# AKSHAY PRAKASH (Issue No: 3 of 2022)


All info in this PPT is collected from various open sources available on the internet. If you feel, my views are incorrect, kindly neglect them & excuse me. I sincerely respect your views. Also kindly excuse me for my typo errors, if any

# MOP's Green H2/ Green Ammonia Policy dated 17/02/2022:

***(A step forward towards National H2 Mission)***

**Complied By**

**Vijay L Sonavane**

**ME(Elect)**

**Date: 28th Feb 2022**

# Thought for the day !!


**Mary Elizabeth Dole is an American politician & author who served in the Nixon, Reagan & Bush Presidential Administrations. She also served as a US Senator for North Carolina from 2003 to 2009.**

# National Hydrogen (H2) Mission

- **Hon. PM launched National H2 Mission on India's 75th Independence Day (i.e. 15th Aug, 2021), which aims to aid GOI in meeting its climate targets & making India a green H2 hub.**
  - **Green H2 & Ammonia are envisaged to be the future fuels & will replace fossil fuels. Production of these fuels by using power from RE, termed as Green H2 & Green Ammonia, which is one of the major requirements towards environmentally sustainable Energy Security of India.**
- **On 17th Feb 2022, MOP has released a Policy Document on Green H2/ Green Ammonia, which is the Major Policy enabler for production of Green H2/ Green Ammonia using Renewable Energy Sources (RES)**

# What is Hydrogen?

- **Hydrogen fuel is a zero-emission fuel, when burnt with Oxygen, It can be used in fuel cells or IC engines. It is also used as a fuel for spacecraft propulsion. (Aviation)**
  - **We cannot mine H2, or extract pure H2 gas from natural sources.**
  - **H2 is incredibly light, & also Energy-dense by mass. (3 times higher than diesel). This makes H2 a rich source of energy: but in order to make H2, a practical & portable source of Energy, we do have to compress it or liquefy it, before we can use it, which is a significant challenge.**
- **H2 can be produced thro' several chemical processes & from different resources, including Natural Gas, fossil fuels, Nuclear Power & Renewable Energy (RE)**
  - **Presently, most H2 produced is used in Chemical IND. Less than 0.1% of H2 gas is used for power production**

## Hydrogen production:

- Natural gas (as a feedstock) which contains H2 is reacted with Steam at high temp & high pressure to produce H2 & by-product is CO2.
  - (CO + H2O = H2 + CO2)
- Presently, Fossil fuel feedstock (Coal/Lignight/Gas) is used for producing 95% of H2.
  - Using this H2 doesn't release carbon into atmosphere locally, but while producing it release CO2. This means that fossile fuel based H2 pathway is not "Net- Zero" : so, it is not ideal.
- For 5% H2 production, a more ENV friendly alternative called Electrolysis is used.
  - Here, H2 is produced by splitting water (H2O) into H2 & O2, using electricity. If process is powered by RE, (Solar or Wind), this makes it a genuinely zero-emissions approach & is termed as GREEN HYDROGEN.

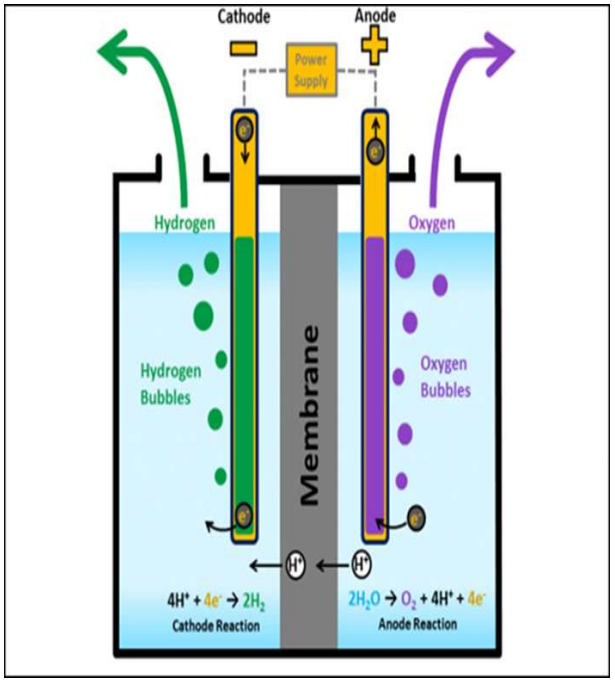
## Type of Hydrogen:

### 1. Grey Hydrogen: Coal or Lignite)

- Extracted from hydrocarbons (fossil fuels: (coal/lignite)
- CO + H2O: H2 + CO2 *(By-product: CO2)*

### 2. Blue Hydrogen:

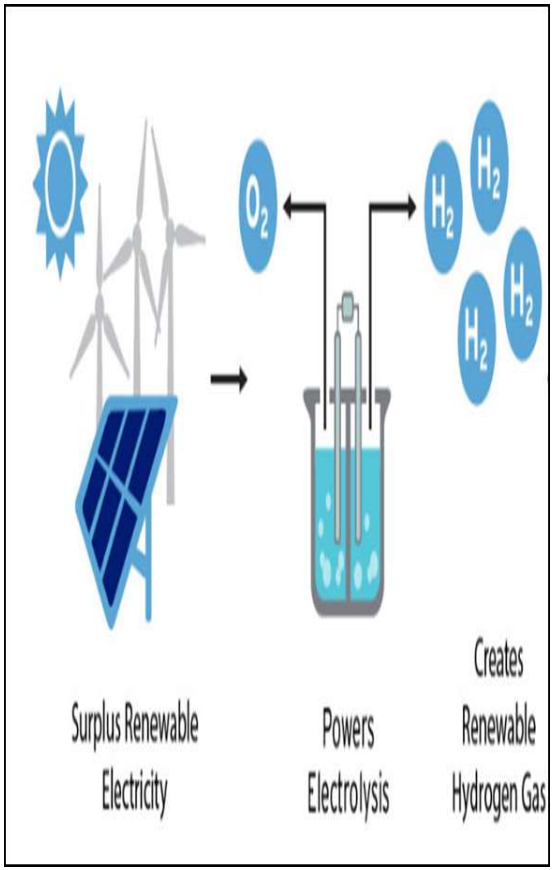
- It is sourced from Natural Gas: (By-product: CO, CO2)
- By-products can be Captured & Stored underground (Capturing & Storing System (CSS) rather than releasing them into atmosphere, so it is better than Grey H2, but it is a difficult process. More over where to use the captured CO2 is also an issue, *in case it is not be released in atmosphere*
- *Due to concerns about storage of CO2, focusing on blue H2 does not really "make sense" for India given that it would only add to our dependence on imported fossil fuels (Gas)*

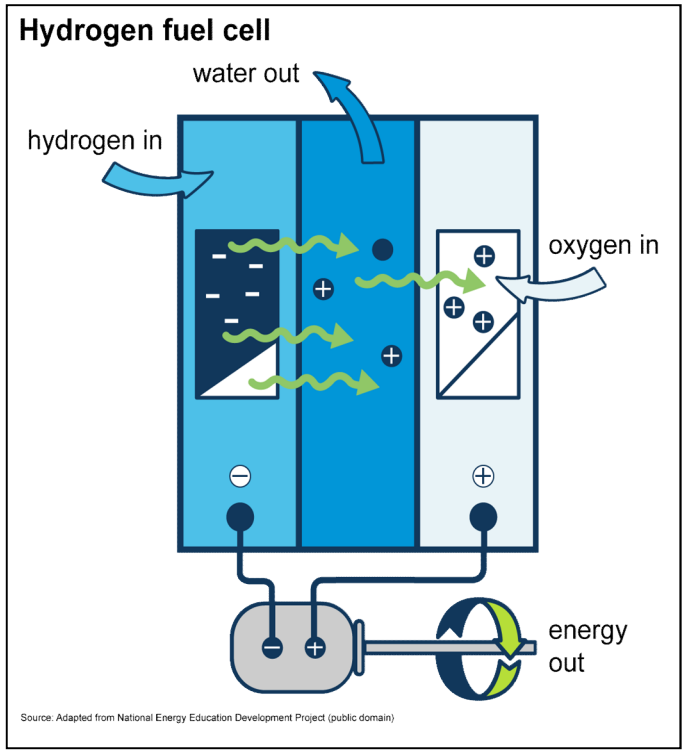

## 3. Green Hydrogen:

- Generated from RE (Solar, Wind). Electricity splits Water into H2 & O2 thro' Electrolysis process.
- It is the Cleanest way to produce H2 because there are no carbon emissions
  - By Products : Water, Water Vapor
- Green H2 production can serve as a primary off-taker for excess RE,
- Growing interest in H2 is triggered by anticipated steep decline in Electrolyzer Costs
  - Going by current solar tariffs & assuming Electrolyser costs at $600/KW, Green H2 would be priced at $2.40/KG. Gray H2 Cost is well below this level
- Cost of Green H2 is expected to fall over decade as RES are scaled & Cost of Electrolysers is coming down

