Green Hydrogen Cluster in Ramagundam, Telangana

Potential and critical success factors

Stakeholder Dissemination Webinar

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

H2Uppp

International Hydrogen Ramp-up Program

Scope of the assignment: Assessment of hydrogen landscape, its techno-economic viability and development of a roadmap for H2 valley in Ramagundam

1 Hydrogen landscape overview in Telangana

Assessment of hydrogen demand potential

- Assess **current & future demand** of H2 in following sectors:
  - Fertilizer: RFCL
  - Mining and Transport: SCCL, TSRTC
  - Others: Chemical, Glass, Pharma, Steel
- Conduct a **"Willingness to Pay"** analysis of consumers for green fuels

As-is overview of policy & regulatory landscape:

- Map all **private and public stakeholders** for scaling up GH2 hub and projects in Telangana
- Identify and assess Industrial demand inducing actions- policy, subsidy, support schemes etc.
- Identify & group **potential hub members** as per value chain presence

2 Techno-economic assessment

Undertake techno-economic assessment of the following areas:

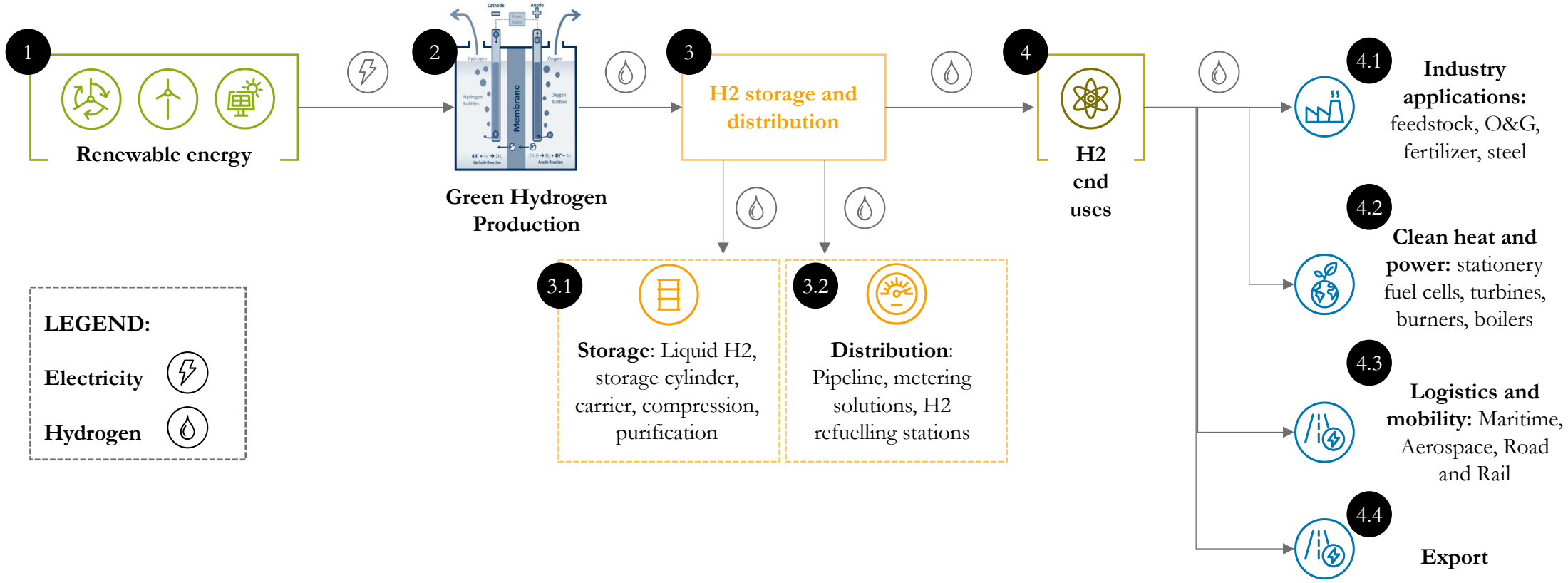
- **Renewable energy**: Assess RE demand & cost to meet GH2 targets
- **GH2 production:** Assess technology, cost, resource availability and ESG risks for GH2 production
- **Hydrogen infrastructure:** Techno-economic and safety scoping for hydrogen storage & transmission infrastructure at hub level and refueling infrastructure for transport
- **Environmental impact and SDGs:** Assess GHG reduction, NOx impact, SDG impact etc. from GH2 production
- **Offtake and cost assessment:** Assess Capex/Opex and overall LCOH for potential demand in Ramagundam cluster & Telangana
- **Skill and capacity building assessment**

