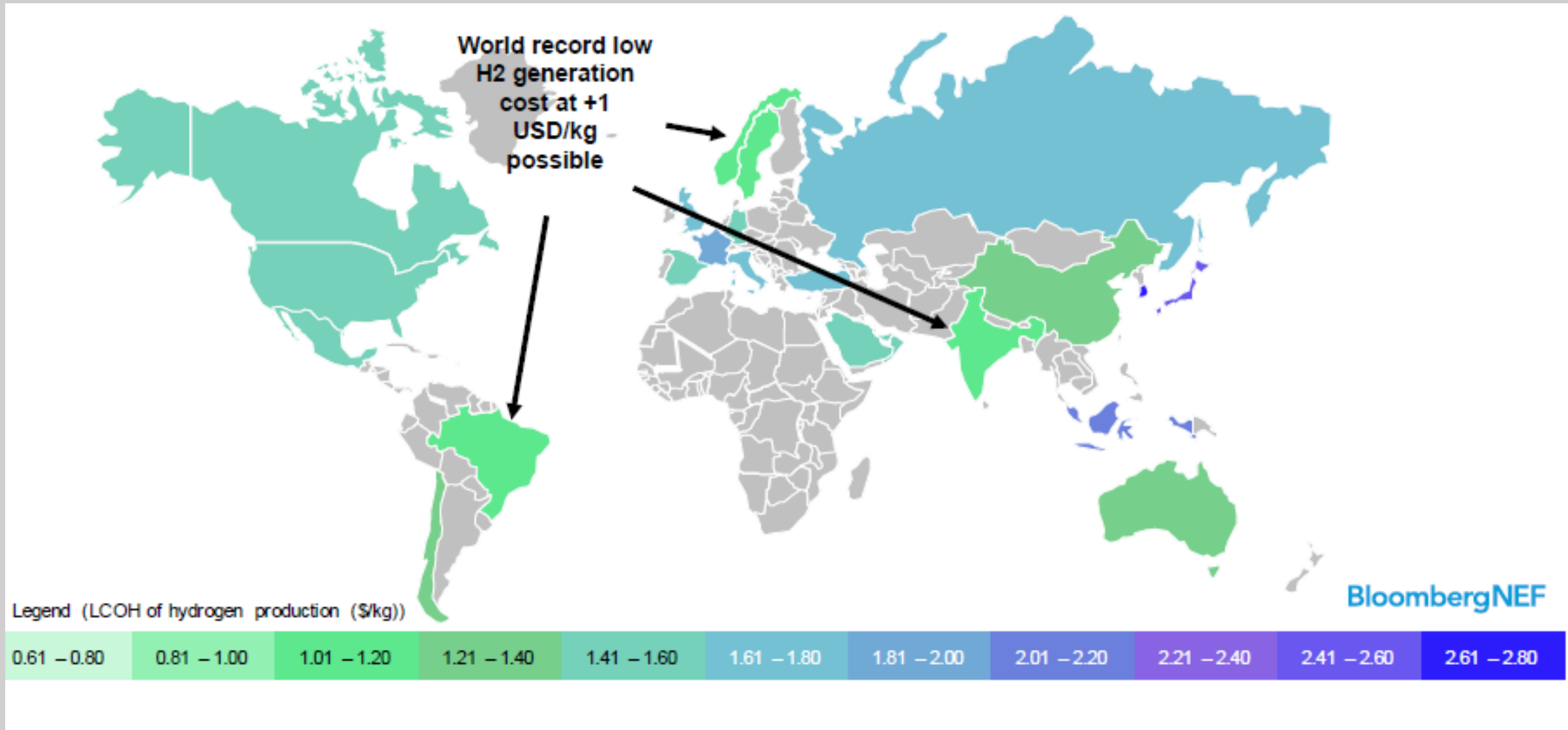
# Green H2 from renewables to be competitive with blue H2 from gas in 2025 and grey hydrogen in 2027



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

# 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.





# 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 CO2 Emissions are Expected to be Averted



## MISSION IMPLEMENTATION TIMELINE

	Facilitate	Green Fertilizers	SIGHT	Pilots & Hubs	Regulations & Standards	R&D
YEAR						
2022-23			Consultation and Market Review	Roadmap for key sectors	Procedure for regulatory approval of pilot projects	Formulation of R&D Roadmap
2023-24	Notification of targets as may be decided by EG	Notification of Bids Award of Capacity	Notification of Incentive Schemes	Call for Proposals Phase I Implementation	Adoption of relevant international standards	Call for Proposals Phase I Implementation
2024-25	Preparatory steps for implementation	Construction				
2025-26	Implementation	Green Fertilizer production	Implementation of Incentives	Call for proposals	Continuous Review and Monitoring	Call for proposals
2026-27						
2027-28				Phase II Implementation		Phase II Implementation
2028-29						
2029-30						

# Kerala's vision and roadmap

## Kerala aspires to become;

- **Net Carbon Neutral State** by 2050
- **100% Renewable Energy** based State by 2040
- **A Green Hydrogen Hub** for mobility, refineries, fertilizer and shipping sectors and a strategic export hub

## Through a variety of interventions such as;

### ❑ **Transport:**

- ✓ 3000 Buses, 1000 Trucks and 100 Boats through HICE, Fuel Cell and Methanol
- ✓ Personal Rapid Transit (PRT) Pods for 10 cities as feeder network to KRAIL and for last mile connectivity
- ✓ 200 km PRT with Hydrogen Pods along highway connecting Thiruvananthapuram & Kochi

### ❑ **Renewable Power Generation:**

- ✓ Potential of ~9,000 MW through Solar, Small Hydro, Offshore and Onshore Wind, Tidal energy sources for adoption
- ✓ Potential of over 6,500 MW of Floating Solar Projects on reservoirs, idle water bodies and 8000 KM canal tops
- ✓ Potential for >11,000 MW PSPPs associated with reservoirs

### ❑ **Green Shipping Hub** using Ammonia and liquid Hydrogen

- ✓ Potential hub for green hydrogen fueling for shipping industry at Kochi and Vizhinjam
- ✓ Potential for Liquid Hydrogen facility using cold energy of LNG in Kochi
- ✓ Exploring tie-ups with LH2 Kawasaki and McDermott for liquid Hydrogen piloting

### ❑ **Refineries and Fertilizers:** Potential Green Hydrogen demand centres of 140 TPD in BPCL Kochi and 82 TPD for FACT Kochi.

### ❑ **Aviation:** Feasibility for pilot projects for SAF and GH2 production being explored by CIAL with GreenStat

### ❑ **Peat and Bio-Gas to Hydrogen:** Potential in Alappuzha for demonstration of low-cost Peat Gas to Hydrogen projects

- ✓ Proposal received from IIT Madras for piloting a 2TPD Green Hydrogen and 4TPD Ammonia plant based on solar and Biogas sources

Kerala emerges to be an export hub of Green Hydrogen and India's transshipment hub with major ports in Vizhinjam, Kochi, Beypore and Azhikkal connected by seamless inland waterways (West Coast Canal) running from Kovalam to Bekal

# Kerala's unique enabling ecosystem

## High Renewable Energy Potential

- Ideal location for green hydrogen production with high rainfall, solar insolation, wind potential
- Presence of waterbodies for floating solar power generation

## Vibrant Power Sector

- 2<sup>nd</sup> in India, as per rating of NITI Aayog on energy efficiency, sustainability, performance of Discom, lcost and trust, energy-friendly measures and new enterprises
- Enabling Policies, Regulations

## A front runner in Green H2 adoption

- Already kickstarted International partnerships, research and pilot projects on green hydrogen in various sectors

## Presence of Potential demand centres

- Refineries, Fertiliser and Chemical industries as potential demand centres

## Strong ecosystem of infrastructure

- Natural Gas and LPG pipelines, CGD infrastructure
- West Coast Canal

## Strategic export locations

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

## Proposed incentives for investors

- Draft incentives and benefits proposed by Kerala to investors are ready
- Working Group is constituted for industry collaboration

