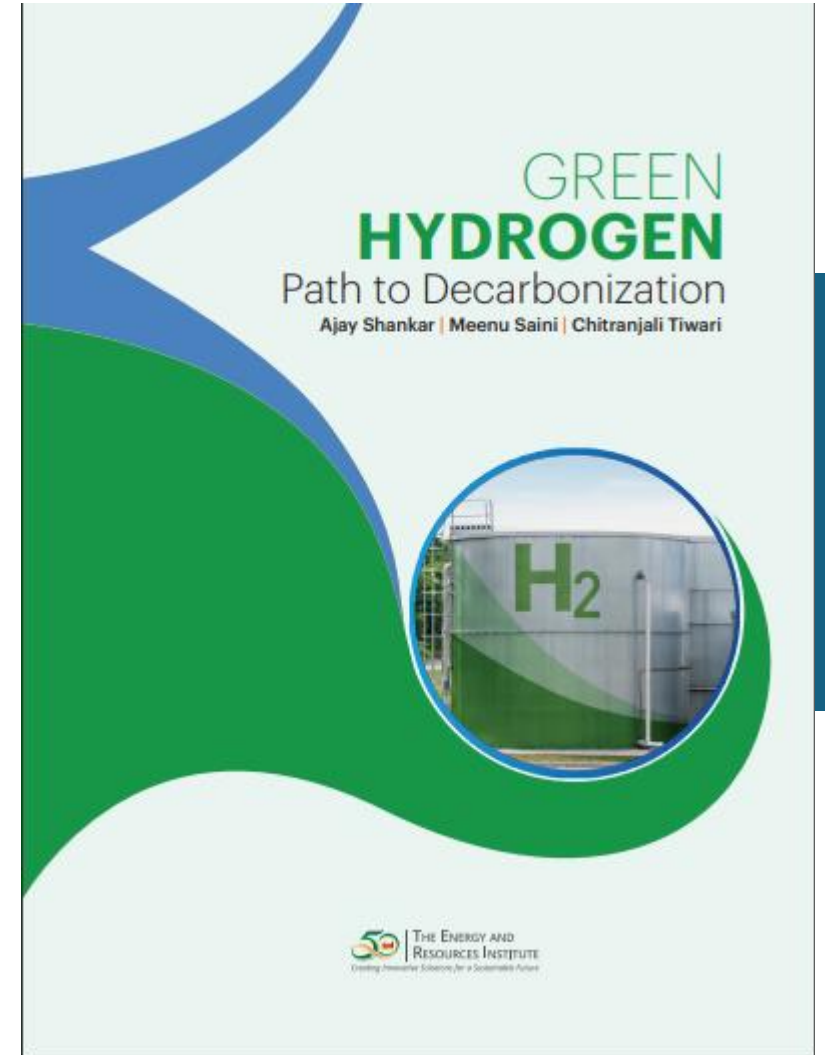


GREEN HYDROGEN

Path to Decarbonization

7th November 2024



Green Hydrogen

- 1 For survival, mankind needs to get to Net Zero at the earliest
- 2 Renewable plus storage or nuclear → carbon free electricity
- 3 Electrify economy with zero carbon electricity → Net Zero
- 4 Hard to Abate Sectors = Electrification not possible
- 5 Green hydrogen emerging solution for hard to abate sectors

Introduction

India's emerging climate leadership

- 01** 500 GW non-fossil capacity – 2030
- 02** Electrification of economy
- 03** EV's growing market share
- 04** Green Hydrogen Mission
- 05** India to be Net Zero by 2070

Green Hydrogen

Green Hydrogen - not an end in itself

It is the means to achieving net zero in hard to abate sectors

- 
- **Downstream use for replacing fossil fuels.**
 - **Carbon free processes for producing green goods and services.**



