

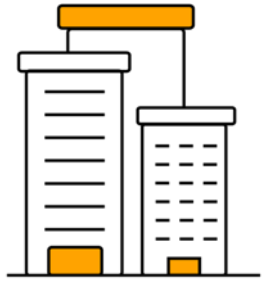
Green Hydrogen towards NetZero Pathways

**Sachin Deole, Director – Sales
Black & Veatch**

17th Oct 2023

Black & Veatch Today

120+
Offices



and

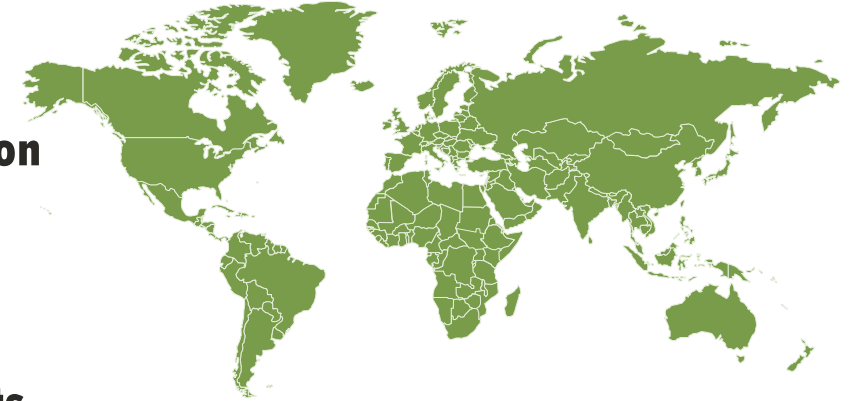


11,000+
Professionals

108
Years Experience

\$4.3B
Revenue in 2022

Projects on
6
Continents



8th largest
100% employee-owned
company in the U.S.

voted

One of “America’s Greatest Workplaces for
Diversity”
in 2023 by *Newsweek*

7,000 Active Projects
Worldwide

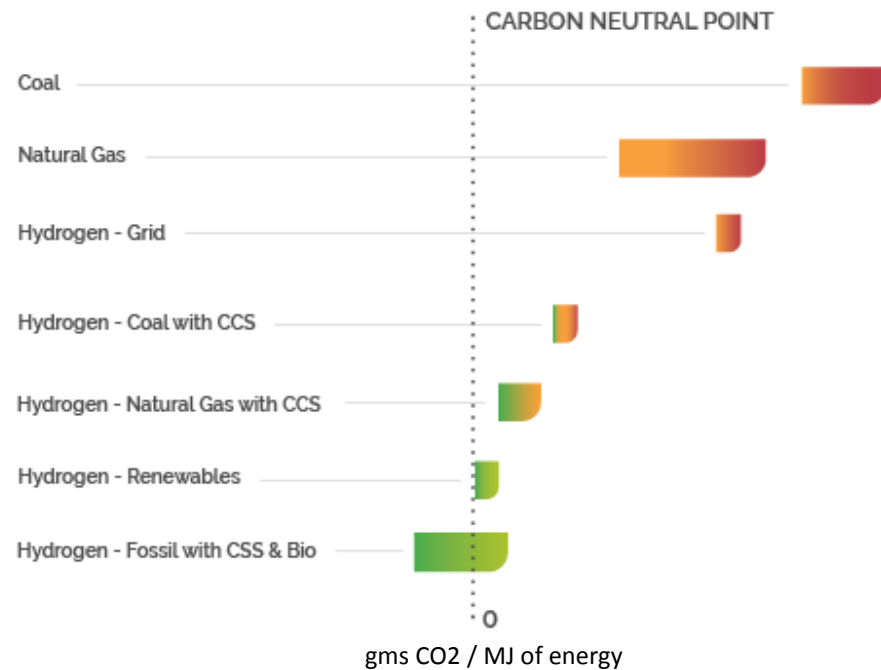
ENR Rankings:

Top 500 Design Firms

Power #2	Telecom #6
Solar Power #2	Petrochemical #8
Hydro Plants #4	Water Supply #8