**Green H2 Gen Process**
**Electrolysis of Water**




- **H2 acts as feedstock in Oil refinaries, fertilisers, & chemical IND, & is also in Iron & Steel IND.**
- **Thus, just one H2 production plant can address Demd requirements of several applications.**
  - **To make zero emission Green H2 competitive with fossil fuels, it should be priced around Rs 150-200/ Kg.**
  - **Blue/Grey H2, produced from natural gas/ Coal, iignite Generated power, is already available at Rs 150/ Kg, but it leads to emission of 9.21 Kg CO2 for every Kg of H2 produced, & hence is not a preferred choice.**




## From H2 to Power Gen:

- **H2 can be converted back into electricity & feed it into the grid.**
  - **Ultimately, a H2 economy would involve producing H2, compressing, liquefying or converting it to ammonia or liquid organic carriers (LOHCs), storing & transporting it, then using it to produce electricity & heat, as well as for IND purposes.**

***It involves "Multiple steps" & hence initially it may not be a cheap option***

**H2 is used to create electricity in two ways:**

- **Through combustion or by powering Fuel cells which can be used as a drop-in fuel for Gens & other equipment.**

**Combusting Hydrogen:**

- **When H2 is combusted in an engine, it produces energy with no local carbon emissions, making it "an appealing" power source.**
- **Its Power Gen capabilities are particularly useful to energy-intensive INDs like Iron, Steel, Chemicals, Fertilizers, Refining, Mining & Cement.**
  - **Conventionally these IND often power their activities on-site with fossil fuel-powered furnaces, they can feed H2 into their furnaces with minor modifications to the burner & fuel systems. This will help them to decarbonise & to move towards Net-Zero.**

***H2 fuel + Air → Engine/Turbine: Combustion → Electricity + H2O as Exhaust***

## Benefits of generating power from H2:

- **H2 is highly versatile. It can be transformed into electricity, synthetic gas, synthetic diesel, or even "H2 carriers" such as methanol or Ammonia. This opens up a wide range of fuel options which can be adapted to the needs of project & site**
- **H2 doesn't cause any local carbon emissions when, we use it to generate electricity**
  - **H2's high Energy Density makes it attractive to IND like long-haul trucking & long-duration energy storage compared to conventional Lithium-ion batteries**
  - **H2 can also be used as a fuel source in heavy IND. These applications are difficult to decarbonise, so switching to H2 offers a handy solution.**

## Hydrogen in e-fuels

- **H2 is an energy carrier. It is used to create several clean-burning, synthetic fuels.**
- **Viability of these fuels depends on having the right infrastructure for producing, storing & transporting H2.**
- **One can convert Green H2 into a carrier like ammonia or methanol.**
  - **These commodities are easier to ship & can be used as a zero-carbon fuel in shipping/ Aviation IND**

# Salient features of "Green H2 policy" dated 17 Feb 22

**What is Green hydrogen?**

- **Hydrogen gas produced thro' Electrolysis of water, an energy intensive process for splitting water into H2 & O2, using Renewable Energy to achieve this.**

**Aim of the Policy:**

- **Boosting domestic production of Green H2 to 5MT by 2030 & making India an "Export Hub" for clean fuel.**

**Policy:**

- **(1) Green H2 / Ammonia manufacturers may purchase RE power from Power Exchange or set up RE capacity themselves or thro' any other developer, anywhere in India.**

- **(2) Waiver of Inter-State Transmission Sytem (ISTS) charges for 25 years will be allowed to the manufacturers of Green H2 & Green Ammonia for projects commissioned before 30th June 2025.**
  - **This in fact is the Master stroke: No ISTS charges for 25 years for RE Power to be procured for manufacture of Green H2/ Green Ammonia.**
- **Green H2 producer will be able to set up a Solar power plant in RAJ to supply RE to a green H2 plant in Assam & would not be required to pay any ISTS Charges. The move is likely going to make it more economical for key users of H2 & Ammonia such as Oil Refining, Fertiliser & Steel sectors to produce green H2 for their own use.**
  - **These sectors currently use Grey hydrogen or Grey Ammonia produced using conventional fuel (Natural Gas or Naphtha).**

