



Roadmap do Mercado Brasileiro de  
**VEÍCULOS PESADOS A GNV**

# Brazil Roadmap for Natural Gas and Biomethane Heavy Duty Trucks & Buses

## Final Report Presentation

for Argonne National Laboratory & the U.S. Department of Energy

In a Webinar sponsored by NGV America

8 December 2021



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# INTRODUCTION & APPROACH

## U.S.-Brazil Energy Forum (USBEF)



- This work has been conducted under the U.S.-Brazil Energy Forum (USBEF), the energy bilateral framework co-chaired by the U.S. Department of Energy (DOE) and Brazil's Ministry of Mines and Energy (MME)
- This project has been funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (DOE-EERE), Vehicle Technologies Office.

## The Principals

- **Jeffrey Seisler**, *Principal Contractor and Expert (CEO, Clean Fuels Consulting)*
- **Marcy Rood**, *Technology Integration Manager, Argonne National Laboratory (Roadmap Project Manager)*
- **Elena Berger**, *Brazil Desk Manager, U.S. Department of Energy*  
**Aldo Barroso Jr.**, *Director Natural Gas, Ministry of Mines and Energy (MME)*
- **Heloisa Borges**, *Director Oil, Gas & Biofuels, Energy Research Agency (EPE)*

With technical support from Gustavo Galiazzi (ABEGAS) and Ricardo Vallejo (Consulgas)



## CONTNENT OF THIS PRESENTATION

- Overview of Roadmap: process & contents
- Brazil Energy Profile: brief overview
- Strengths & Opportunities in the HD NGV market
- Main challenges to HD NGV commercialization
- Next Steps: Roadmap Recommendations
- (Annex w/vehicle data)

# Roadmap Development Process & Activities

- **Nov 2020 – February:** Background research & discussions for draft SWOCs.
- **First two weeks in February 2021:** Series of stakeholder teleconferences ~ 2 hours x 6 Stakeholder groups. Additional meetings w/Inmetro, BNDES (Brazilian Development Bank) and EPE. Total of ~100+ stakeholders.
- **Mid-March 2021:** Requested and received feedback from each Stakeholder group on goals, SWOCs, and the Draft Roadmap.
- **27<sup>th</sup> May 2021:** Virtual Workshop. Three-hour session *presented the results of draft Roadmap to all stakeholder groups to get reactions, input, guidance, questions, etc. for the development of the Final Roadmap.*
- **19 July 2021:** Roadmap finalized and delivered to Brazil MME and EPE.



## **Public-private input from ~ 100+ stakeholder institutions and companies was obtained for a *full* range of perspectives\***

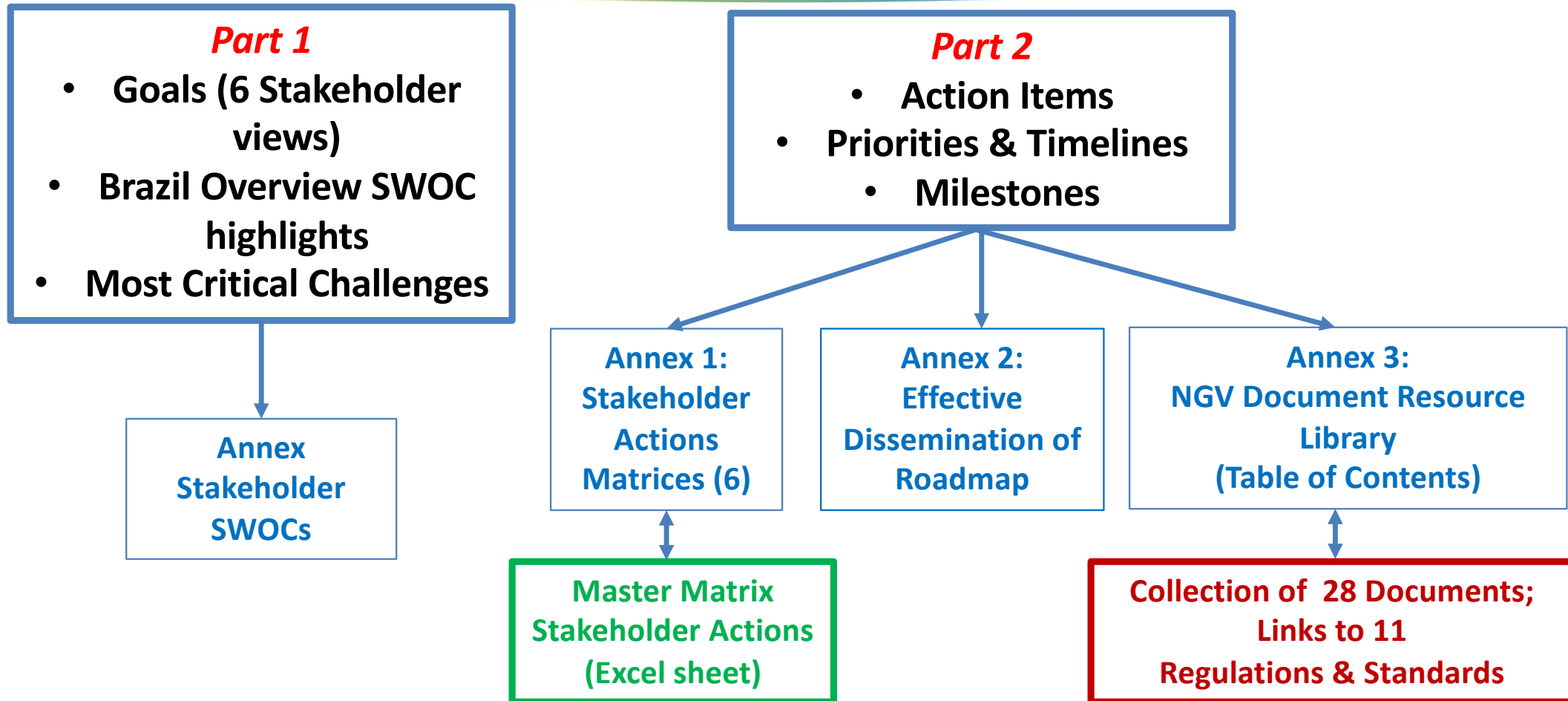
- *Government:* National governments of Brazil and the U.S. as well as Brazilian municipal governments. 
- *The downstream natural gas industry.* 
- *Vehicle manufacturers and NGV systems and component suppliers.* 
- *Fleet operators:* Both private sector commercial and municipal public sector operators of buses and trucks.   

- *Fuel station and infrastructure suppliers.* 
- *Civil society:* Non-governmental organizations; natural gas, environmental and health advocates; universities; financial institutions and other entities supporting non-petroleum-based fuels for the transport sector. 

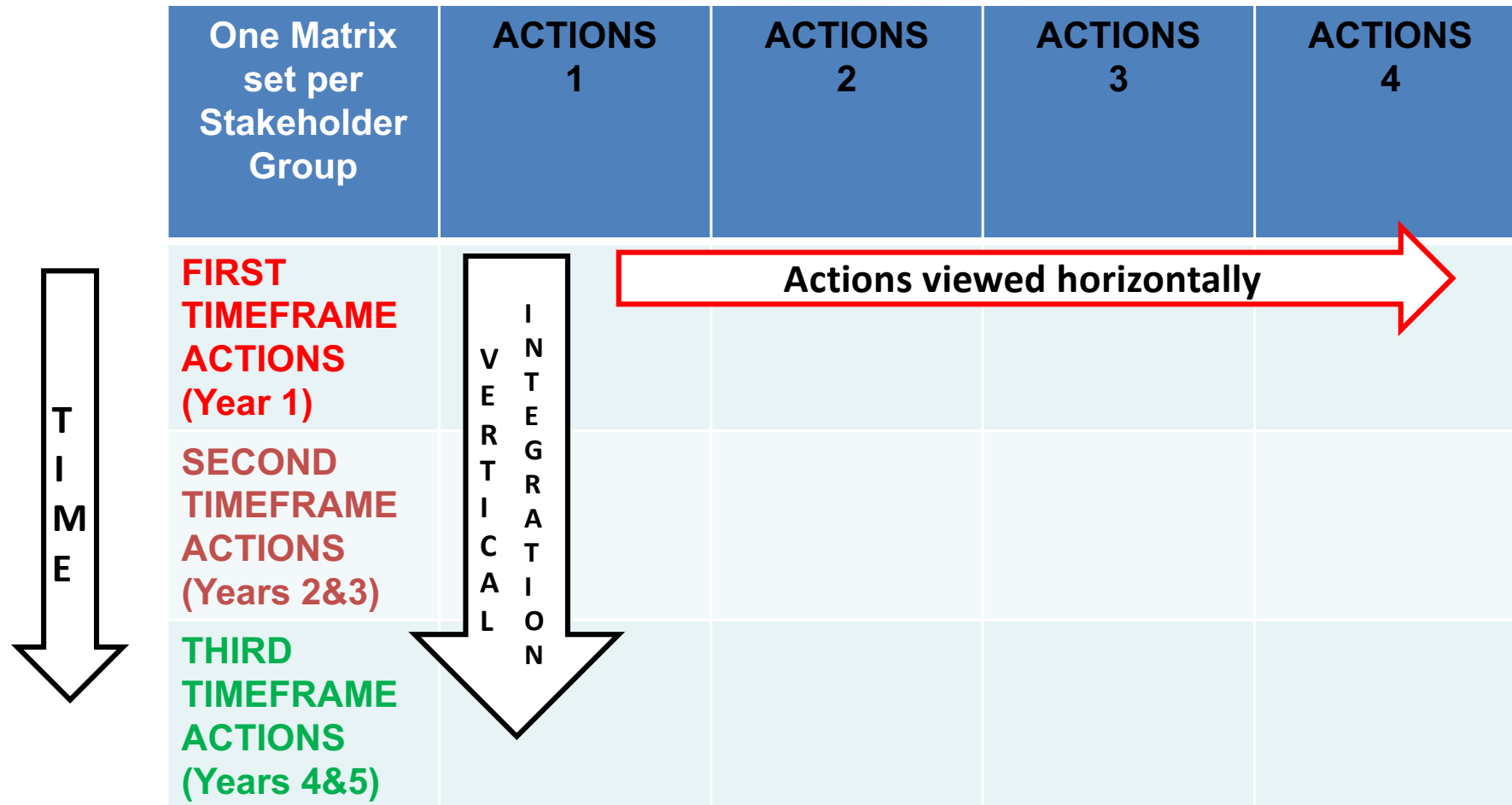
\*A small number of participating stakeholders in the listed participants are missing due to on-line registration or record-keeping issues for the various virtual meetings conducted in the development of the Roadmap. Apologies to those who might be missing from the stakeholder lists.



