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POLICY BRIEF

CHEAP SOLAR AND CROP RESIDUE COULD MAKE INDIA A SUSTAINABLE AVIATION FUEL LEADER

JUNE 2026

Global demand for sustainable aviation fuel (SAF) is rising as the European Union (EU), United Kingdom, and other jurisdictions set mandates requiring airlines to blend increasing shares of SAF with conventional jet fuel and as major airlines voluntarily commit to SAF purchases. Supply has not kept pace: most regions lack the low-cost feedstocks and renewable electricity needed to produce SAF at scale, with market prices doubling that of fossil jet fuel. India is among the few countries positioned to close this gap, owing to two structural advantages: its low-cost solar power and its emerging capability to collect and utilize large volumes of agricultural residue.[1]

First, India's plummeting solar and battery-storage costs have enabled it to produce green hydrogen at among the lowest prices globally. Second, India generates large volumes of agricultural residue—much of it currently burned in open fields between crop cycles—and is developing supply chains and marketplaces (e.g., BiofuelCircle) to collect, densify, store, and deliver it. Open-field residue burning is associated with an estimated 44,000 to 98,000 premature deaths annually and contributes to India having 17 of the 30 cities with the world's worst air pollution, including New Delhi as the most polluted capital city.

Combining low-cost green hydrogen with surplus agricultural residue enables the competitive production of power-and-biomass-to-liquids (PBtL) SAF, a drop-in substitute for fossil jet fuel with near-zero lifecycle greenhouse gas emissions that also reduces air pollution by diverting residue from open-field burning. This pathway can reduce dependence on crude oil imports that currently make up 90% of India's supply, create value from residue that is currently burned, and support India's climate target of reaching net-zero greenhouse gas emissions economy-wide by 2070.

PBtL SAF can provide a domestically-produced hedge against unpredictable, uncontrollable fossil fuel price spikes and supply shortages of imported crude oil-derived jet fuel. New analysis from the UC Berkeley's India Energy & Climate Center and Energy Innovation finds that a 2030 PBtL project could produce SAF at costs that are 40% lower than recent fossil jet fuel prices. Even if crude oil prices revert to pre-Strait of Hormuz closure levels, our baseline forecast still finds PBtL SAF costs are competitive against global SAF benchmarks and also could reach parity with imported fossil jet fuel prices in the 2030s.

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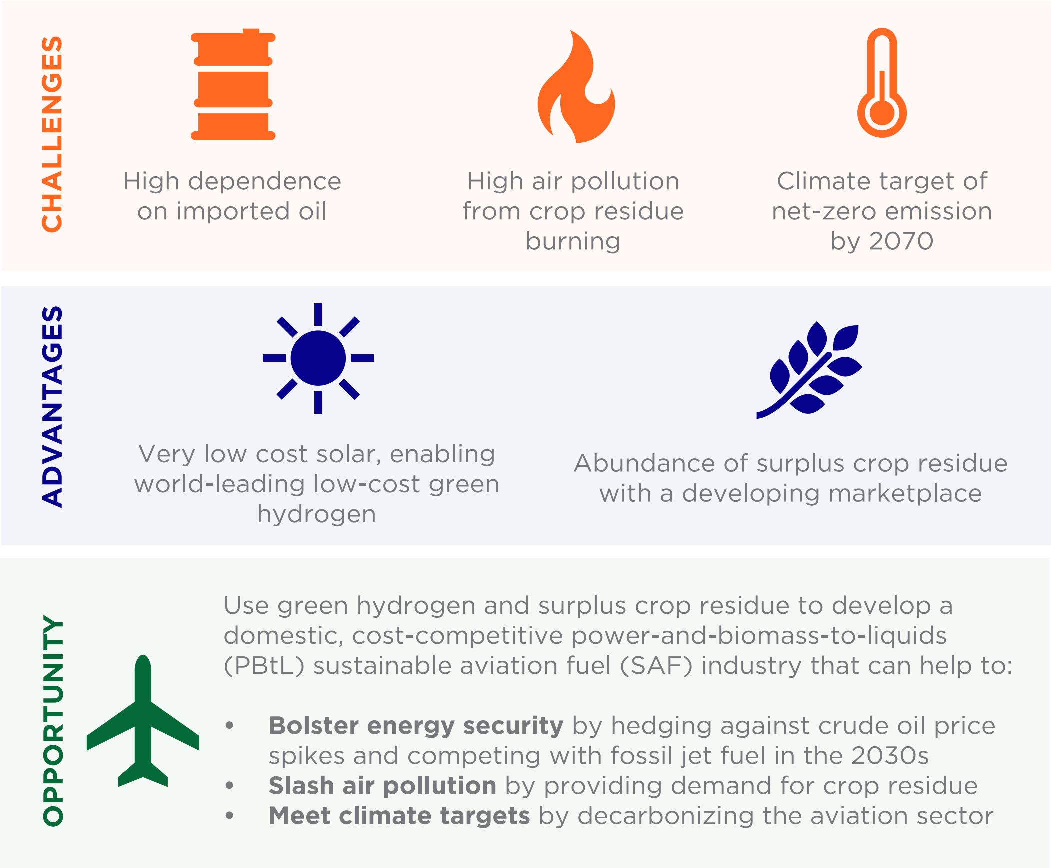
[1] This policy brief summarizes findings from Energy Innovation and the India Energy and Climate Center's "India's Aviation Opportunity: Turning Agricultural Residue and Low-Cost Solar into Competitive Sustainable Aviation Fuel with Power-and-Biomass-to-Liquids" paper published in June 2026. For more details, see: [https://iecc.gspp.berkeley.edu/resources/reports/indias-aviation-advantage-the-case-for-biomass-green-h2-sustainable-aviation-fuel/]