## Research projects and proposed global partnerships

Global research partnerships



# Snapshot of Kerala's Power sector

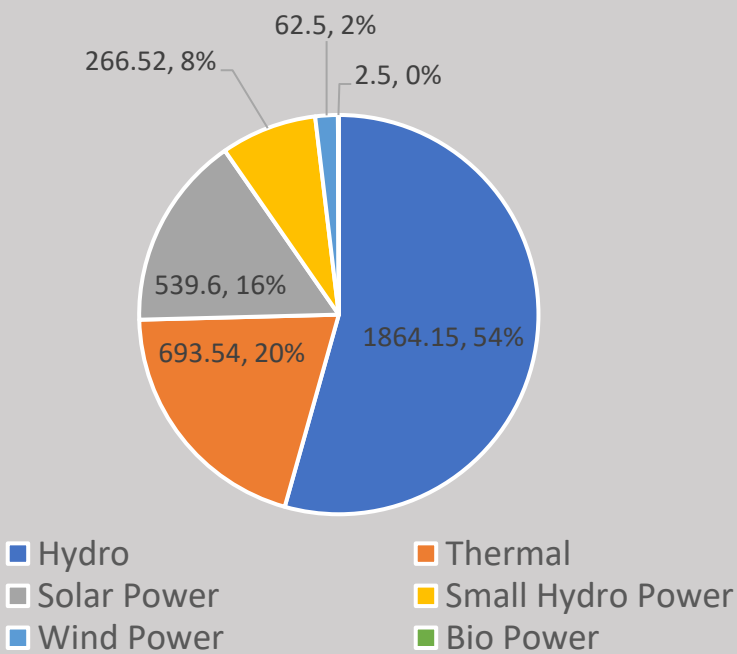
15 Hydro electric Power Plants (>25 MW) can be ideal locations for hybridizing with floating solar/Pumped storage and Hydrogen generation

Total Installed Capacity*	3428.81 MW
Peak Demand (FY21)	4284 MW
Annual Energy Requirement (FY21)	25,144 MU
Own generation(FY21)	7057 MU (28%)
Purchase (FY21)	18912 MU (72%)
Major share of installed capacity by sector	State, 65%
Major source of power generation	Hydro, 54%

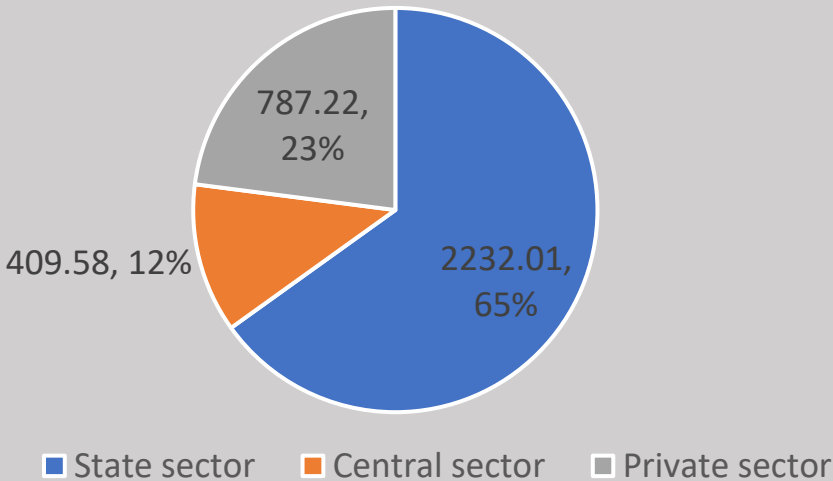
## Key State agencies in power sector

Agency	Role
Kerala State Electricity Board Ltd (KSEB)	State Transmission, Distribution, Generation Utility
Electrical Inspectorate	Statutory authority on electrical safety and standards
Agency for New and Renewable Energy Research and Technology (ANERT)	State nodal agency for RE
Energy Management Centre (EMC)	State Designated Agency under Energy Conservation Act, 2001
Kerala State Power and Infrastructure Finance Corporation Ltd. (KSPIFL)	State Power Financing agency
The Kerala State Electricity Regulatory Commission (KSERC)	Statutory body regulating the power sector including tariff determination.

Installed Capacity (MW), Source wise



Installed Capacity (MW), Sector wise



\* As on 31/08/2022

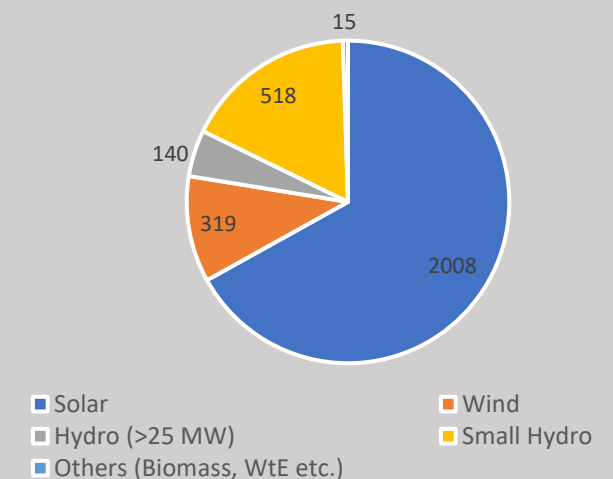
# Renewable Energy Potential of Kerala

## Potential

- It is estimated that Kerala has 8600 MW of RE potential.
- 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 in next Five years 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
<b>TOTAL</b>	<b>8,600*</b>	<b>825.20#</b>

3000 MW by 2027, breakup by source



- The Ministry of New and Renewable Energy (MNRE) has identified the Kerala-Konkan coast as one of the potential sites for offshore wind farms in India.
- Palakkad, Idukki, and Thiruvananthapuram has locations where the wind speed is above 15 km/hr.
- Potential for deployment for tidal energy along the coast

## RPO targets

**Renewable Purchase Obligation (RPO)** mandates that the electricity distribution licensee (i.e., KSEB) should purchase or produce a minimum specified quantity of their requirements from Renewable Energy Sources. This is as per the Indian Electricity Act, 2003. For the FY222, RPO for State is 17%.

- The state has set a trajectory for RPO targets from 2010 till 2021-22 and public consultation is going on for setting the target for the upcoming years.
- The percentage shall be applicable to all Distribution Licensees, open access consumers, and captive users (>100 Kw) within the State (i.e., Obligated Entities)