- **Cost of Power constitutes anywhere between 50% & 70% of the total cost of green H2 production depending on the location of production & Source of RE, whether Wind or Solar. ISTS OA charges in turn is a significant portion of the cost of power.**
- **According to analysis by Council on Energy, ENV & Water (CEEW), the cost of green H2 production could drop by 17% in UP due to waiving of Central ISTS for States importing RE.**
  - **However, if India wants to become a global leader in green H2, production costs would need to fall further & following steps would help meet this objective.**
- **States should also reduce or eliminate Intra State Trans Charges (InSTS) as a top-up to the Central policy of exempting ISTS Charges**
  - **This would not only reduce the H2 production costs but also bring down the significant disparity in InSTS charges between States**

- As an example, for Solar power consumption, UP, GUJ, & MAHA have InSTS charges of Rs. 0.25, 0.90, & Rs 2.3 PU, respectively. This disparity would significantly distort the green H2 market & affect competitiveness of producers in States with high InSTS charges.

- **From the earlier example, waiving-off InSTS Charges in UP would reduce the cost of green H2 production by an additional 5%.**
  - Story is slightly different when RE is produced in the same State as green H2 production. ISTS charges would not apply in such cases. For example, according to CEEW analysis, if InSTS charges were waived off in Guj & power also wheeled from within GUJ, the cost of green H2 production would drop by 12%.
- **Discoms can also procure & supply RE to the manufacturers of Green H2 / Green Ammonia in their States at concessional prices which will only include cost of procurement, WH charges & a Small margin as determined by SERC. Such procurement would also count towards a State's Renewable Power Obligation (RPO)**

- **(3) Open access for Green H2 Consumers will be granted within 15 days of receipt of application.**

- **(4) Banking allowed: Green H2 / Green Ammonia manufacturer can bank unconsumed RE power, up to 30 days, with Discom & use it whenever required.**

- **(5) Manufacturers of Green H2 / Green Ammonia shall be allowed to set up bunkers near Ports for Storage of Green Ammonia for export / use by shipping.**
  - **Land for the Storage prior Export (To set up bunkers) shall be provided by the respective Port Authorities at applicable charges**

**"Implementation of this Policy will reduce dependence on fossil fuel & also reduce crude oil imports. Objective also is for our country to emerge as an "Export Hub for Green H2 & Green Ammonia"".**

- **(6) Single portal for all clearances required for setting up green H2 production**
- **To ensure "Ease of doing Business" a single portal for carrying out all the activities including statutory clearances in a time bound manner will be set up by MNRE.**
  - **Making MNRE as single point for all permissions & approvals cut to make it simpler to operate.**

- **(7) Grid Connectivity, at Gen end & Green H2 / Green Ammonia manufacturing end, to ISTS for RE capacity set up for the purpose of manufacturing Green H2 / Green Ammonia shall be granted on priority to avoid any procedural delays.**

**"Requirement of time bound clearances for these projects would spur investment while grid connectivity on priority will ease operational processes," said Vikram Kirlosar, Chairman, CII Taskforce on Green H2 & vice Chairman of Toyota Kirloskar**

## What next?:

- **GOI is set to come out with mandates requiring that oil refining, fertiliser & steel sectors procure green H2 & green ammonia for a certain proportion (15-20% to begin with) of their requirement**
  - **While Green H2 is not currently made in India on a commercial scale, India's richest men *Mukesh Ambani & Gautam Adani* have announced plans to produce Green H2 in India**
  - **Mayank Bansal, of ReNew Power, said "incentives announced by GOI could help lower cost of H2 manufacturing".**
- **Mop Said "India will set up separate manufacturing zones, waive ISTS charges for 25 years & provide priority connectivity to electric grids to Green H2 & Ammonia producers in a bid to incentivise production**
  - **We hace planned 5MT Grren H2 production target which is half of that by the EU, which plans to produce 10 MT of H2 from RE by 2030**
  - **Germany & Japan could be key markets for green H2 produced in India. Japan intends to build 10,000 H2 refuelling stations by 2030**
  - **China hopes to produce a million fuel-cell vehicles, while Netherlands & Switzerland have already started commercial production of H2 trucks.**