India can mitigate ***three challenges*** by leveraging ***two advantages*** to capitalize on a transformative ***opportunity***



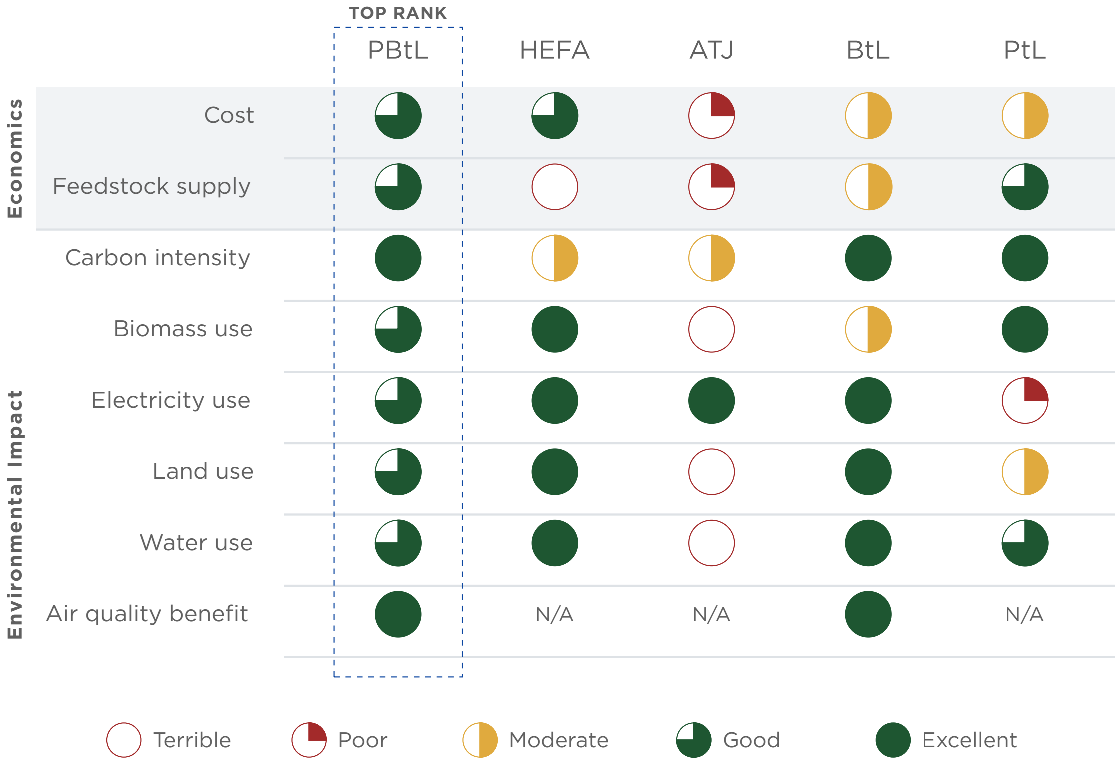
Use green hydrogen and surplus crop residue to develop a domestic, cost-competitive power-and-biomass-to-liquids (PBtL) sustainable aviation fuel (SAF) industry that can help to:

- **Bolster energy security** by hedging against crude oil price spikes and competing with fossil jet fuel in the 2030s
- **Slash air pollution** by providing demand for crop residue
- **Meet climate targets** by decarbonizing the aviation sector

FIGURE 1: India's sustainable aviation fuel opportunity.