\* MNRE Annual Report 2020-21

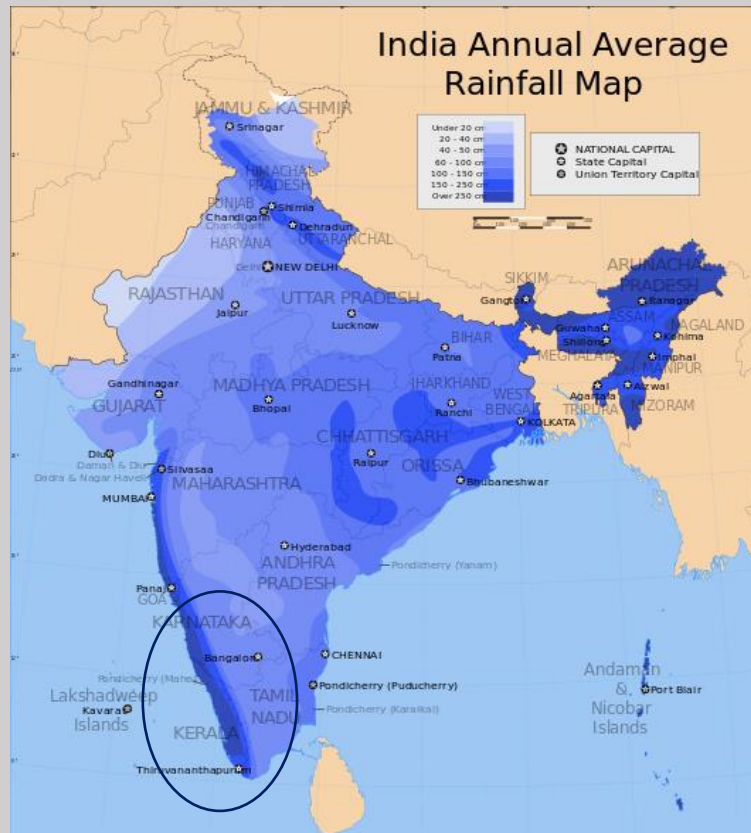
# mnre.gov.in as on 31.05.2022

Kerala Renewable Purchase Obligation (RPO) Targets

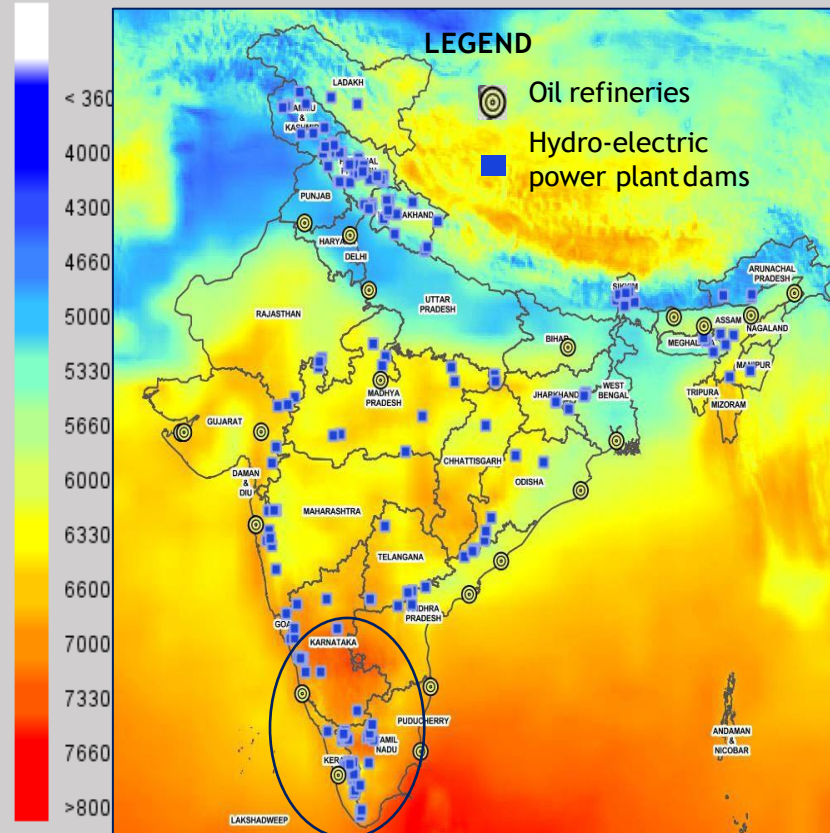
Financial Year	Percentage Share of Total Purchase of Power from Renewable Energy Sources		
	Non-Solar	Solar	Total
2019-20	8.00	4.00	12.00
2020-21	9.00	5.25	14.75
2021-22	10.25	6.75	17.00

# Kerala's unique advantages favoring green hydrogen production

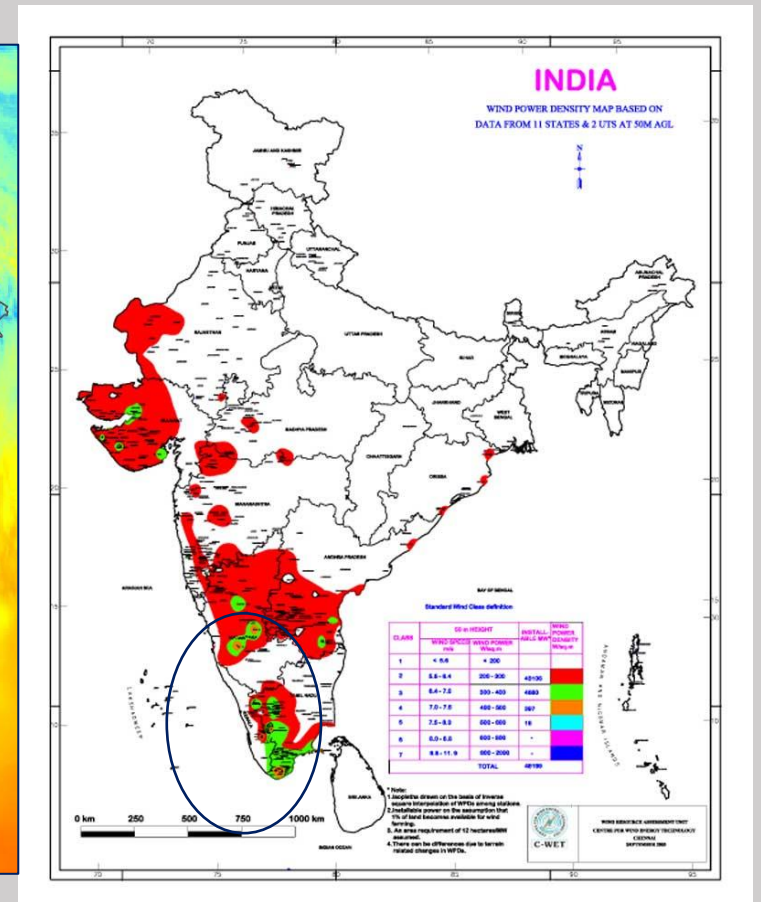
- Majority area of Kerala is blessed with **high annual rainfall (>250 cm annual average)** and high annual average **solar insolation (> 6600 MJ/m<sup>2</sup>)**
- Districts such as Palakkad, Idukki, and Thiruvananthapuram have wind power density >**250 W/m<sup>2</sup>** and regions neighboring Tamil Nadu are high intense regions for wind farm development
- 2 prominent refineries (**BPCL Kochi and MRPL Mangalore**) are in close proximity to **15 Hydro electric Power Plants (>25 MW)** which can be ideal locations for **hybridizing with floating solar/Pumped storage and Hydrogen generation**



Average annual rainfall map of India



Geospatial maps of green hydrogen demand centers (e.g., crude oil refineries), hydro electric power plant dams with annual average solar insolation (MJ/m<sup>2</sup>) and wind power potential (W/m<sup>2</sup>)



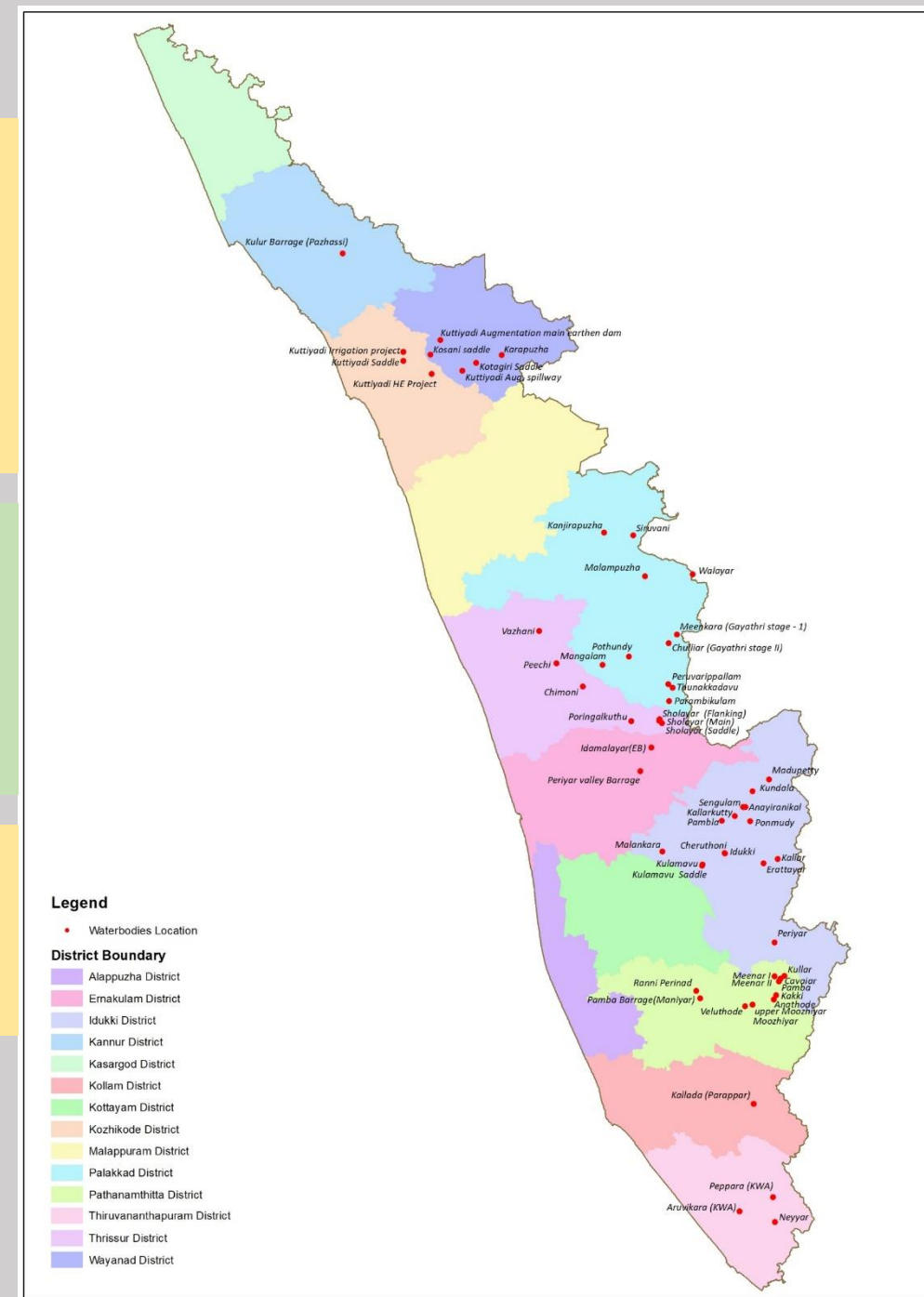


# Significant potential for Floating Solar Power Plants in Kerala

- Floating solar power plants if set up in **61 Large Dams\* of Kerala** can help to generate power without gobbling up precious agricultural land in space-challenged state like Kerala
  - **‘National Register of Large Dams (NRLD) -2019’** of Central Water Commission, Government of India maintains a database of the large dams
- **Key takeaways derived from 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): **~5000 MW**
- 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.

