Sustainable Aviation Fuels (SAF) and Sustainable Marine / Maritime Fuels (SMF) Stakeholder Mapping and Survey

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Introduction

What is it?

- Sustainable Aviation Fuels (SAF), an alternative fuel to conventional jet fuel, is made from non-fossil feedstocks.
- Similarly, Sustainable Marine / Maritime Fuels (SMF), also made from non-fossil feedstocks, is an alternative green fuel to conventional marine fuel.

What does it consist of?

- Both, Sustainable Aviation Fuels (SAF) and Sustainable Marine / Maritime Fuels (SMF) consist of synthetic hydrocarbon obtained from non-fossil feedstock.

Why do we want it?

- In order to reduce global carbon footprint, the most viable energy transition option for aviation sector as well as marine sector is to source fuel from non-fossil origin, which ensures sustainability of global environment.

Introduction

Why SAF/SMF is important for India?

- The aviation and marine industry in India is growing exponentially
- The ATF demand is expected to grow @ CAGR of 17%*
- Decarbonization of the aviation sector is critical to meet its 2070 net zero-target and mitigate climate change
- Dependance solely on fossil fuel would not reduce carbon footprint
- Lower Green Energy Cost and better feedstock availability in India
- Employment generation possibility - about 0.5 million to meet only domestic demand
- Promising export possibility - international flights/fleets refueling can be done in India

* Petroleum Planning & Analysis Cell under MoPNG

Agenda

1. **Project Introduction**
2. Key Findings
3. Recommendations
4. Way Forward

Project Introduction

As India seeks to transition to a low-carbon economy, Sustainable Aviation Fuels (SAF) and Sustainable Marine / Maritime Fuels (SMF) adoption in the aviation and maritime sector is vital. GIZ, through the International PtX Hub, requested Dornier Group India to conduct a stakeholder mapping and survey in India along the SAF and SMF value chain.

The entire project delivery was divided into two main tasks, namely;

Task 1: Stakeholder Mapping

- Identification, Categorization and Mapping - Carried out by desktop study and discussion with subject experts

Task 2: Stakeholder Survey

- Preparation & Circulation of Survey Questionnaire, Collection of responses, analysis of the responses and identification of the key findings.

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Key Findings

The stakeholder survey on Sustainable Aviation Fuels (SAF) and Sustainable Marine / Maritime Fuels (SMF) resulted in the following key findings:

1) Awareness of on-going developments on SAF and SMF by Government Authorities, Industry Bodies, Research Institutions and Airlines / Marine Lines.

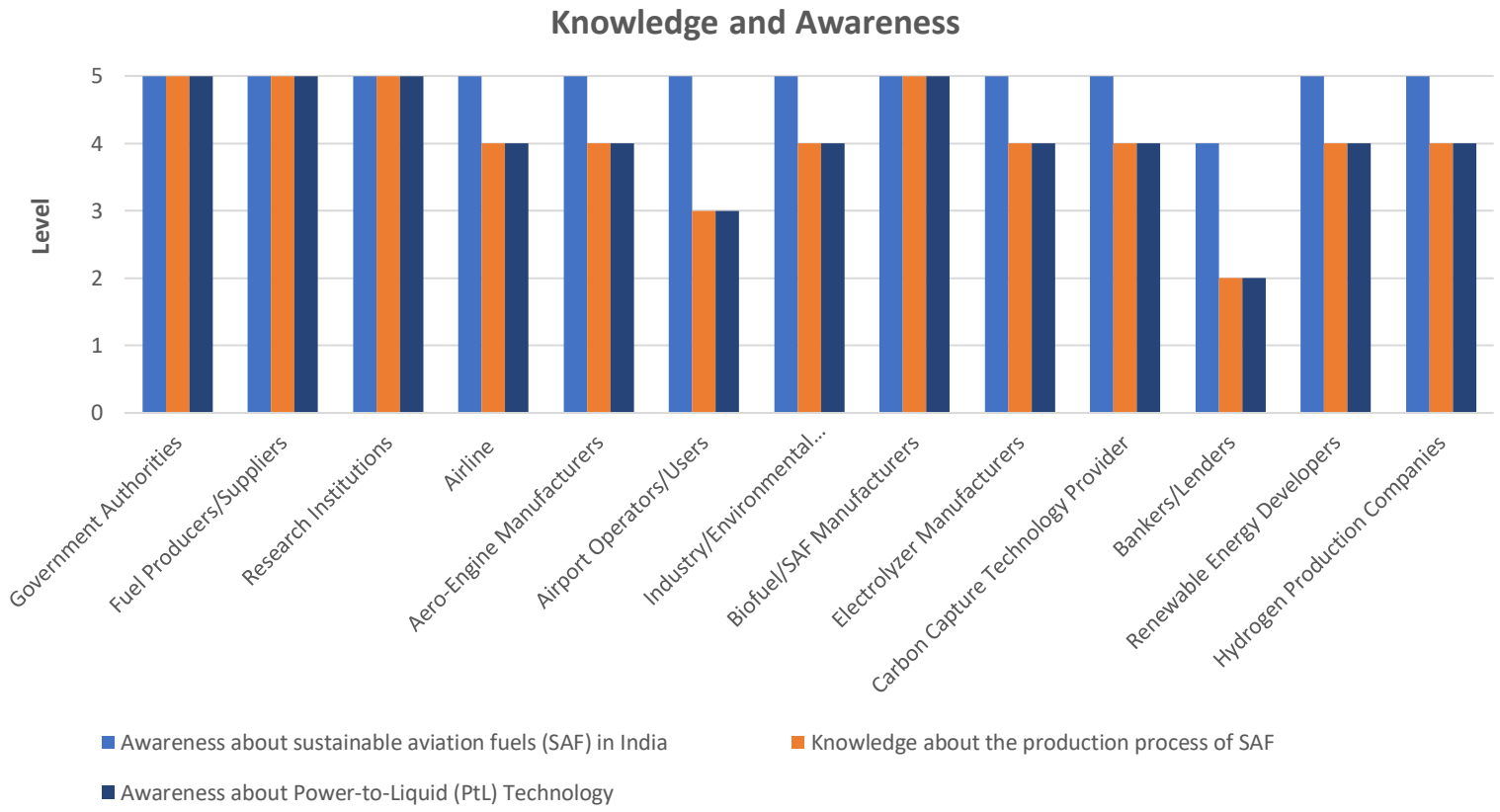
2) Awareness of possible reduction in carbon footprint on adoption of SAF and SMF.

3) Public-Private Partnership (PPP) promotion by government for SAF and SMF usage and manufacturing.

Knowledge and Awareness of SAF

Summary of findings:

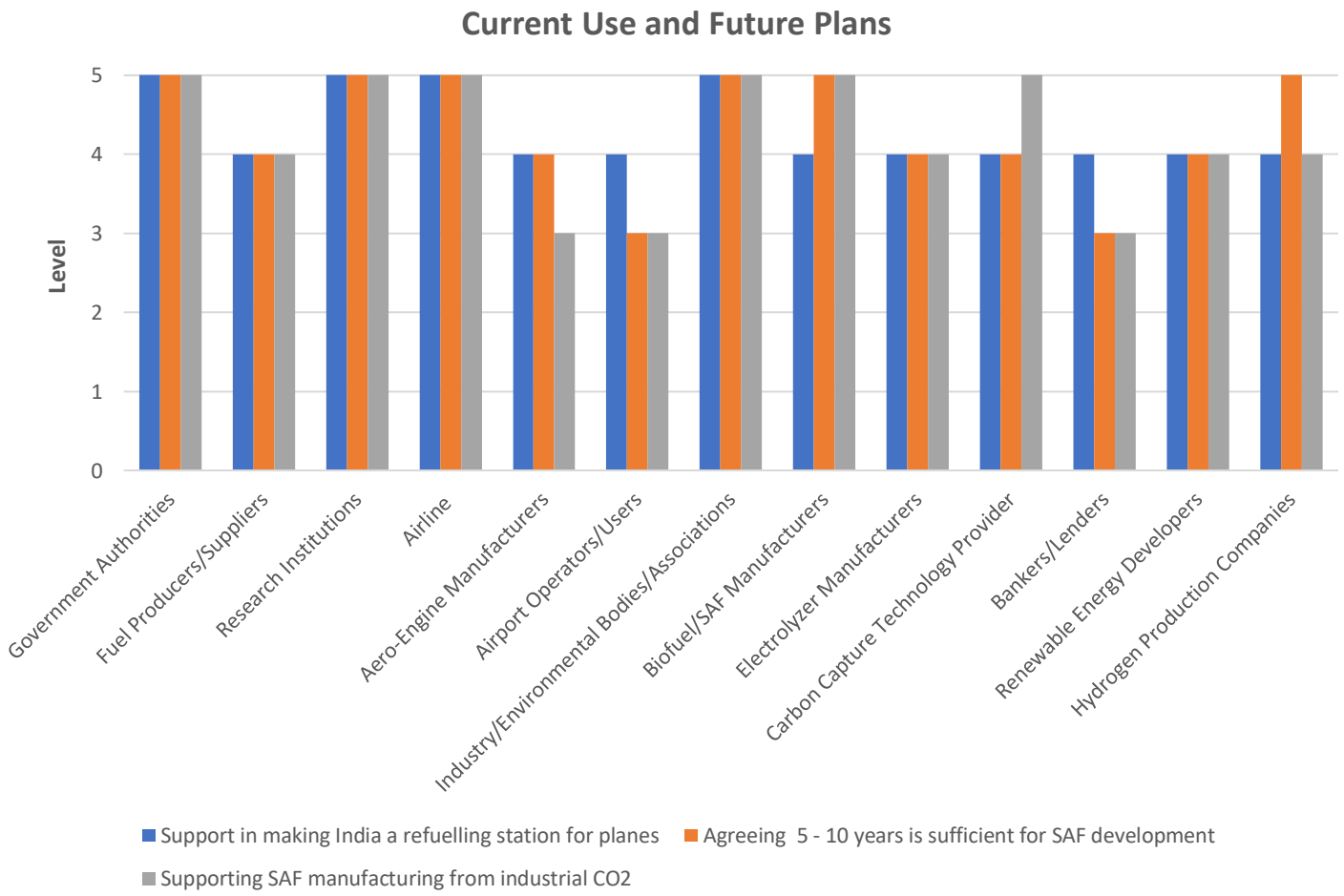
1) The industry and the government is aware, banks and IFIs need to be appraised.
2) Regulatory framework to be aligned with ICAO guidelines.
3) Inviting International developers for SAF production.
4) India is also focussing on Green Ammonia export, and initial research projects are taken jointly by Oil Companies and Research Institutes.
5) Oil Companies are planning to established their SAF Plant and enhance refuelling facility for domestic and export market.
6) Multiple domestic airlines have conducted demonstration flights with SAF blended jet fuel.



Current Use and Future Plans of SAF

Summary of findings:

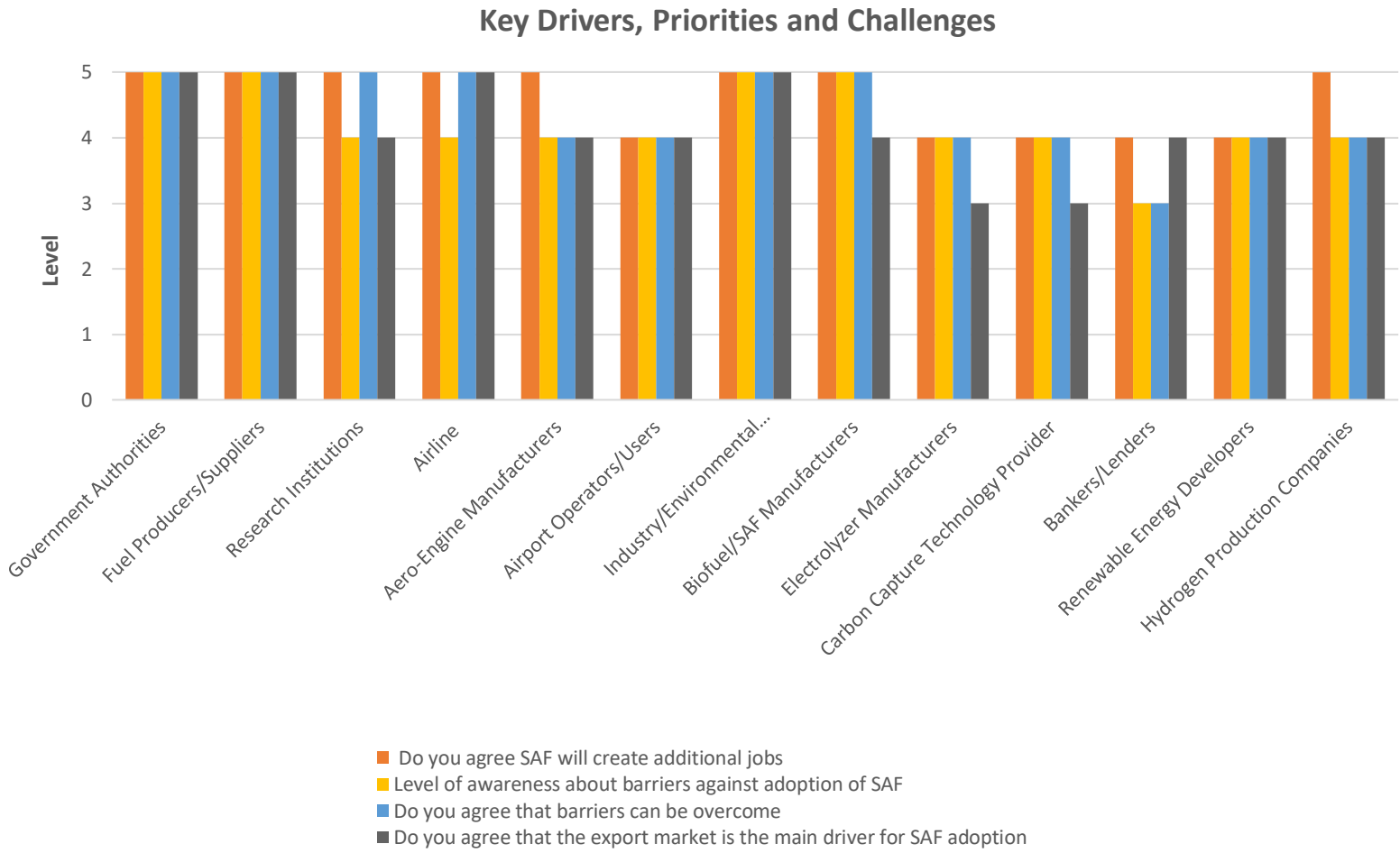
1) Industry & Government is aligned to build refuelling stations near to International Airports.
2) Preferred feedstock is industrial CO_2 and industrial solid waste / MSW.
3) Co-processing with Oil Refineries
4) International Airlines and Private Jets are the main market for SAF.



Key Drivers, Priorities and Challenges of SAF

Summary of findings:

1) Substantial government incentives for cost and support for export market.
2) SAF will create additional jobs for construction and O&M.
3) ICAO is continuously improving the feedstock and manufacturing guidelines.
4) With the increasing awareness and technology improvement barriers will be removed.
5) Reducing RE cost and logistic incentives will further facilitate bringing down cost of SAF.