# Overview of Complete Roadmap & Documents



# THE ESSENCE OF THE ROADMAP WHAT CAN STAKEHOLDERS DO.... AND WHEN SHOULD THEY DO IT?



# Each Stakeholder Group has four sets of ‘Action Items’ over three timeframes\*

Public sector	INTERAGENCY COORDINATION (VERTICAL & HORIZONTAL)	STANDARDS, REGULATIONS & TARIFFS (Poli-Techs)	INFORMATION , ANALYSES & COMMUNICATIONS	INCENTIVES, MANDATES & POLICIES
Gas Industry	DEVELOP GAS INDUSTRY NGV STRATEGY PLAN	DEVELOP CNG, LNG & BIOMETHANE FUEL STATION NETWORK	COMMUNICATIONS & OUTREACH TO NGV CUSTOMERS	ADVOCATE FOR GOVERNMENT SUPPORT FOR NGV MARKETS
OEMs, System & Component Suppliers	TECHNOLOGY DEVELOPMENT	STANDARDS AND REGULATIONS	MARKETING & COMMUNICATIONS	GOVERNMENT RELATIONS (ADVOCACY & EDUCATION)
Fleet Operators	VEHICLE OPERATIONS	FACILITIES MANAGEMENT (Fueling & Workshops)	INFORMATION & COMMUNICATIONS	PERSONNEL MANAGEMENT & TRAINING
Fuel Infrastructure Suppliers	TECHNOLOGY & SYSTEMS DEVELOPMENT (also best practices)	FILL GAPS IN STANDARDS & REGULATIONS	STRATEGIC MARKETING & COMMUNICATIONS	ADVOCACY & EDUCATING GOVERNMENT
Civil Society	TECHNOLOGY & SYSTEMS DEVELOPMENT (also best practices)	FILL GAPS IN STANDARDS & REGULATIONS	STRATEGIC MARKETING & COMMUNICATIONS	POLICY ADVOCACY , EDUCATING & TRAINING

\*These are annexed in Part 2 & provided in a separate Excel file as a Master Matrix for ease of comparison and integration



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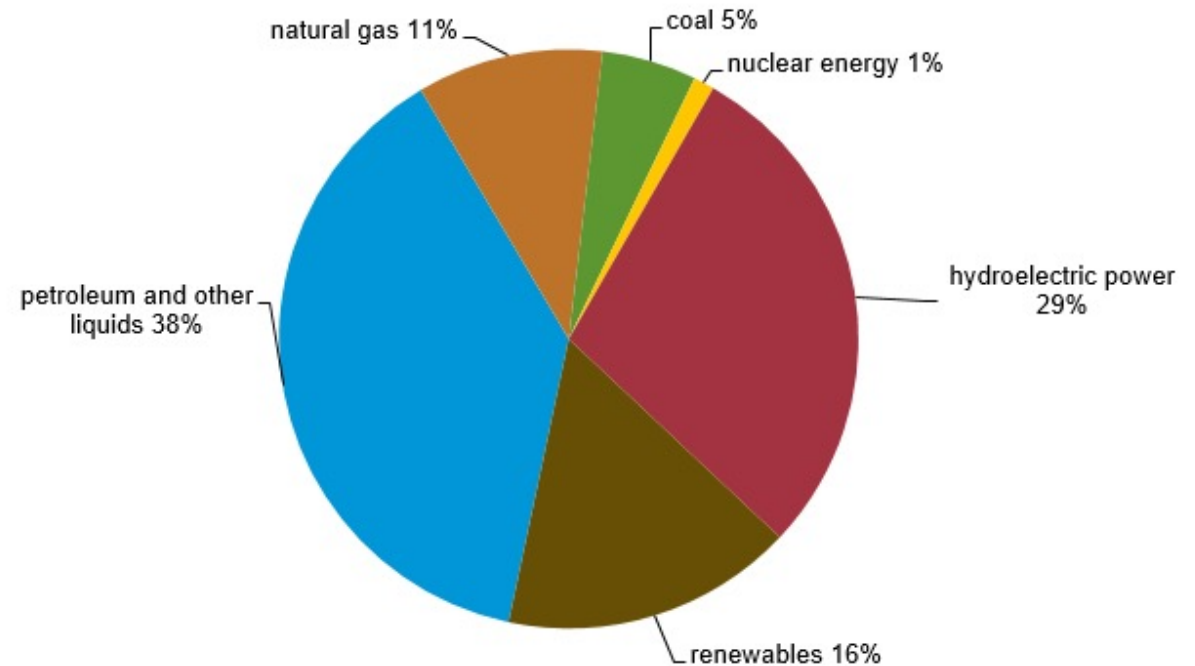
# QUICK OVERVIEW BRAZIL ENERGY PROFILE



# BRAZIL ENERGY CONTEXT

- 3rd in the world for its renewable energy capacity (MW) and 2<sup>nd</sup> in production (GWh)\*
- Vast natural gas resources that will be exploited through new infrastructure development

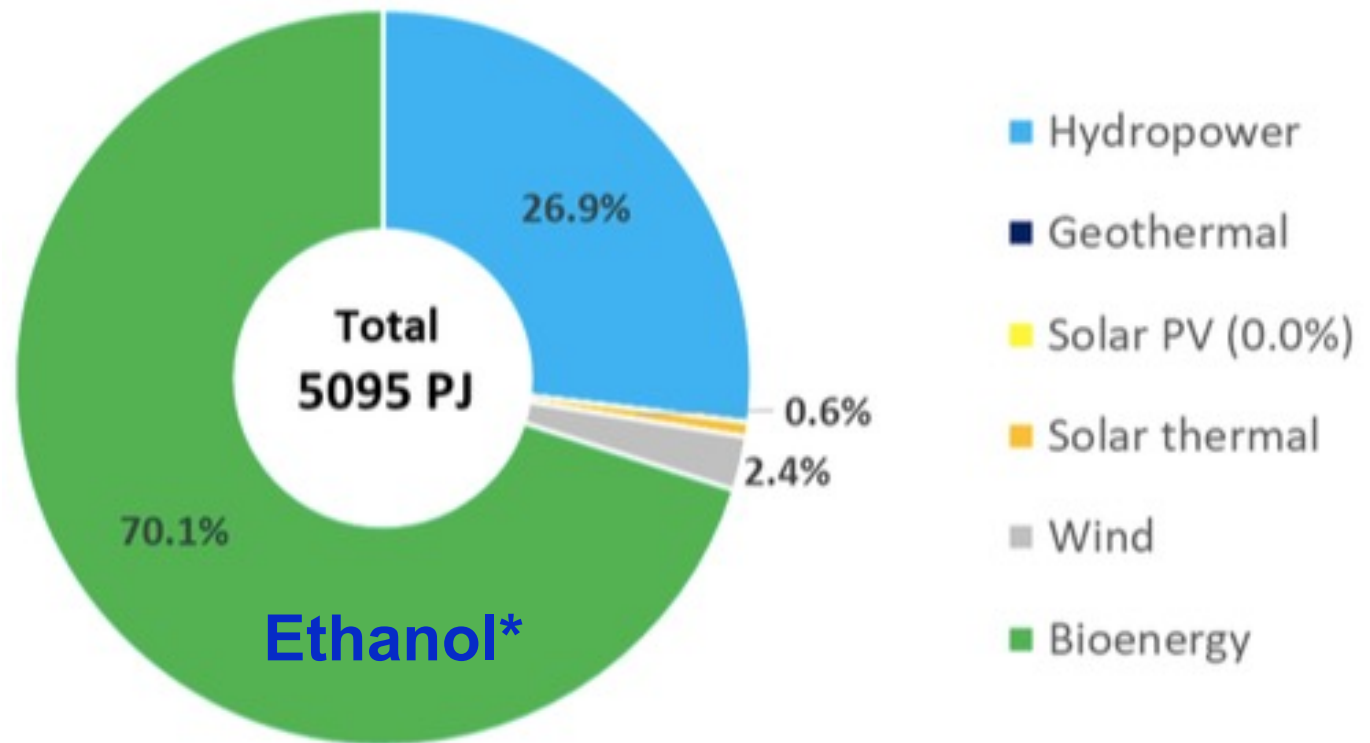
Figure 1. Total primary energy consumption in Brazil by fuel type, 2019



\*Source: International Renewable Energy Agency, 2019.