Iron and Steel



Fertilizer



Heavy duty trucks



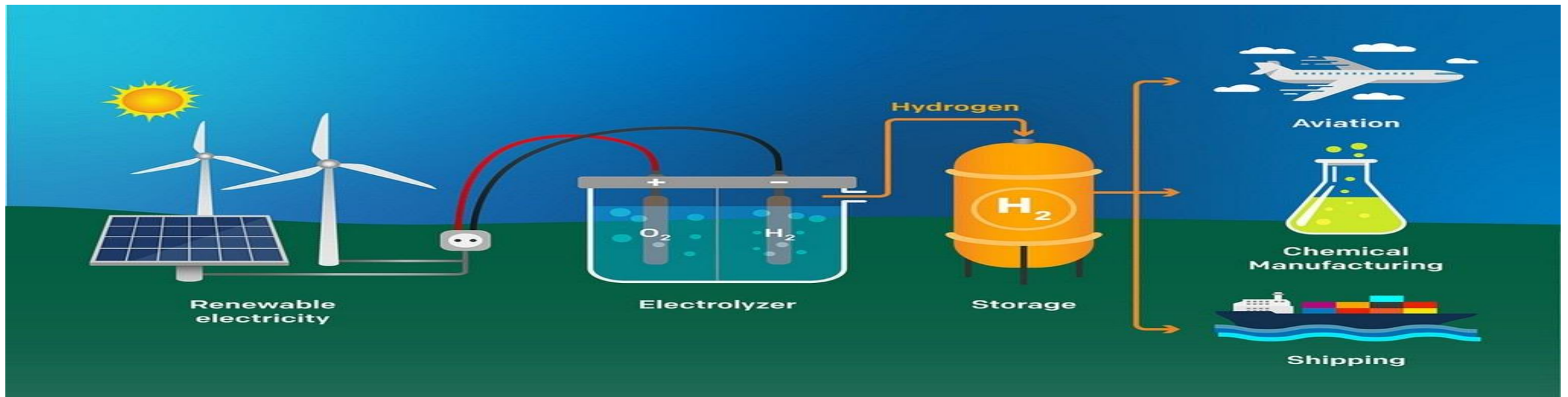
Shipping



Aviation

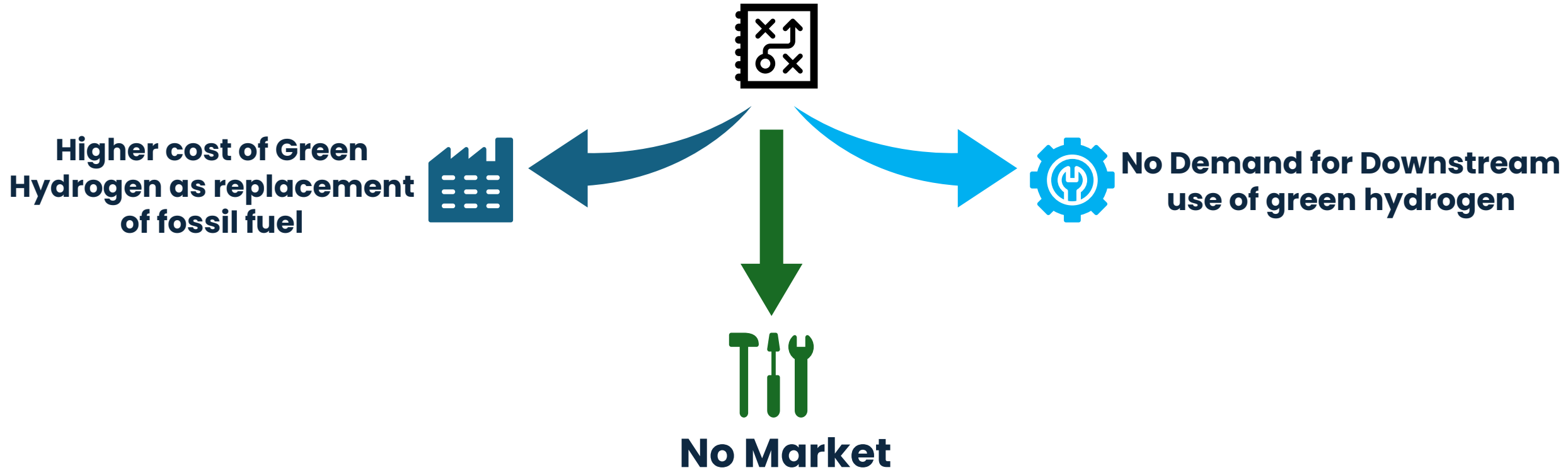
Green Hydrogen Production

- • Hydrogen production from Water through electrolysis using electrolyzers
- Electricity from renewables + storage or Nuclear
- Hydrogen production from Biomass and Biowaste
- Hydrogen Production by direct splitting of water molecule by solar, nuclear energy - futuristic



Core Challenge

Challenge



Recommendations

Key lessons from success of Solar Mission

De-risking investment essential for getting competitive private sector entry

Assured purchase through long term PPAs gives reasonable returns and certainty

Create competitive industry structure through bid design.

Repetitive competitive bids generate efficiency gains and give lower prices

Recommendations

Procurement of green hydrogen

Competitive bid to be invited for long term supply for downstream use from the date plant starts production

Separate bids for supply of green hydrogen to pilot steel and ammonia plants

Separate bids for supply of green hydrogen from sewage and bio waste to filling stations for hydrogen trucks

Recommendation

Strategy

➤ Delink procurement of green hydrogen from downstream use

➤ Separate bidding for green hydrogen and downstream production reduces risks, should result in lower prices

➤ Make India cost competitive globally in the new hydrogen economy

➤ Become major exporter of green goods. Benefit from CBAM

R&D and Technology Development

Take India to global technology frontier

R&D funding -> narrow focus

Choose high-impact challenging problems

Invite proposals. Entertain Unsolicited proposals

For major impact problems more than one group may be funded

Accept potential time and cost overruns at the outset. Intrinsic to R&D

Technology developed by government funds. Freely available as public goods

Iron and Steel

24% share in the industry GHG emissions in India

Recommendations

Establish a 1 MTPA green steel pilot plant - minimum size
Technology at early stage

Plant to be set up by SPV with government funding
Risk too high for private investment

Make all large Indian steel firms partners in SPV with nominal equity