3 Roadmap preparation

- Develop a short & medium-term **road map** for valley development
- Recommend necessary governance structures & capacity to be created
- Identify risks & recommend mitigation plan

Concept of Hydrogen Valley

Localized demonstration of the entire Green Hydrogen value chain in a defined geographical area - from production to subsequent storage and its transport & distribution to various off takers and consumption



Concentration of potential off-takers positioned Ramagundam region an ideal location for Hydrogen Valley development

***Glass** – NG substitution*

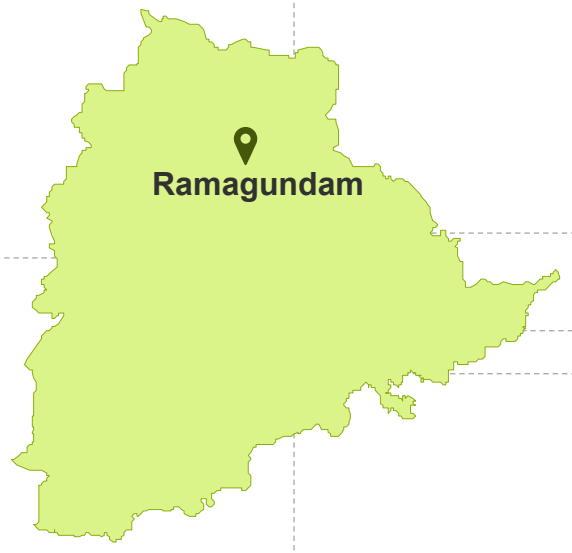
AGI Glaspac (Sanathnagar and Bhongir) – **210 km**

***Cement-** Heating agent*

MyHome Cement – **287 km**

***Others** – may be explored*

Pharmaceuticals and chemicals



***Fertiliser** – Grey H2 substitution*

RFCL (Ramagundam Fertilizers And Chemicals Limited): **<1 km**

***Coal Mining** – FCEV, Energy storage*

SCCL (Singareni Collieries Company Limited) – **0 km**

***Public Transportation** – FCEV*

TSRTC (Telangana State Road Transport Corporation): **~7 km**

Other enablers

Favorable RE policy, Land for valley near SCCL facilities, Water from Godavari

The H_2 valley could potentially generate a long-term demand of ~75 TPD; however, Pilot could be designed with smaller quantity of 2-3 TPD

Sl.	Offtaker (sector) and Use cases			Short-term GH_2 demand (TPD) [Pilot stage]	Medium-term GH_2 demand (TPD) [2027 - 2030]	Long-term GH_2 demand (TPD) [2030 - 2040]
1.	RFCL (Fertilisers)	Ammonia production and NG desulphurization		2	5.5	45
2.	TSRTC (Transportation), 500 km roundtrip	Hydrogen fuel cell buses (FCEV)		0.2	2	8
3.	MyHome (Cement)	Hydrogen fuel cell trucks (FCEV)		0.2	4	10
4.	SCCL (Mining)	Hydrogen fuel cell trucks (FCEV)		0.2	2	10
5.	AGI Glaspac (Glass)	Melting furnace		0.02	1	2
	Total			**2.62**	**14.5**	**75**
	Electrolyser capacity (MW)			**8-9**	**45 - 50**	**220 - 240**
	RE Capacity (W+S) (MW)			**20 - 22**	**120 - 130**	**620 - 650**