The nascent sustainable aviation fuel market has been dominated by hydroprocessed esters and fatty acids (HEFA), which relies on waste fats, oils, and greases that are in short supply. The aviation industry has thus looked toward other technologies that can use feedstocks that do not face the same supply limitations, such as ethanol, agricultural residue, hydrogen, and carbon dioxide (CO_2). However, these technologies face barriers to scale that have stunted their growth and frustrated governments and airlines: Alcohol-to-jet (ATJ) relies on land- and water-intensive ethanol that faces high prices from mandates to blend it with gasoline and raises concerns about the impact on food prices; biomass-to-liquids (BtL) suffers from high capital costs from wasting substantial shares of the carbon embodied in the agricultural residue that it gasifies for conversion into SAF; and power-to-liquids (PtL) needs huge volumes of green hydrogen and captured CO_2 (e.g., from an industrial facility or the air), with the latter lacking enabling infrastructure.

Power-and-biomass-to-liquids (PBtL) combines the strengths of the BtL and PtL pathways: it uses agricultural residue as a sustainable, lower-cost carbon source (the BtL strength) and green hydrogen to produce much more SAF from the same amount of carbon (the PtL strength). PBtL has been under-discussed globally because most countries do not have ready access to crop residue or cheap green hydrogen, let alone both. However, our analysis shows that Indian PBtL projects can produce SAF at lower costs and carbon intensities than competitor technologies thanks to India's uniquely advantageous conditions: its emerging agricultural residue supply chains and low green hydrogen prices. Specifically, PBtL becomes the most cost-effective SAF in India once green hydrogen prices fall below $3.4 per kilogram—prices which may have already been achieved by recent Indian auctions and which our analysis shows can be met through off-grid solar-and-battery projects by 2030. PBtL also has the best balance of biomass, electricity, land, and water usage—not overleveraging any one resource—which positions it to scale and eventually serve most if not all of India's jet fuel demand through 2050.



		TOP RANK PBtL	HEFA	ATJ	BtL	PtL
Economics	Cost	◕	◕	◔	◑	◑
	Feedstock supply	◕	○	◔	◑	◕
Environmental Impact	Carbon intensity	●	◑	◑	●	●
	Biomass use	◕	●	○	◑	●
	Electricity use	◕	●	●	●	◔
	Land use	◕	●	○	●	◑
	Water use	◕	●	○	●	◕
	Air quality benefit	●	N/A	N/A	●	N/A

○ Terrible ◔ Poor ◑ Moderate ◕ Good ● Excellent

FIGURE 2: Summary of power-and-biomass-to-liquids' (PBtL) advantage over competing sustainable aviation fuel production pathways, including hydroprocessed esters and fatty acids (HEFA), alcohol-to-jet (ATJ), biomass-to-liquids (BtL), and power-to-liquids (PtL).

PBtL's cost, feedstock availability, and carbon intensity advantages over other SAF technologies suggest Indian developers can sell the resultant SAF into regulated markets to help the industry's early-stage commercialization. Our analysis further suggests PBtL SAF may be able to compete directly with Indian fossil jet fuel in the 2030s. Factors that would advance PBtL SAF's competitiveness include: higher crude oil prices than our baseline forecast (which may be more likely as part of the long-term fallout from the Straight of Hormuz's ongoing months-long closure); higher taxes for fossil jet fuel relative to what would be assessed for domestic SAF; or policies that penalize fossil jet fuel for its climate pollution (estimated at $86 per ton CO_2) or subsidize PBtL SAF for its use of agricultural residue that would otherwise be burned in open fields (with an estimated avoided premature death benefit from local air pollution of $230 per ton biomass).

Domestic PBtL SAF projects also benefit from long-term, rupee-denominated jet fuel contracts that provide price stability over the life of the project. By contrast, fossil jet fuel is subject to crude oil price inflation and rupee depreciation against the United States dollar (given crude oil is purchased in U.S. dollars). These monetary impacts mean PBtL SAF may only cost 18% more than fossil jet fuel in 2030 when levelized over the 25-year lifetime of a project, with this gap closing entirely for projects commissioned in 2036 under our base case assumptions.

