

EVALUATION OF SMALL LNG AND CNG SUPPLY OPTIONS FOR TRANSPORTATION AND OFF-GRID LOCATIONS IN BRAZIL (PROJECT 26)

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Project Description

- Alternatives of expanding the natural gas infrastructure beyond the pipeline network
- Focus on LNG transported by lorries, ships and trains
- Modelling tool in excel to allow cost estimation

Recent Achievements

Two papers approved for submission at Rio Oil and Gas and LNG summit 2019

- ✓ MONETIZING STRANDED GAS WITH SMALL-SCALE LNG: A CASE STUDY TO INCREASE THE REVENUE STREAM OF A BRAZILIAN OILFIELD
- ✓ THE EXPANSION OF THE USE OF NATURAL GAS IN THE ENERGY MIX OF SÃO PAULO VIA SMALL-SCALE LIQUEFIED NATURAL GAS

Assessment of substitution by NG via SSLNG

- ✓ Power plants fuelled by diesel
- ✓ Interaction with Project 25 (Blue corridor)
- ✓ Railways



CASE STUDY: EXPANDING THE USE OF NG IN THE ENERGY MIX OF SÃO PAULO STATE VIA SSLNG



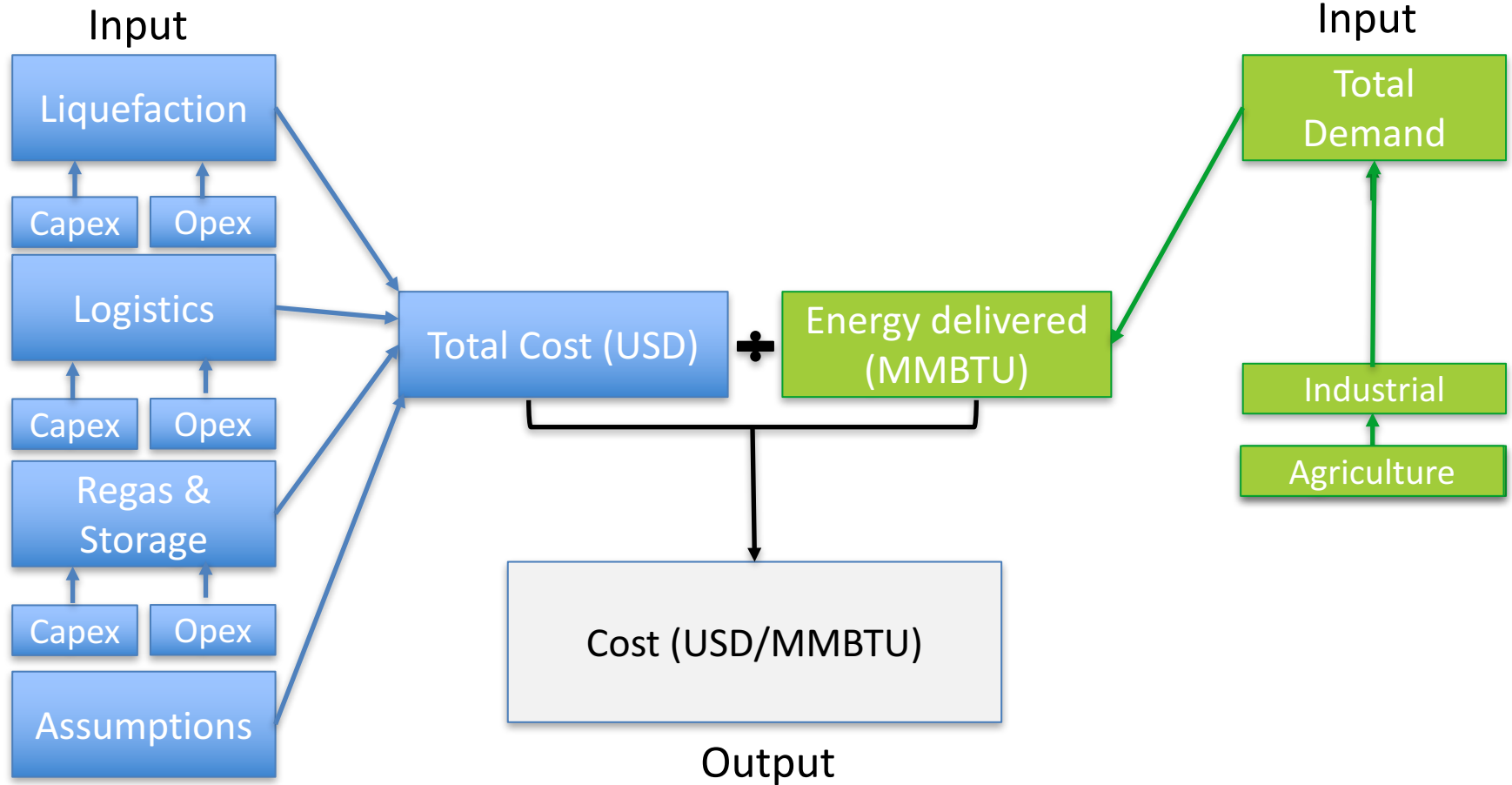
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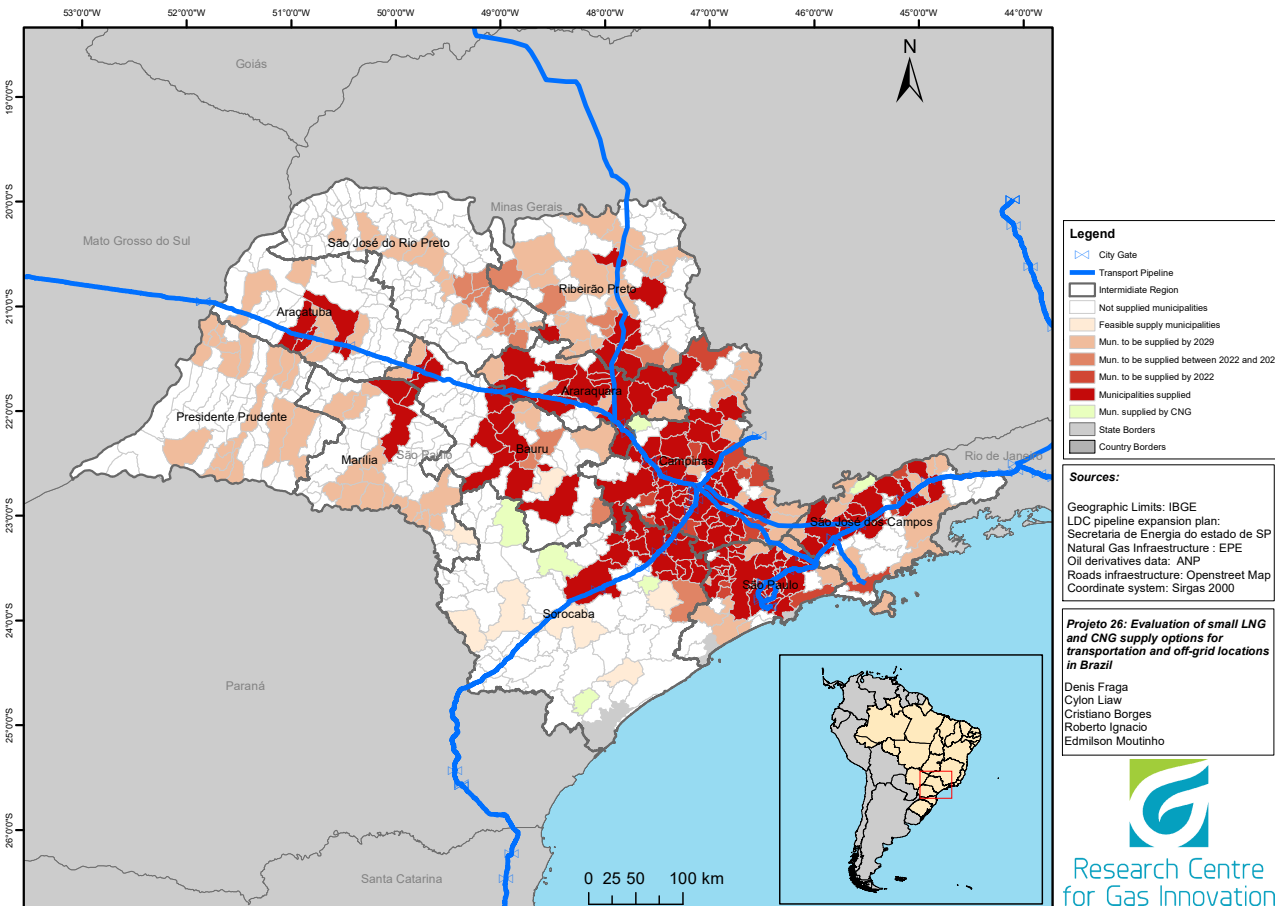
Case Study