Joint management of SPV by Indian steel firms

Long term technology transfer agreements for this steel plant
Reduce Intellectual property (IP) cost for future plants

Government to buy all the steel produced on a cost-plus basis for use in government projects
Marginal impact on project cost

Rational decisions on scaling up feasible after successful operation of this plant and cost discovery

Fertilizer

Green hydrogen can replace natural gas in production of ammonia. Green ammonia key input for production of fertilizer.

Recommendations

Invite bid for setting up a pilot green urea plant of the minimum technically feasible size

Assure supply of
Green hydrogen
CO₂ from cement plant through
carbon capture

Bid parameter
Cost of converting green hydrogen
and CO₂ into green urea

Invite bids for supply of green
hydrogen and CO₂ from the
date this plant goes into
production

Government buys all the
fertilizer of this plant
Subsidizes the sale to farmers
as is the existing practice

Following price discovery
government can decide on the
pace of scaling up production
of green fertilizer through
similar bidding process

Heavy Duty Trucks

Long-distance **heavy-duty trucks** may need to be run using green hydrogen to become carbon free as electric heavy-duty trucks are still a work in progress.

Recommendations

Pick up a few busy routes for implementing pilot projects

SPV to invite bids for truck for initial pilot projects
Lease trucks to operators at subsidized rates

Procure green hydrogen from biowaste
Lower transportation cost from plants using biowaste on the highway

Subsidize supply of green hydrogen to new filling stations

Number of trucks in the fleet and filling station should have viable operation size

Shipping

Green hydrogen and green ammonia can be used in shipping

Recommendations

Pilot projects in shipping using
Green hydrogen
Green ammonia

Cost discovery based on providing green
hydrogen or green ammonia at actual cost

States to making all tourism vessels and
inland waterways carbon-free
Increase brand value for tourism

Implement coastal green shipping pilot
projects

Recommendations

Seasonal power demand peaks

➤ Trial of green hydrogen and ammonia for power generation. Which is cheaper?