Govt. of India – Policy Incentives

As per the Green Hydrogen/Green Ammonia Policy:

- Waiver of ISTS charges for 25 years for projects commissioned before 30th June 2025.
- Land allotted at Renewable Energy Parks
- Manufacturers allowed to set up bunkers near Ports for storage of Green Ammonia for export / use by shipping.
- A single portal for all statutory clearances within 30 days

Niti Aayog (Think Tank for policies) has proposed multiple steps for incentivising local production of SAF including:

- 5% GST on SAF
- Waiver of passenger fees for flights operated with SAF.
- Waiver of user development fees for flights operated with SAF.

Barriers and Solutions for Adopting SAF

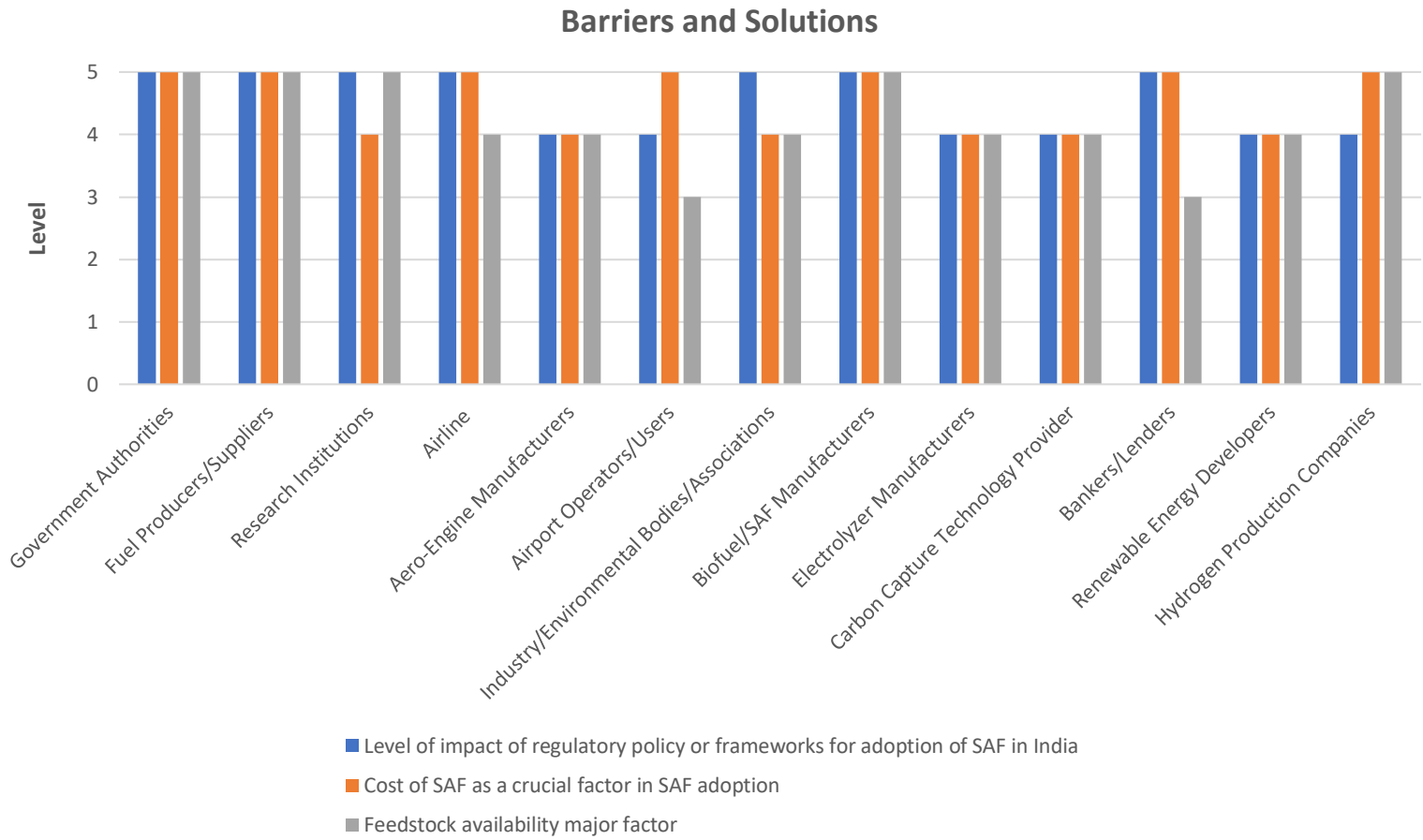
Summary of findings:

Barriers:

1) Technology maturity, safety standards and high initial cost of SAF are the main barriers.
2) Regulatory policy not yet fully developed.
3) Availability of feedstock and cost.

Mitigation:

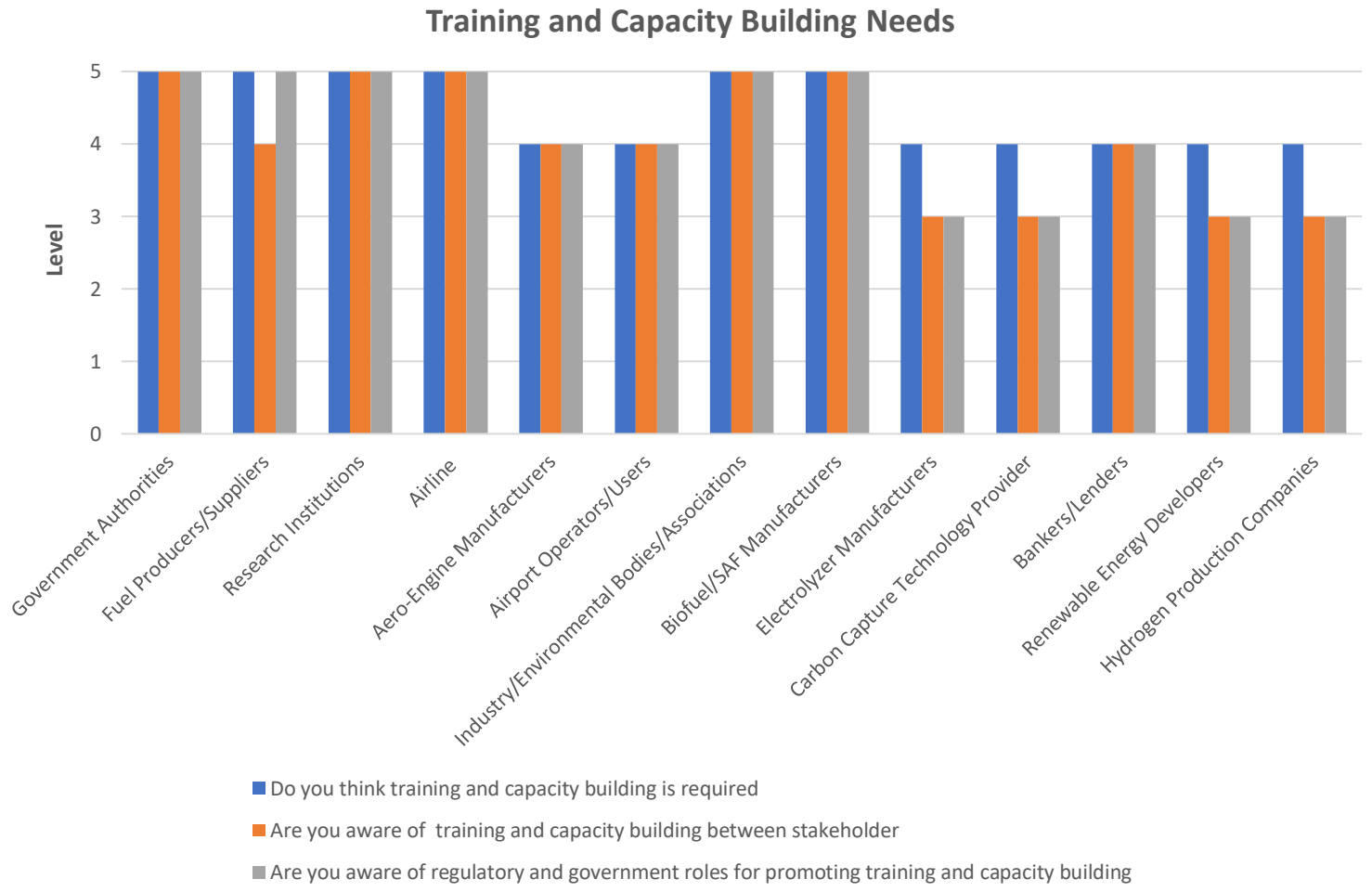
1) Favourable government policies
2) Government support to reduce cost.
3) Inviting technology suppliers / developers to set-up plants in India.