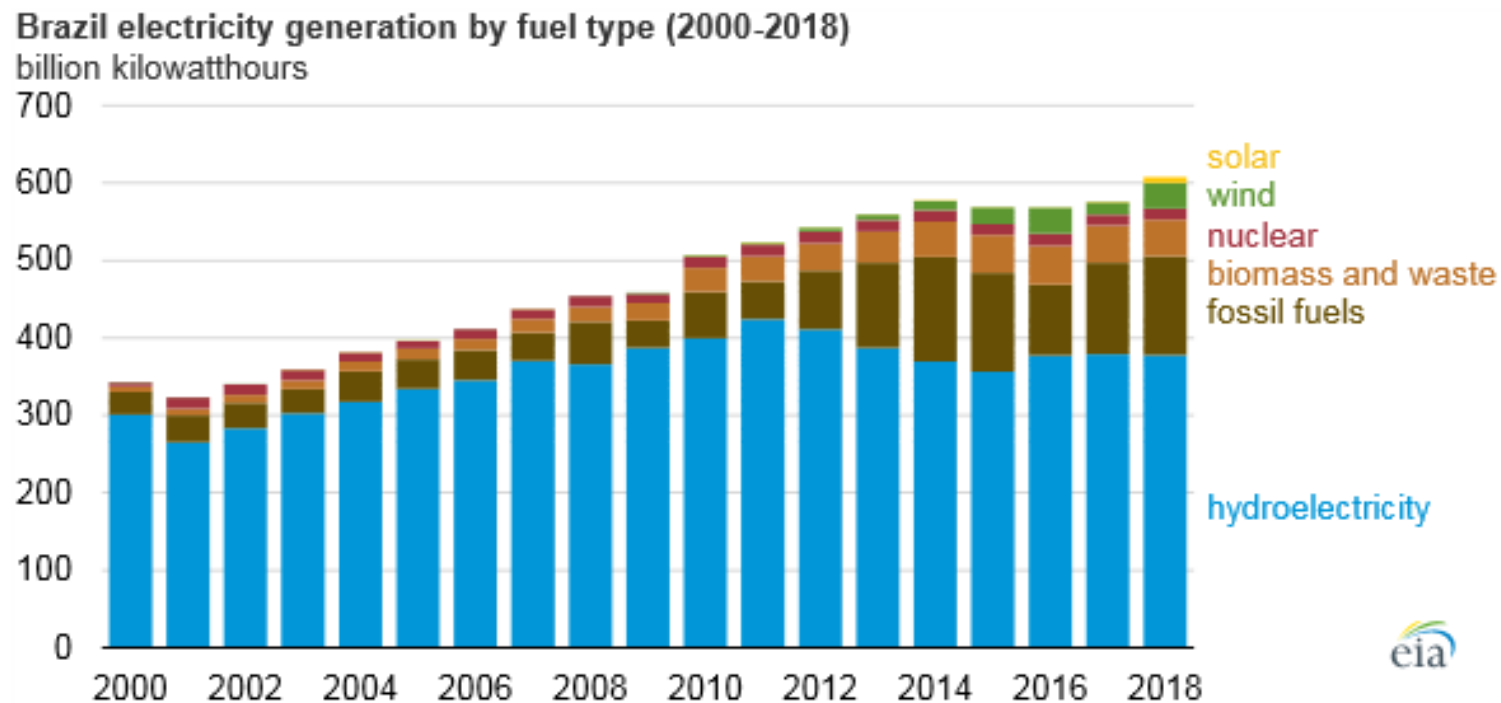
## In the 'renewable energy' sector, bioenergy-ethanol- remains dominant

Much more government & private sector emphasis is being placed on bio-methane to ensure it is part of the mix of renewable fuels.



\*Out of harvest season (May-Oct) Brazil imports cheap(er) ethanol from the U.S. (22,000+ b/d (2019))

## Hydropower dominates electric production (~64%)\* but periodic droughts (2012-2016) resulted in increased use of natural gas (~7%)



Banco de Informações de Geração, National Electric Energy Agency (Agência Nacional de Energia Elétrica – ANEEL). November 2019.

<http://www2.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.cfm>



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# Natural gas infrastructure network for imports, exports and internal distribution will expand considerably in upcoming decades.

*(422 Municipalities currently with gas service)*

## Main figures about natural gas infrastructure in Brazil

**9.409 km** transmission pipelines

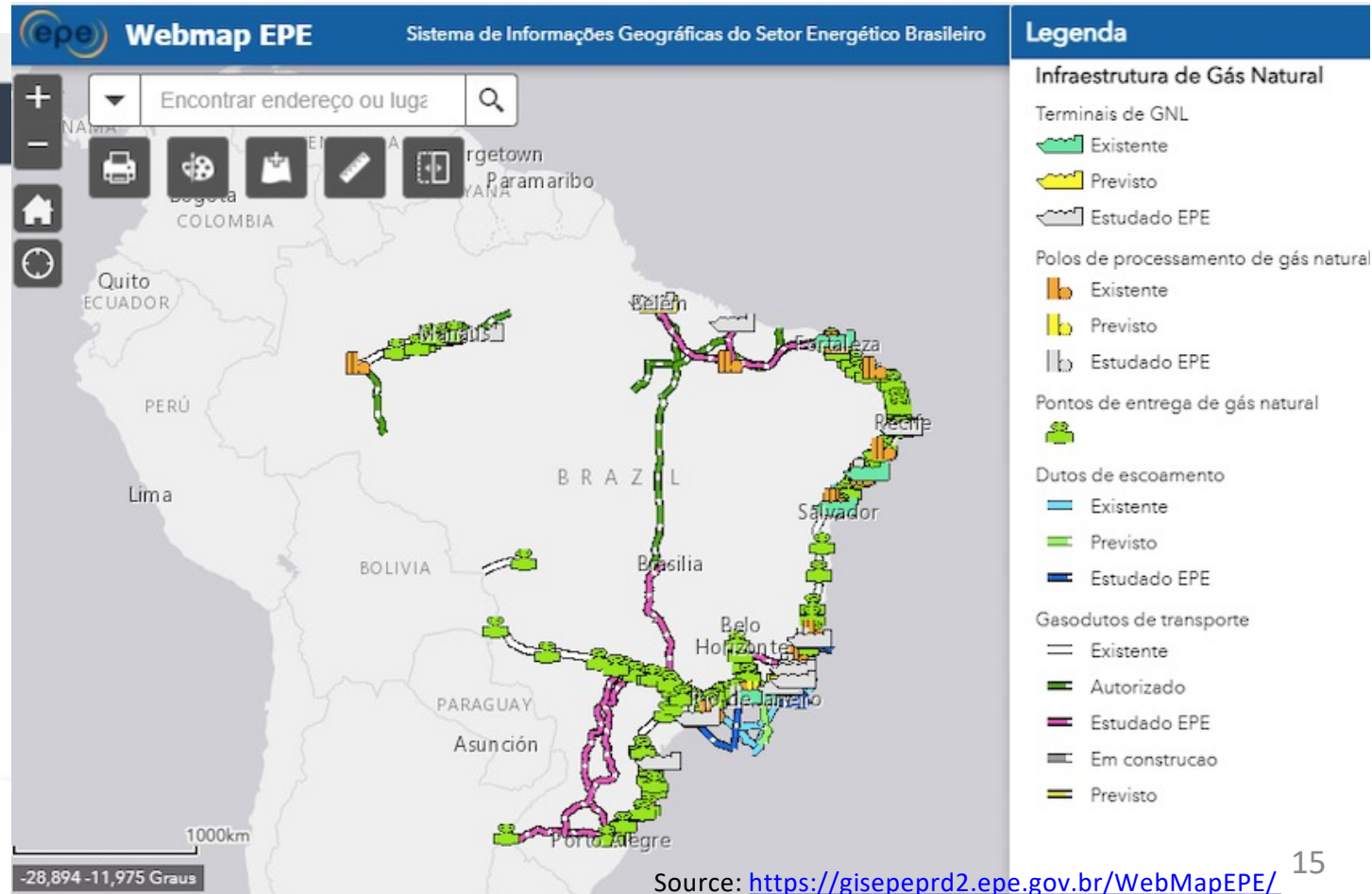
**187** delivery stations (*citygates*)

**33** compression stations

**14** processing plants  
(96 million m<sup>3</sup>/d)

**5** LNG regasification terminals (with a total capacity of 99 million m<sup>3</sup>/d)

Available at  
[www.epe.gov.br](http://www.epe.gov.br)



