

# Hydrogen Economy, relevance for India

a more sustainable energy distributing network

---

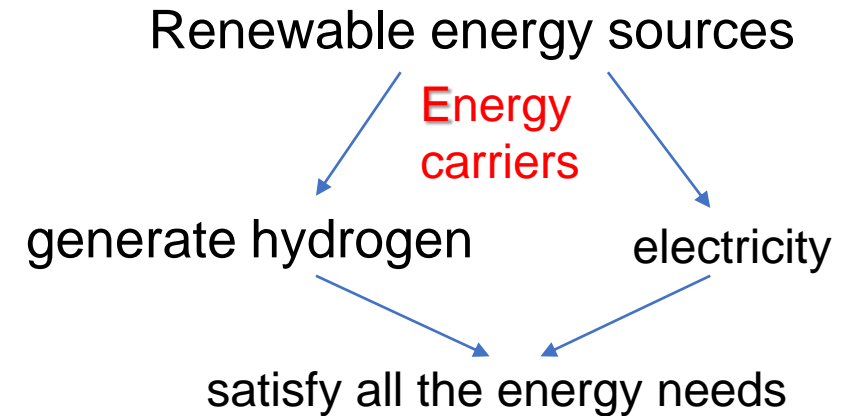
Ritwick Ghosh, Ph. D.

NTPC Limited, Farakka, West Bengal, India-742236

# What is Hydrogen Economy and the dilemma??

The hydrogen economy is an expected energy system for the future which together with electricity should suffice all energy needs

Future energy prospects



## Dilemma !!

The transition to a hydrogen economy

Cost effectiveness is low

But is in the sustainability plan of many nations

# Top Ten Problems of Humanity for Next 50 Years

Smalley's list, in order of priority, was:

In decreasing order of importance



1. Energy
2. Water
3. Food
4. Environment
5. Poverty
6. Terrorism & war
7. Disease
8. Education
9. Democracy
10. Population

**THE TERAWATT CHALLENGE**  
or  
**Energy prosperity goal**



Regardless of the energy sources there will always be a requirement for convenient, clean, safe, energy carriers or forms of energy in the future for the end user

- Electricity
- Hydrogen fuel

# Hydrogen has some unique characteristics that make it an ideal energy carrier

- is produced from and converted into electricity at a relatively high efficiency
- raw material for hydrogen production is water, which is available in abundance (the product of hydrogen utilization is pure water or water vapor)
- possible to be stored as liquid, gas, or solid (metal hydrides)
- can be transported over large distances using pipelines, tankers, or rail trucks
- can be converted into other forms of energy in more ways and more efficiently than any other fuel
- as an energy carrier is environmentally compatible, produces small amounts of NO<sub>x</sub> if it is burned with air at high temperatures

# Challenges

- the inability of lowering the production cost with respect to other forms of electricity
- the amount of energy required to produce hydrogen is always greater than the energy that can be released by hydrogen utilization, (logical sources being hydrocarbon fuels,  $C_xH_y$ , and water,  $H_2O$  and energy)
- these mass production technologies as of yet depend on fossil fuels and emit  $CO_2$
- the only method that generates hydrogen from fossil fuels without generation of  $CO_2$  is direct thermal and catalytic cracking of hydrocarbons which is not cost-effective method
- production by water electrolysis is comparatively efficient (>70%), but because it needs electricity, the method is relatively expensive (> ₹1500/GJ, assuming cost of about ₹ 3.2/kW h)
- electrolysis from photovoltaics although > 93% efficient, is even more expensive

....continued

- storage : hydrogen having a very low atomic weight can easily escape through microcracks and can cause significant losses
- transportation: it is not cost effective to transport the gas through short distances
- safety: safety issues like cold burns i.e. hydrogen flame is nearly invisible, which is dangerous as the fire will not be known until other chemicals are added to it.

# Opportunities

- recently the cost of photovoltaic power is reducing and show prospects of a large scale for electricity and hydrogen generation
- there is a potential to generate relatively inexpensive hydrogen from hydro-power and nuclear plants
- safety: an optimistic way of looking towards hydrogen safety is that if an explosion occurs, hydrogen has the lowest explosive energy per unit stored energy in the fuel, and a given volume of hydrogen would have 22 times less explosive energy than the same volume filled with gasoline vapor



# Relevance of hydrogen fuel to the Indian energy sector

---

- ❑ Under the National Hydrogen Energy Road Map program directed by under direction of the Ministry of New and Renewable Energy, the concept of forming a hydrogen economy was stated in 2006 for bridging the technological gaps in different areas of hydrogen energy.
- ❑ The main aim of the program was to reduce India's dependence on import of petroleum products and promote the use of diverse, domestic, and sustainable energy sources for electricity to remote, far-flung, rural and other electricity deficient areas and in transport.