Training and Capacity Building Needs for SAF

Summary of findings:

1) Need access to ICAO developed the ACT-SAF series of training.
2) India has joined ICAO's "Assistance Capacity Building & Training for Sustainable Aviation Fuels Programme".
3) The Bio-ATF Program Committee was constituted by the MoPNG to encourage the government in adopting SAF by conducting the Bio-ATF Program.
4) The training shall be domestically available to
   - Biofuel producers
   - Biofuel suppliers
   - Biofuel off-takers
   - Regulators
   - Financial Institutions.



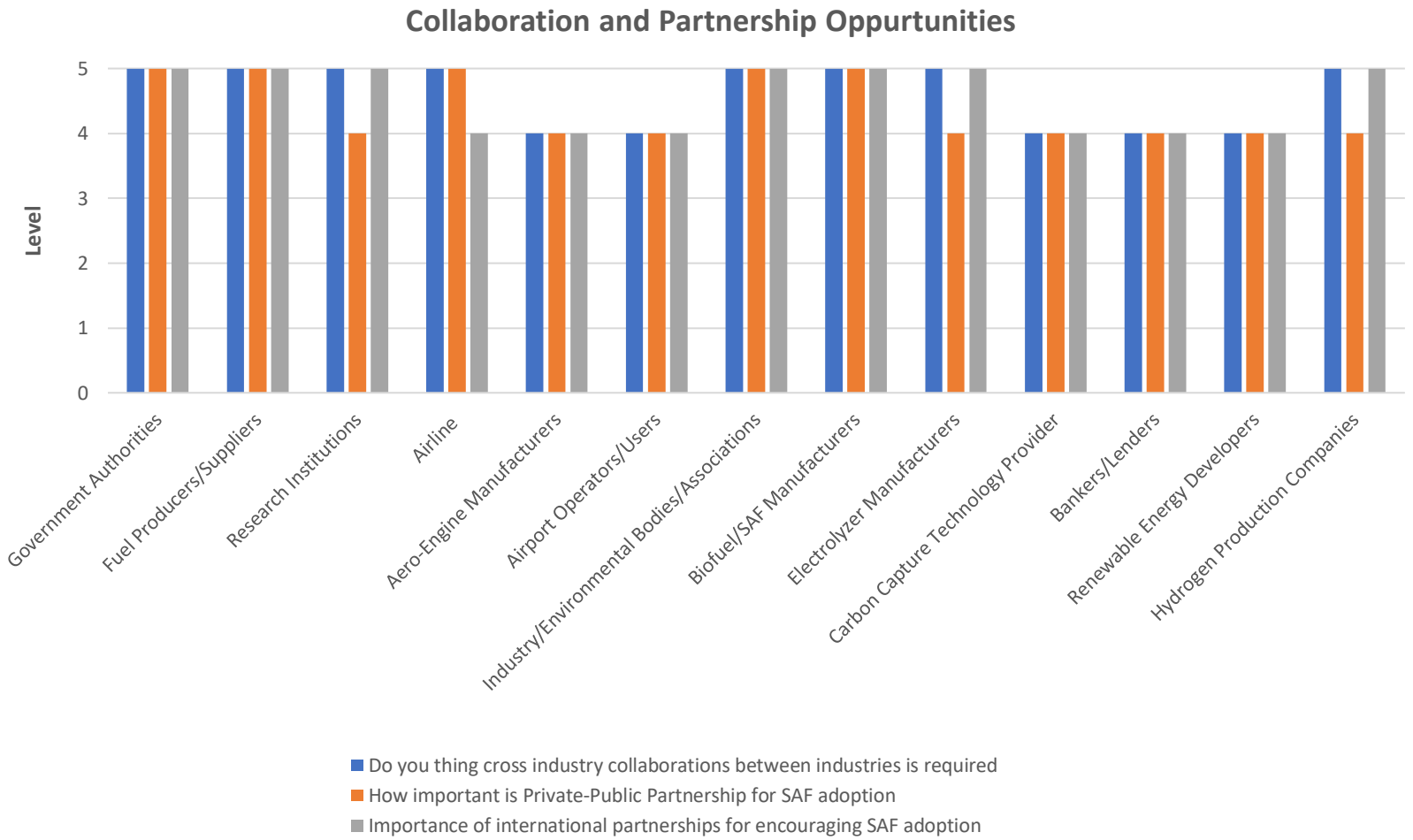
Collaboration and Partnership Opportunities for SAF

Summary of findings:

1) Cross - Industry collaborations has been encouraged between various stakeholders in different industries.

2) Existing collaborations for SAF are;
   - IOCL & Lanzajet
   - CSIR-IIP & Praj Industries
   - BPCL & Sulzer Chemtech
   - MRPL & IAF

3) Partnerships / Collaborations with International developers are key facilitators for large scale manufacturing facilities.



India SAF Project Developments

Companies	SAF Production Technology	Feedstock	Status
Dornier, Govt. of Odisha and India Partner (IOCL)	Power-to-Liquid (Fischer Tropsch)	CO_2 from Incinerable waste/Industrial CO_2	Proposed 100 Million Litres per Annum of SAF including distillates at Paradip, Odisha. Concept/pre-feasibility stage.
IOCL, LanzaJet and domestic airlines	Alcohol to Jet	Corn-based, cellulosic or sugar-based ethanol	To set up SAF Plant at IOCL Refinery in Panipat and produce 86,800 TPA of SAF by 2026.
IOCL and Praj Industries	Alcohol to Jet	Cane molasses and cane syrup	Producing SAF in Praj Laboratory for demonstration flights. Setting up facilities to produce 400 - 500 TPD (146,000 – 182,500 TPA) of SAF by 2030.
CSIR-IIP	Biomass to Jet	Used Cooking Oil (Palm Stearin, sapium oil, palm fatty acid distillates, algae oil, karanja and jatropha)	Produced 10,000 litres of SAF up till now for demonstration flights.
Mangalore Refinery and Petrochemicals Ltd (MRPL)	Biomass to Jet	Non-edible and Used Cooking Oils	To set up SAF plant by 2025 to produce 5,840 TPA of SAF.
Praj Industries and Axens	Alcohol to Jet	Cellulosic biomass	Signed MOU in February 2023 for SAF Production Projects.
BPCL and Sulzer Chemtech	Biomass to Jet	Used Cooking Oil	Produced in Laboratory (In talks with Sulzer for scaling up production).

Global SAF Project Developments

Companies	SAF Production Technology	Feedstock	Status
Infinium and Engie	Power-to-Liquid (Fischer Tropsch)	CO_2 captured from industry	To set up eFuel plant in Dunkirk, France and commence operations by 2028 to produce 100,000 tons of eFuels and Naphtha per annum.
Mitsui and Galp	Biomass to Jet	Used Cooking Oil	To set up eFuel Plant in Portugal by 2025 to produce 270,000 tons of SAF and bio-diesel per annum.
Fulcrum Bioenergy	Power-to-Liquid (Fischer Tropsch)	MSW	To produce 11 million gallons of SAF per annum at plant in Nevada, USA from 175,000 tones of landfill waste. Produced first batch in December 2022.
HIF Global	Power-to-Liquid (Fischer Tropsch)	CO_2 captured from industry	To set up eFuel Plant in Matagorda, Texas, USA by 2027 to produce 1.4 million tons of eMethanol per annum to be further refined into 700 million liters of e-gasoline.
Honeywell and GranBio Technologies	Ethanol to Jet	Biomass residues like forest and agricultural residues	To set up a demonstration SAF plant in USA by 2026 to produce approximately 2 million gallons of SAF.
SkyNRG	Power-to-Liquid (Fischer Tropsch)	CO_2 from industrial source, bio-based or direct air capture	To set up SAF plant in Amsterdam, Netherlands by 2027 to produce 50,000 tons of SAF per annum.
Neste	Biomass to Jet	Animal waste fat, used cooking oil and residue streams from vegetable oil industry	To produce 1 million tons of SAF from plant in Singapore that started operation in April 2023.