Note: Demand estimation is as per PFR prepared by RICH

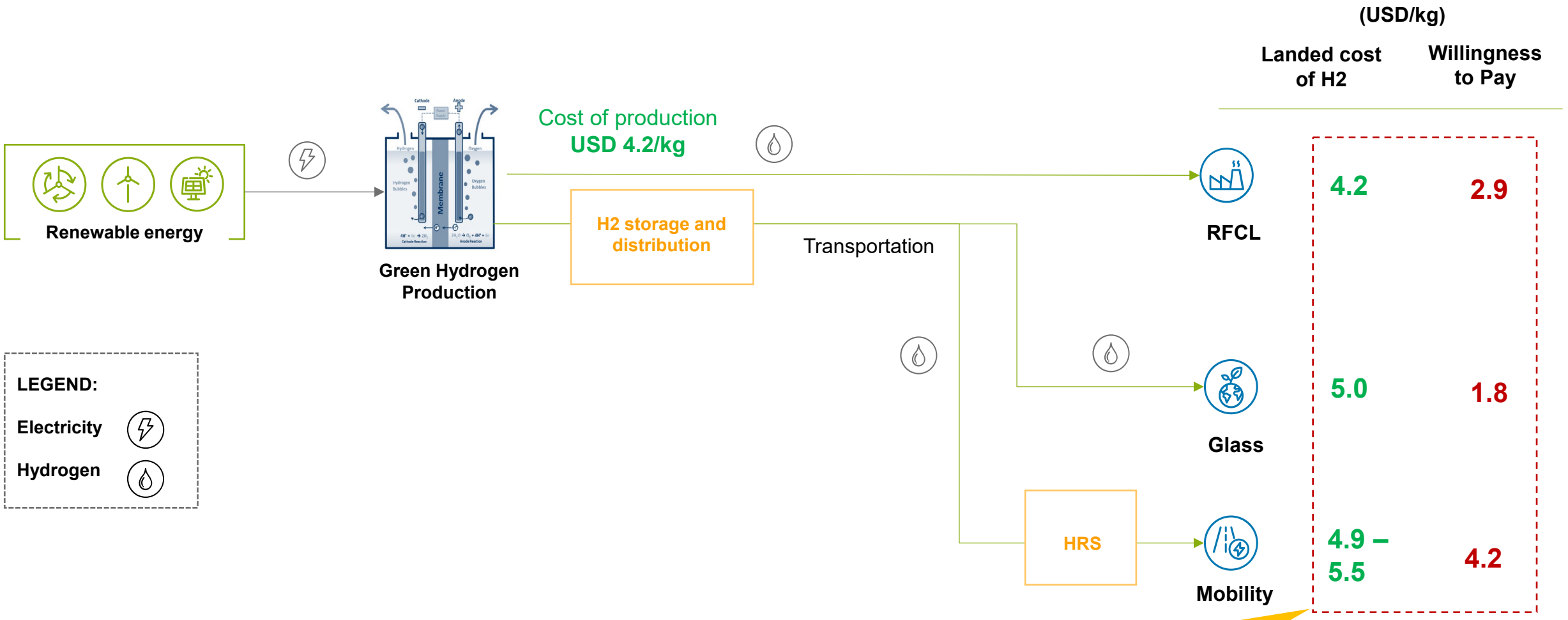
Summary of Infrastructure requirement apart from RE