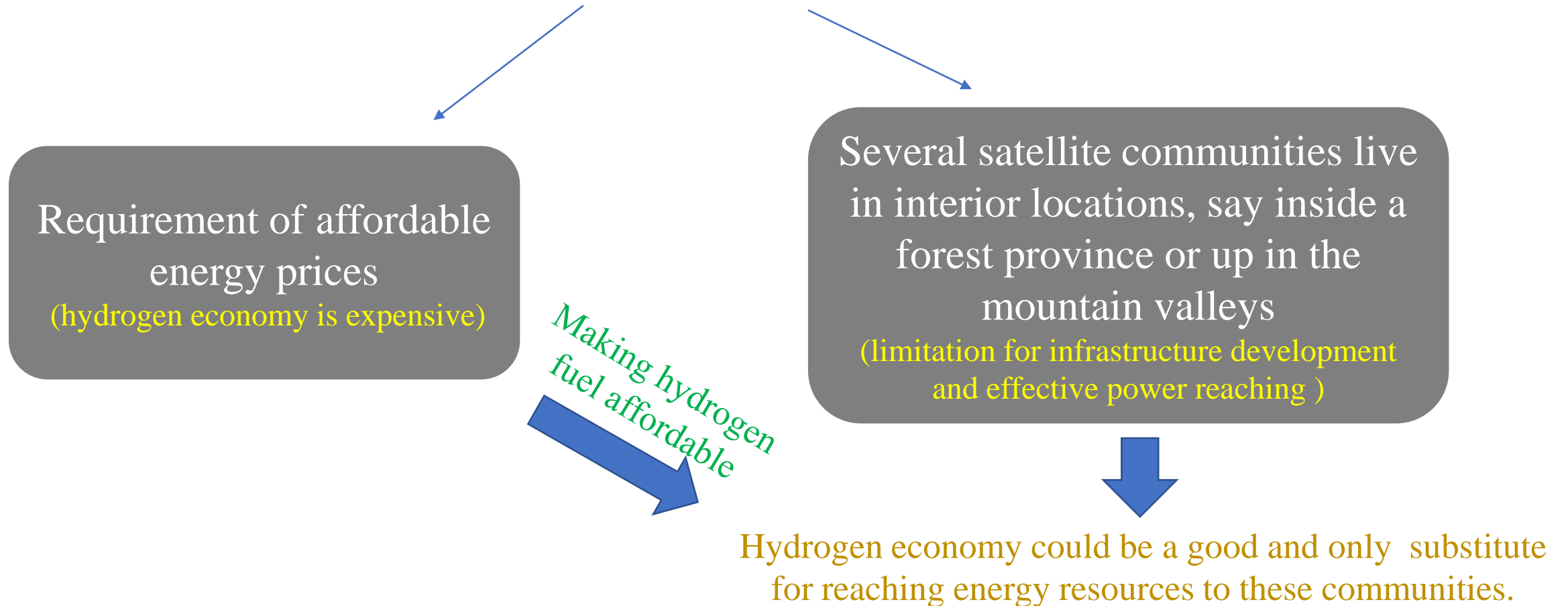


# The Indian power sector scenario

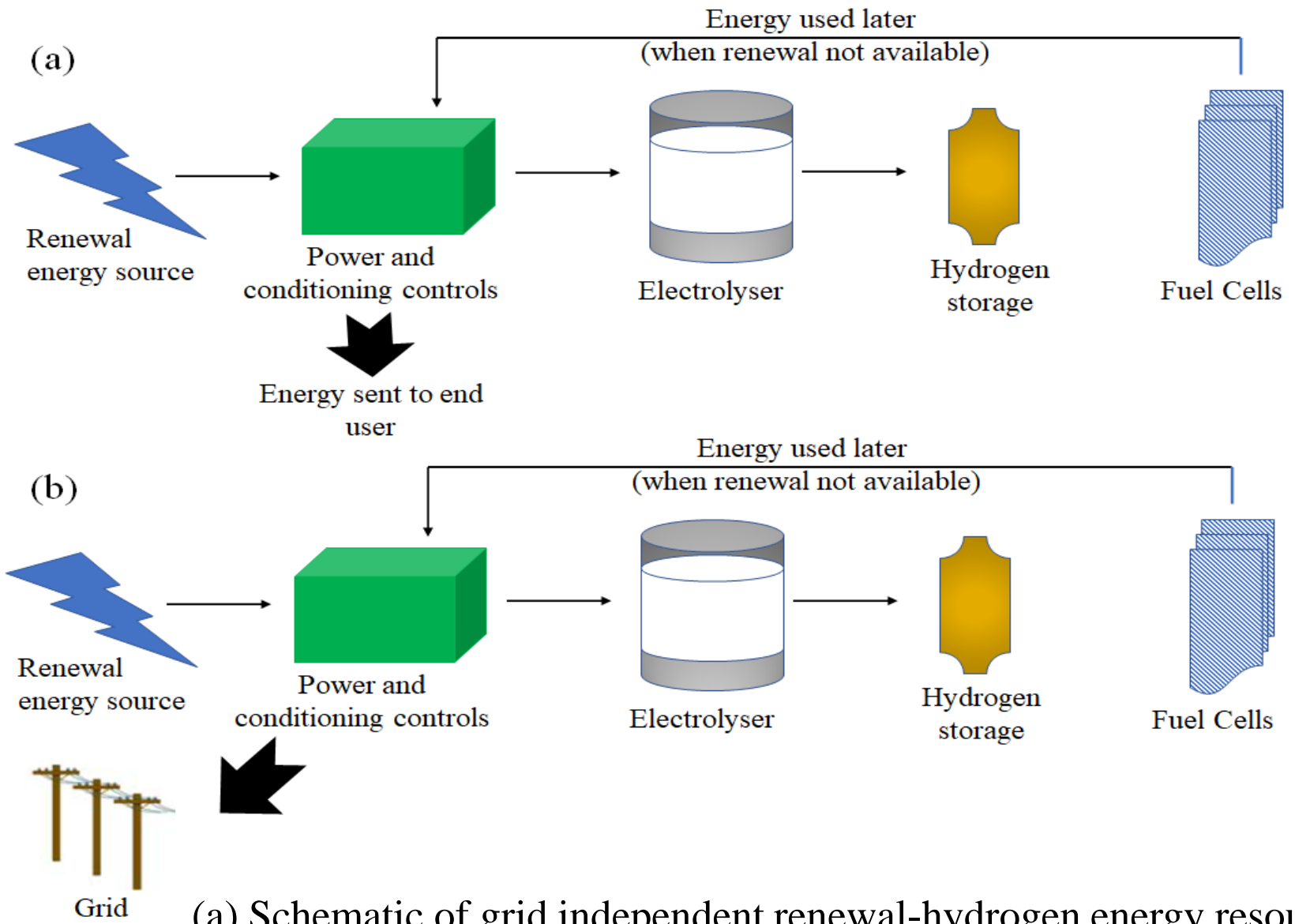
- the power sector in India is still in the developing phase and in sink with different global bodies is setting up optimistic goals towards having a clean and reliable power.
- the last decade of the country's power sector have touched some very relevant milestones i.e. development of a central grid, stabilizing the frequency of the grid, a boost in the renewal energy sector and a significant increase in the per capita power consumption.
- the nation due to its vastness and owing to the challenges in the last mile connectivity, the targets to electrify every home in the country kept getting delayed.
- the geographical diversity of the Indian landscape also sometimes add on to the peril in achieving this ambitious target.

# Challenges in the last mile connectivity

*“Electricity for all” as it goes by the country’s agenda exactly has to face two inherent challenges when it comes to execution of last mile connectivity.*



**Opportunity in the last mile connectivity**



(a) Schematic of grid independent renewal-hydrogen energy resource  
(b) Schematic of grid connected integrated renewal-hydrogen energy system

# Conclusion

- ❑ The present-day research has established efficient conversion of renewal power sources to produce hydrogen fuel, having potential to develop stand-alone grid-independent power systems with energy storage capacity
- ❑ The remote satellite communities often will have access to either solar, wind, hydro or geothermal energy availability. A grid-independent coupled system of hydrogen electrolyser and fuel cell (for storage of the unused power to use during hours of non-availability or discrepancy) with renewal energy source may provide adequate energy to the locality both providing the last mile connectivity and building a self-dependent community
- ❑ It would also be possible to connect to the grid at a later time with infrastructural development
- ❑ Another suitable example of a similar usage is use of hydrogen fuel to run diesel locomotive engines in places where electrification of railway network could not be reached.

Thank You

