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Brazil efforts to implement alternative aviation fuels

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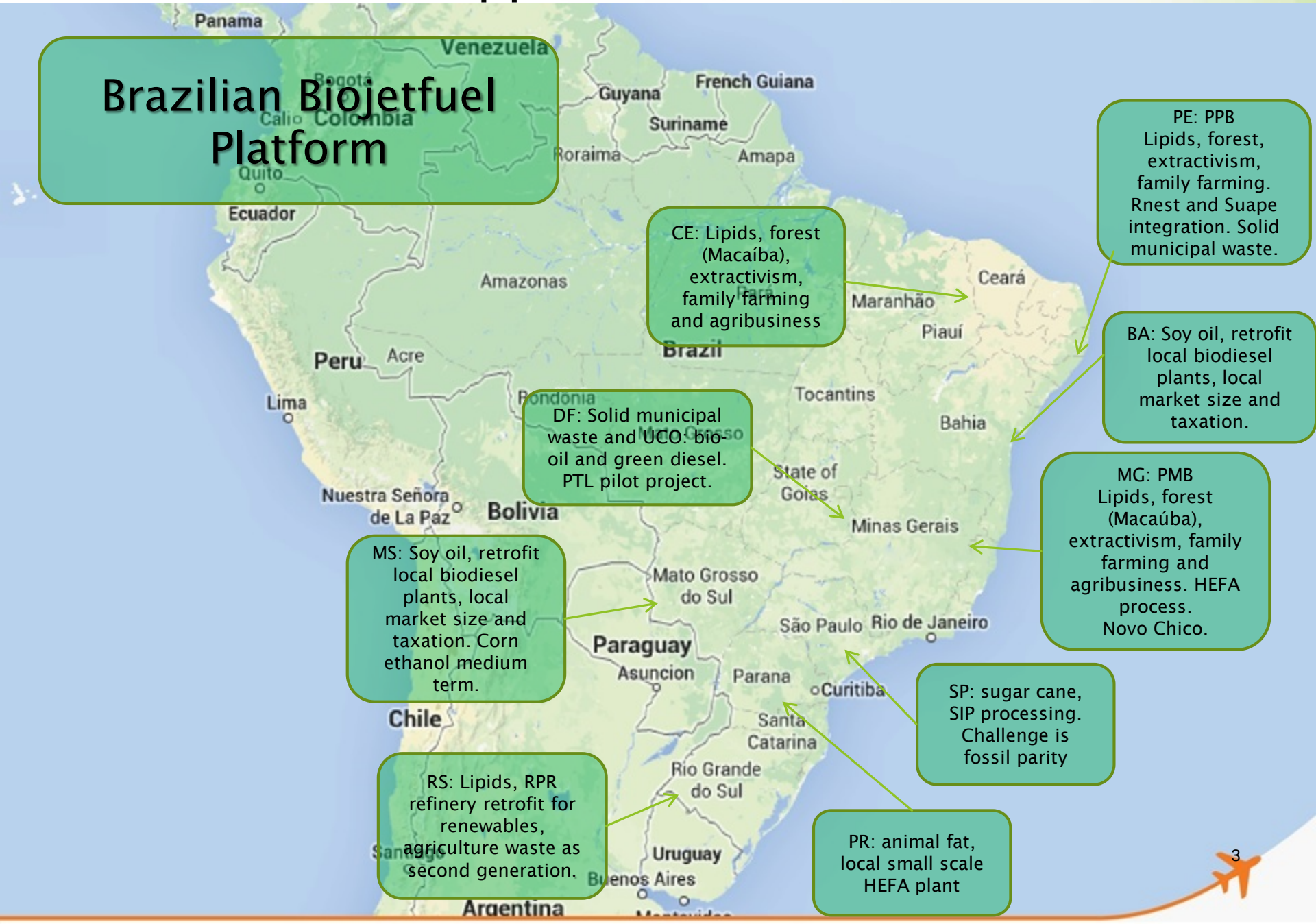
Brazil actual context

1. Brazil has a strong tradition in Biofuels, such as ethanol national program (1975) and biodiesel national program (2002).
2. The first flight in Brazil using biokerosene was on October 23, 1984. An Embraer Bandeirante (EMB-110) turboprop from São José dos Campos (CTA) to Brasília.
3. Since 2011 more than 360 SAF flights in Brazil, but no continuous operations. Demo flights and campaigns.
4. Research and Development capability, efficient biomass production, pilot and industrial scale plants, enough market scale for jetfuel (6 bi ton/y).
5. No commercial production. Why?