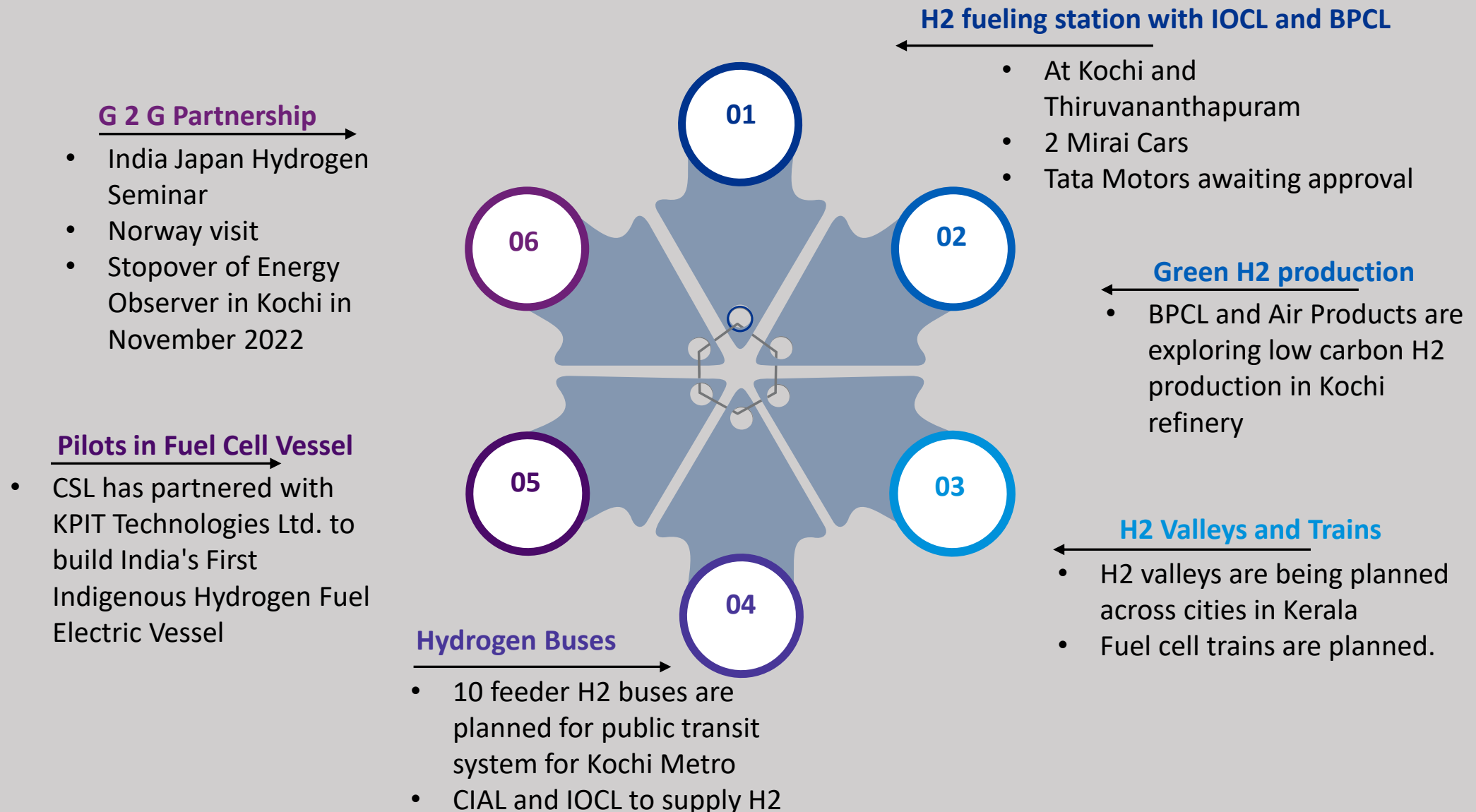
\*A large dam as per definition of International Commission on Large Dam (ICOLD) is;

- A dam with a height of 15 metres or greater from lowest foundation to crest.
- A dam between 5 metres and 15 metres impounding more than 3 million cubic metres of water.



# Kerala - A front runner in adopting H2 across ecosystem

- **Travancore Cochin Chemicals (TCC)**, a public sector firm, aims to be a major hydrogen supplier in Kerala.
- **Vytilla Mobility Hub** will host a major **hydrogen dispensing station**.
- TCC has a chlor-alkali unit with hydrogen as by-product from the production of caustic soda.
- Hydrogen from the TCC has been identified as cost effective to meet the need for hydrogen fuel cell buses in the State.
- Hydrogen dispensed from the hub will serve both **water transport vessels linked to Kochi Metro** as well as **public transport vehicles**.



# Demand drivers for Green H2 adoption in Kerala

End usage	Purpose	Potential Customer
Refinery	<ul style="list-style-type: none"><li>De-sulphurisation of products such as diesel and petrol.</li></ul>	<ul style="list-style-type: none"><li>BPCL, Kochi</li><li>MRPL Mangalore</li></ul>
Ammonia production	<ul style="list-style-type: none"><li>Ammonia, a compound made of nitrogen and hydrogen, is extensively used in the fertiliser/ chemical sector (nitrogen-based (urea), complex fertilisers such as diammonium phosphate (DAP).</li><li>There is potential for the use of ammonia as a hydrogen carrier and fuel for shipping</li></ul>	<ul style="list-style-type: none"><li>FACT Kochi</li></ul>
Methanol production	<ul style="list-style-type: none"><li>Hydrogen is a <b>main feedstock in the production of methanol</b> and is currently produced primarily from natural gas in India</li><li>Methanol is primarily used to produce various chemicals and solvents, as fuel for transport in the form of various blends, marine fuel, and cooking.</li></ul>	<ul style="list-style-type: none"><li>Cochin Petromins Pvt. Ltd. (CPPL)</li></ul>
Transport	<ul style="list-style-type: none"><li>Targets <b>1 million</b> EVs by <b>2022</b></li><li><b>1000</b> goods carriers, <b>3000</b> buses, <b>100</b> ferry boats</li><li>Potential demand of <b>30 Kg Hydrogen per day per Bus/Truck</b></li></ul>	<ul style="list-style-type: none"><li>KSRTC</li><li>KMRL</li></ul>
Heat and Power generation	<ul style="list-style-type: none"><li>Blending with Natural Gas, LPG</li><li>Power-H2-Power as another form to provide storage and flexibility using Fuel Cells</li></ul>	<ul style="list-style-type: none"><li>GAIL Kochi-Mangalore Gas Pipeline</li><li>CGD operators in 14 districts</li><li>IOCL, Kochi</li><li>KSEB</li></ul>
FACT, Kochi	<ul style="list-style-type: none"><li>Demand for Ammonia in FACT Kochi plant is ~1.8 Lakh MT/annum.</li><li>0.31 lakh MT of H2 (17.7% of 1.8 lakh) is required to produce 1.8 lakh tonne of Ammonia which translates to a demand of ~ 1000 MW* RE and Electrolyser capacity.</li></ul>	
BPCL, Kochi	<ul style="list-style-type: none"><li>BPCL has refining capacity of 15 MMTPA, making it the largest public sector refinery in the country.</li><li>BPCL requires ~140 TPD H2.</li><li>As per NITI Aayog, 25% of H2 used in refineries, fertilizer and steel plants be Green H2 by 2030.</li><li>This translates to a demand of 35 TPD of Green H2</li></ul>	

