# Green Hydrogen Feasibility in Developing Countries

## - Prospects and technical challenges

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Panel discussion at the webinar on

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

Organized by

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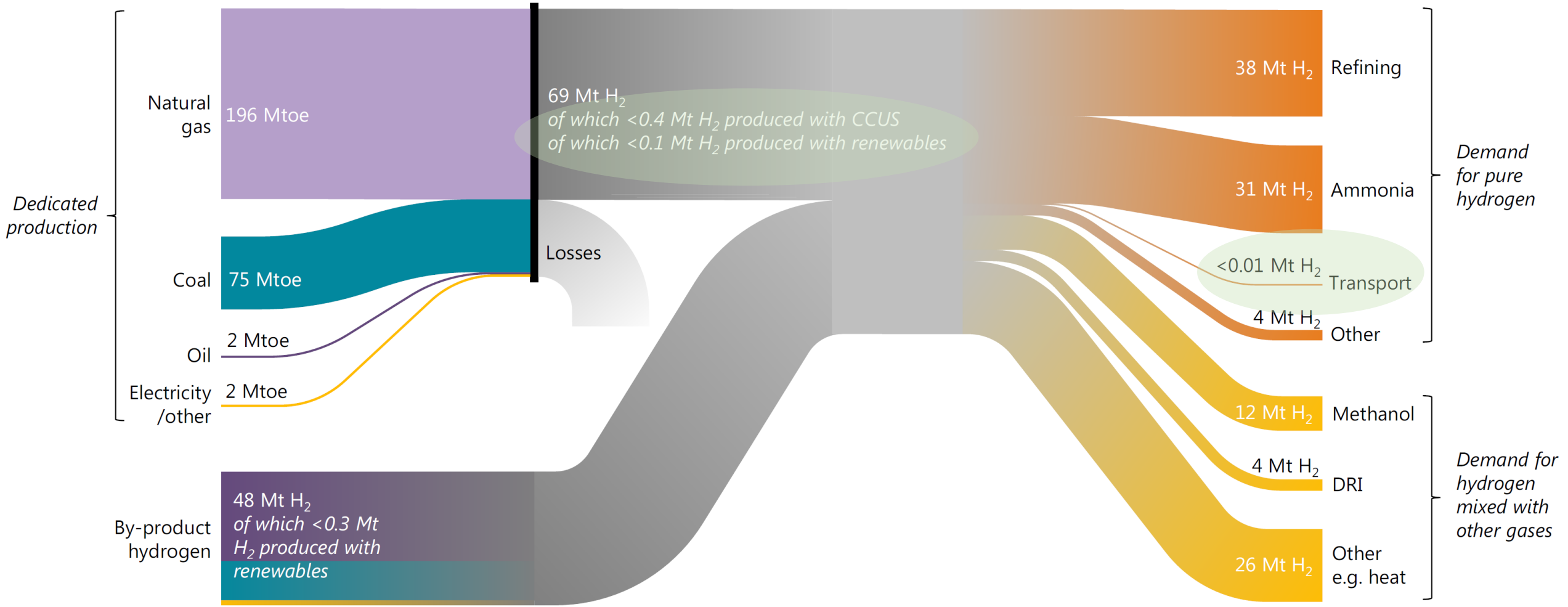
SEER
Sustainability in Energy And Environment Research