Brazil biomass opportunities



Local facilities and projects

Actual:

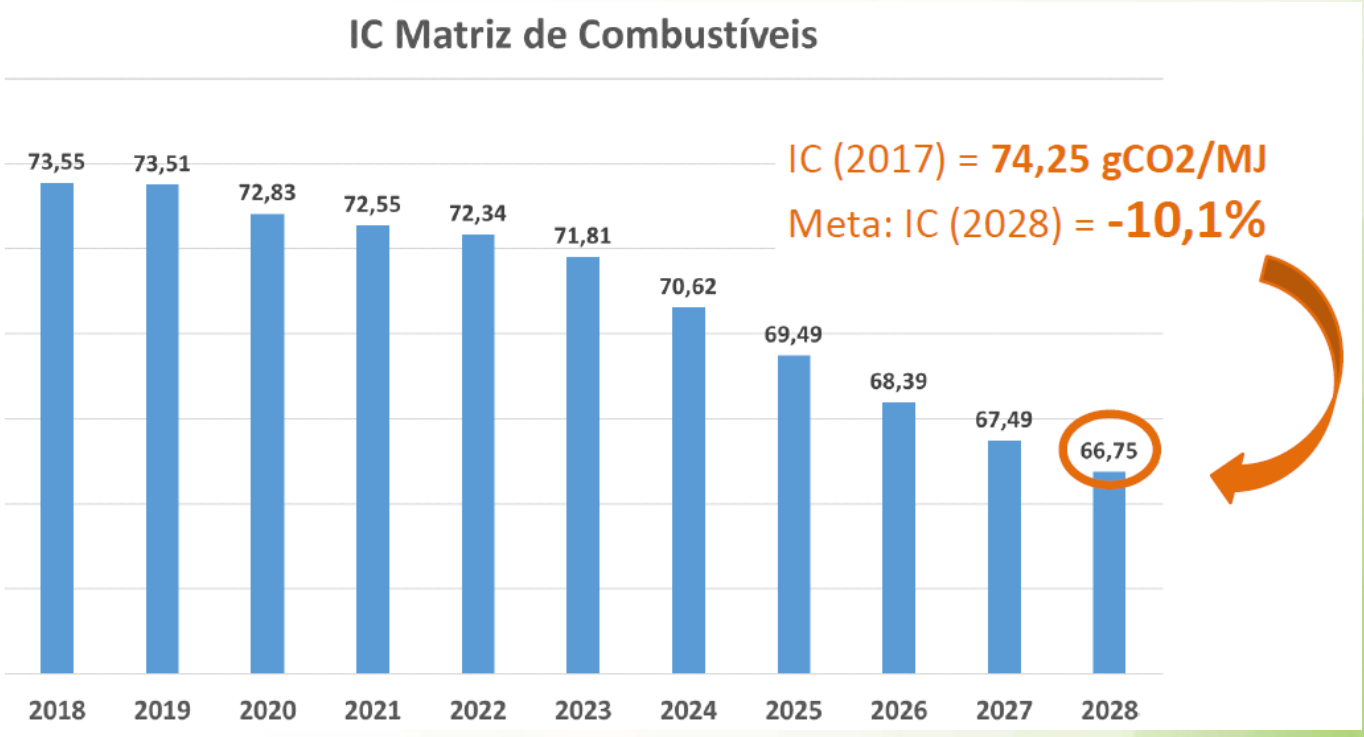
1. SIP Plant (commercial scale) in São Paulo, ready to deliver (from sugar cane)
2. HEFA Plant (small scale) in Paraná, ready to deliver (animal fat and UCO)

Projects on going:

1. HEFA (commercial scale) project in Minas Gerais, using TCR (Susteen) and HDO/HC (Green Fuels) technology, using Macaúba palm oil and forest residues (RenewCo);
2. HEFA (commercial scale) project in Bahia, soy bean oil and local biomass;
3. PTL (power to liquid - pilot scale) in Brasília, a Brazil-Germany project , to demonstrate technical viability;

RenovaBio – New national policy for biofuels

1. December 2017, the Brazilian Government instituted the National Biofuels Policy, named RenovaBio.
2. The first step of the policy was to define the target of reducing CI of the fuel matrix, In June 5, 2018, the Brazilian authorities set a reduction target of 10.1%, to be achieved in 10 years, equivalent to a reduction of emissions of 591 million tones of fossil CO2.



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RenovaBio – New national policy for biofuels

1. In order to achieve these goals, fuel distributors will need to acquire bonds equivalent to carbon credits, called CBIOs, on the Stock Exchange Market (Brazilian B3).
2. Each CBIO corresponds to one tonne of CO2 that is no longer emitted, and it is generated from the production of biofuel.
3. To perform the calculations of CO2 equivalent emissions, the program has developed an environmental calculator base on Life Cycle Assessment (LCA), named RenovaCalc, from which each producer will be able to define the Carbon Intensity of their biofuel.
4. The major innovation of RenovaBio, compared to equivalent programs in other countries, was to consider in the system various biofuels, allowing the producers "mine" CBIOs. The CIs of these biofuels are obtained from the comparison with the CI of the reference fossil fuel (eg. Fossil jetfuel versus SAF).

Final Notes

1. Renovabio will start commercialize CBIOs in Jan 2020.
2. As a market driven policy, there a lack of understanding on its behavior and real results.
3. Projects an increase share of biofuels on the fuel matrix from 20% (2018) to 28,6% in 2028.
4. Actual modeling points a market share for SAFs of 3,40% in 2028, and a maximum impact of 1,6% on the jet fuel price. Also an average CBIO cost of USD 10 per tonne of CO2 equivalent.
5. To offset CORSIA emissions in 2028, Brazilian airlines will need approximately 430,000 m3 of SAF, pointing a market share for SAFs of 4,54% (70% LCA reduction).
6. To offset domestics flight emissions in 2028, Brazilian airlines will need approximately 1,873,000 m3 of SAF, pointing a market share for SAFs of 18,75% (70% LCA reduction).

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Questions

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Thank you
for your attention