\*Assuming CUF of 19%, Electricity requirement: 50 kwh/kg H2, Water requirement: 10 Litre/Kg H2, Electrolyser efficiency: 80%

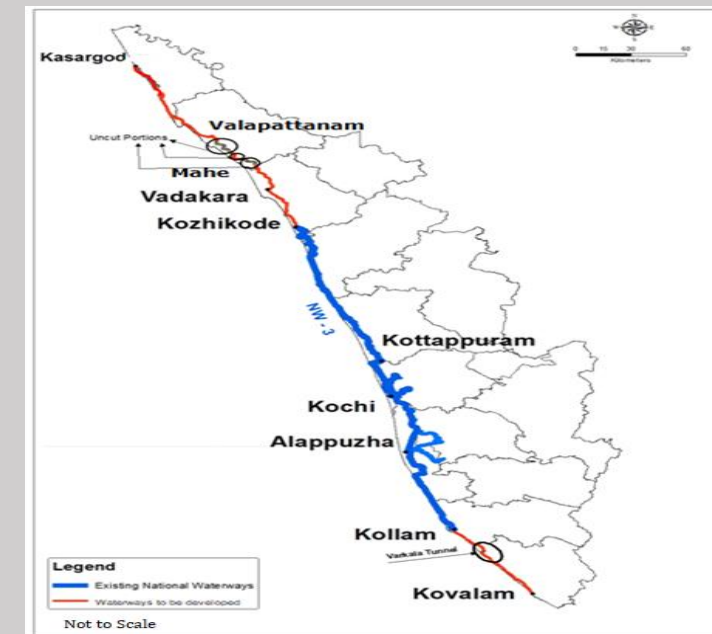


# Potential Sites for hosting Economic Development Opportunities in GH2 value chain

**1** South, runs 616 kms from north to south of Kerala

## 2 for navigation

The entire route length of NW-3 has been provided with aids to facilitate 24 hours navigation.

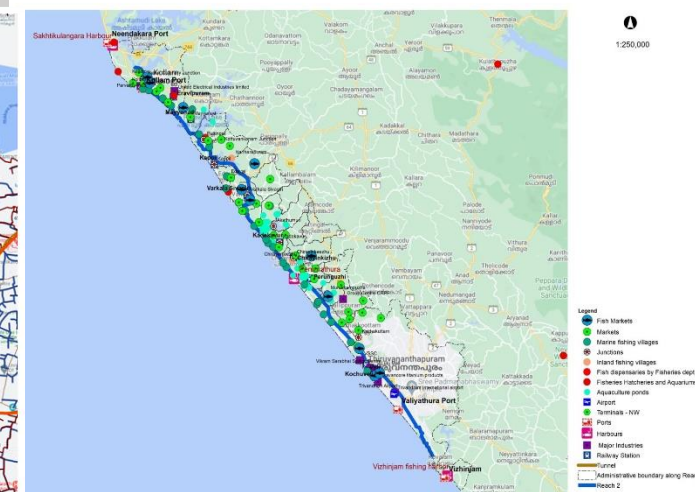
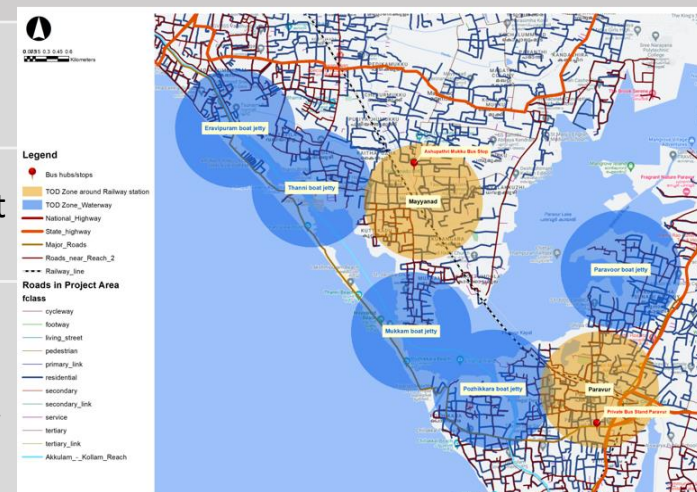


**Mapping of Economic Development Opportunities (EDO) along the West Coast Canal (WCC) is being undertaken by Government of Kerala;**

State envisions to transform the WCC into an **economic and trade corridor of Kerala.**

Concept Planning for **Transit Oriented Development** along the West Coast Canal is being undertaken

Economic Development Opportunities (EDOs) of **industry, RE, transport, tourism, trade and agriculture sectors** are being assessed along 13 **reaches for integrated development of economy along WCC.**



**Government of Kerala proposes to acquire land parcels for developing the identified EDOs along the waterways which shall be made available for investors through transparent process.**

**Government of Kerala is working on fast-track basis to complete WCC to ensure continuous navigability of entire stretch by 2025-26 with new cross structures, flow control gates, rail crosses and dredging activities. WCC would offer strategic locations to investors for Hydrogen generation.**

# Kochi Water Metro



- Kochi Water Metro is an integrated ferry transport project in Greater Kochi region proposed by Kochi Metro Rail Limited.
- It is the first of its kind transport system in India and South Asia, that will connect Kochi's 10 island communities with the mainland through a fleet of 78 battery-operated electric Diesel hybrid boats plying along 38 terminals and 16 routes spanning 76 kilometers

- Cochin Shipyard Limited (CSL), which had been awarded the tender to build the fleet of 23 boats that can carry 100 passengers.
- Five of the boats have been delivered to KMRL so far.
- Bid for 55 Water Metro boats (50 seater) to be finalised by February 2023
- The metro agency is expected to directly operate 30 of them through waterbodies in the Greater Kochi area, while the remaining 25 vessels are slated to be operated on public-private partnership (PPP) basis.

**Opportunity for PPP exploration and deployment of Hydrogen Fuel Cell based Vessels and building Metro feeders based on H<sub>2</sub>ICE (having conversion costs in the range of 10-12 lakhs)**





# Cochin International Airport Ltd.

## *An Energy-Autonomous Airport in transformation towards “Net-Zero” Emission-Free Aviation Hub*

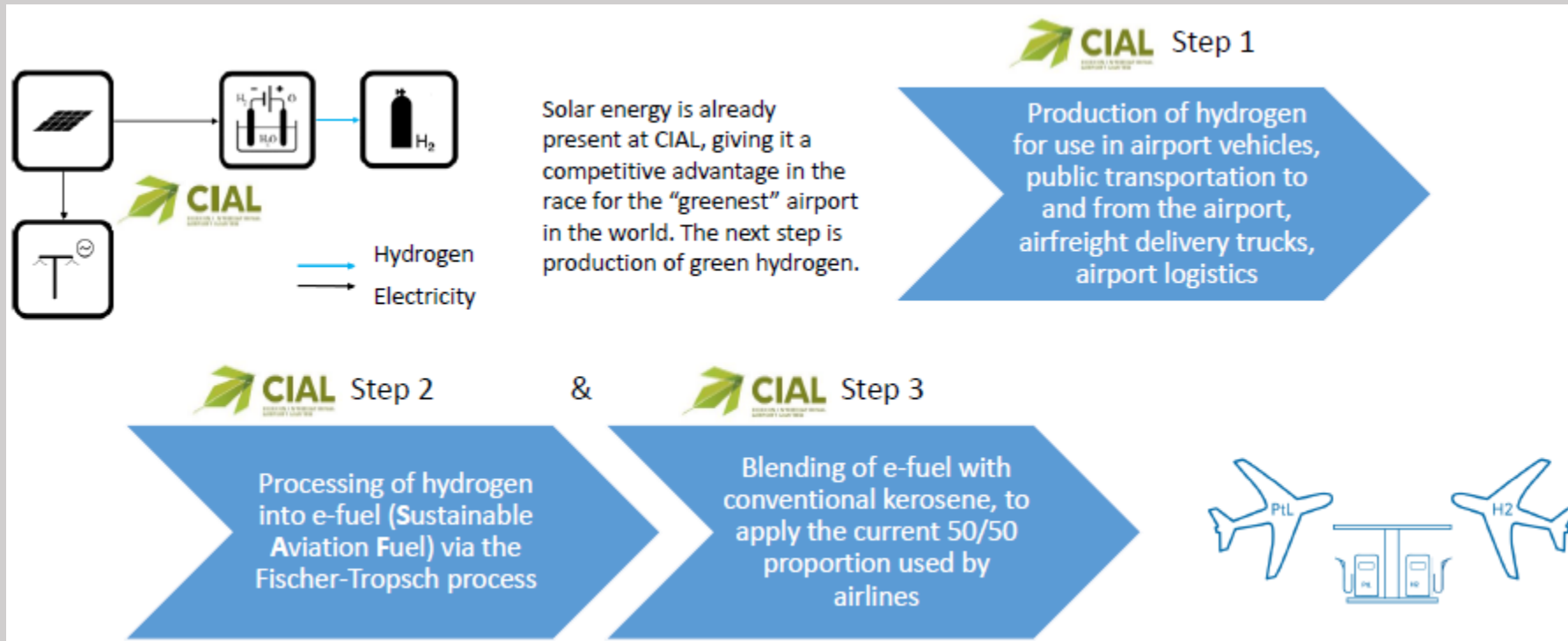


A 50MW solar power plant, using the surrounding land, and also the parking lot, for solar panels. The airport became energy neutral on solar power in 2015, a world first, and now feeds superfluous energy into the grid.