Infrastructure requirement	Timeline			Remark
	Short-term demand	Medium-term demand	Long term demand	
Water pipeline	Can be arranged from Municipality (~0.1 MLD)	~25 km water pipeline from Godavari to SCCL H2 plant site for ~1 MLD	~4 MLD water connection in the long run	For pilot project, water can also be arranged through the Municipal corporation. There is an existing pipeline from Godavari to RFCL and SCCL; an evaluation is required if that pipeline can be used for additional water in the medium term
Hydrogen Pipeline	**~1 km** pipeline with capacity **~100 kg/hour** from plant site to RFCL facility at 50 bar pressure	~1 km pipeline with capacity ~250 kg/hour from plant site to RFCL facility at 50 bar pressure	~1 km pipeline with capacity ~1900 kg/hour from plant site to RFCL facility at 50 bar pressure	Enhanced capacity can be augmented in the future based on actual requirement
Hydrogen Storage	**~1 Ton**	18-20 Ton	50 - 60 Ton	**3 days storage** considered for outstation consumption point
Hydrogen Refueling station (HRS)	1 refueling station in SCCL site	8 refueling station in SCCL site, Myhome site and TGSRTC depot	25 – 28 refueling station in SCCL site, TGSRTC depot and Kodad (MyHome cement plant)	In the short term, 1 TPD HRS will be deployed; in the medium and long term 2 TPD HRS would be deployed
Truck for Hydrogen transportation	Hydrogen truck **(Tube Trailer)** will be deployed to transport H2 to AGI Glaspac plant located at a distance of 240 km			GH2 supply through truck is cost competitive up to **approx. 500 km distance**

Summary of investment requirement – Pilot phase would require INR 250 - 280 Cr

Focus areas	Unit	Timeline		
		Pilot Project (2024- 27)	Medium term (2027 - 30)	Long term demand (2030-40)
Electrolyser system and utilities	INR Cr	58	239	1090
RE – Solar + Wind +BESS	INR Cr	152	840	4328
Hydrogen storage	INR Cr	10	144	480
HRS - 2 TPD	INR Cr	35	240	700
Pipeline	INR Cr	3	3	3
Fuel Cell Bus	INR Cr	5	100	360
Fuel Cell Truck	INR Cr	6	120	250
Tube trailer	INR Cr	2	2	4
Total (Cumulative)	**INR Cr**	**270**	**1688**	**7214**
Capex requirement for each Phase	**INR Cr**	**270**	**1418**	**5526**
	USD Million	**33**	**171**	**666**

Impact assessment on end-use industries – VGF is required for all industry segments to become commercially viable



Critical success factors for valley development

		Action items
1	Identification of implementation partner and setting up a Governance system	Identify an “Implementation Partner” and set up a PMO with participation from Government and industry stakeholders
2	Phasing of hub development with a definite “Pilot to Scale-up” plan	Start early with “Pilot Project” and define a roadmap for scaling-up through demand aggregation
3	Selection of a Valley developer or anchor investor	Select the valley developer cum anchor investor through global competitive bidding; the developer will coordinate with all ecosystem players
4	Innovation in Business Model, Commercial model and allocation of fiscal incentives	Design a viable business model through robust offtake contracts and bridge the gap between LCOH and “Willingness to Pay” through suitable fiscal incentives – VGF, tax credit, waiver in T&D charge, capital grant etc.
5	Leveraging international experience of valley development	Learn from similar experience of valley/hub development across the globe especially in US and Europe/Germany through knowledge transfer and international collaboration

Roadmap: Phased approached for valley development

1 Pre-pilot stage

1. Preparation of objective, vision and strategy for the GH2 valley in Ramagundam
2. Identification of key stakeholders for the valley
3. Development of communication and awareness campaign for the green hydrogen valley
4. Engagement with stakeholders to identify requirements and delivery needs
5. High-level feasibility study to gauge the willingness to pay for green hydrogen
6. Designing pilot for green hydrogen valley and funds mobilization

Ongoing

2 Pilot stage

1. Signing of off-take agreements for 2.6 TPD
2. Commissioning of pilot project at SCCL facility
3. Modification of general operations of end users to integrate green hydrogen from pilot plant
4. Operational efficiency building for hydrogen production and transportation to end users
5. Testing of the pilot projects and reporting key findings of the pilot projects
6. Roadshows and workshops to disseminate pilot project findings
7. Evaluate success