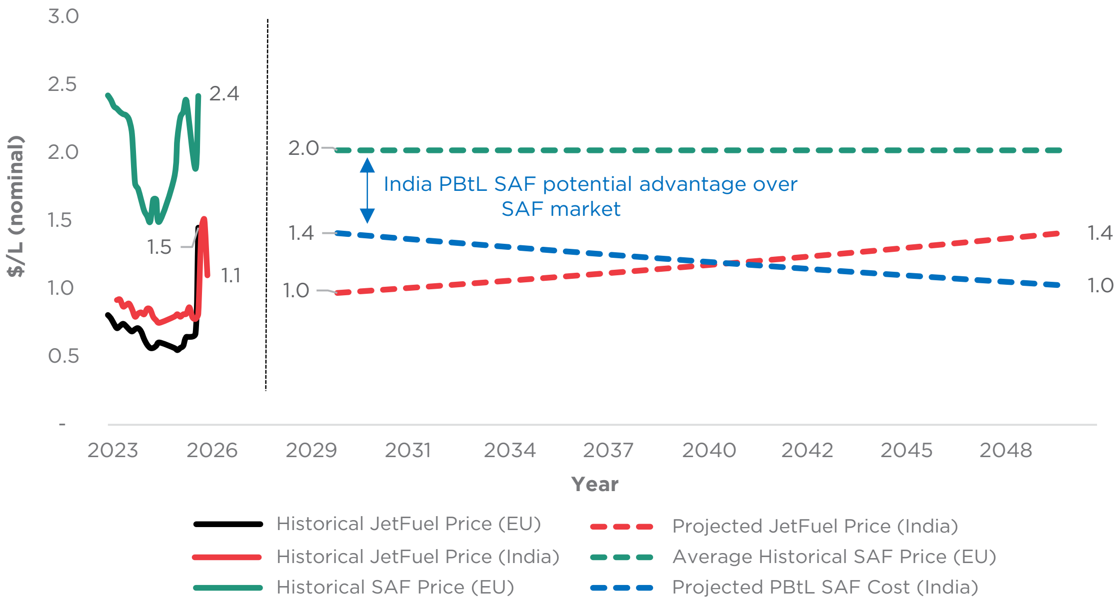


FIGURE 3: Comparison of projected Indian power-and-biomass-to-liquids (PBtL) sustainable aviation fuel (SAF) production costs for a project commissioned in 2030 vs. historical Indian and European Union (EU) jet fuel market prices, historical and average EU SAF market prices, and projected imported Indian fossil jet fuel prices.

Because PBtL's economics depend on green hydrogen prices and agricultural residue availability, project costs and production opportunities will vary by location. Our spatial analysis finds that the areas surrounding the Delhi, Pune, and Mumbai airports may be most favorable to support first-of-a-kind PBtL SAF projects. Specifically, Maharashtra, Haryana, Rajasthan, and Uttar Pradesh may be best suited for demonstration projects and early industry development. As the industry grows, it should prioritize low-cost PBtL SAF production, then screen for residue sufficiency (i.e., ensuring sufficient supply to support a large facility) and the logistics of fuel transport to airports.