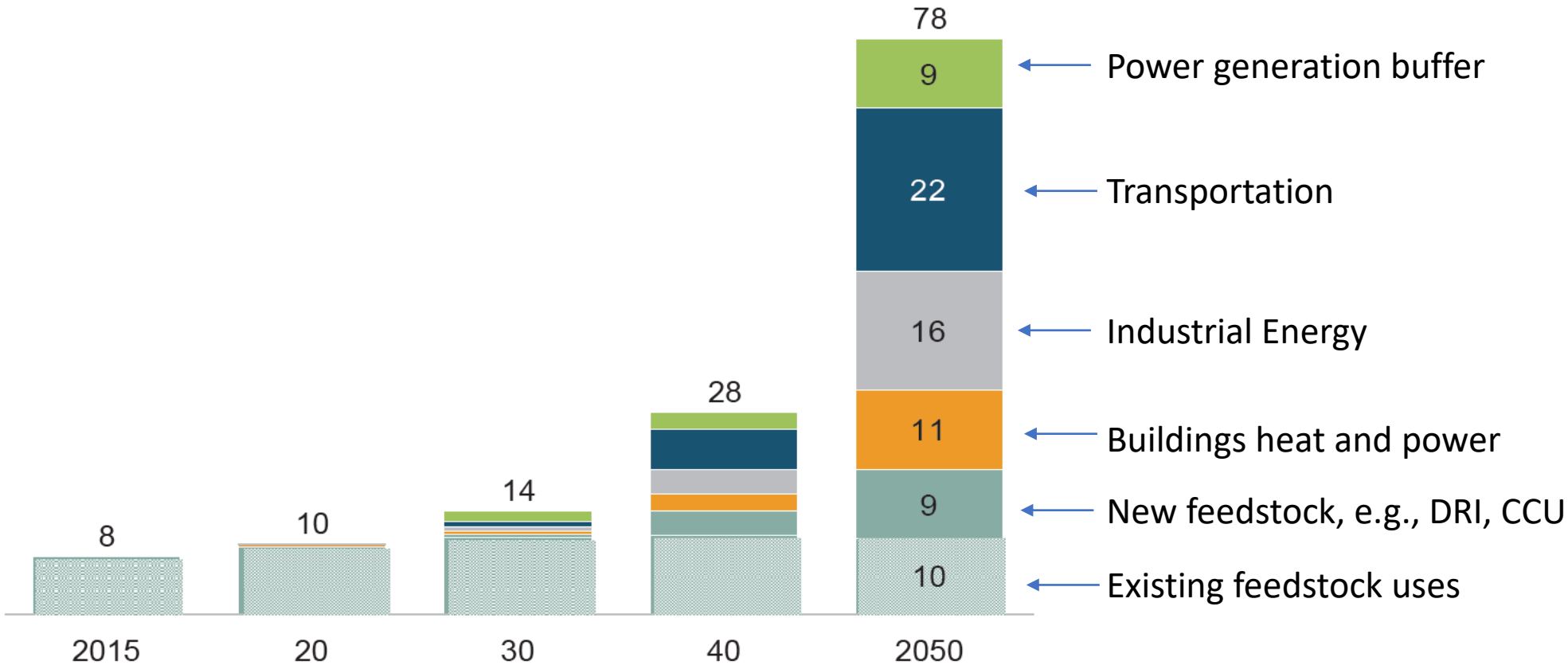
# Hydrogen value chain




Source: The Future of H2, IEA, 2019

# Projection of $H_2$ uses by 2050

- $H_2$ use to be increased 10 fold by 2050




Global Energy (EJ) demand supply with Hydrogen (Hydrogen Council, 2017)

# Incentives and challenges to grow hydrogen market

## Incentives will be needed to develop a $H_2$ roadmap

**Economics**

- Government incentives
- Mandates
- Equipment and labor cost
- Efficiency improvement

**Industries**

- Oil, gas & chemicals
- Transportation
- Power generation
- Domestic cooking (blended with NG)