No- Go / **Go**

3 Post-pilot scaling

1. Signing of off-take agreements for 75 TPD
2. Development of operating and commercial model for the hydrogen valley
3. Infrastructure development for the valley in line with demand activators
4. Skill and capacity development
5. Governance mechanism for instituting implementation of the valley elements

Continuous stakeholder consultation and multi-level monitoring

Governance mechanism for valley implementation

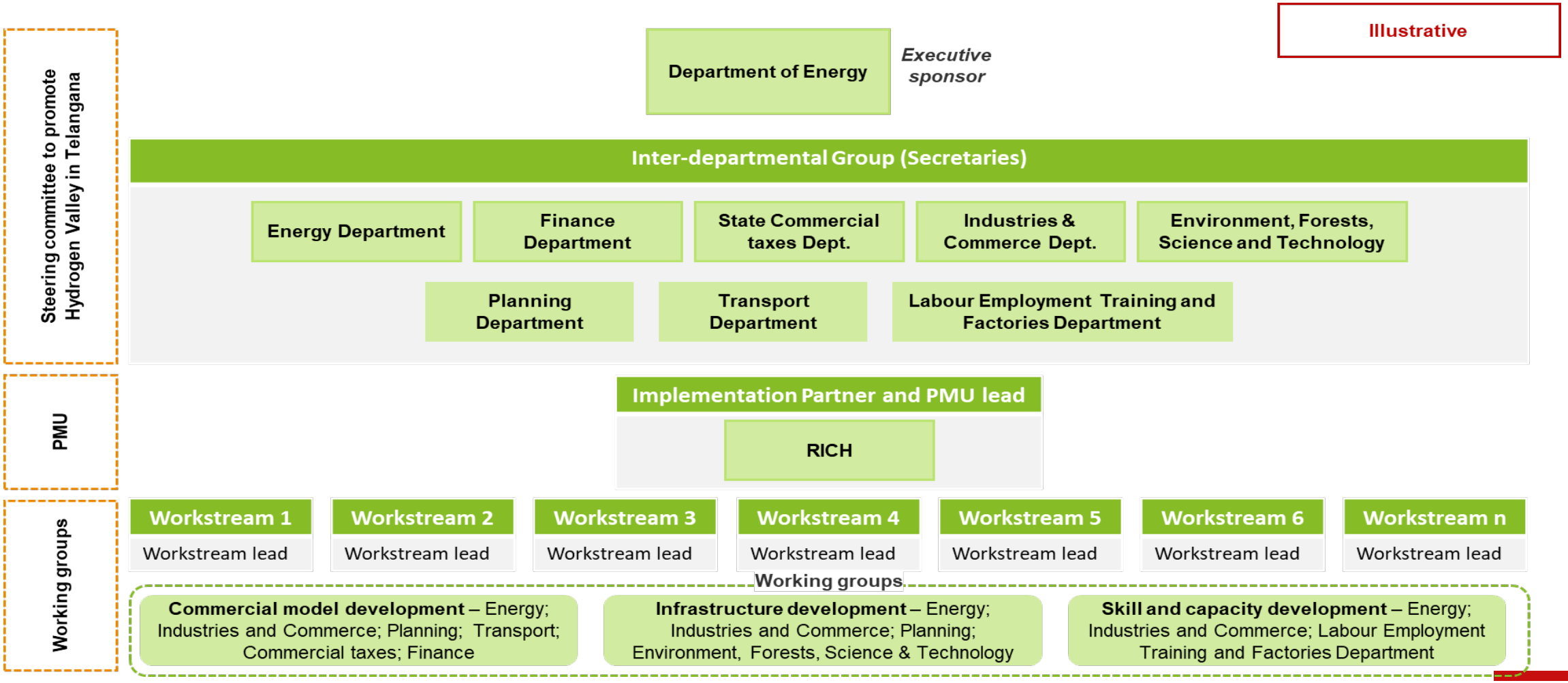
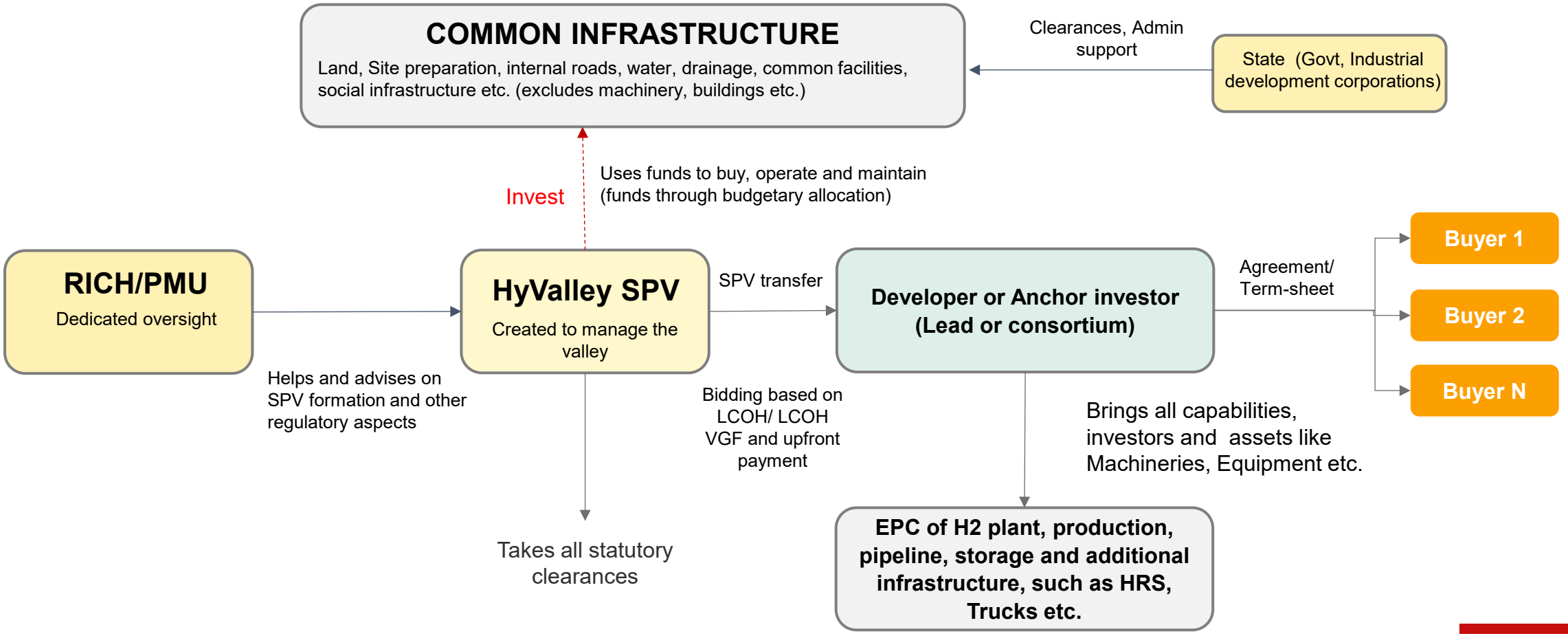


Illustration of a Valley commercial and operating model



Scope of Government support and VGF

Policy support	Rationale	Impact
Capital grant for Hydrogen production and allied infrastructure	Any incentive in the form of capital grant can reduce the delivered LCOH. This grant can be tailormade by the state government for the valley development	**30% capital grant** will reduce LCOH by **USD 0.30 – 0.35/kg**
Waiver of electricity charges	Waiver of State Transmission charges and electricity duty can optimize the LCOE used for water electrolysis. Other charges, such as Cross Subsidy Surcharge, Additional Surcharge are already waived off for captive configuration.	Waiver of transmission charge (STU) for 10 years can reduce LCOH by **USD 0.25 – 0.30/kg**
Equity infusion from the Government	Equity infusion from the State Government can reduce the burden on the developer/anchor investor and optimize the return expectation.	Customizable
Other incentive	Tax exemption can further improve the risk-profile of the project, which can optimize the LCOH	Customizable