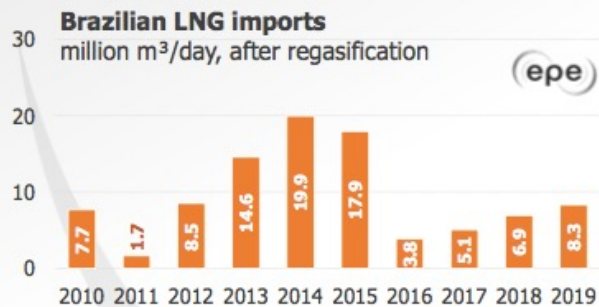


# Availability of LNG will increase, also providing new opportunities for the HDV transport sector.

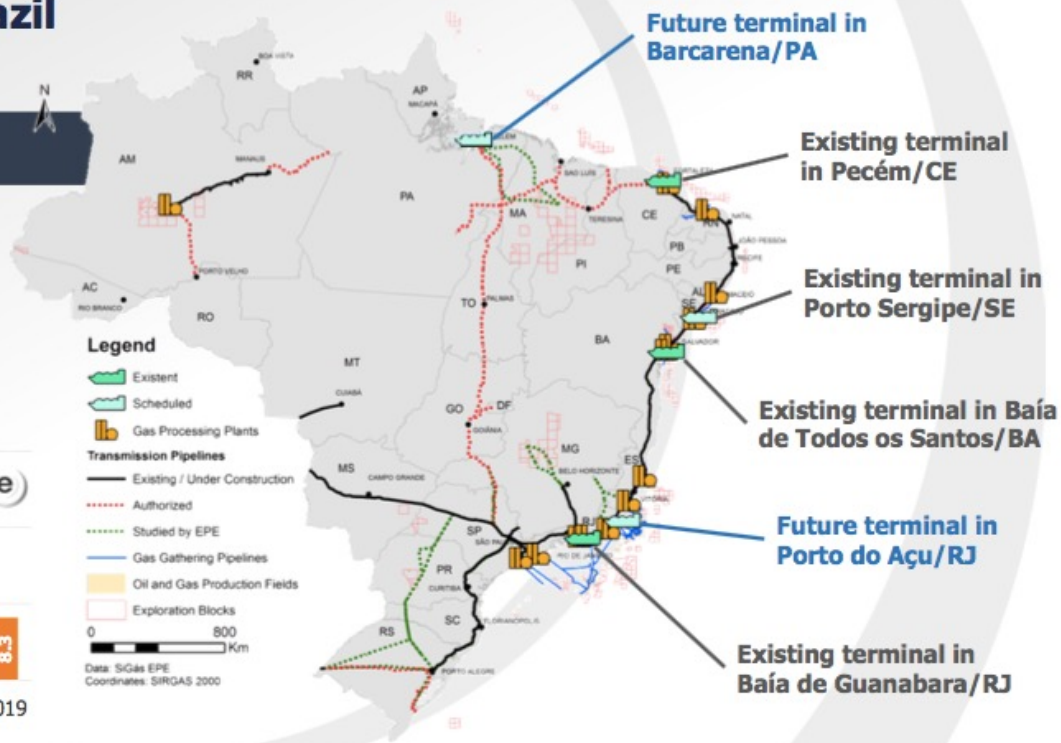
## LNG infrastructure in Brazil

### Main figures about LNG infrastructure in Brazil

- 4 Existing LNG regasification terminals
- 2 Future LNG regasification terminals



Source: MME, EPE



**LNG  
Ports**

*A nexus  
for fuel,  
trucks,  
trains  
&  
ships!!*



**THERE ARE MANY STRENGTHS AND OPPORTUNITIES IN  
THE HD NGV MARKET THAT COULD BE ATTRACTIVE TO  
INVESTORS AND STAKEHOLDERS**



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## The Future of *Natural Gas Supply Outlook is Optimistic*



- The Brazil gas industry is **embarking on a new plan** supported by the government (The New Gas Law, 2021) to **diversify** the natural gas **supply** and **expand** the natural gas **distribution** to areas where gas previously has not been available.
- **Supply of domestic natural gas** is anticipated to increase 80+% by 2030 and continue **strong growth to 2040 and beyond.**<sup>1</sup>
- **Biomethane** is a **renewable resource option** that achieves **extremely low CO<sub>2</sub> levels on a well-to-wheel basis**; as much as -95%.<sup>2</sup>
- Natural gas can **help improve the trade balance** by replacing imported diesel fuel, which represents about 20% of diesel consumed in Brazil.

<sup>1</sup>Gas for the Development, BNDES 2021/2020.

<sup>2</sup> California Energy Commission; European Commission; etc.



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# Government Policies & Analyses Supporting NGV Development are Moving Forward



- Environmental challenges and health impacts of emissions from the transport sector are recognized and have been evaluated.\*
- Existing NGV policies, standards and regulations provide foundation for expansion to the HDV sector.
- Some financing and incentives at national, regional and local jurisdictions exist for EVs and NGVs (good potential for expansion of financial incentives).
- Strong national support for expansion of natural gas supply and infrastructure with the New Gas Market (NGM) program will stimulate demand and, as such, more investments in supply.
- Some 'horizontal' mechanisms already exist for Interagency coordination of energy /transport policy. (Energy Policy Committee; Interagency Working Group on Natural Gas)
- RenovoBio policy: Biomethane defined as renewable energy & Carbon Credits provided biomethane can be used to reduce biofuels production footprint.

\*For example: *Evaluation of the impacts on public health and its value due to the implementation of natural gas vehicle in the energy transport matrix - public transport (bus) in the metropolitan regions of Sao Paulo and Rio de Janeiro*, Evangelina Vormittag, Technical Director, Institute of Health and Sustainability

## OEMs in Brazil have NGV technologies to meet the needs of the bus & HD truck customers.\*



- **Environmental advantages** of NGVs are well proven and documented (CO, NOx, particulates, etc.) compared to diesel vehicles.
- **Dual-fuel option** (diesel-natural gas, compression ignition) for HDVs presents viable alternative to 'dedicated' methane-only variants/options. (Conversion system can be removed so the truck can be re-sold as a 'diesel'.) Can achieve Proconve7 with methane catalyst.
- **Government policy makers are supportive** of expanding the NGV – LNG and biomethane - beyond the LDV market and into HDVs.
- **Options for renewable biomethane** will be increasingly attractive as production facilities expand.
- **The market is large and diverse**, with space for proactive players.

*\*Scania: product based on modular system. Gas engine is adaptable to the system. 340hp, 280hp, 9/1 & 13L and 320hp for buses).*

As of May 2021 only Scania provided HD NGVs in Brazil  
1 bus and 1 truck model with a variety of engine sizes

Most of the other OEMs have gas variants but they are not (yet) offered in Brazil















## TRUCK & BUS SNAPSHOT

**Total Trucks (all types):**  
**1,964,692**  
**New (2018) 75,987**

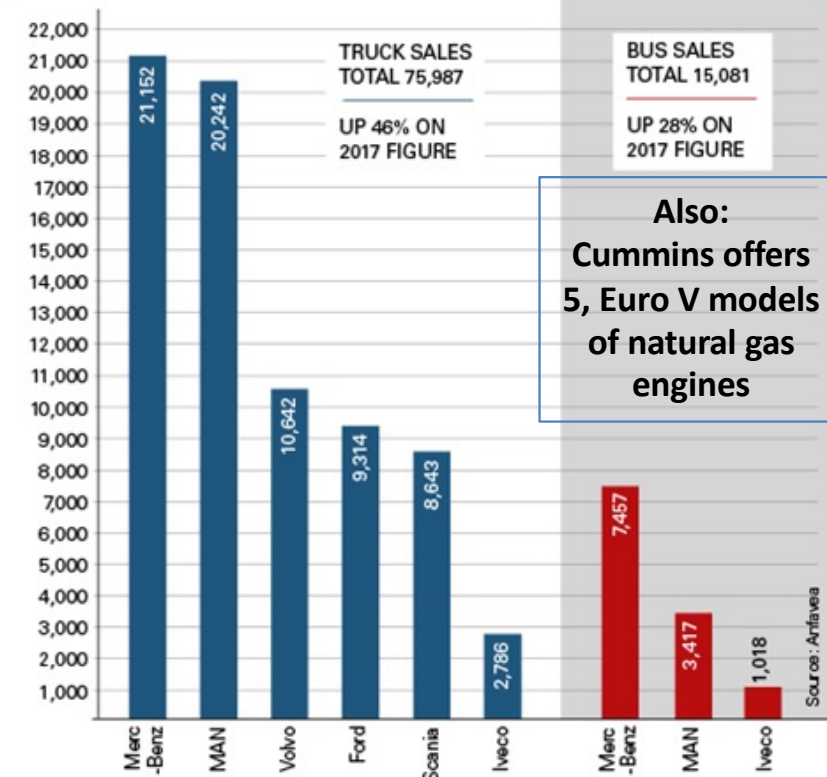
**Total Buses (metro): 335,932**  
**New (2018) 11,755**

**Semi-heavy trucks (15-45t):**  
**23,226**  
**Heavy (45t+):**  
**51,718**

## Truck & Bus OEMs

Empresas Companies	Caminhões Trucks	Ônibus Buses
Agrale		
Audi		
BMW		
CAOA		
CNH (Iveco)		
DAF		
FCA (Fiat, Jeep)		
Ford		
General Motors		
Honda		
HPE (Mitsubishi, Suzuki)		
Hyundai		
Jaguar Land Rover		
MAN		
Mercedes-Benz		
Nissan		
PSA (Peugeot, Citroën)		
Renault		
Scania		
Toyota		
Volkswagen		
Volvo		

## Brazil's truck and bus sales in 2018



Sources: Brazilian Automotive Yearbook, 2020; & Gas Para O Desenvolvimento, National Bank for Economic and Social Development, BNDES, 2020.