- Which municipalities in the state of SP could have NG via SSLNG to displace oil fuel and electricity?
- What is the size of this substitution?
- Is the replacement by SSLNG economic sound?

Model design



Which municipalities in the state of SP could have NG via SSLNG to displace oil fuel and electricity?



645 Municipalities

- 136 supplied by pipelines
- 6 supplied by CNG (1:200)
- 19 by 2022
- 18 by 2022 and 2029
- 136 by 2029
- 7 feasible but not determined

323 Potential municipalities

Which municipalities in the state of SP could have NG via SSLNG to displace oil fuel and electricity?

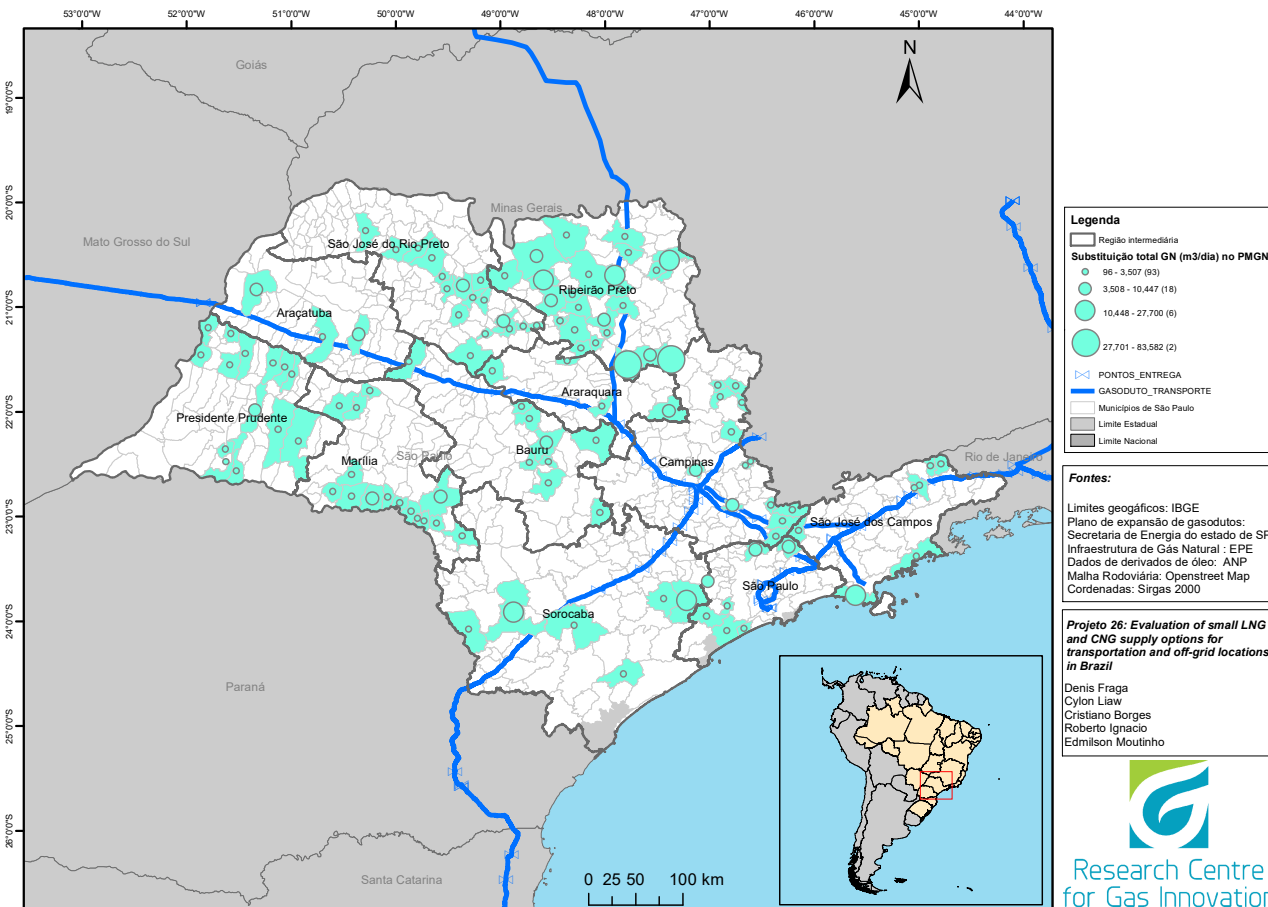


- 20 municipalities not in LDC's long term expansion plan
- Strong Industrial and Agricultural GDP activities