**Environmental impact**

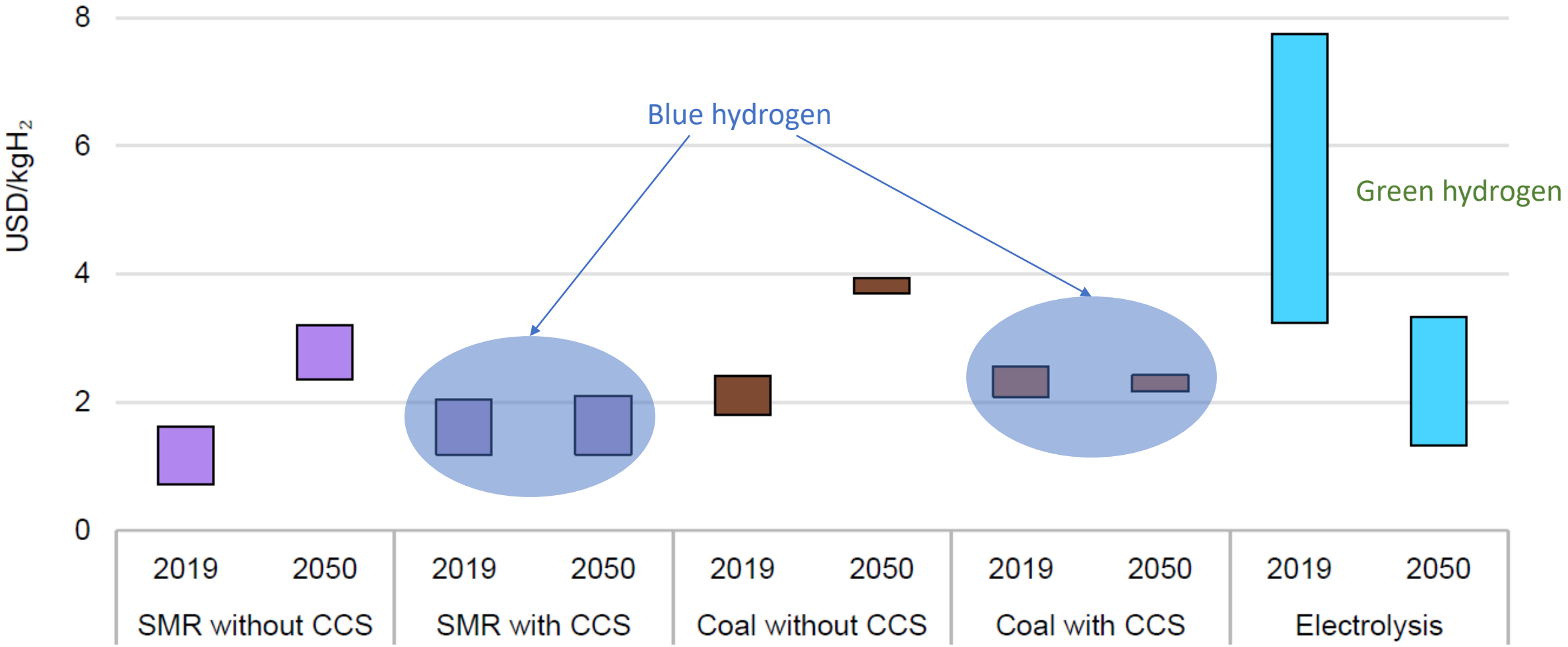
- Electrolyzer based $H_2$ is **water resource intensive**
- Gasification from coal is common

**Optimization of Emerging Technologies**

- Electrolyzer
- Catalytic reforming
- Fuel cells
- Gas turbines with $H_2$ adaptability

**~ 16.6 million tons potable water** per **1 Mt of $H_2$** produced

# Green hydrogen economics – still work to be done




Source: IEA 2020, Energy Technology Perspectives

# Power generation application

- Gas turbines now can take up to around 30% $H_2$ with Natural Gas reducing 10% emission*
- Major issue is with NOx emission and performance impacts*
- Expected to have the capability to burn 100% $H_2$ by 2025 by Mitsubishi and Siemens

Image source: https://power.mhi.com/products/gasturbines/lineup

* MHI Report 2019, Initiatives in the Hydrogen Supply Chain Aimed at Realizing a Carbon-Free Society

# Issue with transportation

- Liquifying $H_2$ is one proven option
- Converting to $NH_3$ and reconverting to $H_2$ is being considered for easier handling
- There may be several options, but an easy and cheap transportation method will go a long way!