# "More incentives needed for green H2 policy": say experts

## DIL MAANGE MORE…

- **Currently, manufacturing Green H2 is a costly proposition & in cognizance of this:**
  - **GOI has correctly waived off ISTS charges but various states have varying InSTS charges, which also needs to be waived off**
- **India also needs to plan to provide Central Financial Assistnace (CFA) to set up Electrolysers, as it wants to make the use of green H2 mandatory for refineries & fertiliser plants.**
  - **To reach the target of 5MT Green H2, a large amount of land, large infrastructure & money would be necessary**
  - **"The reality is solar alone cannot be a sole green H2 producer as there are certain inherent limitations in power balancing calculations. GOI needs to create highly motivating new incentives in R&D for green H2," said Nandan Kundetkar, CEO of Femto Green H2 LTD**

- **Green H2 projects should be awarded higher RPO credit than equivalent RE consumed for production. (say 1.5 multiple, over the amount of power consumed to produce green H2)**
  - **Cost of green H2 today is at least twice as much as fossil-based H2. Therefore RE producers & end-users of green H2 should be incentivised for taking on the risk for their investment.**
- **GOI should allow significant Banking of RE in the initial phase of mission without any monetary implications.**
  - **Green H2 cost is a function of level of utilisation of Electrolyser, which are devices used to split water into H2 & O2, using RE power. With the solar-only power Gen operation, electrolyser is utilised only 33% of time in a year. (max CUF of Solar plant)**
- **However, green H2 production costs could be reduced by up to 40% if excess solar power is banked & the electrolyser is utilised 95% of the time in a year.**
  - **Further, ISTS charge waiver needs to be extended up to 2030, post which green H2 would become commercially viable due to scale of production, advancement in production technology & lower RE costs.**

- **India's largest oil firm Indian Oil Corporation (IOC) is setting up 'Green Hydrogen' plants at its Mathura & Panipat Refineries by 2024 to replace carbon-emitting units. which will help cut costs. Mr. SSV Ramakumar, Director IOC, said "New policy will help cut the cost of manufacturing green H2 by 40-50%".**
- **Oil refineries, Fertiliser plants & Steel units use H2 as process fuel to produce finished products.**
  - **In refineries, presently, Gray H2 (produced from fossil fuels, (such as Natural gas or Naphtha) & results in Carbon emissions) is used to remove excess Sulphur from Petrol & Diesel.**
  - **IOC plans to replace this 'Grey H2' with 'Green H2' by using electricity from RES, (Solar or Wind power), to split water into two H2 atoms & one Oxygen atom thro' Electrolysis process.**

- **Consider e.g. basic cost of RE is Rs 2 PU at Gen site (Solar farm in Raj or Ladakh). This becomes Rs 4 to 7 PU after adding Trans charges during its transit thro' T/Ls in different states**
- **At a factory-gate cost is Rs 4 to 7 PU. Green H2 production costs come to Rs 500/kg. Current Grey hydrogen cost of Rs 150/ kg.**
- **Under Green H2 policy announced on Feb 17, RE used for green H2 production will get OA without Central Surcharge & Zero ISTS charges for 25 years for projects commissioned before June 30, 2025.. This will bring the cost of green H2 production down by 40 to 50%. (i.e. to Rs. 250-300/Kg).**
  - **Green H2 cost will go down further if electrolyzers, used to split water into H2 & O2 are indigenously manufactured instead of present practice of importing them.**

- **IOC plans to set up a 40 MW electrolyser at Mathura (UP) refinery & 15 MW unit at Panipat (in Haryana) & IOC is targeting to produce 70,000 MT/ year, Green H2 by 2030, accounting for 10% of its overall consumption by that time.**
- **Across all refineries, current H2 demand is about 1.4 MT, which is projected to rise to 2.6 MT by 2030. IOC is also exploring manufacturing of Electrolysers or outsourcing production of green H2.**
  - **India is targeting 15 GW electrolyser-making capacity & is considering production-linked incentives (PLI) to encourage local manufacturing.**
  - **Current cost estimates are based on alkaline water electrolysis, which consumes 55 KWH to produce 1 Kg H2. Use of Polymer Electrolyte Membrane (PEM) electrolysis would bring down the requirement of electricity to 35 KWH, thus reducing cost.**