- High consumption of electricity and oil fuel
- Total potential substitution volume (58.310 m³/day)



Source: Prepared by the author based on (Gallo 2018) and (Strapasson 2004)

Which municipalities in the state of SP could have NG via SSLNG to displace oil fuel and electricity? (Within the pipeline long term expansion plan)



- 119 municipalities in LDC's long term expansion plan (infrastructure due to 2022 and 2019)
- Total potential substitution volume (440.015 m3/day)

Source: Prepared by the author based on (Gallo 2018) and (Strapasson 2004)

Is the replacement by SSLNG economic sound?

Prices adopted (usd/mmbtu)

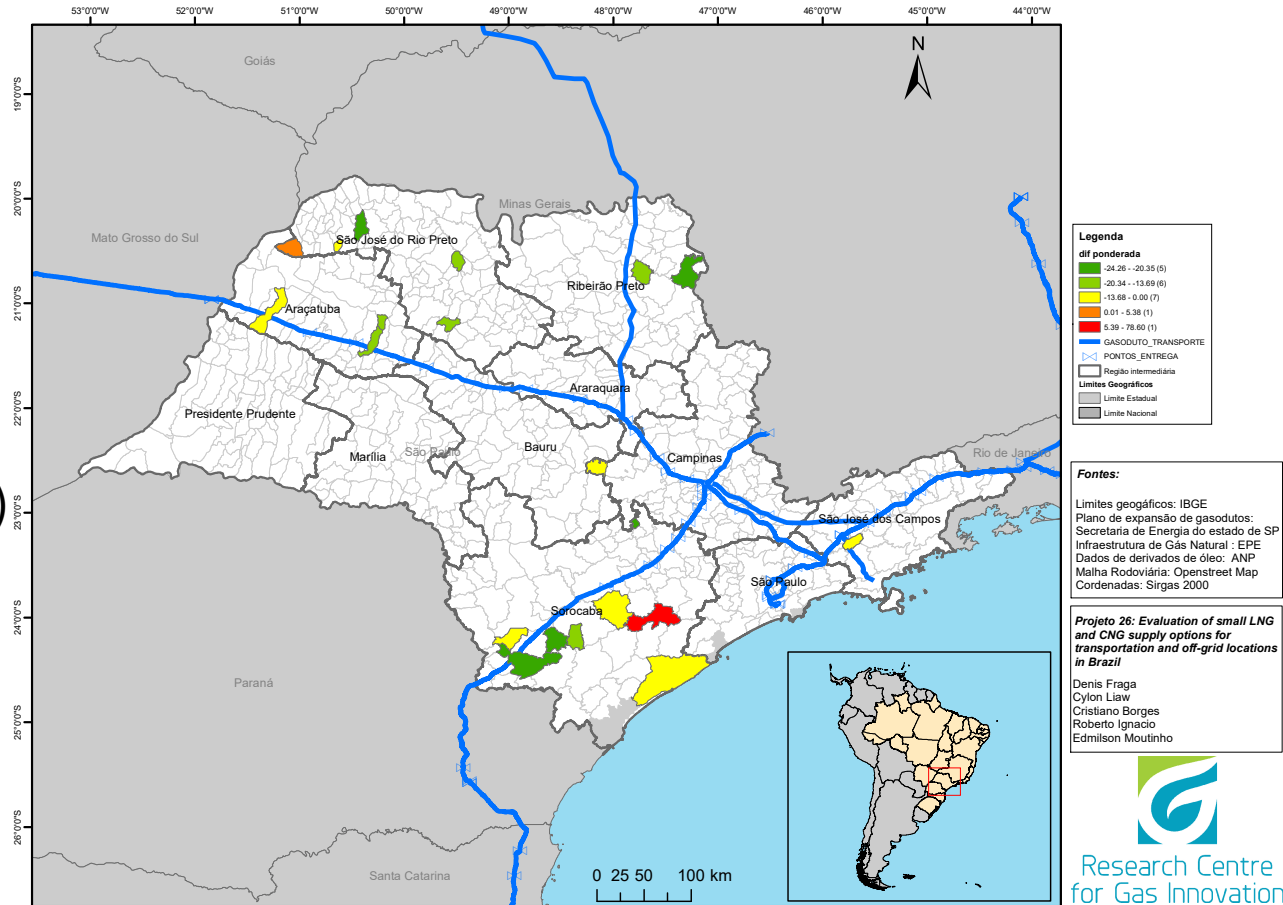
NG City Gate	Oil Fuel	Electricity	SSLNG
7,12 USD	16,41	43,44	Liquefaction, Logistics, Regas and Storage @ 10%