Image source: https://global.kawasaki.com/en/stories/hydrogen/

# Challenges - Space requirement

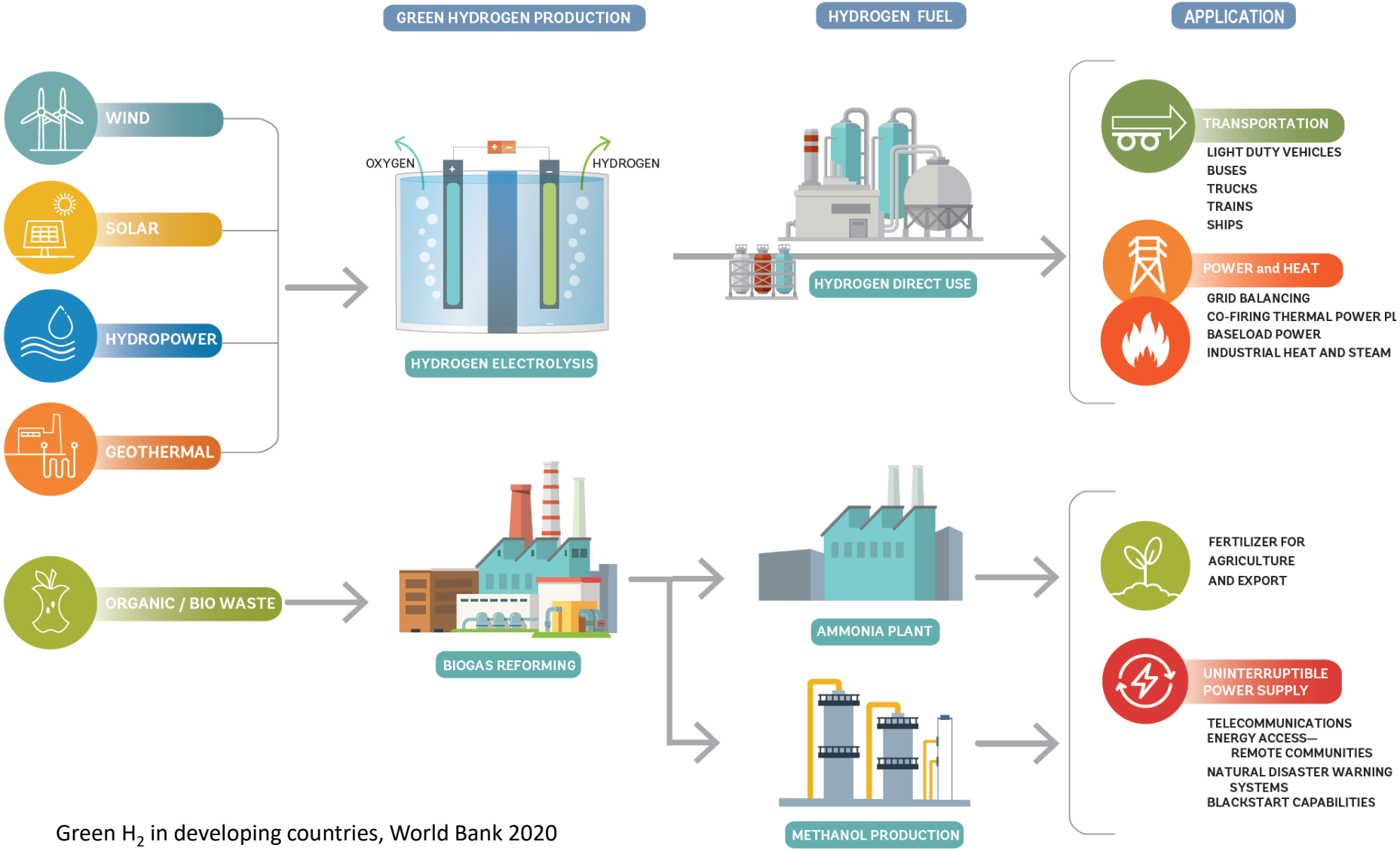
- Space for Solar PV, Alkaline electrolysis cells and Water purification plant etc.