➤ PSP, CSP, and BESS, offer daily storage for getting carbon free electricity



➤ Green fuels essential for meeting seasonal demand peaks

Needed for full decarbonization of electricity



Recommendations

Pilot Projects



Discovery of higher cost
Pace of scaling up to evolve



Higher cost borne by government for its own project, consumer for brand value



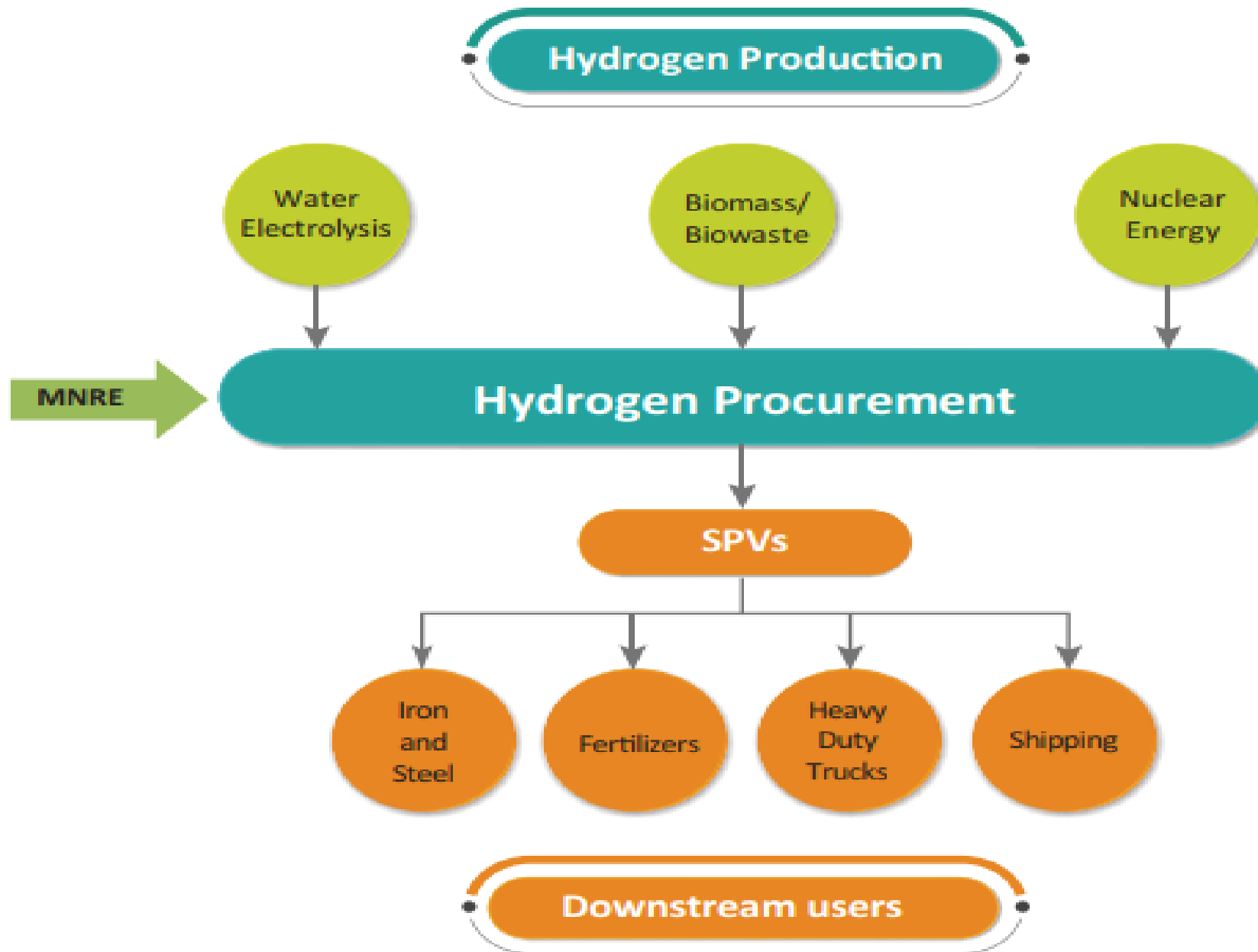
Lower embedded carbon -Market in Europe – CBAM