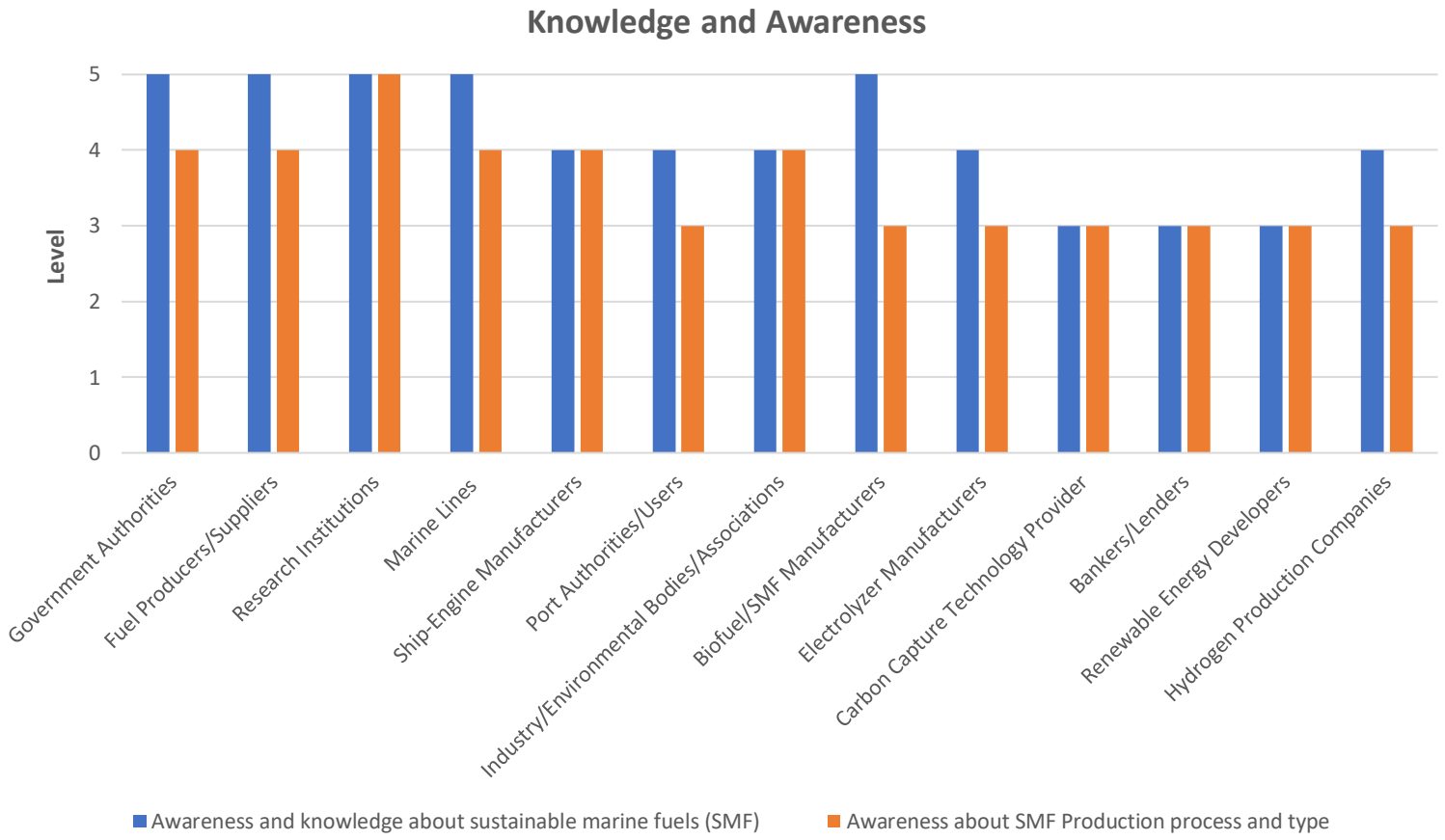
SAF Project Description – India (Typical)

Key Parameters	Description
Capacity	100 MLA SAF/e-fuels (10% market share for Refuelling)
Location	Within 4 Kms of Pradip Port, Odisha
Land	250 Acres, by Industry Department
Power Supply	• Green Power intake is planned through 765/400 KV ISTS, Paradip Substation for development Green Hydrogen, Ammonia & SAF within 11 kms from ISTS • Power requirement 450 MW RTC • Long term PPA ($50-55/MWhr)
Water	Raw Water - 50 m^3/hr, (Arranged by IPICOL through WRD, Odisha)
Waste Supply (900 TPD of CO_2)	2,000 TPD of Organic Industrial waste, and/or Biogenic Industrial CO_2
Green Hydrogen (44 TPD)	Through Electrolyser process (PEM Electrolyser), $3200-$3600/ton
Fuel Certification	ASTM D7566, ASTM D1655
Off-taker	IOCL for Domestic, IOCL/Developer for Export Market
Statutory Clearances	As per OSPCB and MoEFCC norms
Product Mix	SAF, Diesel and Napha (60/10/30)

Knowledge and Awareness of SMF

Summary of findings:

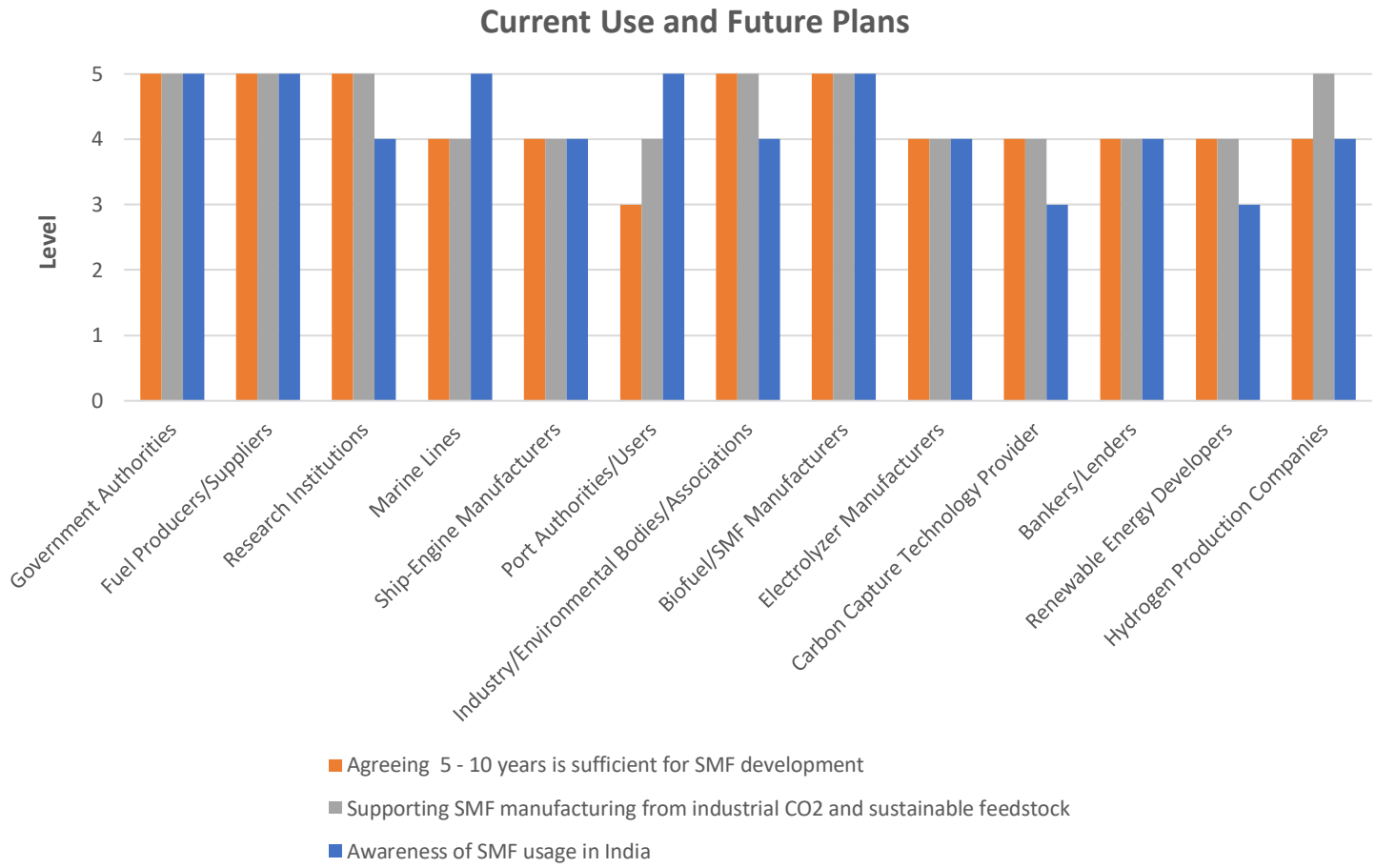
1) The industry and the government is aware, banks and IFIs need to be appraised.
2) Regulatory framework to be aligned with IMO guidelines.
3) Inviting International developers for SMF production.
4) Liquid biofuels explored as alternative fuel in shipping industry to replace conventional marine fuels.
5) Oil Companies are planning to established their SMF Plant and enhance refuelling facility for domestic and export market.
6) Minimum modification in ships for usage of green methanol as present in liquid state. Green methanol is derived from biomass feedstocks or renewable electricity.
7) Ammonia and hydrogen are green fuels requiring minimal engine modifications.



Current Use and Future Plans of SMF

Summary of findings:

1) Industry & Government would like to utilize industrial CO_2 (as sustainable source) as feedstock, and strongly support this.
   - Industrial CO_2 from cement, steel and power
2) Successful trial runs conducted with blended biofuel by;
   - The Great Eastern Shipping Company
   - Cochin Shipyard Limited for Inland Waterways Authority of India
   - The Indian Register of Shipping.
3) India has proposed to the IMO to establish a target of 5% sustainable marine fuel mix by 2030.



Key Drivers, Priorities and Challenges of SMF

Summary of findings:

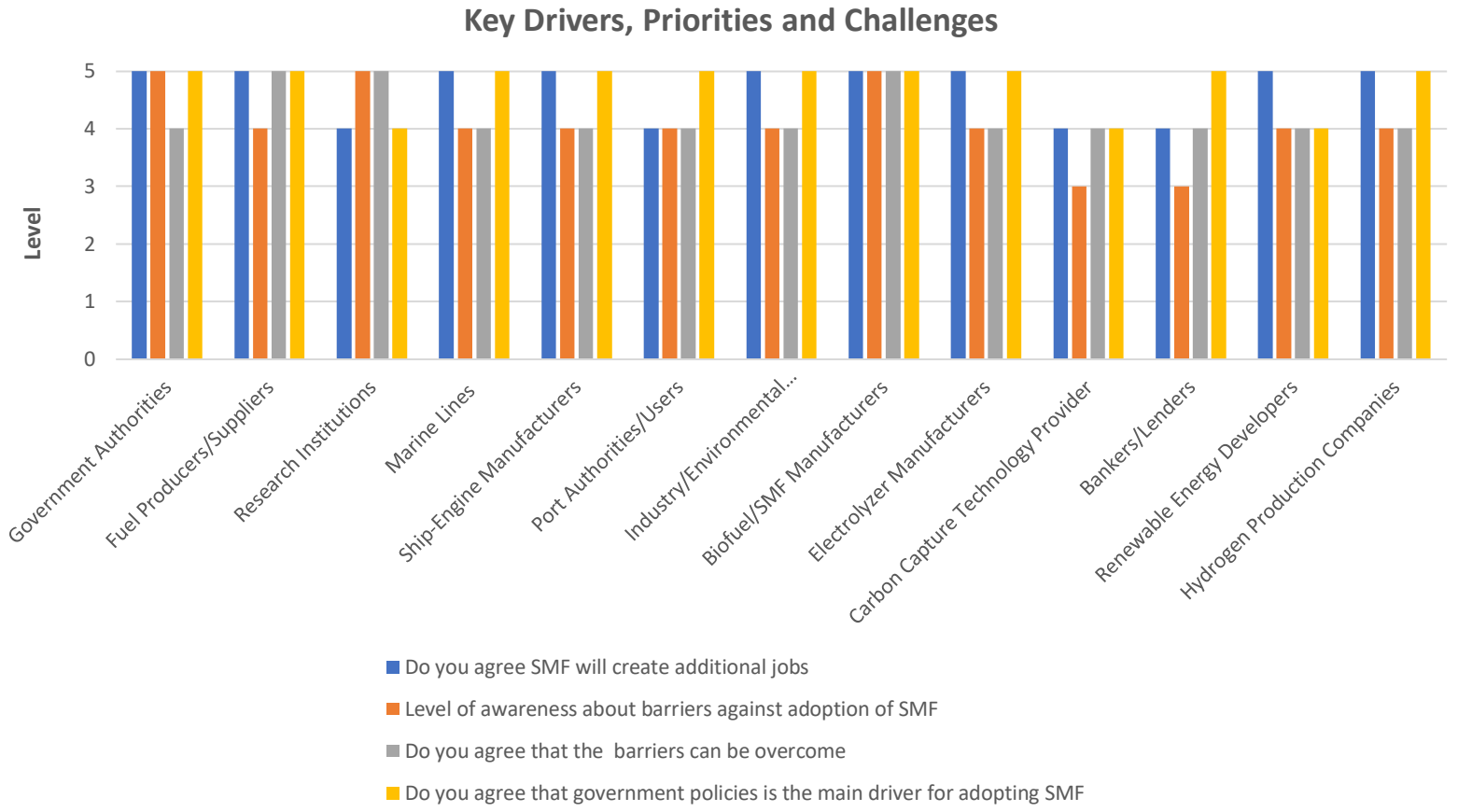
1) Substantial government incentives for cost and support for export market.

2) SMF will create additional jobs for construction and O&M.

3) SMF has significant contribution in decarbonization.

4) GOI through Directorate General of Shipping have issued circular no. 18 of 2022 permitting biofuel and its blend as fuel on board Indian flagged shipping vessels.

5) Establishment of National Centre of Excellence in Green Port and Shipping (NCoEGPS) for regulatory framework development.



Govt. of India – Policy Incentives

As per the National Policy on Biofuels (2022):

- Sourcing of multi-lateral and bi-lateral funding including carbon financing shall be encouraged.
- 100% FDI in biofuel technologies encouraged for domestic use
- Financial incentives including viability gap funding, subsidies and grants
- NABARD and Public Sector Banks soft loan financial assistance
- Grants to Research Organizations, Institutions for undertaking R&D and setting up demonstration projects, specialized centers in high technology areas.