Steps down the decarbonization ladder

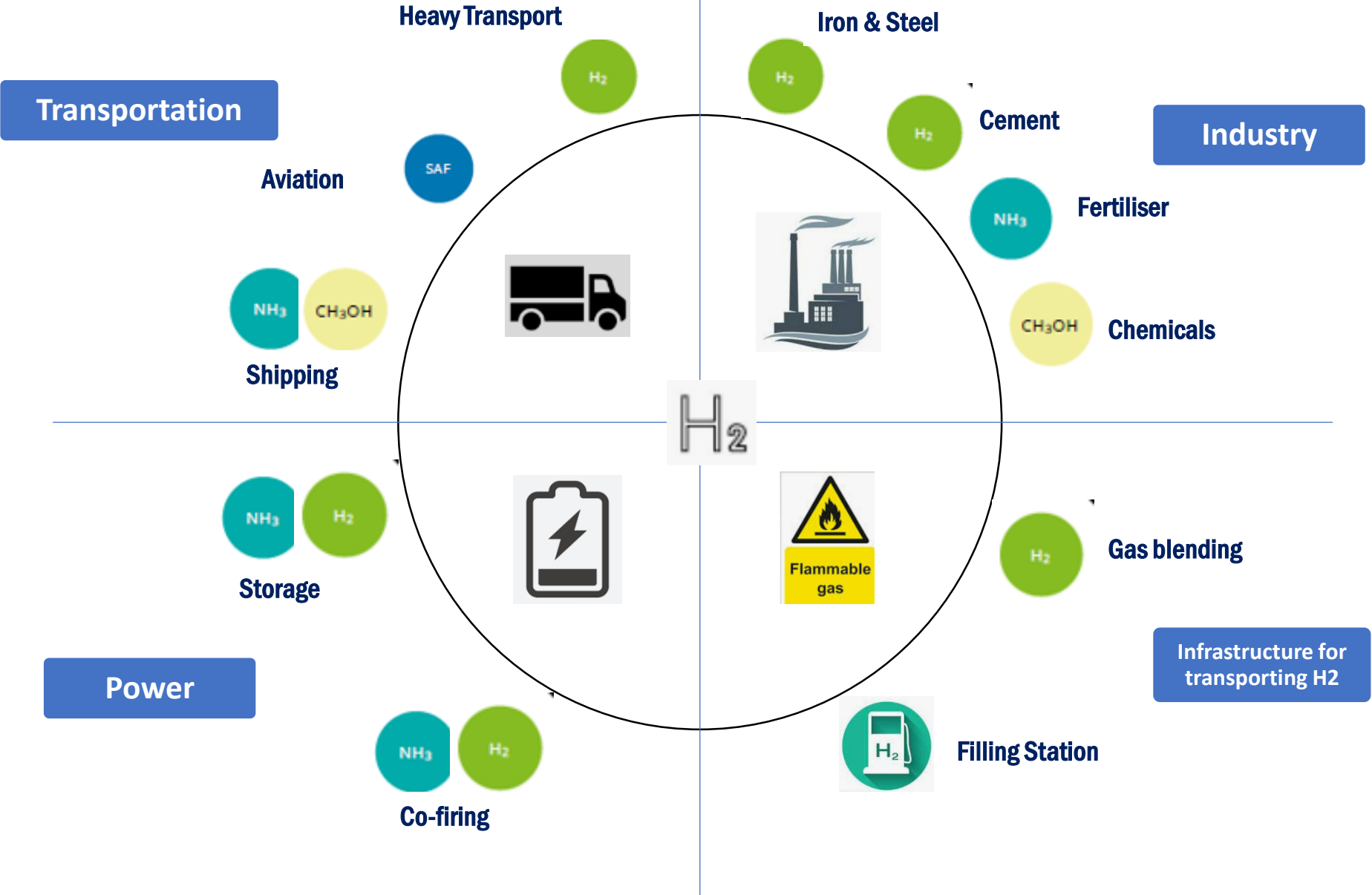
Black & Veatch proprietary concept



- **Small Pilot / industrial C&I** projects being implemented
- **Gradual transition** expected as India climbs down carbon emissions ladder
- **Solar + Wind** installations are 116 GW (27% installed cap)
 - Large expansion plans of 500 GW by 2035
- Existing vast network of transmission lines
- Hydrogen expected to surface as **long-term option** beyond 2028
- Ammonia seen as a potential carrier for energy solution

Renewable build up & better grid resilience will allow India to take rights steps to **cleaner fuel solutions**

Clean Hydrogen Uses and its Derivatives



- **Site selection**
 - Location depends on offtake (export or domestic)
 - Distance of nearest TL corridor & its availability. Better **grid connectivity** required
- **Integration with Renewable Profile**
 - **Supply side fluctuations** - Grid resilience enhancement would be necessary
 - **Optimum** selection of storage capacity (BESS capacity / PSP)
 - Grid banking – monthly / yearly
- **Electrolyser selection**
 - Type of Technology (PEM / AEM / SOEC)
 - Electrolyser manufacturing in India, **readiness & shop capability** in 4-5 years
- **Storage / Transportation & compression**
 - Limited ability of Suppliers / proven products, No Product standardization (Pumps, Valves etc)
 - Long distance NH3 transfer / handling (new challenges)
- **Safety**
 - Statutory approvals on **H2 handling**, policy & guidelines
 - Fugitive emissions & its solution
- **Water** – Critical natural resource & its availability in long term is important
- **Economical viability** – Most large-scale global H2 projects under implementation facing cost & time overruns



- **Green H2 off-take demand** - key driver
 - Project **economic viability** – success towards financial closure
 - Incentives will be critical (banking, PLI, Viability-gap etc..)
 - Policy development
- **Technology** maturity
 - Electrolysers, Key Suppliers in value chain
- Tying up the individual pieces
 - Expected cost & schedule **escalations**
 - **Integration** with support of knowledgeable partner
- **Power pricing** & distribution infrastructure
 - RTC power, storage options, T Lines, H2 hubs
- Capacity drives **economics**
 - Long term solution (post 2028)