In 2021, a hydraulic power plant with an initial 4MW power is added to the CIAL energy generation system.



CIAL proposes to undertake ITEAL: Innovative Fuels for Low-Emission Aviation



ITEAL is a Project Study finalized in Germany in 2022, and presented at ILA Berlin Air Show, raising interest of further EU countries, for potential international partnerships.

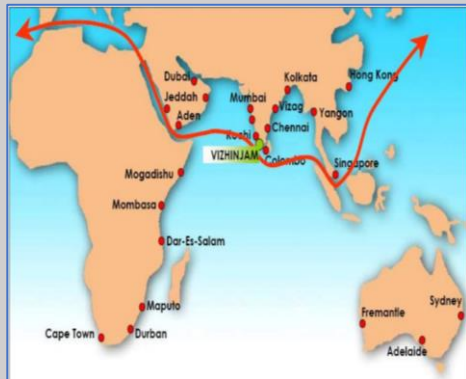
**Opportunity to partner with CIAL  
for investments in SAF**



# State would facilitate access of strategic import/export locations to the investors..

The State is accessible through **17 seaports** which include 1 major **International Container Terminal (ICT)** at **Cochin Port** and India's first **Mega Transshipment Container Terminal** is coming up at **Vizhinjam**. An LNG terminal is operational (**Petronet LNG**) at **Kochi**

## Vizhinjam Port



- Phase 1 capacity of 1 million TEUs and 6.2 million TEUs in next Phases
- Close proximity to the international East-West shipping route.
- Availability of 20m contour within one nautical mile from the coast.
- Minimal littoral drift along the coast, hardly any maintenance dredging required.
- Links to national/regional road, rail network, airport

## Cochin Port



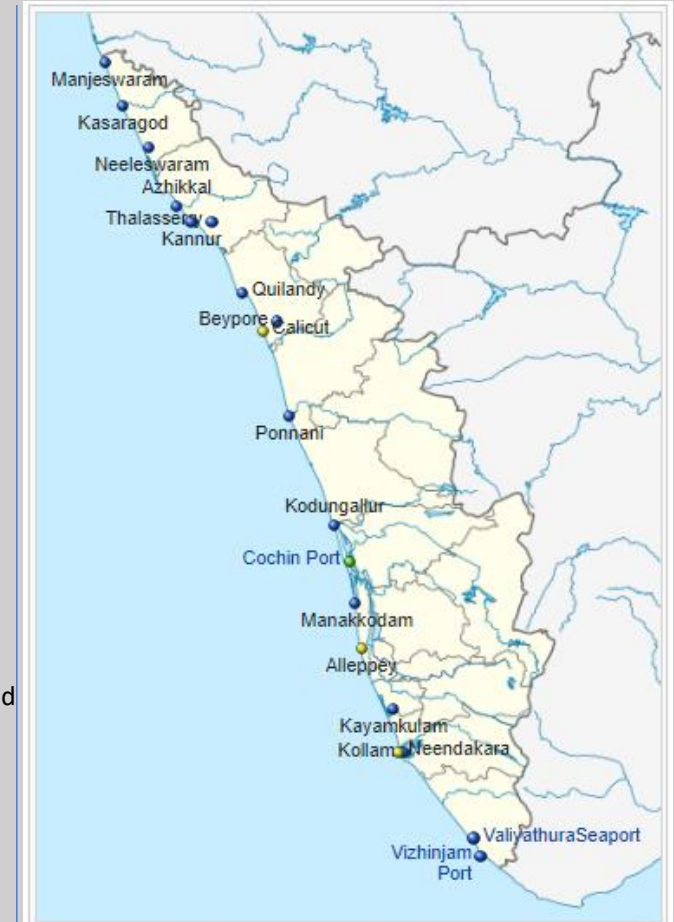
- An all weather natural Harbour
- Connectivity with rail, road, air, inland waterways
- Proximity to international maritime highway
- **Cochin Port Authority** has about **881.43 ha** (2177.14 acre) of land at various locations in Ernakulam District
- Land Use Plan is available and **Land Management is guided by PGLM, 2015**, notified by GoI.
- Guidelines permit **Major Ports to allot land on nomination basis to Government Departments/ Organizations**

## Petronet LNG Terminal, Kochi



- 5 MMTPA nameplate capacity
- The terminal area is situated in the SEZ of Puthuvypeen near the entrance to Cochin Port.
- The Terminal has been commissioned in 2013.
- Ancillary services such as storage & reloading, Gassing up and cool down (GUCD), bunkering options are also offered at Kochi terminal
- Distributes NG through trucks (Taral), and full utilization to achieve once GAIL pipeline is fully commissioned
- PLL is exploring opportunities in **Green Hydrogen** with reputed players in domain

## Major and minor ports in Kerala



# Ongoing proposals for global cooperation in Kerala

## 1. Kochi Green Hydrogen Hub (KGH2) by IH2A

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.

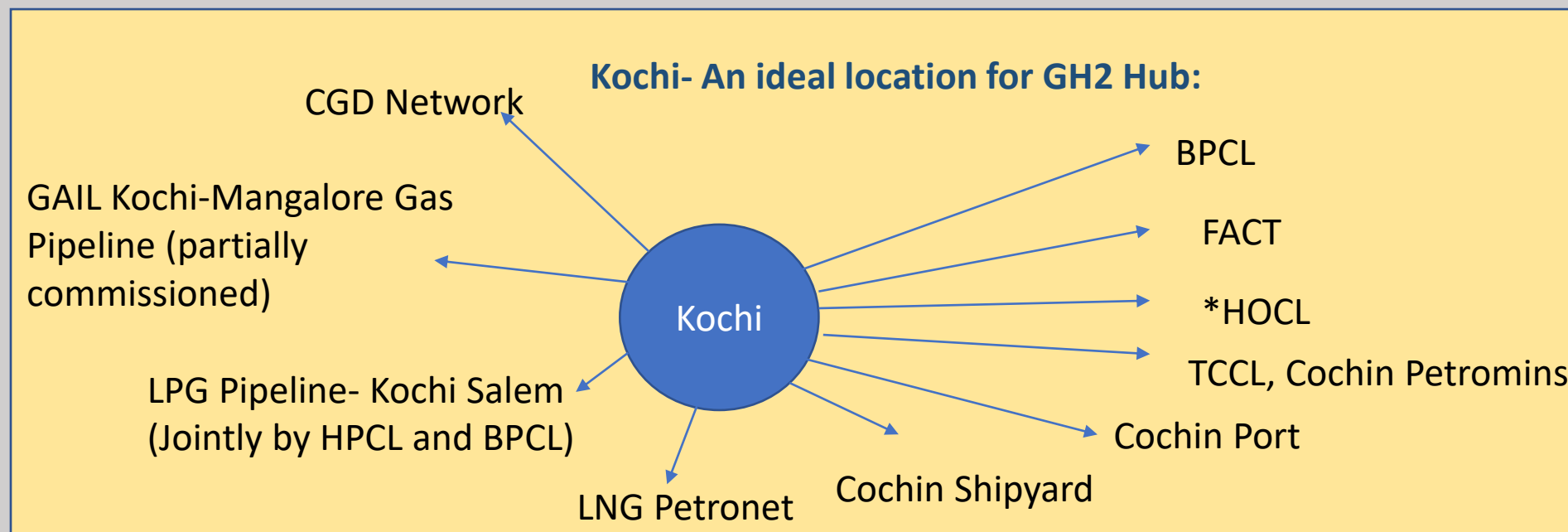
### Objective:

The proposal envisages potential capital expenditure of **USD 575 million**, to build a **60-tonnes per day (TPD)** green hydrogen plant with a **150 MW** Electrolyser, Storage and Infrastructure, which could achieve giga-watt scale and build the hydrogen economy in Kerala.

