Greenhouse gas savings and economic feasibility of ethanol pipelines in Brazil: A case study

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> *What is the private value of ethanol pipelines in the Brazil context?*

and,

> *What are the potential greenhouse gas savings that can be attributed to ethanol pipelines in Brazil?*

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- Our reference case calculates private net present value of US$288 million and cumulative GHG savings of 17.5 million Mg CO_2-e over 30 years.

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- Trucking is relatively GHG intensive compared to other modes, and higher marginal cost.
- Is the upfront investment in other modes worth it?

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- $\sim$800km to go.

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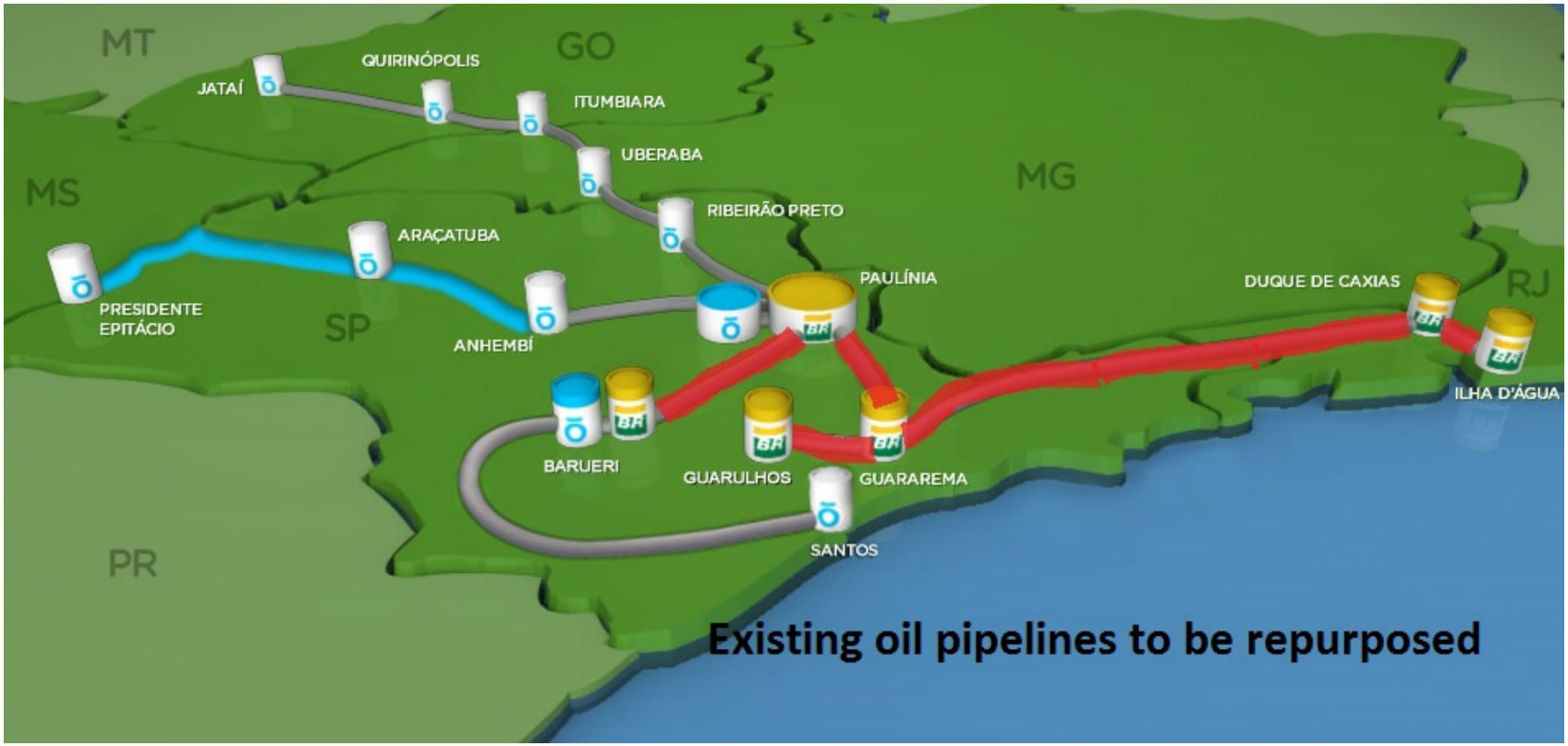

