



Brazilian Automotive Market: Use of Biodiesel Blend B7

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Introduction / Motivation

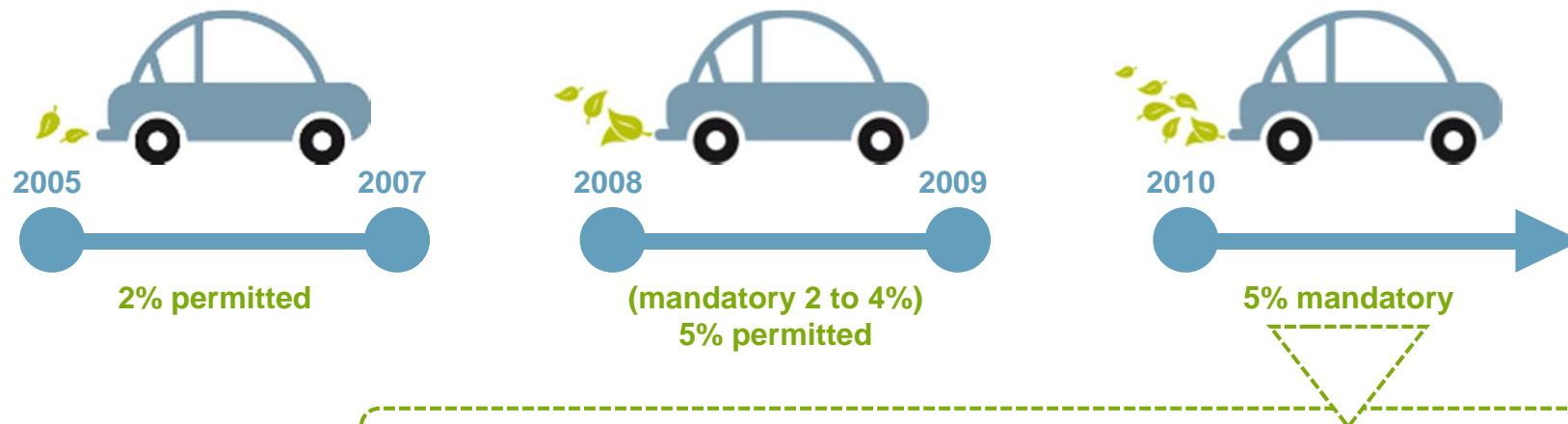
BRAZIL

- ❑ **2013: In use, 5% biodiesel addition to diesel;**
- ❑ **It was created a government working group to study the biodiesel blend increase to 7%;**
- ❑ **Literature review: use of biodiesel in EU and USA, to study the main differences compared to Brazil.**