Source: *Motoring on: Brazil's heavyweight OEMs prepare for growth*, Tony Danby, Automotive Logistics, May 2019

## There are new opportunities and *strategies to locate & expand the methane fuel Infrastructure for HDVs*



- **The HDV market is a potential anchor for infrastructure development** and expansion of the natural gas supply with the support of state governments to regions not served by a gas pipeline.
- **Establishment of ‘blue corridors’ for CNG, LNG or biomethane** can deliver gas for vehicles (and other potential markets to regions not serviced by gas pipelines.). A Biomethane Blue Corridor plan exists.)\*
- **Opportunities for centralized or small-scale liquefaction** for distribution of LNG to the heavy-duty sector.\*
- **Potential for ‘truck stop’ CNG/LNG stations.** (Can be installed in existing diesel stations.) Starting with single hose for test truck/fleet, not to impair LDV fueling (but more storage capacity would be needed). These would be where the highest concentration of trucks travel, to take advantage of existing fuel stations. *(Some assessments currently exist.)*
- **Potential for mobile fuel stations** (fuel tank truck that also includes dispenser), especially for fleet ‘trials’ of NGVs. (Question if the regulatory authorities would allow this option.)
- **Portable LNG stations** (use truck-supplied LNG) to provide gas to fleet operators.
- **Co-locate where other gas markets exist that could complement the vehicle sector.** Also, for the potential use longer term of Liquefied-to-CNG stations (L-CNG).

\*Four scenarios for a Blue Corridor in the State of São Paulo and analyzes its environmental and economic impacts. The results show that LNG costs up to 40% less than diesel, while reducing: CO<sub>2</sub> equivalent emissions by up to 5.2%; particulate matter (PM) emissions by 88%; and nitrogen oxides (NO<sub>x</sub>) by 75%. NOTE: The information needs to be updated with the most recent studies.



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# Infrastructure Concepts & Strategies for HDVs (Cores, Rings & Corridors)



## BNDES Blue Corridor Plan: Phase 1



BNDES has done excellent analyses to prepare for expansion of the NGV fuel station network.

## BNDES Blue Corridor Plan: Phase 2





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# **MAIN CHALLENGES OF BRAZILIAN MARKET DEVELOPMENT HEAVY DUTY TRUCKS & MUNICIPAL VEHICLES (buses & garbage trucks)**

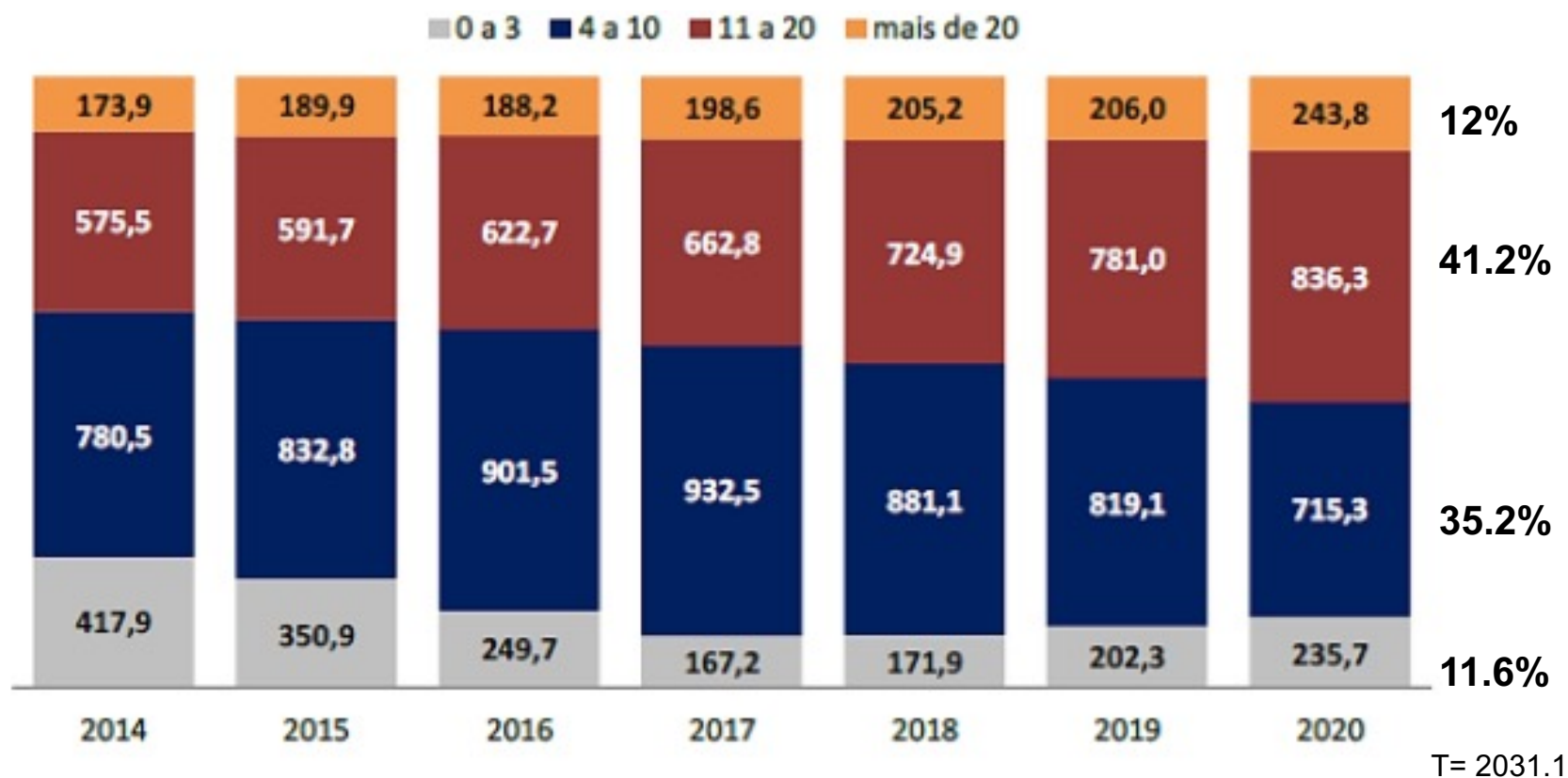
## *NGV Technologies Face Constraints Due to Availability and costs*



- *Local production capability* for heavy duty NGV technologies and components is lacking. Further development is needed.
- Natural gas HDVs are more expensive than diesel HDVs. (Early purchase incentives required.)
- Lightweight CNG cylinders Types III & IV suitable for HDVs are not available in Brazil and homologation/certification of these tanks in Brazil is expensive.\* Steel cylinders today are mainstream for NGVs – light and heavy duty.

*\* (~R\$ 300,000 / US\$ 53,395, re-certifiable **every** three years, for foreign manufactured cylinders. Source: Inmetro.)*

## More than 50% of trucks in Brazil are 11 years or older. (Targets for dual-fuel conversions?)



*"The learning of the gas industry in the development of heavy vehicle supply infrastructure,"*  
Joao Quatrone, MAT, presented at Natural Gas Mobility, ABEGAS, 24-25 October 2019.

## KEY WEAKNESS



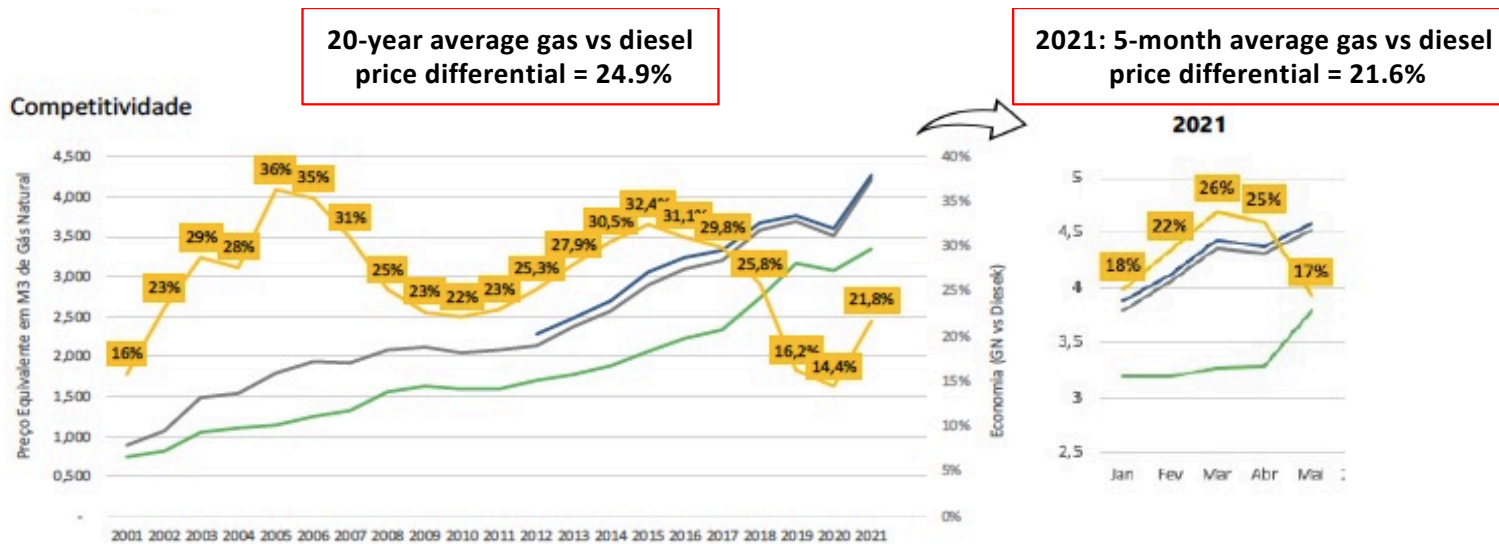
### *Fluctuations in fuel price differential: gas vs. diesel*

- Fluctuations of both diesel and gas prices, as well as the *Real* exchange rate, affect the generally favorable price differential between the two competing fuels.
- Diesel pricing system is subject to the pricing strategy of the major refiners and oil importers in Brazil.
- The gas price is adjusted every three months and can lag, up or down, related to diesel.