Source: Prepared by the author based on Crosso (2015), MME (2017), Firjan (2017)

- 18 municipalities (out of 20)

Competitive volume

57.750 m3/day



Is the replacement by SSLNG economic sound? (Within the pipeline long term expansion plan)

Prices adopted (usd/mmbtu)

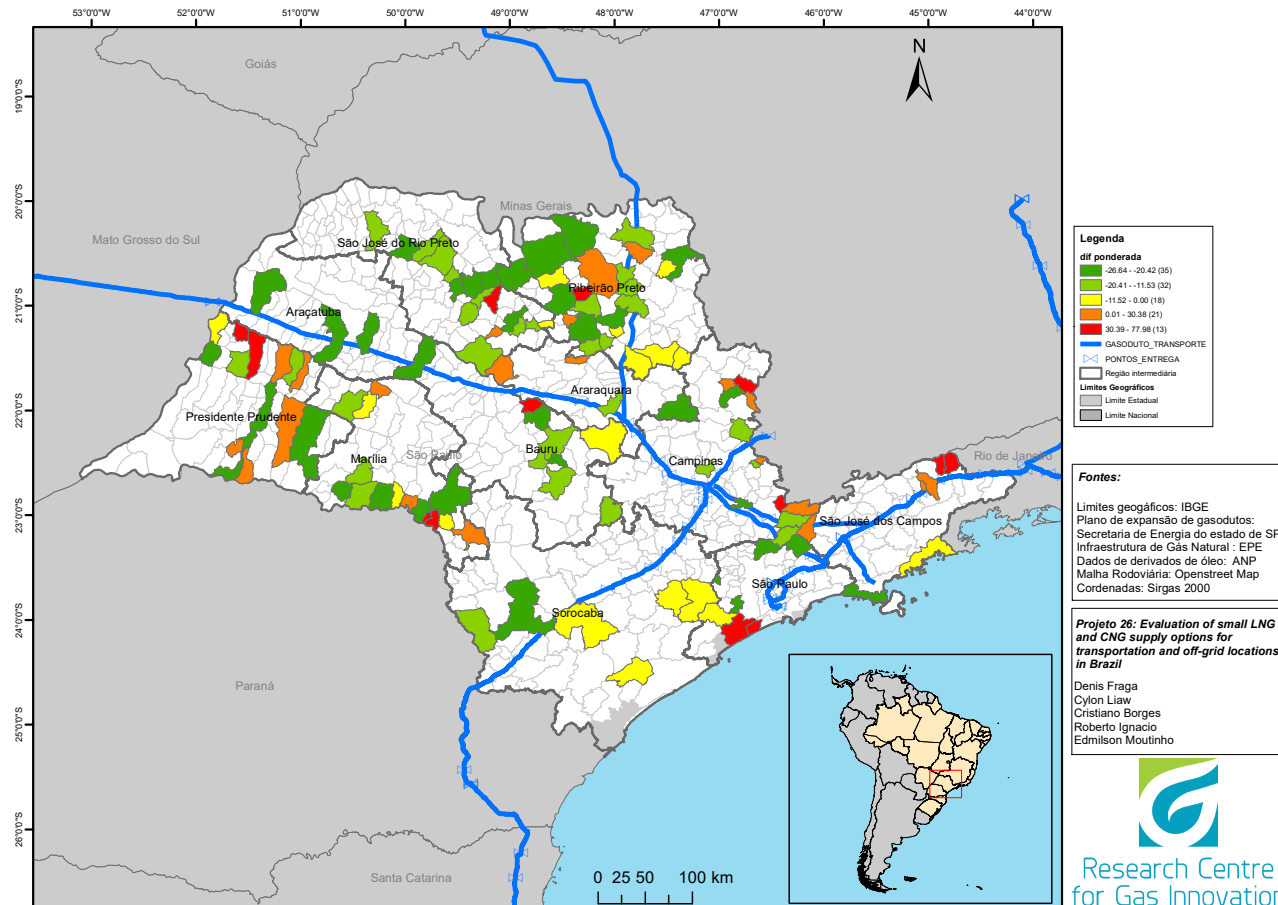
NG City Gate	Oil Fuel	Electricity	SSLNG
7,12 USD	16,41	43,44	Liquefaction, Logistics, Regas and Storage @ 10%