Biodiesel Market Evolution - Brazil



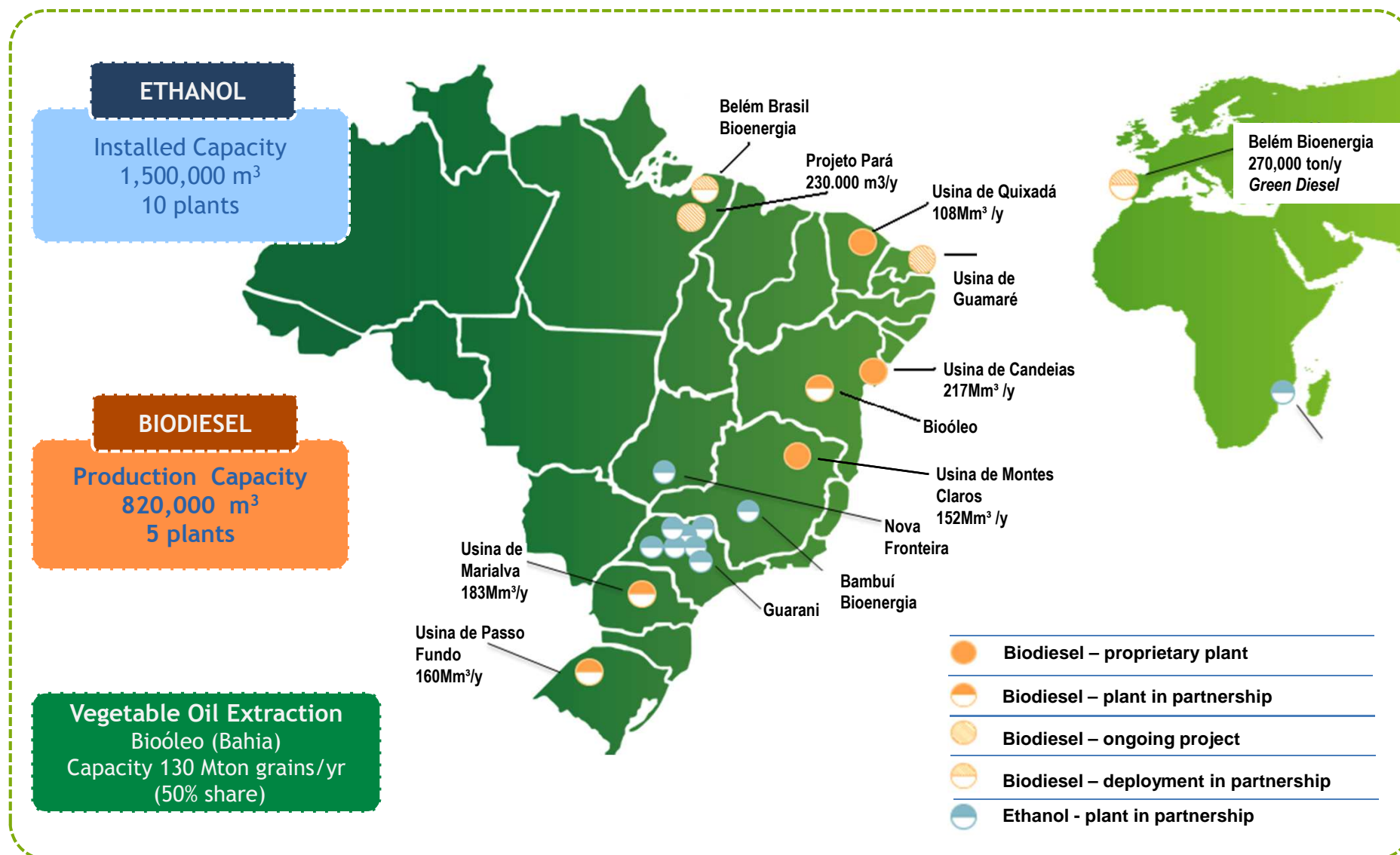
Law 11097/2005 - established mandatory content of biodiesel in diesel. The addition of biodiesel to diesel has been negotiated by stakeholders considering technical limitations.



Higher percentages may be used, once authorized by the National Petroleum and Biofuels Agency-ANP for testing or use in:

- Proprietary or specific vehicle fleets;
- Sea, river or railroad transport;
- Electric power generation;
- Specific industrial process.

Petrobras Biocombustível - Operational Plants



Biodiesel Quality

Challenges

Quality standards



**Market penetration
Environmental impact**

- ✓ Market requirements and fuel specification
- ✓ Performance, emissions and engine durability;
- ✓ Safety for storage and transportation;
- ✓ Fuel stability (thermo and biological).

Impacts of Biodiesel and Diesel Blends

- ✓ more sensitivity to microbial degradation;
- ✓ increase in engine out NO_x ;
- ✓ lubricant and engine cleanliness degradation and polymer formation;
- ✓ lower stability and worse cold flow properties (increase the risk of filter plugging).

In addition, biodiesel impurities can result on:

- ✓ deposits formation (fuel filters, injector tips, bottom of fuel tank...);
- ✓ degradation of some elastomers;
- ✓ corrosion of metals;
- ✓ poisoning of SCR , DPF and oxidation catalyst.

Europe Scenario for Biodiesel Blends

- ❑ 2009 ➡ Allowed up to 7% of biodiesel volume in diesel (EN590).
- ❑ 2010 ➡ The UK Society of Motor Manufacturers and Trades (SMMT)
“...it is unlikely that B7 causes some problems, even for older vehicles...”;
➡ All new cars sold in the EU can use B7.
- ❑ 2012 ➡ New Biodiesel (B100) specification, EN 14214:
 - ✓ oxidation stability (from 6 to 8 hours);
 - ✓ monoglycerides (from 0,80 to 0,70 wt%).