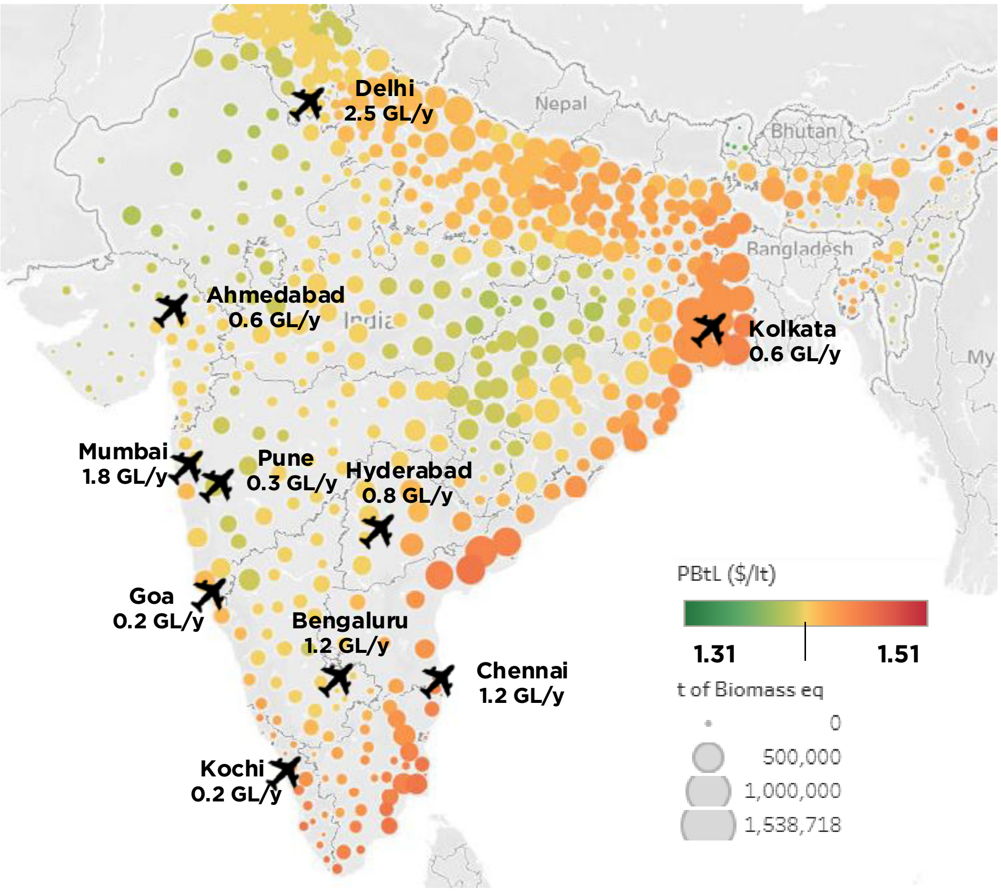


FIGURE 4: Levelized cost of PBtL-derived SAF mapped against India's busiest airports (2030).

Despite PBtL's advantages over other SAF technologies and favorable price trajectory relative to fossil jet fuel, its success is not inevitable. It needs government support to help bring all the pieces together, de-risk first-of-a-kind demonstration projects, and connect it to regulatory markets at home and abroad. Indian policymakers can support PBtL's demonstration and growth to realize this vision in myriad ways:

1. Launch first-of-a-kind PBtL demonstration projects in the regions surrounding the Delhi, Pune, and Mumbai airports with concessional finance, viability-gap support on hydrogen, streamlined siting and environmental approval, and airport pipeline integration. Support the coordination of developers given the various components that must come together (e.g., solar, batteries, electrolyzers, biomass suppliers, gasifiers, Fischer-Tropsch providers). Mobilize public sector undertaking oil companies (e.g., IOCL, BPCL, HPCL, ONGC) as anchor developers for early PBtL projects by including PBtL in their medium-term capital expenditure plans through ministerial direction, similar to how they have been directed to lead recent green hydrogen auctions. Provide technical and regulatory support to potential developers or suppliers who may have little or no experience working in India.

2. Use trade policy to monetize early volumes: align sustainability criteria with European Union and United Kingdom mandates that exclude SAF derived from food and feed crops, consider negotiating recognition of India's residue-based PBtL under synthetic aviation fuel (e-SAF) carve-outs given its extensive reliance on green hydrogen, and enable bonded logistics for export via key hubs.

3. Establish an incentive program targeted at scaling PBtL deployment beyond the first-mover demonstration projects, such as taxing or penalizing fossil jet fuel for its climate pollution (e.g., at India's estimated social cost of carbon of $86 per ton CO_2) and providing incentives tied to the use of crop residue that would otherwise be burned (e.g., at an estimated benefit of $230 per ton biomass from avoiding premature deaths from air pollution). This may more realistically take the form of expanding India's Carbon Credit Trading Scheme to include aviation and providing more direct subsidies for PBtL projects that meet certain thresholds (e.g., verifiable use of green hydrogen and surplus agricultural residue). Any incentive program should be reviewed periodically against key indicators, such as whether crop fires are declining relative to a baseline trajectory or whether there are signs that farmers are expanding crop cultivation due to the value that agricultural residue now provides. As a failsafe, provide a cap on agricultural residue use economy-wide that is based on current uses (i.e., that which provides the current definition of "surplus" residue) and does not exceed current or forecast levels of surplus residue.

4. Expand India's SAF blending targets (limited to international runs) to include domestic runs. Increase the blending target beyond 5% in 2030 to provide longer-term business certainty. Provide a floor or carve-out in the blending mandate for PBtL SAF using green hydrogen and agricultural residue. Complement this support with airport-level tenders mimicking Solar Energy Corporation of India (SECI) green ammonia auctions under the Strategic Interventions for Green Hydrogen Transition (SIGHT) scheme.

If Indian policymakers can successfully demonstrate and scale this industry, they can advance toward self-reliance and climate goals, improve air quality and rural economies, and position India as a global leader on the aviation decarbonization challenge.