Many variables ... more opportunities to optimize ... select right partners

Decarbonising Beyond Renewables



Engaged on many developing global Power-to-X projects



EPC for world's largest hydrogen hub
ACES Delta – 220 MW Electrolyser



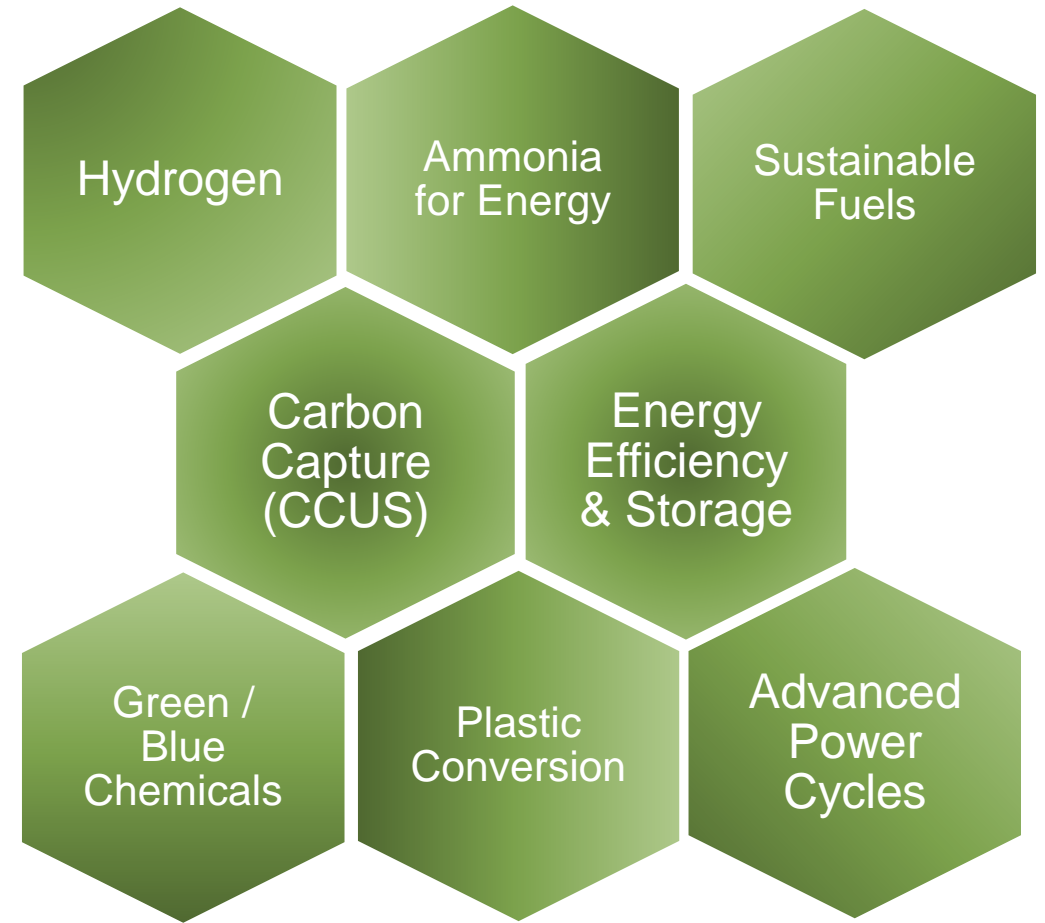
Largest Hydrogen based CCPP in NA
Intermountain Power Plant – 840 MW



Multiple Ongoing Electrolysis, Reforming, Ammonia, and E-Fuels Projects

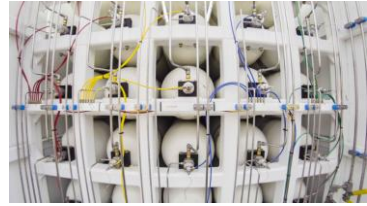


24 Hydrogen Fueling Stations – EPC
FirstElements, Air Liquide, Sprint



Participating in dozens of projects globally and in India

Project references India / International



CENTER FOR
Hydrogen
SAFETY

Executive Member



BLACK & VEATCH



Hydrogen Refueling Station Designs

Confidential Client

Engineering Design, optimisation, procurement specifications, Compression/storage in vessels/trailers

Green Hydrogen, Green Ammonia & Mobility (600 TPD)

Feasibility - *Confidential Client*

Production of H₂ via AWE/PEM, Compression/storage in vessels/trailers, Generation & export of Green Ammonia

FEED – 1 MMTPA Green Ammonia

EverWind Fuels, Nova Scotia – Canada

Production of hydrogen via AWE/PEM type Electrolyzer

Phase 1 –**Power thru** certified Green Power from Nova Scotia grid

Phase 2 - Onshore Wind (Offshore Wind planned later),

Generation & transport / export of green ammonia from existing deep water port Hawkesbury



Thank you!

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