Barriers and Solutions for Adopting SMF

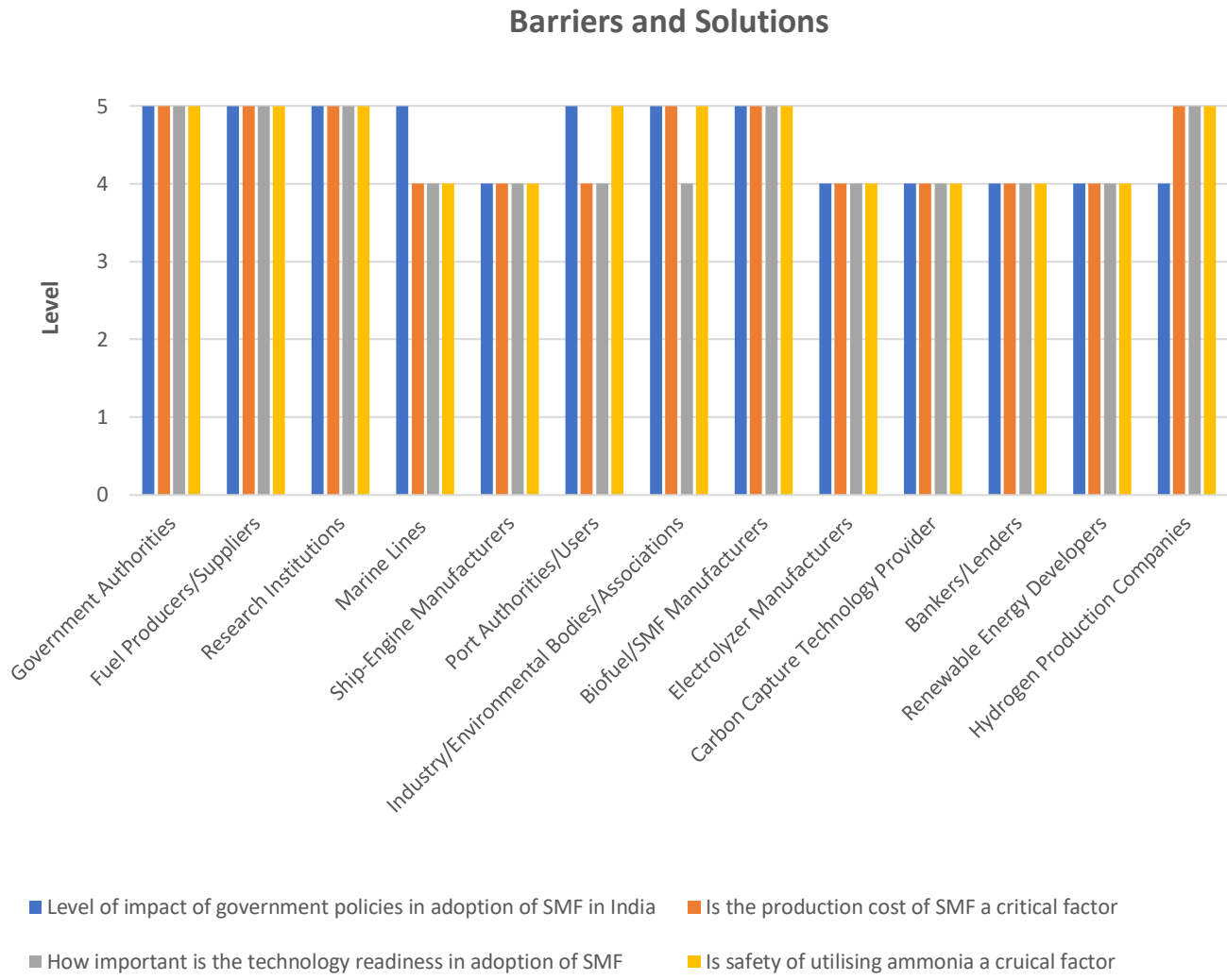
Summary of findings:

Barriers:

1) High production cost and availability.
2) Low-cost sourcing of Green methanol. No clear regulatory policy.
3) Ammonia is toxic to human and aquatic life.
4) Complex technology and high initial cost.

Mitigation:

1) Government incentives.
2) Feedstock availability
3) Technical collaborations
4) Commercialization of green methanol inputs.



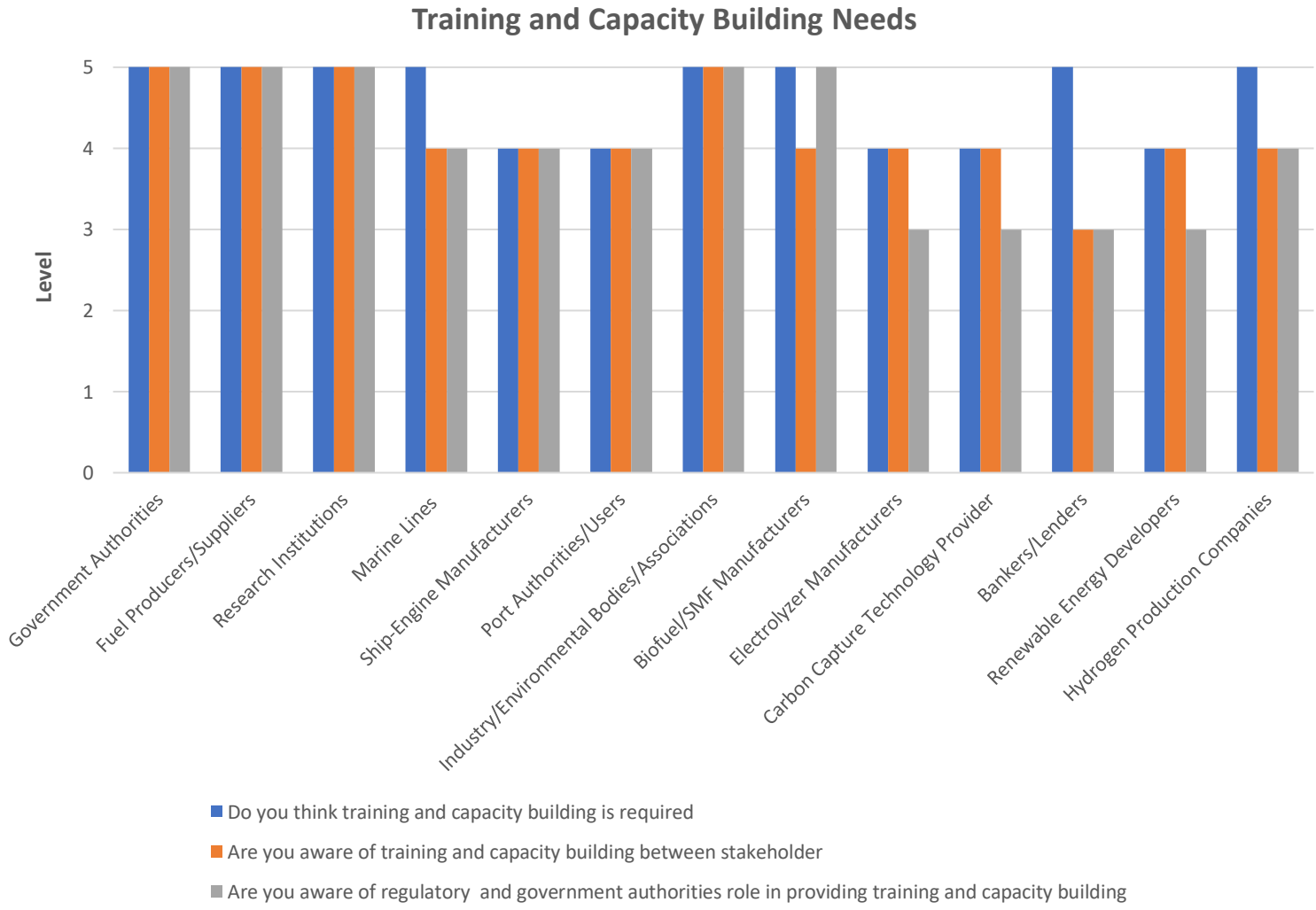
Training and Capacity Building Needs for SMF

Summary of findings:

1) TERI and the EU delegation developed a roadmap for EU-India Collaboration.