### Demand centres:

The plan focusses on the transport use-case in the first phase, aligning with the state government's plans for zero-emission transport, to power Hydrogen-ICE retrofitted bus fleets of 60 buses and build the required infrastructure.

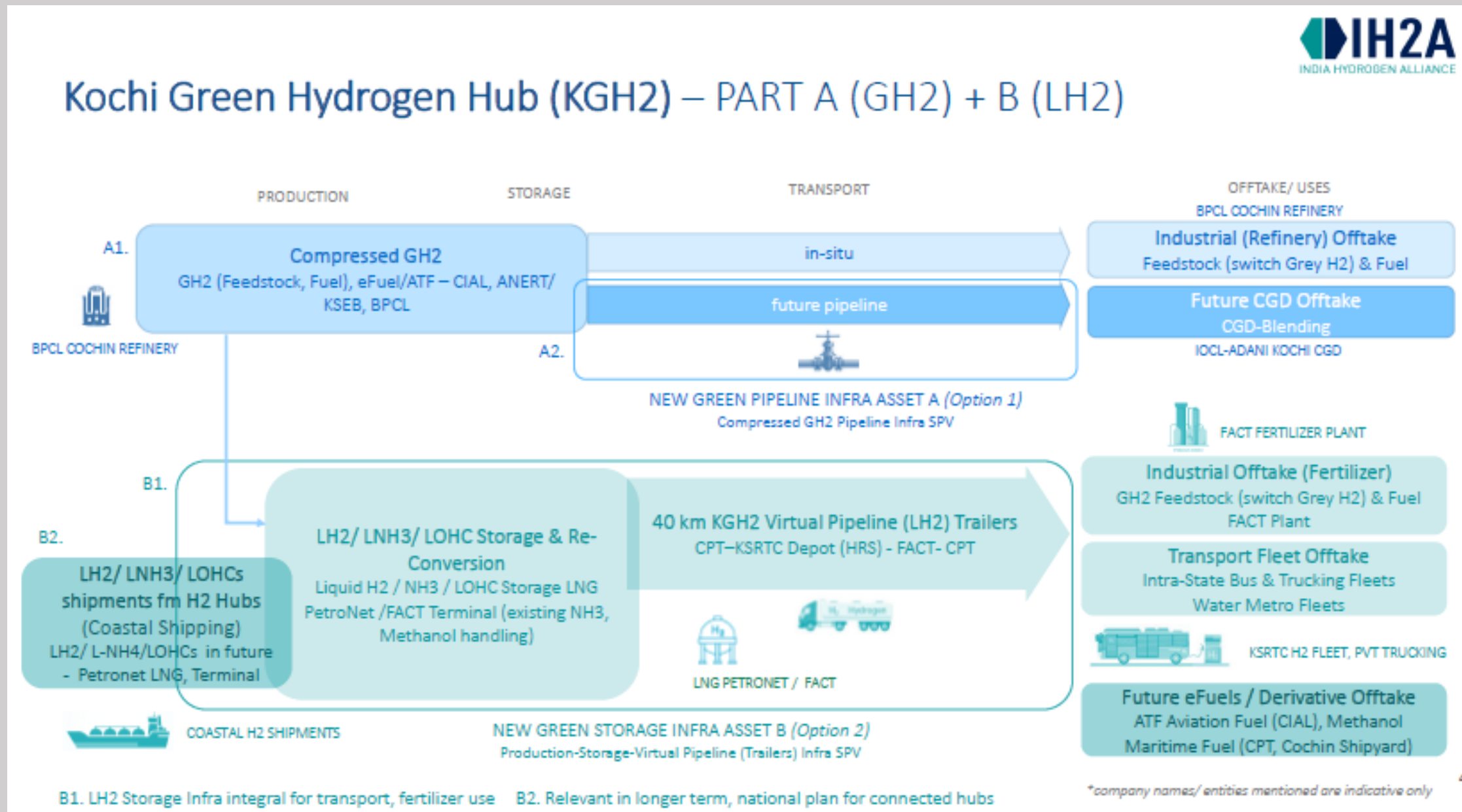
In the second phase, industrial demand for green hydrogen from refineries, fertilizer and chemical plants is expected to drive capacity expansion and scale-up the KGH2 hub



\*HOCL- Hindustan Organic Chemicals Ltd. (for production of Hydrogen Peroxide and Phenol)

# Ongoing proposals for global cooperation in Kerala

## 1. Kochi Green Hydrogen Hub (KGH2) by IH2A





# Ongoing proposals for global cooperation in Kerala

## 2. Green Hydrogen Valleys

Department of Science and Technology, Ministry of Science and Technology, Government of India has invited proposal from agencies to set up **Hydrogen Valleys** under **Mission Innovation** to demonstrate how the entire value chain of hydrogen (production, storage and transportation) as an energy vector fit together in an integrated system approach.

- Kerala aspires to develop 2 Green Hydrogen Valleys in **Kochi** and **Thiruvananthapuram (Vizhinjam)**.
- **IIT Palakkad is arranging a workshop on 15<sup>th</sup> Feb’ 2023 at Thiruvananthapuram**

**What is Hydrogen Valley?**

- Defined geographical area where hydrogen serves more than one end sector or application in mobility, industry and energy.
- This typically covers all the necessary steps in the hydrogen value chain, from production (dedicated renewable electricity production) to subsequent storage and its transport & distribution to various off-takers.

**Mission Innovation:**

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

**Stakeholders & Departments involved**

1. Department of Science and Technology, Ministry of Science and Technology, Government of India
2. Power Department, Government of Kerala
3. Energy Management Centre
4. ANERT
5. Impact Hydrogen, TuDelft
6. IIT Palakkad
7. FACT, BPCL, HOCL, VISL

**Funding**

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

# Ongoing proposals for global cooperation in Kerala

## 3. MoU with Port of Rotterdam

Department of Ports, Government of Kerala has entered an MoU with Port of Rotterdam on **11<sup>th</sup> October 2017** for exploring possibility for cooperation in **port, logistics**, and related projects in Kerala. **The MoU shall be renewed to explore areas in Green Hydrogen opportunities.**

Areas of services shall be **master planning, organization, digitization, education and training.**



### Stakeholders & Departments involved

1. Department of Ports, Government of Kerala has entered an MoU with Port of Rotterdam on 11th October 2017
2. Vizhinjam International Seaport Ltd.
3. Other Major and Minor ports in Kerala

# Ongoing proposals for global cooperation in Kerala

## 4. Exploring partnership with Hamburg Port Authority to set up a Hydrogen Hub at Kochi

Hamburg Port, known as Germany's "Gateway to the World" is the Germany's largest seaport by volume and a public sector institution. In terms of TEU throughput, Hamburg is the third-busiest port in Europe (after Rotterdam and Antwerp) and 15th-largest worldwide.



### Areas of discussion

- a) Building port infrastructure for exporting green hydrogen (GH<sub>2</sub>) and hydrogen derivatives (H<sub>2</sub>X) from Kochi to Germany for meeting Germany's decarbonization targets
- b) Assessing the requirement for building required infrastructure for fuels for shipping
- c) Trade of GH<sub>2</sub> and H<sub>2</sub>X between ports/ countries
- d) Opportunities for shipbuilding of GH<sub>2</sub> powered vessels, and vessels suitable for inland waterways
- e) Planning of projects to build integrated value chain of hydrogen at both the ends (Kerala and Germany)
- f) Exploring PPPs in land parcels identified as Economic Development Opportunities (EDOs) by Government of Kerala along Inland Waterways in proximity to Cochin

### Stakeholders & Departments involved

1. Power Department, Kerala
2. EMC, ANERT
3. Vizhinjam International Seaport Ltd.
4. Cochin Port and Cochin Shipyard Ltd.