Mapping and developing of additional skill-set for development and operating the valley will be critical

Availability in India

Good | Medium | Poor

	RE generation	Hydrogen plant EPC	Manufacturing (Electrolyser and BOP)	Operations	Storage & Transportation	End-use of Hydrogen	Others
Availability of skills/ competencies	Project Engineering EPC Operation Policy and regulations	Engineering Design Basis (Mech, Elec, C&I) Codes and Standards Procurement Safety engineering Inspection	Stack manufacturing BOP manufacturing Manufacturing of valves, tubes, power electronics Sourcing of raw materials	Electrolyser operation Maintenance Safety management Certification	Transport infra management Safety management	Process modification & integration Refueling station Digital infrastructure	Contracting and off-take agreement Optimization and simulation
Rationale/ Remark	India has a **matured RE industry** with more than 30 players operating in this space	Green Hydrogen EPC currently is in **nascent stage**. India has seen finalization of few pilot scale projects. Knowledge and expertise related to engineering, construction and commissioning **resides in a fragmented manner.** **Procurement of technology and capex items** is not a challenge	**Stack manufacturing** is not currently available in India. Developers are dependent on **foreign OEMs.** Few critical items of BOP, such as **compressor, purifier** are not manufactured in India in a large way.	**Only small-scale electrolyzers are in operation in India**. Skill-sets required for commercial scale operation are still not available Existing process industry experience (e.g., fertilizer, refinery) of **handling H2 safety and maintenance of equipment/pipeline** can be leveraged **Certification of Green Hydrogen** is another important focus area for industry	Existing hydrogen plants are mostly captive. Knowledge and competencies related to **road transport of H2 (tube-trailer) and H2 storage** is limited. Existing safety management competencies can be leveraged from process industries	Capability for **impact assessment of integrating green hydrogen in existing system** (glass, urea etc.) is limited in the industry. The country requires adequate knowledge of **setting up and operating HRS in commercial scale.**	Capacity building is required for **H2 contracting and offtake agreement** **Optimization and simulation capabilities** are required to optimize RE, BESS and electrolyser sizing

Immediate way forward: Develop the Pilot project for an aggregated demand of ~2.6 TPD

Particular	RFCL	TGSRTC	MyHome	SCCL	AGI Glaspac	IOCL (NG line)
Hydrogen demand (TPD)	2.0	0.2	0.2	0.2	0.02	Not considered
Centralized electrolyser	8 – 9 MW Alkaline					
Centralized Hydrogen storage	~1 Tons at the outlet of electrolyser					
RE	**6 – 7.5 MW (Solar), 16 – 25 MW (Wind);** BESS will not be required if 4 – 4.5% power is sourced from the Grid					
Hydrogen refueling system	**One HRS at the SCCL premise** with capacity 200 kg/hr (average capacity required for TGSRTC, MyHome and SCCL is 0.6 TPD)					
Fuel Cell Bus		2 – 3 Buses				
Fuel Cell Truck			1-2 Heavy duty truck	1-2 Heavy duty truck		
Tube trailer					1 tube trailer for transportation	
Specific infrastructure	**1 km Hydrogen pipeline** **~1 Ton Type 4 storage** and associated infra				Storage tank at the AGI Glaspac site - **~200 kg Type I**	
Total investment	**INR 250 – 300 Cr**					

Key success factors

Onboarding of implementation partner

Signing of off-take agreement

Financial support from State and Central Govt

Thank you