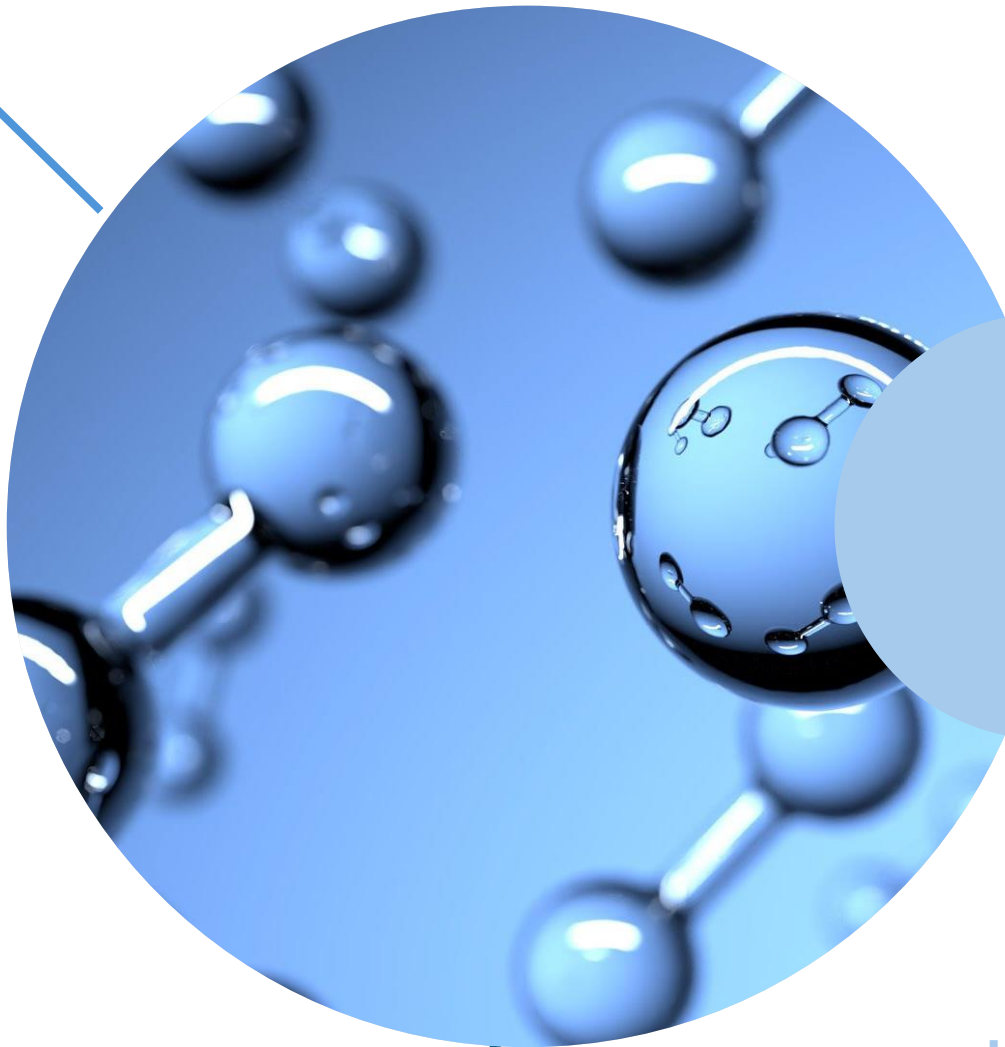


Lower GST rate as done for EVs



Mandate new capacity to be carbon free
Equalize cost by carbon tax on older fossil fuel-based capacity





**THANK
YOU**