# Ongoing proposals for global cooperation in Kerala

## 5. Exploring possibility of using Peat Gas for conversion to Grey Hydrogen or power generation with Carbon Capture technology

Organic rich soils (peat) store significant amount of global soil carbon (C) in the form of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>). Peat soils act as sinks and are a source of greenhouse gases (GHG) which occur in the form of Free Phase Gas in coastal landforms. When peat comes into contact with air, its carbon combines with oxygen in the decomposition process, and is released as carbon dioxide. South-West India has an extensive wetland system and is the primary source of GHG emissions, and CH<sub>4</sub>, in particular, has high potential to contribute to global climate change.



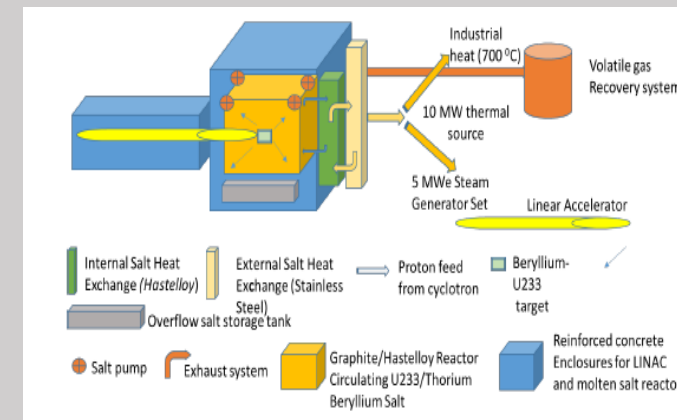
**Areas of biogenic gas accumulation at the depth of 5m and 17-22m at two study areas of Alappuzha peatlands of SW India. (Study funded by Gas Authority of India Limited and IIT Madras.**

## 6. Thorium based Dispersed Power and Heat Advanced Subcritical Microreactor (ASMR)

ASMR is a Low cost, low risk solution to reducing Greenhouse Gases from Industrial and Electric Power Sector.

Integrated Energy Systems (IES) with Distributed microgrid, Smart electrical grid and Small microreactors using Molten Salt uranium and thorium fuel cycle are being developed at **Virginia Thorium Energy ASMR and Radio Isotope Development Facility.**

Senate bill S4242, “Thorium Energy Security Act” once passed will enable our thorium energy programs on fast track



# What Kerala can offer to investors for Green Hydrogen related investments?

1. A **comprehensive policy on RE and Green Hydrogen generation** with key incentives and promotions is being formulated by State.
2. Major incentives as proposed in the **National Hydrogen Policy** shall be considered for adoption for the State
  - For certain MW capacity of early bird investment for Green Hydrogen and associated renewable power generation in the State, Banking facility and certain relaxations on T&D (Wheeling charges) shall be provided.
3. Government would take lead role in building **critical common infrastructure** (e.g., power evacuation lines) and from time to time devise new policies.
4. Setting up of a **centralised storage facility** for the Hydrogen at ideal location in Kochi in proximity to major consumption points.
5. Government would also facilitate obtaining various **consents/clearances** required for project proponents in a time bound manner
6. Provision to **allocate land for PPP developments**, particularly along the West Coast Canal
7. Kerala shall facilitate **green hydrogen hub related investments in ~1100 Acres of land of NTPC** (Rajiv Gandhi Combined Cycle Power Plant, Alappuzha, Kerala, fueled by imported and indigenous naphtha) where NTPC is seeking State's assistance for green investment. A floating solar plant is set up on the lake adjacent to it (~92 MW). This would be an **ideal hub for Green Hydrogen Hub development**.
8. **Facilitation for accelerated deployment of Small Hydro and Pumped Storage Hydro Projects** (State is estimated to have ~11 GW of Small Hydro and Pumped storage potential as per NHPC assessment)

## Key incentives proposed in Kerala- Draft Green Hydrogen Policy 2023

Parameter	Features
<b>Open Access</b>	Green Hydrogen/Green Ammonia plants will be granted Open Access for sourcing of Renewable Energy within 15 days of receipt of application complete in all respects.
	Renewable Energy can be sourced from a co-located Renewable Energy plant, or sourced from a remotely located Renewable Energy plants, whether set up by the same developer, or a third party through Open Access or procured renewable energy from the Power Exchange.
<b>Transmission, wheeling charges and Cross Subsidy Surcharges</b>	<ul style="list-style-type: none"> <li>• 50 percent exemption from wheeling charges</li> <li>• 50 percent exemption from intra-state transmission charges</li> <li>• 100 percent exemption from cross-subsidy surcharge.</li> </ul>
<b>Banking</b>	Shall be permitted for a period of 30 days for Renewable Energy used for making Green Hydrogen/Green Ammonia
<b>Connectivity</b>	Connectivity, at the generation end and the Green Hydrogen/Green Ammonia manufacturing end, to the Transmission and Distribution network shall be granted on priority.
<b>RPO compliance</b>	Renewable Energy consumed for the production of Green Hydrogen/ Green Ammonia shall count towards RPO compliance of the consuming entity
<b>Aggregation of Green Hydrogen demand</b>	In order to achieve competitive prices, ANERT may aggregate demand from different sectors and have consolidated bids conducted for procurement of Green Hydrogen/Green Ammonia through any of the designated implementing agencies.
<b>Floating solar Power Projects</b>	Land shall be allocated on long term lease basis on water bodies, reservoirs, uncultivable farmlands flooded with saline/brackish water etc. to developers for setting up of Floating solar Power Projects. A draft guideline is being prepared and the same is under public consultation.
<b>Creation of Land Bank</b>	INR 300 Crs is earmarked in the State Budget 2023-24 for procuring land along the West Coast Canal waterways and 1000 Crs is earmarked for the Land acquisition activities of developing industrial and infrastructure investment corridor around Vizhinjam International Seaport Ltd. for developing economic development activities in green energy and hydrogen domain, for making available to the investors on the basis of State's PPP policy.

## Key incentives proposed in Kerala- Draft Green Hydrogen Policy 2023

Parameter	Features
<b>Viability Gap Fund/Grant/Equity support</b>	<p>INR 200 Crs is announced 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. This fund shall be utilized for the following purposes;</p> <ul style="list-style-type: none"> <li>• INR 50 Crs shall be earmarked as State's or any of its partnering agencies' share in the first Kerala Green Hydrogen Hub for subsidizing the Green Hydrogen generation cost.</li> <li>• For the first 100 MW electrolyser deployment in the state, Capital Expenditure (CAPEX) subsidy of 25% shall be eligible for electrolysers. Minimum capacity to avail it shall be higher than 50 MW.</li> </ul>
<b>Incentives proposed in the 'Kerala Industrial and Commercial Policy 2023-28'</b>	<ul style="list-style-type: none"> <li>• The 'Kerala Industrial and Commercial Policy 2023-28' is expected to be published in February 2023 and detailed public and stakeholder consultations are completed.</li> <li>• Incentives proposed in the 'Kerala Industrial and Commercial Policy 2023-28', such as Investment Subsidy on Fixed Capital, SGST Reimbursement, Apprenticeship Incentive (Manufacturing sector), Waiver of Stamp Duty &amp; Registration charges, reduction in Land Conversion charges etc., shall apply to new green hydrogen/ammonia investments subject to projects falling under MSME (Investment in Plant &amp; Machinery not exceeding INR 50 Crs and turnover not exceeding INR 250 Crs.), Large (Investment in Plant &amp; Machinery above INR 50 Cr. and not exceeding INR 300 Crs) and Mega (Investment in Plant &amp; Machinery above INR 300 Crs) categories.</li> </ul>
<b>High Level Committee</b>	<p>The High Level Committee (HLC) which is set up for carrying out all the activities and monitoring and evaluation of floating solar projects scheme with the Chief Secretary as the Chairman, ACS (Power Department) as Convenor and Secretaries of the participant departments (Agriculture, Environment, Finance, Fisheries, Forests, Irrigation/Water Resources, Local Self Government, Revenue) and CEO (ANERT) as members would carry out all the activities and monitoring and evaluation of the 'Kerala Green Hydrogen Policy 2022' as well.</p>

**First State to announce a scheme of ₹200 crore 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.**



നിങ്ങളുടെ സംരംഭം  
ഞങ്ങളുടെ അഭിമാനം

Your Investment  
Our Pride

*Thank  
You*



State is well positioned to become the hub of sustainable investments

Leader in SDG | Strategic geographical location | Export-specific Infra strength | Digital State | Green Infrastructure focus |  
High quality of life | High quality talent pool | Renowned Startup Ecosystem