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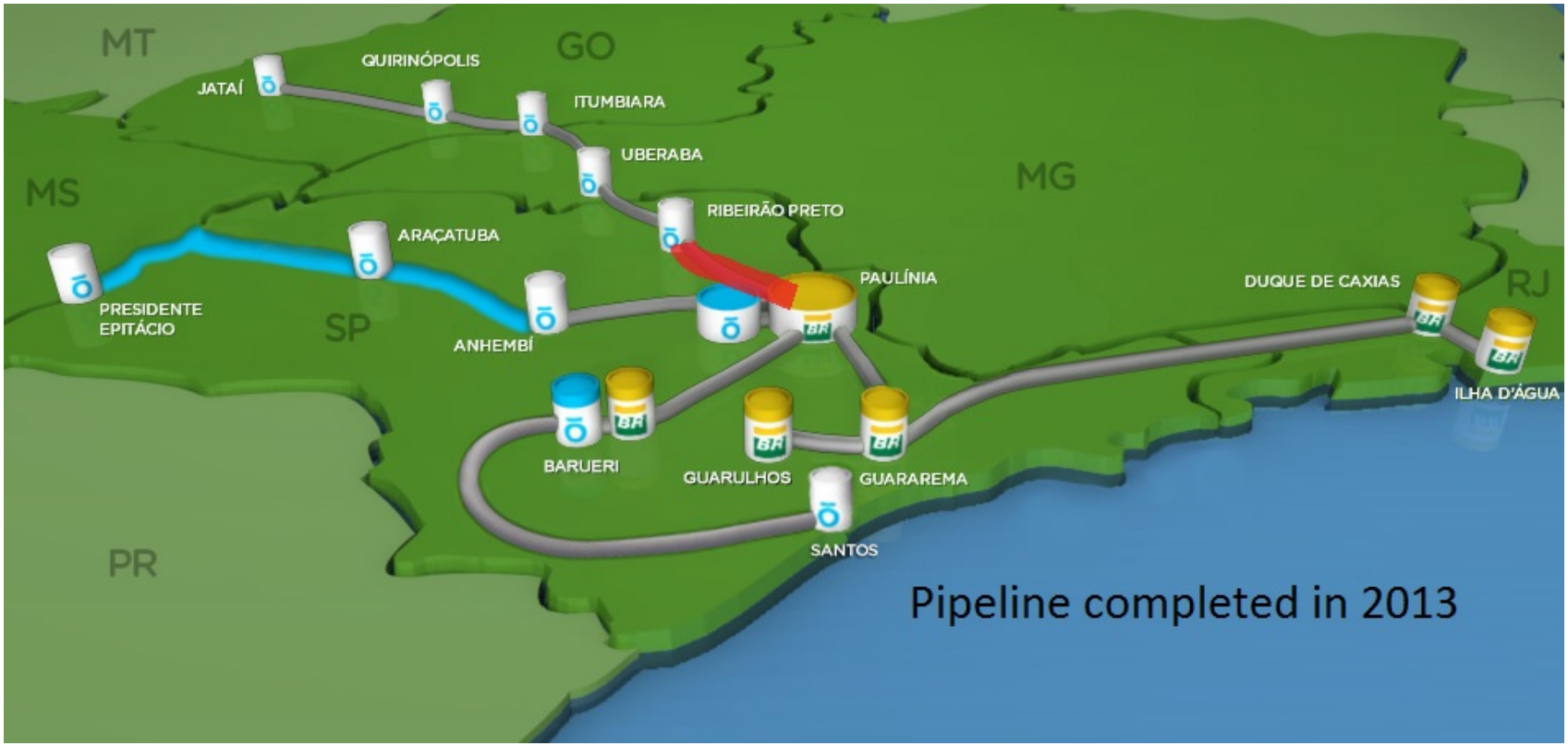

