ecorodovias

SINELEC BRASIL

- **HS-WIM - High Speed WIM**
- **MLFF - Multilane Free Flow**

Brazilian Experience

[1] - Weight in movement

HS-WIM – A Game Changing Technology in Brazilian Weighting Model

ecorodovias

SINELEC BRASIL

Traditional Scales:

- **Partial weighing and lack of full vehicle coverage**, enabling **evasion from the weighing system;**
- **Speed reduction requirements,** causing congestion, queues, and safety risks;
- **Complex, high-cost infrastructure**, with elevated CAPEX, OPEX, and operational headcount;
- **Inefficient and fragmented operating model,** limiting scalability and real-time data usage.

HS-WIM – A Game Changing Technology in Brazilian Weighting Model

ANTT Regulatory Sandbox

- Controlled environment for testing;
- Due to the success, ANTT allowed Ecorodovias to implement HS-WIM instead traditional scale;
- INMETRO certification mandatory for direct enforcement.
- Implementation made in Partnership with Sinelec and Kistler.

International Benchmarking with Brazilian Authorities

Sinelec's presentation in Amsterdam

HS-WIM – A Game Changing Technology in Brazilian Weighting Model

ecorodovias

SINELEC BRASIL

INMETRO Requirements

- From 7km/h to 90km/h;
- 2,5% - Total Gross Weight;
- 4,0% - Total Gross Weight;
- Cryptography Module.

To this day, it is the only product certified for weigh-in-motion in Brazil for direct enforcement.

DIÁRIO OFICIAL DA UNIÃO

Publicado em: 01/08/2024 | Edição: 147 | Seção: 1 | Página: 30

Órgão: Ministério do Desenvolvimento, Indústria, Comércio e Serviços/Instituto Nacional de Metrologia, Qualidade e Tecnologia

PORTARIA Nº 402, DE 30 DE JULHO DE 2024

O PRESIDENTE DO INSTITUTO NACIONAL DE METROLOGIA, QUALIDADE E TECNOLOGIA - INMETRO, no exercício da competência que lhe foi outorgada pelo artigo 4º, § 2º, da Lei n.º 5.966, de 11 de dezembro de 1973, combinado com o disposto nos artigos 18, inciso XI, do Anexo I ao Decreto n.º 11.221, de 05 de outubro de 2022, e 105, inciso XI, do Anexo à Portaria nº 2, de 4 de janeiro de 2017, do então Ministério da Indústria, Comércio Exterior e Serviços, bem como a Lei n.º 9.784, de 29 de janeiro de 1999 e a Portaria Inmetro n.º 436, de 02 de outubro de 2023;

De acordo com o Regulamento Técnico Metrológico para instrumentos de pesagem automáticos de veículos rodoviários em movimento aprovado pela Portaria Inmetro n.º 019/2022; e

Considerando os elementos constantes do Processo Inmetro n.º 0052600.006580/2023-88, resolve:

Aprovar os modelos 9195GC3x, 9195GC4x e 9195GC5x, de instrumentos de pesagem automático de veículos rodoviários em movimento, classe de exatidão 1A, marca ECORODOVIAS/KISTLER, de acordo com as condições de aprovação, disponível no sítio do Inmetro: http://www.inmetro.gov.br/pam/.

MARCIO ANDRE OLIVEIRA BRITO

Este conteúdo não substitui o publicado na versão certificada.