# Fluctuating price differential (gas vs. diesel) lengthens the TCO, making fleet decisions more difficult

## Competitiveness of Natural Gas to Diesel



*Typically, natural gas must be 30-50% less than diesel to create a favorable TCO.*

Natural Gas Diesel Diesel S10\* % Natural Gas vs Diesel

**Custo Considerando Equivalência Energética**

Combustível	R\$/m3 EqGN	USD MMBTU
Diesel	4,5753	\$23,36
Gás Natural	3,7900	\$19,35
Economia do GN		17,2%

**Dados:**  
 Diesel 9.159 Kcal/litro  
 GN 9.400 kcal/m<sup>3</sup>  
 MMBTU = 26,8 m<sup>3</sup>  
 Dollar Com: R\$ 5,25

EqGN = equivalente a gás natural

\*Diesel S10 = A maximum sulfur limit of 10 mg/kg (S10) for use in on-road heavy-duty diesel vehicles certified to PROCONVE P-7 emission regulations

# Lack of regulations and standards for HDVs remain a critical issue for the Brazilian NGV market

- **The absence of regulations for LNG** trucks, tanks, fuel connectors/receptacles and fuel stations (including Liquid-to-CNG stations [L-CNG]) **constrain the current use of the LNG option.**
- **Fuel connectors.** Still using bayonet-style connector with 'O'-rings and not NGV-1 or 2.
- **Dual-Fuel (diesel/gas)** is available but there are no regulations... and they are complex.
- **Gas composition.** Ethane content is about 6%, with the legal limit at 12%. But the Brazilian National Petroleum Agency (ANP) is considering raising this to 18% (!!)\* Other issues such as methane content/Wobbe index currently being discussed.
- **Fuel price labeling.** 'Energy equivalency' at the public fueling station needed but is challenging to change (diesel and gasoline liter equivalents for all fuels). Truck fueling stations present a new opportunity!
- **Standards.** ISO standards are used to some degree but Brazilian standards are the principle foundation (also Mercosur, which uses ISO). **United Nations** Economic Commission for Europe (UNECE) regulations are not recognized, and these include LNG, dual-fuel systems, cylinders, fuel connectors, dangerous goods vehicles, etc.

\*Engine OEM recommended maximum ethane limits: CAT-dual-fuel 6%; Cummins 4%; Detroit Diesel 6%; Mack 11%.

Source: *Effects of Gas Composition Variations on the Operation, Performance and Exhaust Emissions of Natural Gas-Powered Vehicles*, Hien Ly, CFS, August 2002

## *Tariffs and taxes can significantly slow or disrupt the development of natural gas HDV markets*



- **Import tariffs impede new, environmentally friendly (and beneficial) technologies** from coming to Brazil, such as NGVs and associated equipment like lightweight CNG cylinders Types III and IV required by the HD NGV suppliers.
- While **NGVs are subject to import tariffs, electric vehicles are not**, establishing a potential competitive disadvantage for NGVs if/when HD EVs also are imported.
- The amount and level of **various taxes** on vehicles and their use **affect the TCO** of HD NGVs.



## *Balance in energy and transport policies will be needed to help shape favorable market for gas trucks and buses*



- **Incentives (and mandates) for electric** and hybrid vehicles, particularly if they exceed those for NGVs (CNG & LNG), **will influence (and reshape) customer decisions** about their use of diesel and alternative fuels.
- Over time, **concerns about fossil methane as a greenhouse gas** and its contribution to global warming will impact NGV markets, at least globally, if not nationally; *(potentially motivating a shift toward greater production and supply of biomethane).*
- Creating **Federal government funding**, incentives and fiscal support mechanisms for NGVs **are necessary** to motivate a sustainable, customer-driven market for natural gas HDVs.



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# **NEXT STEPS: THE ROADMAP RECOMMENDATIONS TO COMMERCIALIZE HD NGVs**

# PROCESS: The Roadmap recommends horizontal integration of government policy making (with stakeholder input) & vertical integration of stakeholders in the decision process.



## Horizontal Integration

The government already has begun to develop and manage an Interagency policy making process at the Federal level; also to include a High-Level Group of Stakeholder Representatives



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Vertical integration of State & Local Public-Private Partnerships (P<sup>3</sup>) is recommended using the U.S. Clean Cities model



### THE AGENDA

- Policy development (Incentives; taxation; etc.).
- Fuels and Infrastructure development strategies.
- Standards & Regulations development/refinement.
- Marketing strategies of vehicles and fleets.
- Education/Training.
- Communications & Outreach (including media and public relations).

## Brazilian Development Bank (BNDES) plan for market expansion of HD NGVs, already being developed, is aligned with many Roadmap recommendations\*



- Expansion of the registration of brands and models of CNG vehicles.
- Financing of CNG stations in facilities of logistics and urban transport operators.
- Financing the qualification of CNG stations for the supply of heavy vehicles.
- Treatment of the regulatory issue *of diesel-gas* (dual-fuel).
- Coordinated strategy for urban mobility.
- Structuring of blue corridors .

\* Source: *Gas for the Development*, BNDES, February 2021

## Public Sector Action Plan (Year 1 & on-going)



International models exist to help fill gaps in Brazil NGV regulations but they are *not yet* adopted by Inmetro

- ✓ **L-NGVs.** Begin development of standards/regulations for LNG trucks, fuel tanks, connectors/receptacles & stations (LNG & L-CNG).
  - *Models exist: ISO standards & UNECE regulation R.110*
- ✓ **Dual-fuel.** Begin development of regulations for Dual-Fuel (diesel-gas) conversion systems.
  - *Model exists: UNECE Regulation-49*
- **Temporary exemptions** for HDV LNG truck and fueling should be considered while Brazil standards are developing.... *if the technologies already are in compliance with international standards/regulations!*

# Essential: adopt & use NGV-2 (ISO 14469-2) Universal quick-fill fuel connector for HDVs



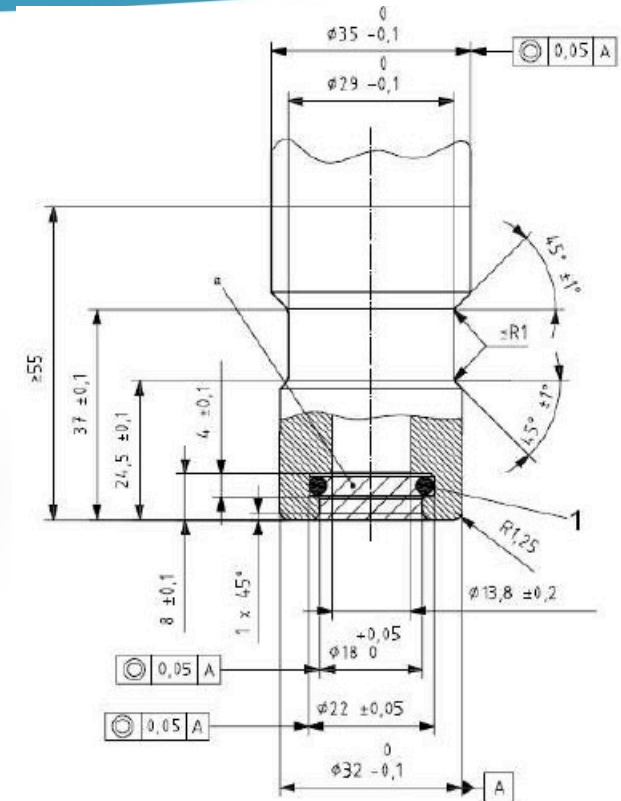
The currently used 'bayonet'-style fuel connector at Brazil public fuel stations is not adequate for high speed fueling requirements for HD trucks and buses.

**NGV-2 provides for significantly reduced fueling time for HDVs. (Classes M2, M3, N2 & N3 vehicles)**

**NGV-1** (light duty vehicles) and **NGV-2** are the universally accepted CNG connectors by the NGV industry worldwide.



Photo: WEH



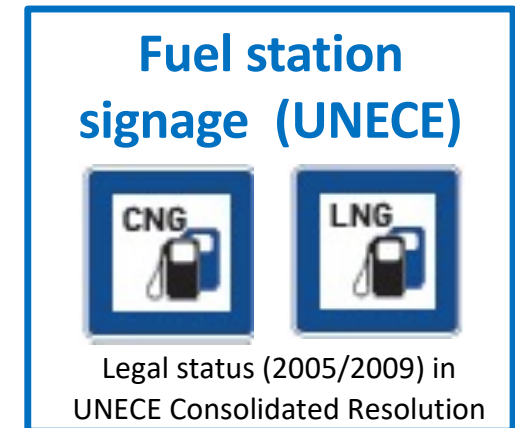
**NGV-2 is approved  
ISO & in UNECE R.110**

# OTHER IMPORTANT STANDARDS/REGS ISSUES

## MONITORING, AMENDING & INVOLVEMENT IS NECESSARY



- Natural gas, LNG & biomethane<sup>+</sup> composition.
  - Key issues: Wobbe index; Methane number (anti-knock resistance); and ethane content (CNG/LNG).
- Emissions certification test fuels.
- Small-scale liquefaction systems.
- ADR (dangerous goods vehicles) certified to run on CNG/LNG (UNECE ADR regulations exist).
- Create diesel-liter-equivalent (DLE) for user-friendly sale of gas to fleet operators.
  - Challenging for existing LDV market (*but possible*)
  - Possible (and recommended) for the ‘new market’ of HDVs
- If not already in force, CNG cylinder end-of-useful-life handling procedures.