2) Training required in;
   - Handling
   - Production technologies
   - Safety

3) Target training audience are;
   - Biofuel Producers & Suppliers
   - Shipping Companies
   - Government and Regulatory Bodies
   - International Shipping Bodies
   - Financial Institutions



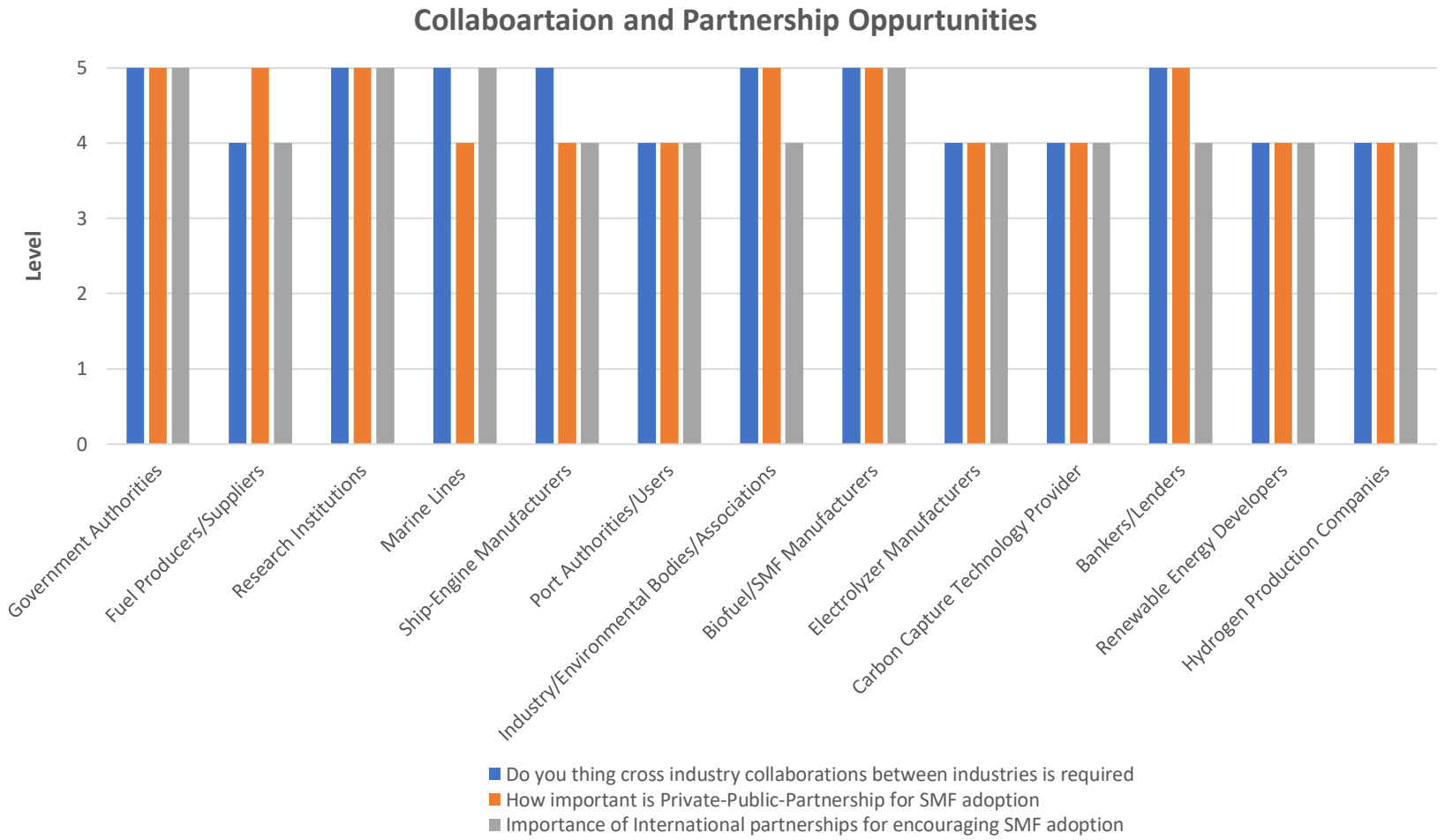
Collaboration and Partnership Opportunities for SMF

Summary of findings:

1) Cross - Industry collaborations has been encouraged between various stakeholders in different industries.

2) Need public-private partnerships to be formed for;
   - Promoting SMF adoption
   - Encouraging knowledge sharing
   - Technology transfer
   - Drafting Favorable policy

3) India is a member of “Global Biofuel Alliance”.



India SMF Project Developments

Companies	SMF Production Technology	Feedstock	Status
Umwelt Energy	Power-to-Liquid (Green Methanol)	Green Hydrogen and CO_2 captured from industry	To set up Green Methanol plant in Tamil Naidu, India to produce 100,000 tons of green methanol per annum. Currently land acquired for the plant. Certain amount of green methanol to be used as SMF.

Global SMF Project Developments

Companies	SMF Production Technology	Feedstock	Status
European Energy and Clariant Catalysts	CO_2 to Liquid (e-Methanol)	CO_2 captured from industry	To set up e-Methanol plant in Kasso, Denmark and commence operations by end of 2023 to produce 32,000 tons of e-Methanol per annum. Supply large portion of e-Methanol to Shipping Company (Maersk) as SMF.
SunGas Renewables	Biomass to Liquid (e-Methanol)	Biomass residues like forest and CO_2 captured from industry	To set up e-Methanol Plant in USA by 2027 to produce 400,000 tons of e-Methanol per annum. Certain portion to be used as SMF.
Cepsa	Power-to-Liquid (Green Ammonia)	Green Hydrogen	To set up green ammonia plant in Spain by 2027 to produce 750,000 tons of Green Ammonia per annum Certain portion to be used as SMF.
Monjasa and HØST PtX Esbjerg	Power-to-Liquid (Green Ammonia)	Green Hydrogen	To set up a green ammonia plant in Esbjerg, Denmark by 2028/29 to produce approximately 600,000 tons of green ammonia. Certain portion to be used as SMF.
OCI Global	Biomass to Liquid (e-Methanol)	Green Hydrogen and Renewable Feedstocks	Doubling e-Methanol plant capacity to 400,000 tons in Texas, USA. Construction to start in 2025. Using certain portion of eMethanol as SMF for shipping industry.

Agenda

1. Project Introduction
2. Key Findings
3. **Recommendations**
4. Way Forward

Recommendations

- Government support for Funding research on SAF/SMF projects
- Government grant, concession for SAF/SMF projects
- Recognition of SAF/SMF under carbon credits
- Government mandate for minimum usage of SAF/SMF as increasing trajectory
- Adoption of Sustainability standard and lifecycle GHG emissions method for certification of feedstock supply and fuel production
- Promoting SAF/SMF Production from non-agricultural feedstock
- FDI rule relaxation for SAF/SMF
- Encourage formation and functioning of Stakeholder Consultation Groups
- Sharing of Marketing Infrastructure
- Off-take agreements for domestic and international market, target price and incentives.
- Certification for the sustainability of feedstock and fuel

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Way Forward

1. **Technology availability for Plant**
   - Source of CO_2 – existing industrial source
   - Fuel Synthesis – based on non-agricultural feedstock
   - Blending and Certification – export ready (ASTM)
   - Re-fueling Hubs – international airports/seaports
2. **Project structures for IFI participation**
   - Project SPV – Indian partner, Developer, Financial Advisor
3. **Enabling framework**
   - Encourage FDI
   - Concessions / regulatory framework to achieve target price
4. **Others** – Feedstock Analysis

Contact Details

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