Source: Prepared by the author based on Crosso (2015), MME (2017), Firjan (2017)

- 85 municipalities (out of 119)

Competitive volume

433.022 m³/day



Conclusion

- The potential for substitution outside the pipeline expansion plan is lower than the SSLNG range and economic sound
18 municipalities with volume of 57.750 m³/day
- The potential for substitution within the pipeline expansion plan is within the SSLNG range and economic sound
85 municipalities with volume of 433.022 m³/day
- Most of the potential substitution volume is from the agricultural sector
- Diesel replacement can be a *game changer* in terms of potential substitution volume
- LDCs expansion plan captured most of the market potential



RAILWAYS



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Advantages of transporting LNG by rail

- Transportation of larger quantities at low costs to distant locations
- Direct delivery to the end customer (with available railway connection or hauled by lorries to the final destination)
- Lower CO₂ emission compared to trucks (per ton-kilometre comparison)
- Utilization of the existing infrastructure for small-scale volumes

Types of LNG transportation on railway

LNG ISO container



LNG Tank wagon



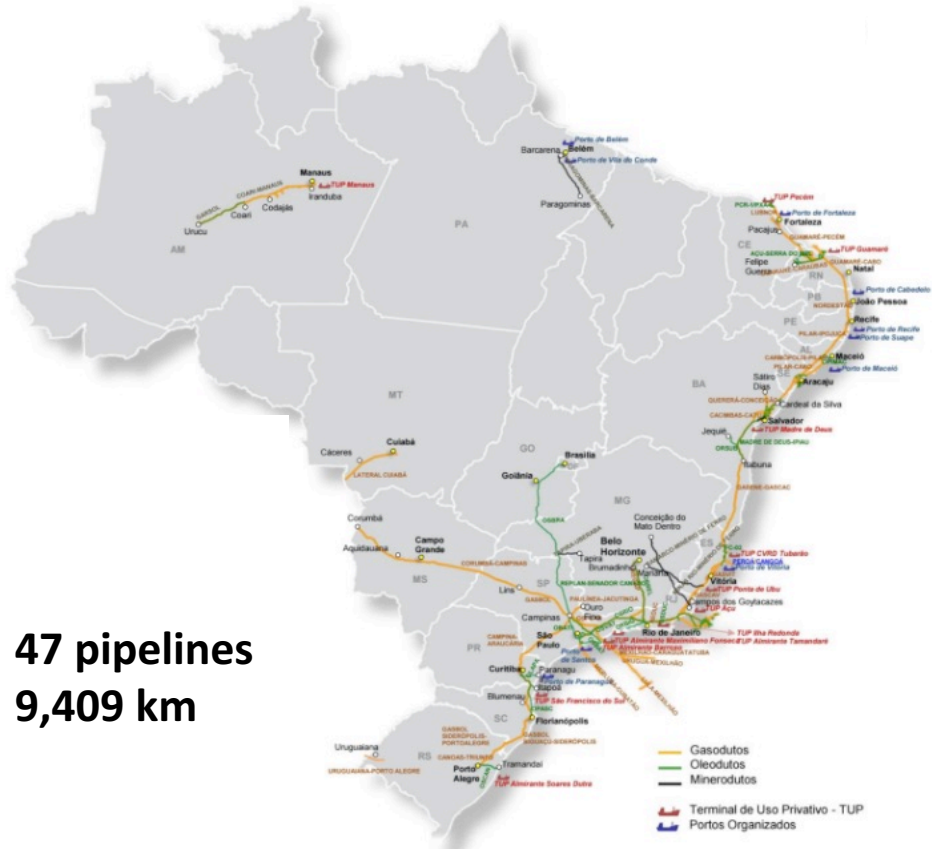
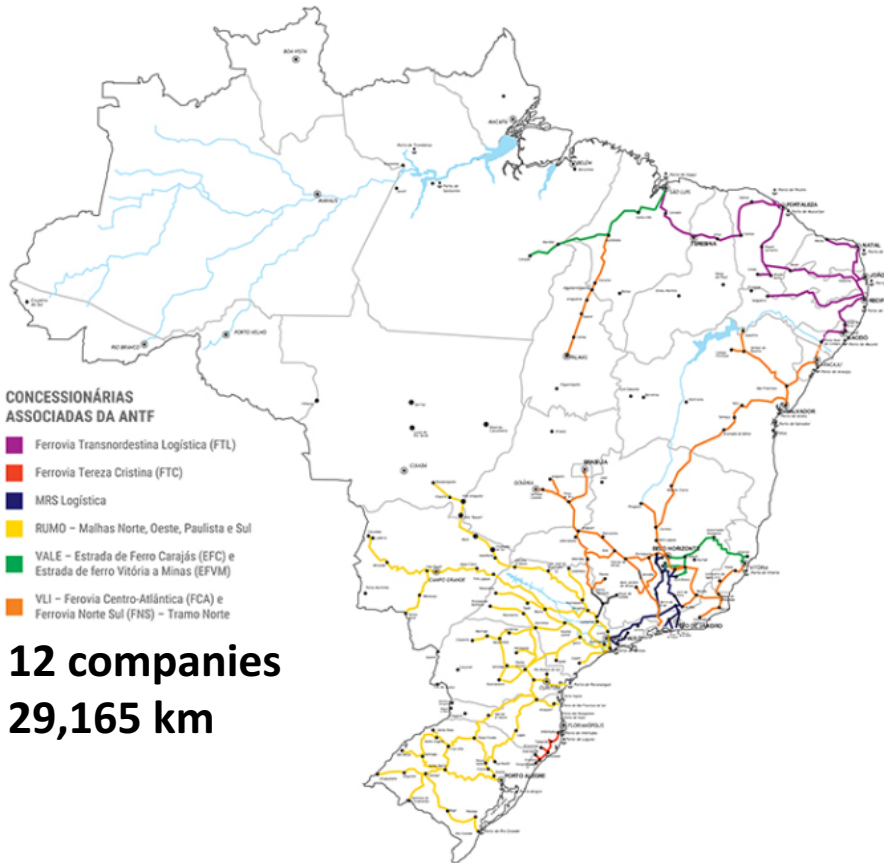
Transportation via Railways



International benchmark

- Portugal and Spain: technical visit in 2017 – ongoing studies regarding the railway connected to the LNG import terminal
- Energy scenario, transportation matrix and operational conditions were considered in:
 - Japan: ongoing LNG rail transportation since 2000
 - EUA: running tests in Alaska since 2014
 - Sweden: planning phase since 2016

Brazilian railway x pipeline network



Brado Logística

- Expertise in container multimodal transportation
- Logistics corridor: Sumaré (SP) – Rondonópolis (MT)
- NG potential demand in MT to be analyzed (agriculture)
- Diesel displacement in locomotives