For a 700 MW 1 by 1 Combined Cycle plant (100% $H_2$) *

Power plant area ~13 acres
Electrolysis area ~19.25 acres
H2 storage area ~14 acres
**Solar PV area ~10960 acres**

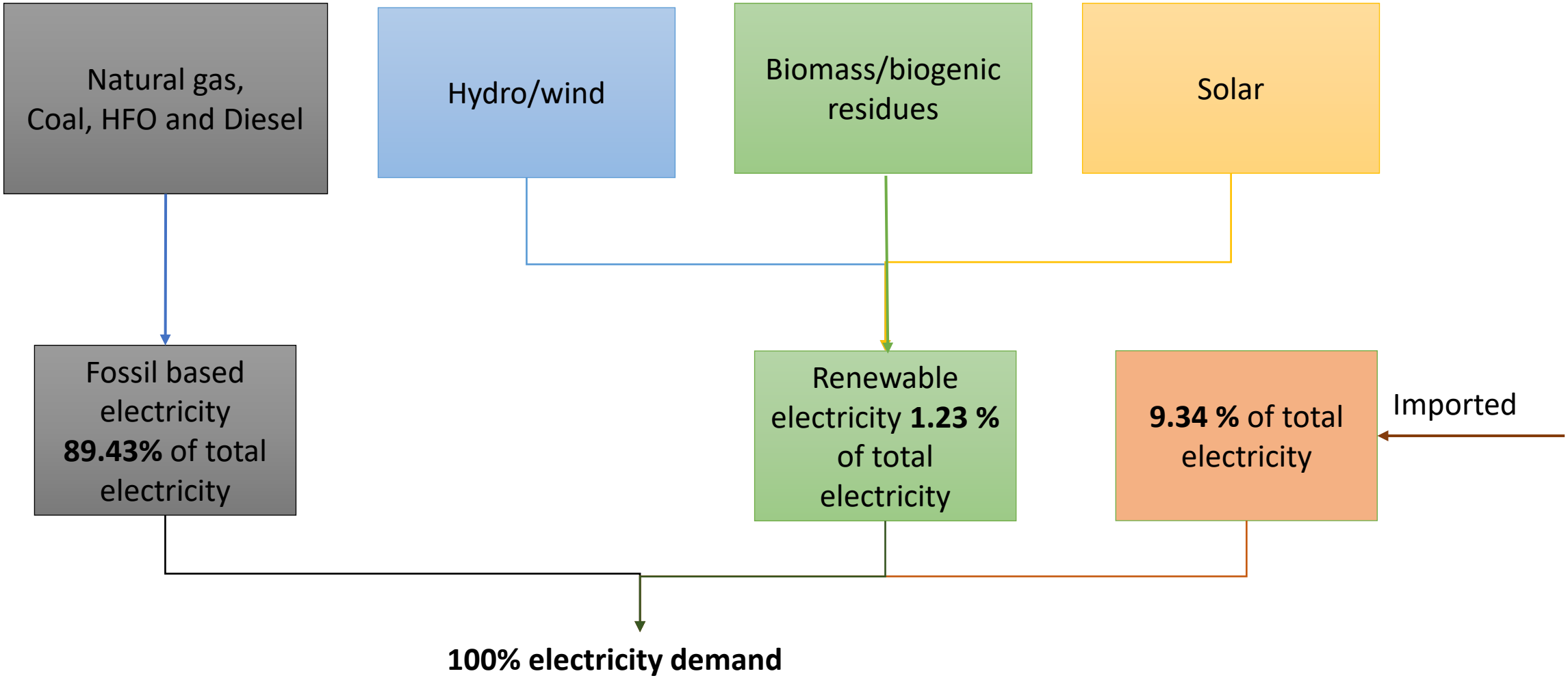
*Based on the power event talk by Justin Schnegelberger, Burns McDonnel, May 5, 2021