INMETRO

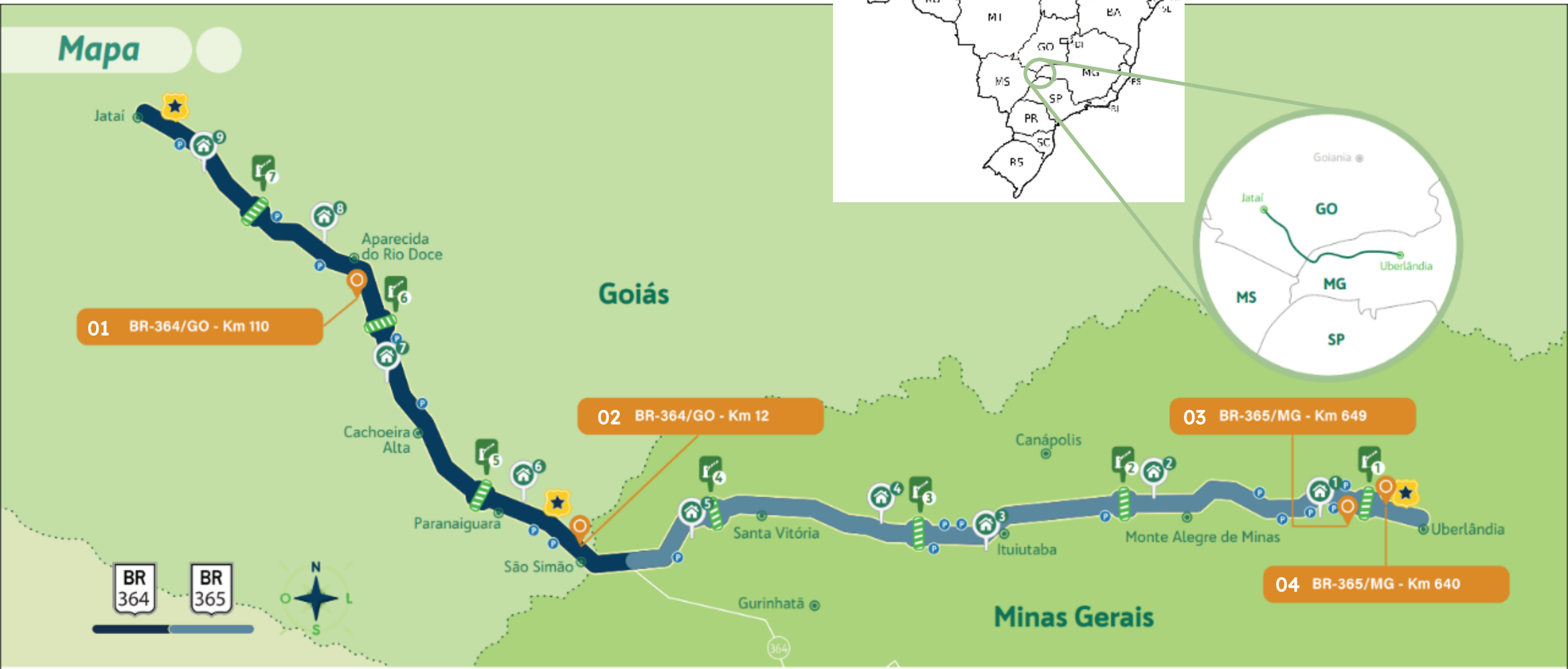
Inmetro publica aprovação de modelo de novo sistema de pesagem automático para rodovias brasileiras

Ecovias Cerrado

ecorodovias

SINELEC BRASIL

ANTT Sandbox Project: 4 sites



025 Key Results

ecorodovias

SINELEC BRASIL

HS-WIM

- 6 Stations
- 42.935 fines
- less than 1% of frauds
- 35% dos autos de todo o país
- 20% less CO2 emissions

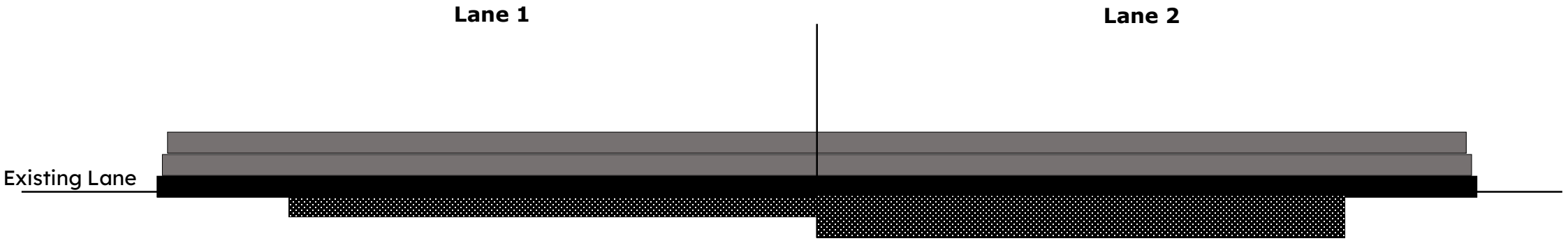
Traditional Scales

- 38 Stations
- 79.547 fines
- 423.197 escapes
- 5x violations than fines

HS- WIM TECHNOLOGY CHALLENGES - GOALS

- Pavement for Weighing Lane (flexible
- Weight Accuracy – Less than 2,5% TGW and 4% group of
- Brazilian Classification – More than 100 truck classes to identify
- Real time data collection - Government

Pavement construction process



- Milling and Reconstruction with HMA FxB using High-Modulus Asphalt (4 cm Layer 1 | 8 cm Layer 2)
- 4 cm HMA FxB Reinforcement using High-Modulus Asphalt across the entire platform
- 9 cm GAP FxD Reinforcement using Rubber-Modified Asphalt (2 layers) across the entire platform