<sup>+</sup> **Biomethane quality.** Agência Nacional do Petróleo, Gás Natural e Biocombustíveis, Ranp 685 – 2017. **ANP Resolution No. 685 OF 06/29/2017** establishes the rules for the approval of quality control and the specification of biomethane from landfills and sewage treatment plants for vehicular use and residential, industrial and **commercial installations to be sold throughout the national territory.** 37

## OVERVIEW OF OPPORTUNITIES TO LOWER COSTS & IMPROVE THE ECONOMICS (TCO)



- Stabilization of fuel price differential between natural gas and diesel.
- Federal & local taxes: fuel, vehicles & road.
- Reduce import tariffs for NGV technologies.
- Financial incentives/assistance: subsidies & loans.
- Lowering regulatory costs.
- Carbon credits to OEMs and fleets.
- OEM favorable fleet leasing program vs. purchase.

***All*** stakeholder engagement is needed, with the focus on  
the ultimate customer: ***fleet operators!!***

## Stabilization of fuel price differential between natural gas and diesel is THE key for fleet operators.



- Developing a policy mechanism to stabilize the price differential is complicated by exchange rates (with the US\$), as well as institutional and regulatory challenges.
- **Conclusion:** A mechanism to stabilize the fuel price-differential may be impossible to create, so: *Other price reduction mechanisms must be developed to create a favorable TCO for fleet operators.*

## GAS SELLERS OPTIONS TO STABILIZE FUEL PRICE DIFFERENTIAL



- Natural gas seller provides price of gas linked to the price of diesel at X% (30-50% less?), guaranteeing a stable price differential for fleet owners TCO.
- Based on a long-term contract (5 years?) (even consider 'Take or Pay' provision by gas supplier).
- Multi-stakeholder financing partnerships focused on the customer: Consider a program similar to The Clean Energy *Zero Now* model.

## Federal & local taxes 'Wish List' of possible cost-reductions for fuel, vehicles & road use



- **Reduction of state natural gas fuel tax**, specially ICMS (a form of VAT), which varies by state, between 7% and 18%.
- **Reduction of tax for CNG/LNG trucks acquisition.**
- **Exemption for the annual ownership tax (IPVA)**, applicable to CNG/LNG trucks. It is a state tax and the criteria change by jurisdiction. Tax normally ranges from 1.5% to 4% of the asset assumed price. (Some states already give discounts for NGVs.)
- **Price reduction of annual mandatory insurance (DPVAT)**, applicable to CNG/LNG trucks. It is a fixed price, depending on the vehicle category.
- **Price reduction of annual licensing**, applicable to CNG/LNG trucks.
- **Exemption of road tolls**, applicable to CNG/LNG trucks. Prices vary, depending on the road concession contract and number of axles. *(Has been very popular and successful in Germany!)*

## Tariffs impede the importation of critical NGV technologies but there are solutions and opportunities.



### Create favorable tariff conditions to make imported NGV technology that is *not available* in Brazil more cost-competitive as Environmentally Friendly Technologies (EFTs)

- CNG/LNG trucks and *lightweight* CNG cylinders (currently as much as 35% import tax).
- Gas engines, NG fuel systems and other equipment.
- Generally, expand the so-called “ex-tarifario” granted for ISO-certified CNG cylinders and LNG dispensers. For example, reduce import taxes from 35% to.... 3%(?).

## Regulatory cost reduction for cylinder manufacturers: *Certificate of Conformity (CoC) for the **life** of the cylinder*



- CNG cylinders are manufactured to a certified life of 15-20 years. They are subject to *periodic inspections* along with auto safety inspections (**not** re-certification).
- **BUT:** Current Brazil regulations require foreign CNG cylinder manufacturers to undergo complete CoC **re-certification every three years** at a cost of R\$ 300,000 (US\$ 53,395).
- This requirement is not associated with safety and *seems to be* a punitive, revenue-raiser that will further drive up the cost of already-expensive imported lightweight CNG cylinders.



# Additional potential cost reduction concepts to support OEMs & fleet purchases of NGVs.



- **Carbon credits to OEMs and fleets.**

Provide carbon credits to OEMs for building/selling NGVs and to fleet operators for purchasing them. Can be tied to Proconve 8 (for OEMs) and tons/GHGs reduced by fleets.

- **OEM favorable fleet leasing program vs. purchase.**

Helps reduce the cost burdens – initially – of modifying maintenance facilities to accommodate gas vehicles & and doing self-maintenance (training required).

- **For municipalities, in particular, create collaborative vehicle purchase programs to reduce higher cost of vehicles.**

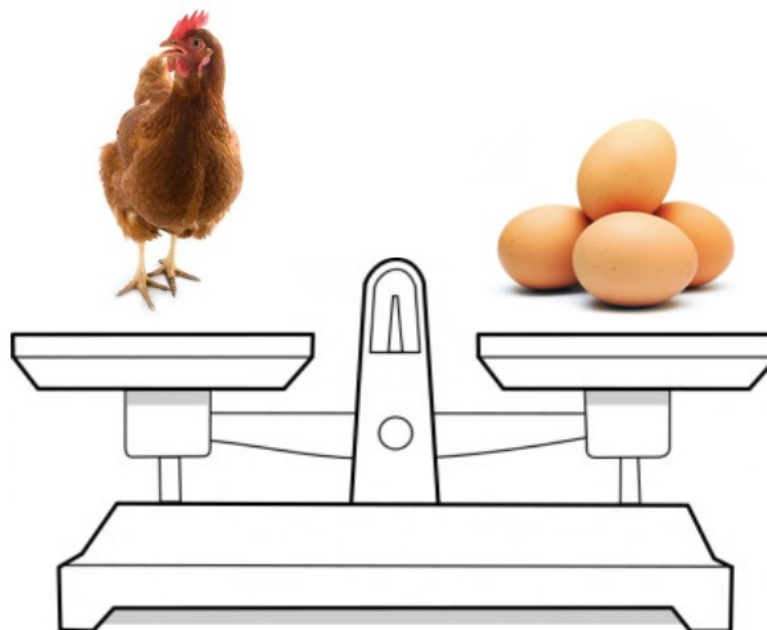
Working with other fleet operators and OEMs, developing ‘*bulk purchases*’ of similar vehicles (buses) vs. smaller, individual vehicle purchases could result in reduced costs (economy of scale) to both OEMs and fleet operators.



# Balancing Chickens & Eggs



There are a wide variety of options and opportunities to develop the fuel station network to suit the short-medium-and- long-term needs of fleet owners & operators.



## **Municipal Fleets**

- Buses
- Garbage Trucks

## **Logistics Fleet Operators**

- Larger Commercial
- Smaller Private

# Understanding the fueling preferences for HDV fleet operators is critical to creating the appropriate and sustainable HDV fuel network



## Locating Fuel Stations

- **Public stations may not be suitable for HDVs** and must be evaluated to determine storage & compressor capacity suited for high-flow HDVs to avoid back-ups of LDV customers. (And ready to provide NGV-2 fuel connector.)
- **Central, on-site fuel stations** are most popular for many fleet operators (fuel price discounts for large volume; technical control over fueling operations).
- **Blue Corridors/gas highways** for over-the-road trucking: Shared public stations or at designated truck-stops.
- **Dedicated HDV stations shared by multiple fleets** strategically located, inside the urban core. Economic for fleets & attractive for gas retailers for high-volume gas sales (including biomethane).

## Gas Delivery Options

- **Pipeline gas** directly to the compressor station.
- **Mother-daughter stations:** fuel brought by large-volume trucks from a central fuel depot to local stations, either CNG, LNG or biomethane....as a *'virtual pipeline.'*
- **Truck-mounted portable fueling stations** (CNG and LNG) appropriate for small private fleets or fleet demonstrations 'trying out' a small numbers of trucks.

## Opportunity: Focus on “hub ports” (air & sea)



**Airports and seaports** are important, high fuel-consuming ‘hub’ locations serving many diverse and high-fuel-consuming vehicle operators (trucks, ships & rail).

- Typically, airports & seaports are sources of highly concentrated air pollution.
- Large number of vehicles visit and circulate continuously.
- Many types of fleets: public & private sectors (LDV & HDV).
- Need very few fueling stations within the facility (one in the ‘secure areas’ and one for public access).
- Highly visible for visitors and other fleets operators.
- New opportunities at LNG receiving terminals to deliver to LNG trucks or CNG as L-CNG.