# Green $H_2$ production in developing countries



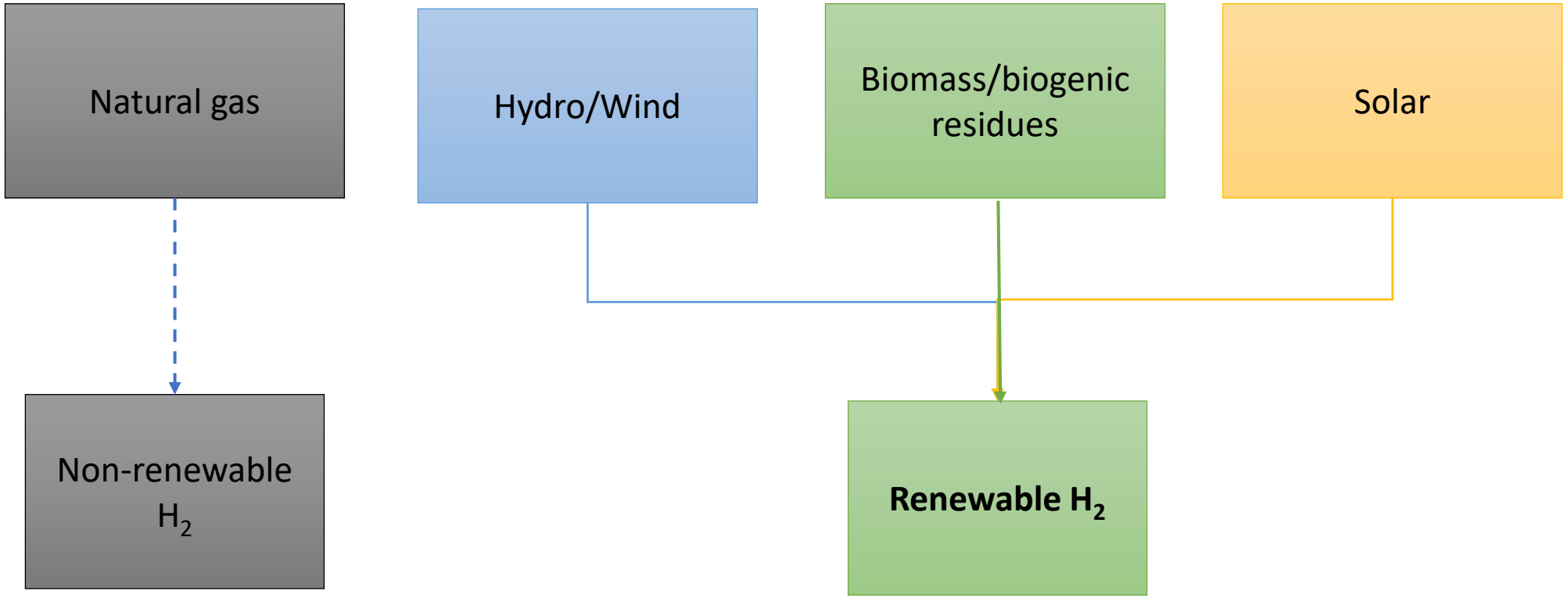

Green $H_2$ in developing countries, World Bank 2020

# A developing country example - Bangladesh



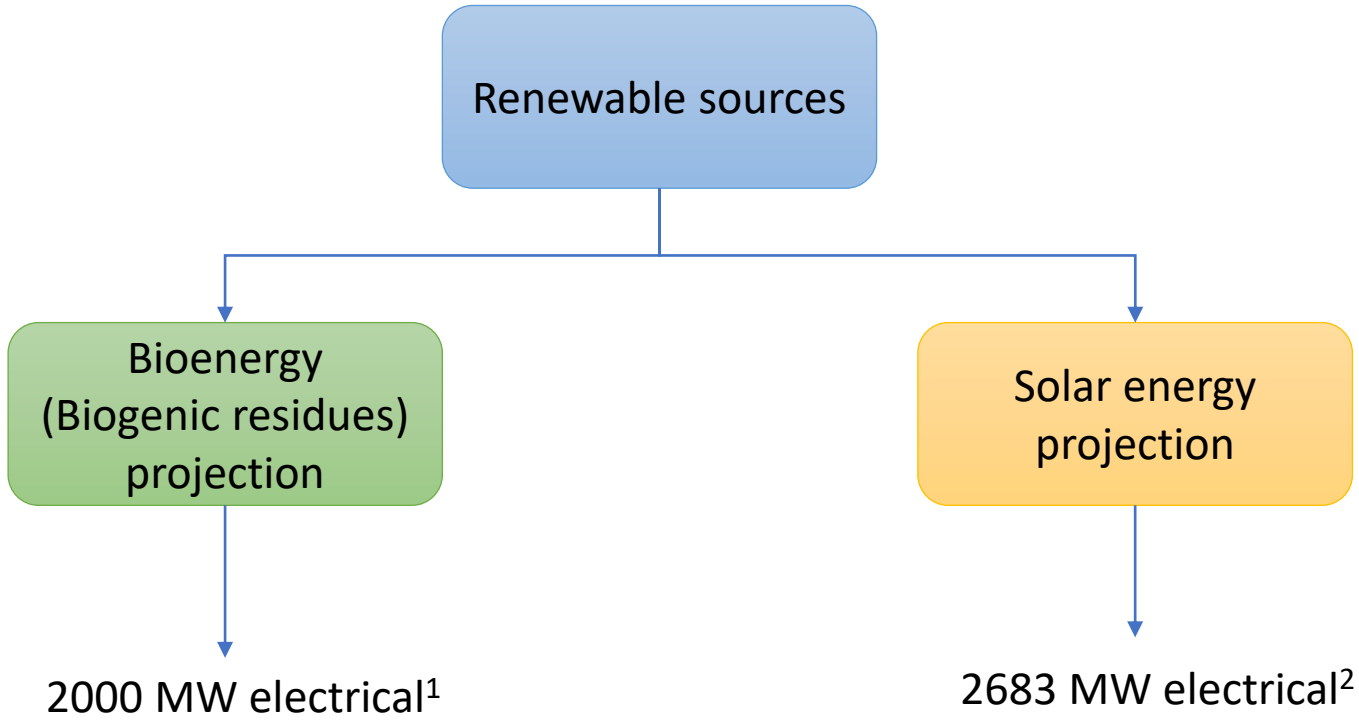

Source: Annual report 2019-2020, Bangladesh Power Development board

# Developing country scenario – possible renewable sources




For example, Natural Gas in Bangladesh is **depleting** fast

# Bioenergy and Solar energy in developing countries – Bangladesh as an example

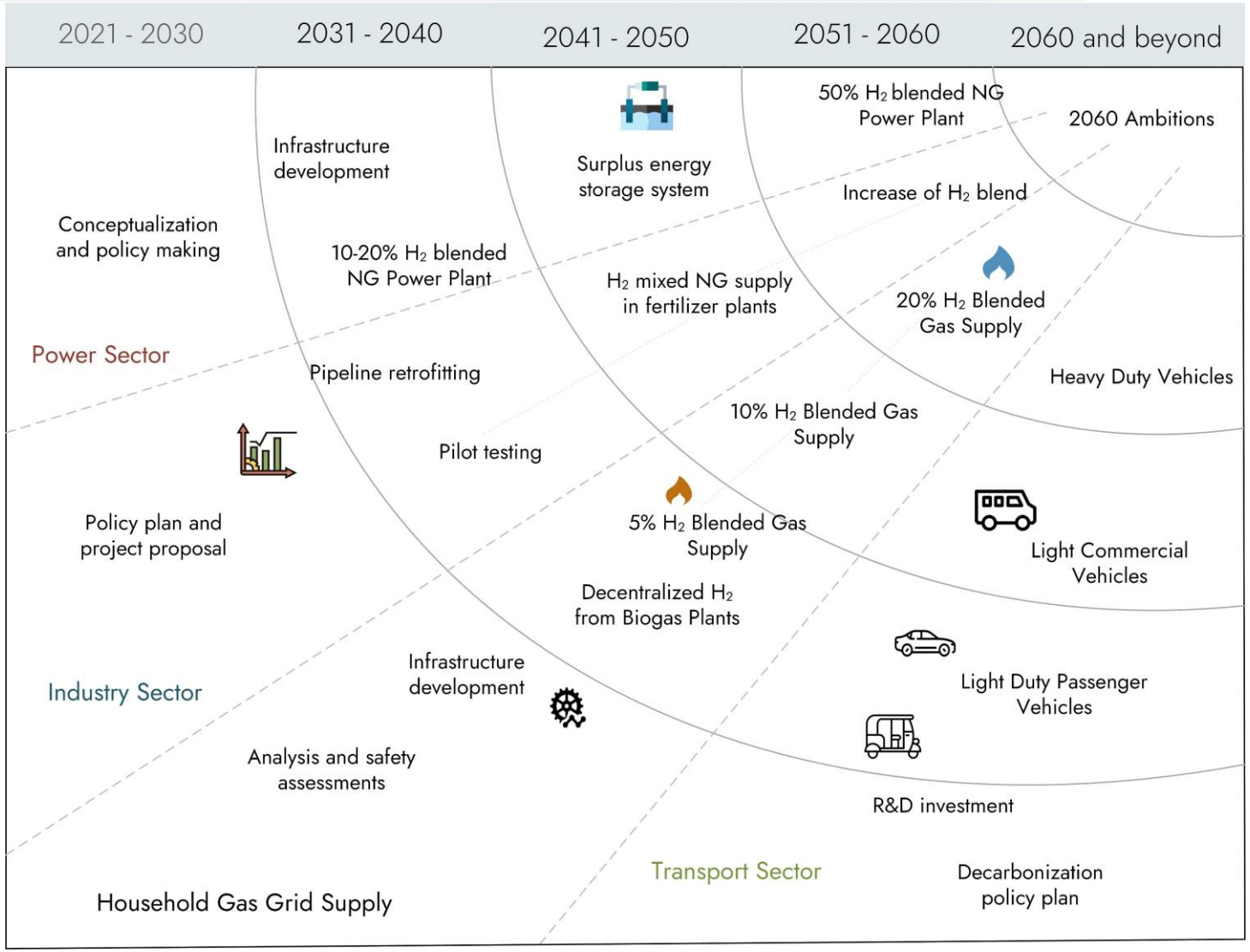



Total power generation capacity of Bangladesh will be 28,520 MW by 2030[2]. According to SDG goal for Bangladesh, 20% of the electricity should be renewable by 2030, however, current share is only 1.23%[4] of electricity generation and 3.25%[3] of final energy consumption