# Biggest Challange:

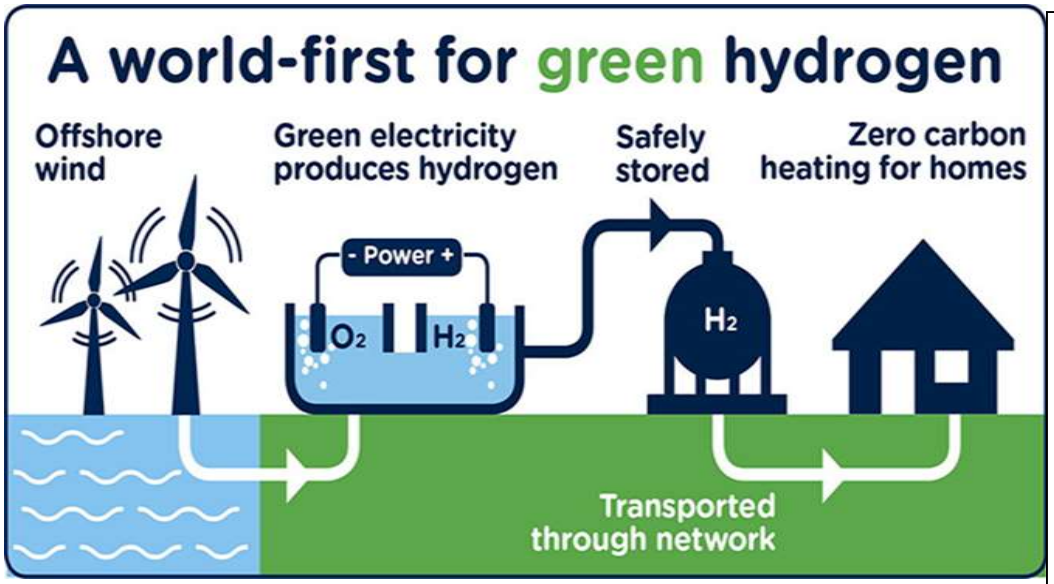
- **Global supply crunch of electrolysers needed to produce green H2 & a lack of domestic manufacturers is a major challenge to India's ambitious targets to use Green H2 as the zero-carbon fuel,**
  - **India's green H2 target would require at least 10 GW Electrolyser capacity to split water into H2 & Oxygen.**
  - **Electrolyser capacity, required to realise these ambitious programs, are not available right now in India**
- **Global Electrolyser capacity was 0.3 GW in 2020, & is expected to reach nearly 17 GW by 2026, as per the International Energy Agency (IEA) report (Dec 2021).**
  - **Entire production capacity of big global Electrolyser manufacturers is booked till 2025.**
- **India will initially import electrolysers. Govt refiners are also planning to form JVs with foreign Cos for manufacturing the electrolysers in India**

# Conclusions: Green H2 is the "future" of Power Sector

- **MOP's PRACTIVE Policy Document on Green H2/ Green Ammonia, is the Major Policy Enabler for boosting domestic production of Green H2 using RES to 5 MT by 2030 & making India an "Export Hub" for clean fuel.**
- **Hydrogen gas produced thro' electrolysis of water, is an energy intensive process for splitting water into H2 & O2. GOI planes using RE to achieve this.**
  - **Green H2 is still in its infancy & key challenge is its affordability. Currently, one kg of green H2 costs about Rs 500/kg & Policy aims to bring it down to 150/kg by 2030.**
- **In the Policy "Waiver of ISTS charges for 25 years" will be allowed to manufacturers of Green H2 & Green Ammonia for projects commissioned before 30th June 2025. This is a "Master-stroke" in this policy**
  - **MNRE will act as single window for all statutory Permission for Green H2 production. Power banking with Discom has been allowed. OA permission for H2 manufacturers within 15 days**
- **As we import 85% of our Oil requirement & 53% of our gas requirement, the Hydrogen Policy will act as a critical enabler, if not a game-changer, but GOI must continue to innovate, increase R&D, & importantly provide clarity on demand-side measures like H2 purchase obligations.(H2PO)**

# Thanks!! Your Response is awaited !!

(Contact: vlsonavane@gmail.com/ M: 98333 62062)




**Denis Allen Hayes is an ENV Advocate & an Advocate for Solar power. He rose to prominence in 1970, as the coordinator for the first Earth Day. Hayes founded the Earth Day Network & expanded it to more than 180 Nations.**