*(ISO has developed fuel connector & bunkering standards for LNG ships.)*



EU. Maglog project

# COMMUNICATIONS & PUBLIC RELATIONS

## All Stakeholders have responsibility for “NGV Outreach”

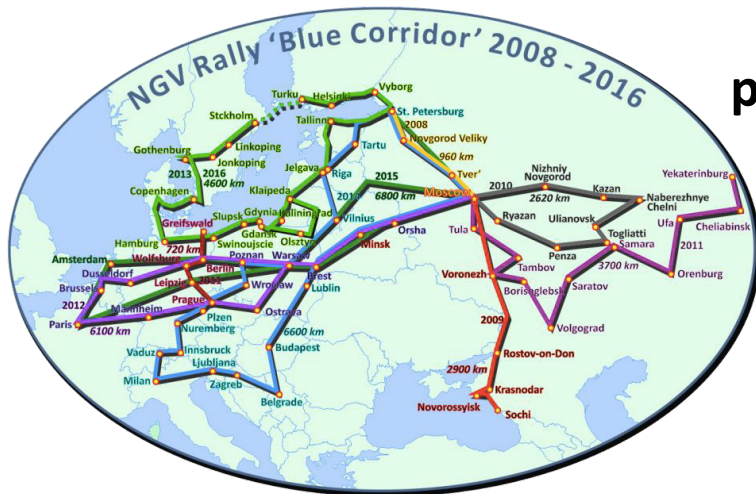


- **Public Sector.** Outreach & analyses to provide confidence to stakeholders of a firm policy direction and goals.
- **Gas Industry.** Targeted media campaign to truck & bus fleets touting economics & environmental benefits of NGVs.
- **OEMs & Equipment Suppliers.** Targeted outreach to largest fleet operators (commercial & municipal) to provide NGVs matching customer profile.
- **Fleet Operators.** Tell customers their ‘green fleets’ are environmentally responsible. Also, to share operational and best practice experiences with stakeholders and policymakers;
- **Fuel Infrastructure Providers.** Identify and target large fleets for best fuel options and identify opportunities for shared, HDV fuel station and anchor fleets.
- **Civil Society.** Identify potential *early adopters* and “*Champion pilot fleets*”; Provide results of analytics to government and other stakeholders.



Roadmap do Mercado Brasileiro de VEÍCULOS PESADOS A GNV

# Public relations and advertising campaigns touting Environmentally Friendly, Abundant Gas in Mobility for Today & Tomorrow. *Bringing the vehicles to the public!*



NGV Rallies have been a popular public relations opportunity; also to bring stakeholders together.



Twice across America: 1984 & 1986



Lisbon to Tokyo  
15,000 km: from 5<sup>th</sup> Oct to 9<sup>th</sup> Nov 2009



NGV Rally-2018: 'GAS INTO ENGINES'  
Russian & German Participants



URAL NEXT, LNG/CNG, 1000 km	KAMAZ 43118, LNG/CNG, 1300 km	Камаз NEO, LNG+Disel, 1600 km	Hyundai 87, LNG/CNG, 850 km	Lotos 105, LNG, 600 km	Уаз Патриот, CNG/petrol, 920 km	Лада Веста, LNG/petrol, 1050 km	VW Passat, CNG/petrol, 1000 km

MetanoGraph

## A 'SOFT MANDATE' CONCEPT TO TRANSITION to NATURAL GAS HDVs WITH *REASONABLE MILESTONES*



### Target Fleets of 10+ vehicles

- Concept based upon target population of fleets of 10+ HDVs.
- Natural turnover of HDV fleet vehicles based on 5 years in fleet before sold to second-hand market = 20% turnover of total fleet every year.
- 'Soft mandate' (*WITH incentives*) is to increase NGV % of NEW vehicle purchases of that 20% : Year 1= 10% NGVs; year 2= 20%; year 3= 30%; year 4= 40%; year 5=50% (and some % thereafter).
- For a fleet of 100 vehicles, 20 new vehicles bought per year, 10% = 2 vehicles. Should not be a hardship for any large fleet, even as the numbers grow annually.
- A lower percentage of annual vehicles purchases would make the target of NGV adoption lower but still result in *substantial* amounts of new HD NGVs.
- Instead of 'mandate' also could be a *target milestone*.
- **CAVEAT 1: The program depends upon vehicle availability of the types used by the large fleets.**
- **CAVEAT 2: Concurrent growth of fuel stations also is assumed!**

## Milestones based on a graduated scale-up of NGVs in large fleets will drive the OEM production, fuel station development and large-scale sale of gas. Smaller fleets will follow!



### Assumptions (example)

- **25% of total fleet vehicles are in fleets of 10+ = 474,568 vehicles.**
- 20% turnover p/year = 94,914 vehicles

% NGVs p/year Added	HD NGVs
10%	9,491
20%	18,982
30%	28,474
40%	37,965
50%	47,456
<b>TOTAL in 5 yrs</b>	<b>142,368</b>
<b>OR: assume 10% p/yr for 5 years</b>	<b>47,455</b>

Type of conveyor	Issued records	Vehicles/transporters
Transport companies (ETC)	154.234	1.172.250
Autonomous transporters (TAC)	533.913	700.911
Cooperative	343	25.112
<b>Total</b>	<b>688.490</b>	<b>1.898.273</b>

Source: BNDES elaboration, based on the National Register of Road Cargo Carriers (RNTRC), available by the National Land Transport Agency (ANTT), in [http://www.antt.gov.br/cargas/arquivos\\_old/Statistics.html](http://www.antt.gov.br/cargas/arquivos_old/Statistics.html). Access in: 4 Jun. 2019. as in BNDES, GNV 2020



Roadmap do Mercado Brasileiro de  
VEICULOS PESADOS A GNV

# AND FINALLY, SOME NGV 'RULES OF THE ROAD'

## 1. LEAD WITH THE ENVIRONMENT

- Cleaner air at Proconve 8.
- Biomethane a waste management strategy to achieve GHG goals on a on W2W basis.

## 2. CARROTS AND STICKS, BUT NOT TOO MUCH STICK

- Early adopters get higher incentives.
- Reduce subsidies gradually in accordance with growing market share.

## 3. ALL STAKEHOLDERS MUST BE COMMITTED TO USING NGVS THEMSELVES

- *Government*: Leadership by example.
- *Equipment sellers*: You sell NGVs? Drive NGVs!!
- *Gas guys*: Don't run your vehicles on the competitor's fuel (petroleum);
- *Infrastructure, Equipment suppliers & vendors*: Arrive at customer's site *driving* an NGV.

## 4. MAP OUT THE FUEL INFRASTRUCTURE WITH HUBS, SPOKES & CORRIDORS.

## 5. COMPETITION RESULTS IN LOWER PRICES (with the focus on fleet TCO) .

*The Second-Hand market will develop 'organically'.*



# CONCLUSIONS

## Optimism for the HD NGV markets in Brazil

- Many elements are in place for long term success.
  - Vehicle and fueling equipment suppliers involved
  - Gas suppliers and petroleum retailers engaged
  - Government and industry are cooperating to build the HD NGV market
- LDV NGV market will facilitate the use of HDVs in public and private sector fleets.
- Government support and incentives will help motivate growth of the NGV sector. Policy makers should take benefit of 'lessons learned' in other countries/regions.
- Involvement of managers from metropolitan regions, states and the Federal Government is needed to create a sustainable NGV market (and for other fuel alternatives). (Vertical integration, part of the Roadmap.)
- Strong competition from ethanol, diesel and EVs is a challenge but transparent policies can create a balance of cleaner fuels and technologies.
- Bio-methane could be a game-changer for a growing NGV sector.

The Brazilian partners have embraced the Roadmap.  
We can anticipate growth in the natural gas HD bus & truck markets!



Source: 11th Annual ENGVA Conference logo 2005, Bolzano, Italy



# ANNEX



# REGISTRATION OF TRUCKS BY TYPE 2002-2019

Ano Year	Semileves Semi-light	Leves Light	Médios Medium	Semipesados Semi-heavy	Pesados Heavy	Total Total
2002	6.898	19.627	9.907	15.276	13.972	65.680
2003	5.460	17.925	8.485	16.883	17.209	65.962
2004	5.943	20.245	8.647	22.308	24.341	81.484
2005	6.891	19.943	8.449	22.597	21.653	79.533
2006	7.451	19.385	9.538	20.189	19.408	75.971
2007	8.468	22.639	11.239	27.940	28.299	98.585
2008	8.863	25.441	11.888	37.434	38.661	122.287
2009	6.604	25.823	11.503	34.773	31.124	109.827
2010	7.325	34.466	14.038	49.985	51.893	157.707
2011	7.893	39.453	14.052	57.955	53.517	172.870
2012	6.551	33.346	11.849	45.879	41.549	139.174
2013	5.522	34.090	11.135	47.943	55.886	154.576
2014	3.967	28.725	11.699	45.237	47.427	137.055
2015	3.709	19.375	6.965	22.940	18.663	71.652
2016	3.514	13.161	4.221	14.478	15.186	50.560
2017	3.518	11.687	4.449	13.542	18.747	51.943
2018	4.122	11.554	7.677	17.867	34.785	76.005
2019	5.080	11.242	10.069	23.226	51.718	101.335

Semileves / Semi-light	PBT >3,5 t. < 6 t.	Semipesados / Semi-heavy		Pesados/Heavy	
Leves / Light	PBT ≥ 6 t. < 10 t.	Caminhão-chassi / Truck	PBT ≥ 15 t. e/ and CMT ≤ 45t.	Caminhão-chassi / Truck	PBT ≥ 15 t. e/ and CMT > 45 t.
Médios / Medium	PBT ≥ 10 t. < 15 t.	Caminhão-trator / Truck-tractor	PBT ≥ 15 t. e/ and PBTC < 40t.	Caminhão-trator / Truck-tractor	PBT ≥ 15 t. e/ and PBTC ≥ 40 t.

PBT – Peso Bruto Total / GWW; CMT – Capacidade Máxima de Tração / GCW; PBTC – Peso Bruto Total Combinado / CCGW.  
> maior / more than; ≥ maior ou igual / more than or equal to; < menor / less than; ≤ menor ou igual / less than or equal to.

Source: Brazilian Automotive Yearbook, 2020, p.65.