To meet this goal **both biogenic residues and solar energy have to utilized** to their potential to achieve ~**20 % renewables** including wind and hydro-power

1. Calculated by SEER Group, ChE, BUET based on 60 million tons of biogenic waste generation per year
2. Revisiting Power System Master Plan (2016), Bangladesh Power Development Board, Govt. of Bangladesh
3. SDG Tracker, Indicators NPI 20: Increase renewable energy share in total final energy consumption to 10% (SDG Indicator 7.2.1), (2020).
4. Annual Report 2019-2020, Bangladesh Power Development Board

# A potential $H_2$ roadmap for developing countries – Bangladesh case




* Hossain et al. (2023), International Journal of Hydrogen Energy 48 (54), 20588-20612

## Ongoing Green Hydrogen Projects in Bangladesh

# Renewable Hydrogen Generation with Carbon Recycling (ReHyCaRe) from Biogenic Residues of Bangladesh

Funded by

website: https://rehycare.com/

Implemented by

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ReHyCaRe For Cleaner Energy

The National Academies of SCIENCES ENGINEERING MEDICINE

# ReHyCaRe consortium

- Department of Chemical Engineering, Bangladesh University of Engineering and Technology (BUET), Bangladesh (**Project Lead**)
- Department of Farm Power and Machinery, Bangladesh Agricultural University (BAU), Bangladesh (Partner)
- Department of Applied Chemistry and Chemical Engineering, University of Dhaka (DU), Bangladesh (Partner)
- Department of Biomedical and Chemical Engineering and Sciences, Florida Institute of Technology (FIT), USA (USG-Supported Partner)

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# Thank you!

## Green Hydrogen Feasibility in Developing Countries - Prospects and technical challenges

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