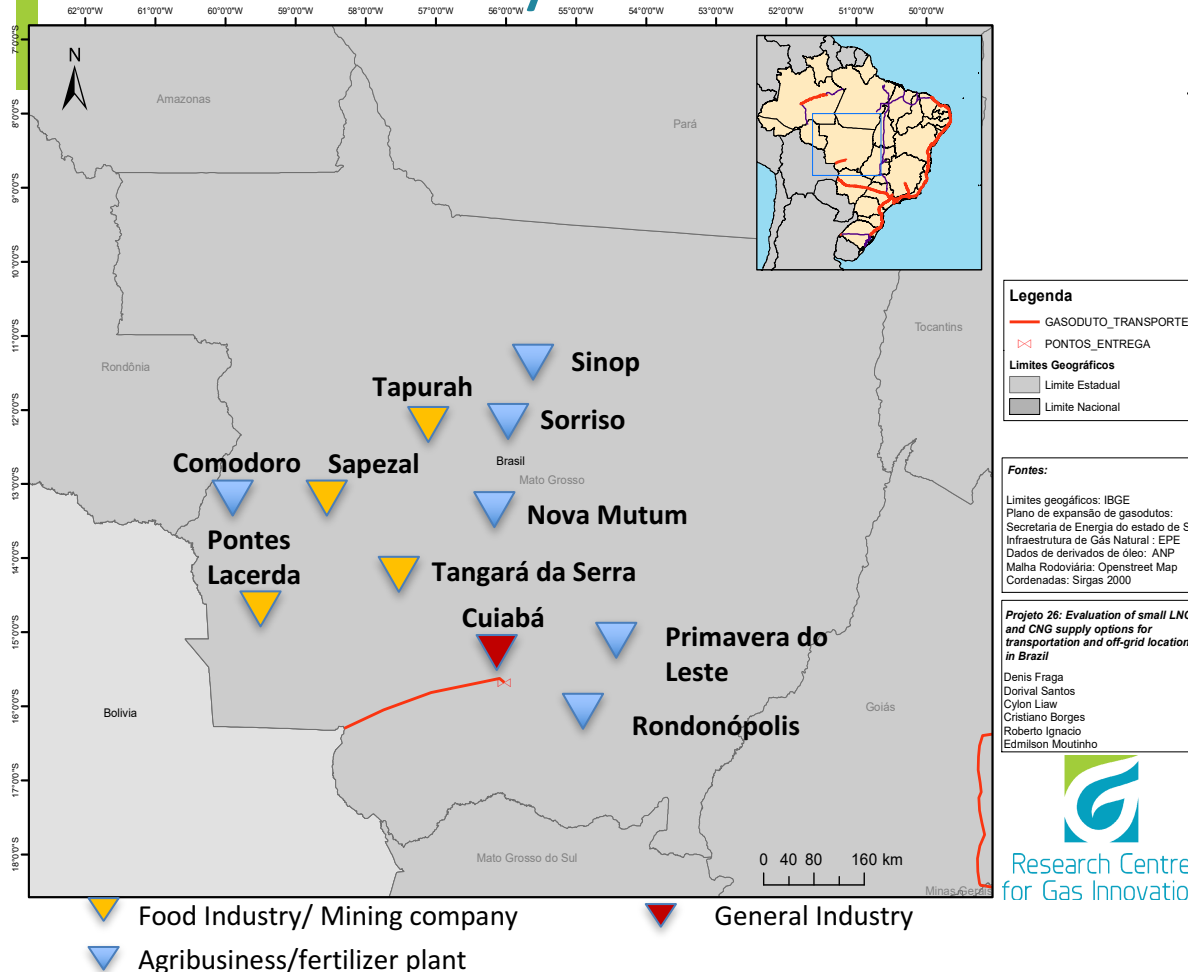
NEXT STEPS



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Mato Grosso is an important site for agro and food industry in which GNL could be used as fuel



Opportunities to access

- Agribusiness
 - Drying process
 - Machinery
- Food Process
 - Steam boilers
 - Machinery
- Other industry to assess:
 - Beverage, cement and other industries in Cuiabá



GasOcidente pipeline:
 Length: 283 km
 Capacity: 4.0 MMm³/d

Next step: feasibility study of GNL small scale truck distribution in Mato Grosso State.



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