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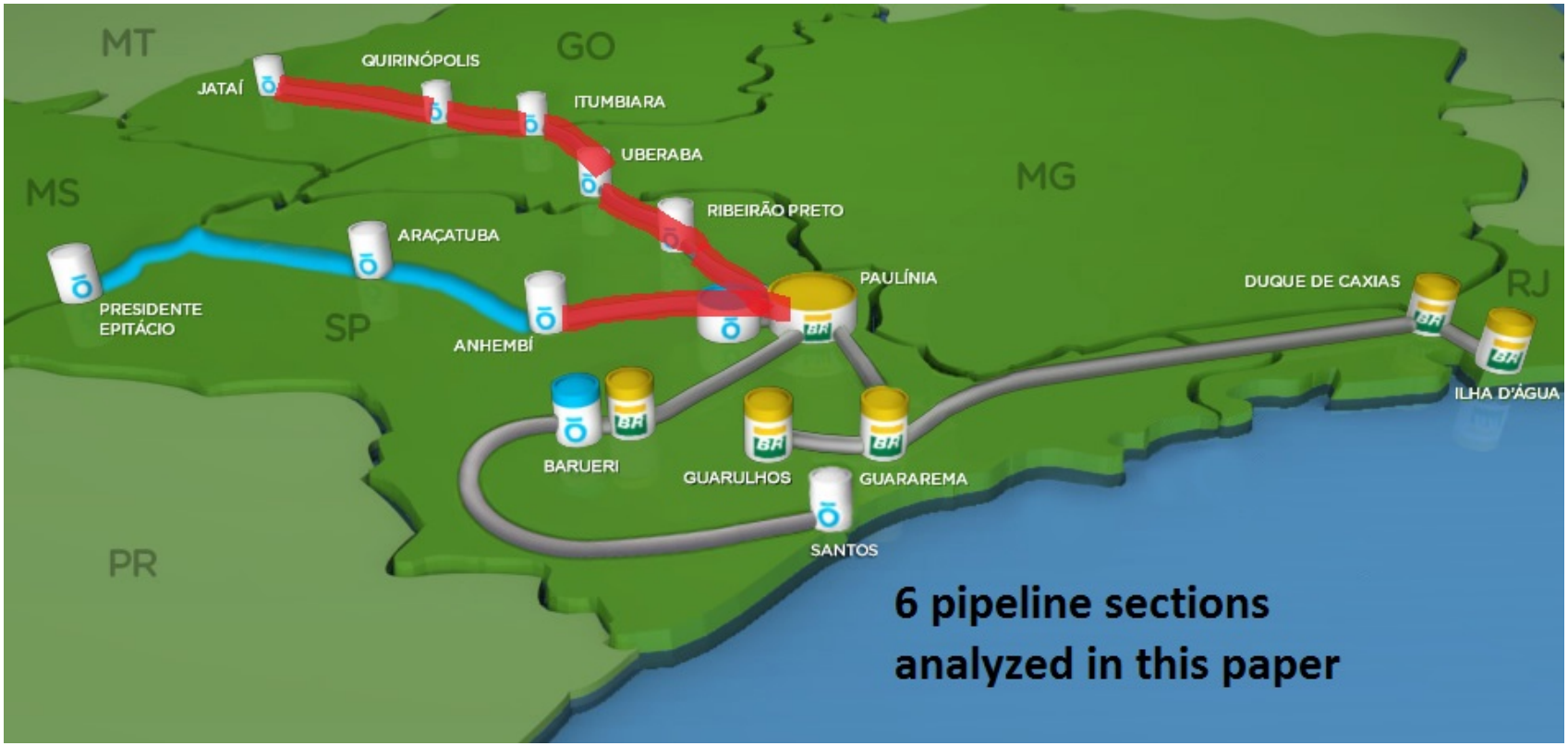

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- Basic model from this paper is extended and parameterized for the Brazil case.

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- High private benefits could indicate subsidies are unnecessary.
- High greenhouse gas savings could indicate that subsidies are justified, when the GHG price is less than optimal.
- Further pipeline projects could encourage further sugarcane ethanol expansion in Brazil.

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- Calculates estimated GHG savings due to the displacement of trucking freight, net of construction, maintenance, and operation emissions.

Key assumptions

Parameter	Value	Source
Ratio of hydrous to total ethanol (%)	60	Approximate national split.
Real cost of capital (%)	6.1*	wikiwealth.com tradingeconomics.com
Lifespan of the project (years)	30*	Assumed.
Maintenance costs as a proportion of initial construction costs (%)	3*	Assumed in Strogen et al.
Construction period (year)	2	Assumed in Strogen et al.
Soil temperature (K)	293.15	NOAA

* indicates a parameter to which the model is sensitive within reasonable values.

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Utilization rate (%)	90	Assumed in Strogen et al.
GHG intensity of electricity (g CO2-e/kWh)	591.6	Reported 2013 (Jan-Nov) CDM build margin emissions factor
GHG intensity of trucking (g CO2/Mg-km)	138	From Strogen et al.
Ratio of trucking distance saved to pipeline distance.	1	Assumed.

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- The pipeline cost model (Rui et al, 2011) out there performs poorly for large pipelines.
- Reported to be estimated at R$7 billion for an original 1300km configuration which the current system is a subset of.
- The R$7 billion is split amongst the original pipelines assuming cost is proportional to length $\times$ diameter^2.

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- Diameter is interpolated for smallest two pipelines assuming flow speed is the average of the others.
- Remaining diameters, lengths, flow capacities, tariffs, obtained from Logum or the Brazil Energy Plan.
- Electricity prices are the average industrial prices by state for 2013.
- Freight tariffs are approximately a 20% discount under trucking rates.

GHG savings assumptions are reasonable

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- Future road wear savings not modeled.

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- Freight cost decrease per liter is US 0.145-0.910c ($\sim$0.4-2.3% of production cost).

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- Further tariff decreases are likely in the coming years.
- It appears that substantial gains are possible by increasing flow rates.
- Because operation costs are convex in flow rates for given diameters, under flow rate uncertainty it is optimal to oversize the pipelines.

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- Valuing using the US Federal Interagency Working Group social cost of carbon values at a 3.0% social discount rate ($32/Mg in 2010 to $61/Mg in 2030) yields present GHG value of US$900 million.

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- More precise estimation of the truck miles saved. Since roads aren't as straight as pipelines, truck miles saved are likely underestimated.

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- Subsidies intended to allow marginal cost pricing appears justified.

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- USA context is different as rail is more widely available.

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  - Under expected increases in sugarcane yields?
  - Under an optimal greenhouse gas price?
- Planned transportation network will support $\sim$20 billion liters of ethanol per year. This looks set to increase with greater yields and expansion into pasture lands.