Published Brazilian Durability Tests Using Biodiesel Blends

SIMEA,

- ✓ 100,000 km travelled using B5 in Ford Ranger model, with Common Rail Injection system;
- ✓ Biodiesel from soybean oil;
- ✓ Considering engine power, fuel consumption, emissions and durability the performance of B5 was similar to diesel.



SIMEA, 2014



- ✓ 100,000 km travelled using B20 (using S500 diesel) in vehicles attending PROCONVE P5 and L4 emissions legislation;
- ✓ No significant difference on emission;
- ✓ Some corrosion problems verified mainly in the metallic part of fuel filling tubes.

Published Brazilian Emissions Tests Using Biodiesel Blends

SIMEA, 2011

- ✓ B5 and B20 (using S50 diesel) in vehicles attending PROCONVE L3 emissions legislation (after 2007) and an engine PROCONVE P5;
- ✓ No significant differences for NO_x, PM and aldehydes emissions.

SAE 2001

- ✓ B2, B20 and B100 tested in different engines without aftertreatment system;
- ✓ There were not significant increase of emissions up to B20 blends.

SAE 2013

- ✓ B5 to B100 tested in engine PROCONVE P7 (EURO V);
- ✓ There were not significant increase of emissions up to B30 blends.

Works Published - Stability

SAE, 2104

- ✓ Oxidation Stability
- ✓ B5, B7 and B10 (using S50 and S500 diesel);
- ✓ Biodiesel from tallow and soybean oil;
 - B5 and B7 → no significant change;
 - B10 → further degradation after ageing.

EXPERIMENTAL TESTS

Bench Engine Tests for B5 and B7 Blends

Characteristic	S500		S10
	Engines		
	P4 (Euro II)	P5 (Euro III)	P7 (Euro V)
Engine size	4.3 L	3.9 L	4.58 L
Injection system	Rotary pump	Common rail	Common rail
Aspiration	Turbo Intercooler	Turbocompressor	Turbocompressor
Max. power	107 kW @ 2,600 rpm	126 kW @ 2,500 rpm	142 kW @ 2,400 rpm
Max. torque	500 Nm @ 1,600 rpm	600 Nm at 1,300 rpm	700 Nm @ 1,100 rpm

CONAMA P7 ENGINE EMISSION TESTS



Emissions Results - B5 referencered

❑ Vehicle L4 / Test method NBR 6601 (dynanometer)

➡ No significative difference

	B5 x B7	B5 x B10
CO	=	=
THC	-8.8%	-7.4%
NOx	=	=
MP	=	-6.9%

- Engine PROCONVE P4 (EURO II)
using diesel S500;

	B5 x B7	B5 x B10
CO	=	=
HC	=	=
NOx	=	2.8%
MP	=	=

- Engine PROCONVE P5 (EURO III)
using diesel S500

Emissions Results - B5 referencered

	B5 x B7	B5 x B10
CO	-11.9%	-16.5%
HC	=	=
NOx	=	=
MP	=	=

- Engine PROCONVE P7 (EURO V)
using diesel S10;
- ESC EMISSION CYCLE

	B5 x B7	B5 x B10
CO	-14.6%	-12.1%
THC	=	=
NOx	=	=
MP	=	=

- Engine PROCONVE P7 (EURO V)
using diesel S10;
- ETC EMISSION CYCLE

New Specification for Biodiesel (B100) in Brazil

Property	Unit	ANP N° 14 / 2012	ANP N° 45 / 2014	EN 14214
Water, max.	mg/kg	200	200	500
Oxidation stability, min. (at 110°C)	h	≥ 6	≥ 8 (B7)	≥ 8
Monoglycerides, max.	% mass	0.8	0.7	0.7
Carbon residue, max	% mass	0.25	-	-

Note: B5 up to June/2104 ; B6 started July/2014 and B7 started november, 1st

Final Comments

- ❑ **Emission and stability tests using B7, no problems were found;**
- ❑ **Need to change the biodiesel specification to use B7 (ANP N° 45 / 2014);**
- ❑ **Reduction of diesel importation and increase biodiesel production;**
- ❑ **R & D projects are ongoing to study the use of higher biodiesel contents.**