TRANSPORT RESEARCH

COST 323

Weigh-in-Motion of Road Vehicles

5.1 Road Geometry

5.1.1. It is strongly recommended that road section between 50 m upstream and 25 m downstream of the system meets the following geometrical characteristics:

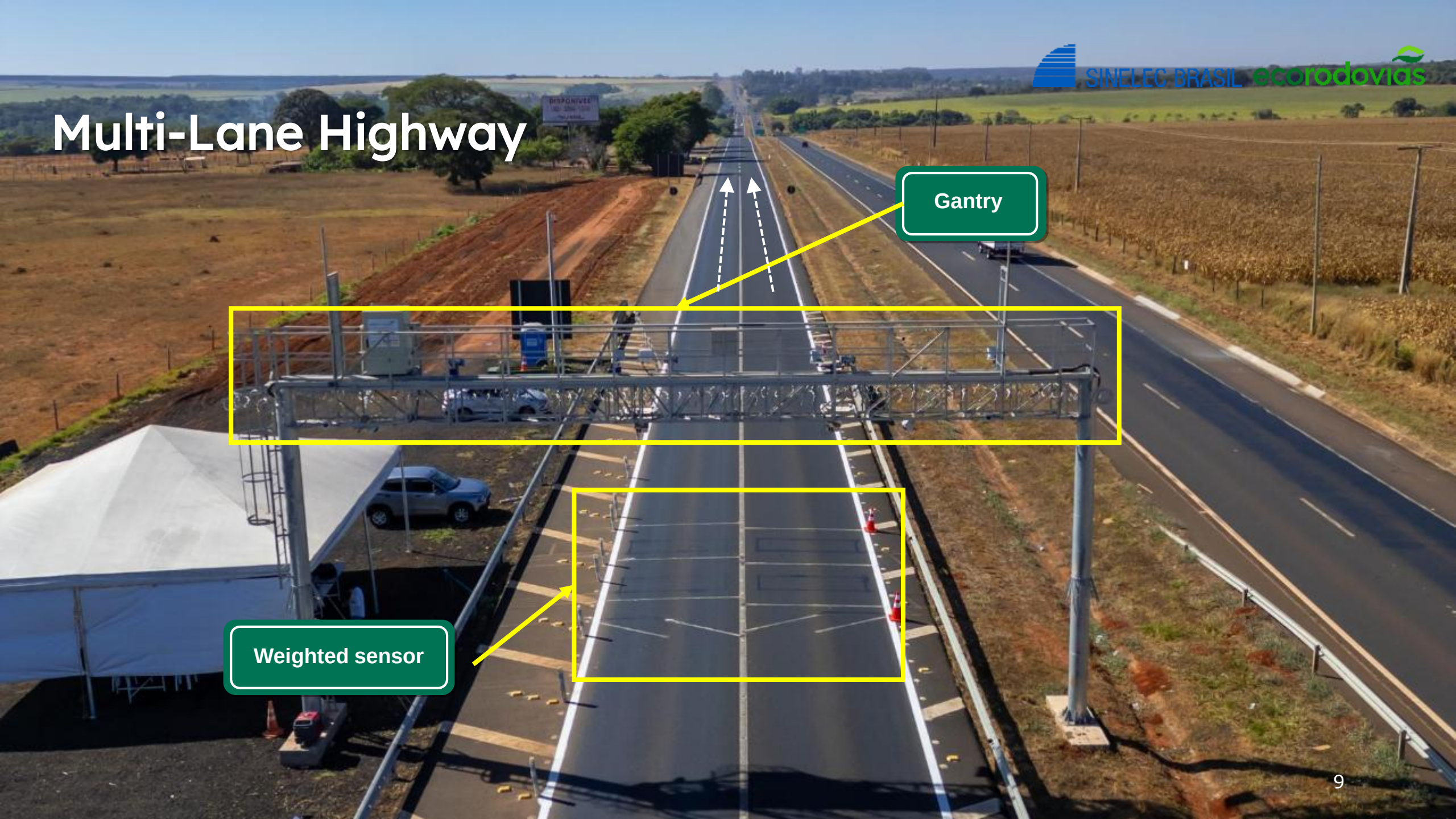
- longitudinal slope < 1% (class I site) or < 2% (other site classes), depending on the site class (see 5.2.2) and as far as possible constant;
- transverse slope < 3%;
- radius of curvature > 1000 m (but a straight road would be preferred).

5.2 Pavement Characteristics

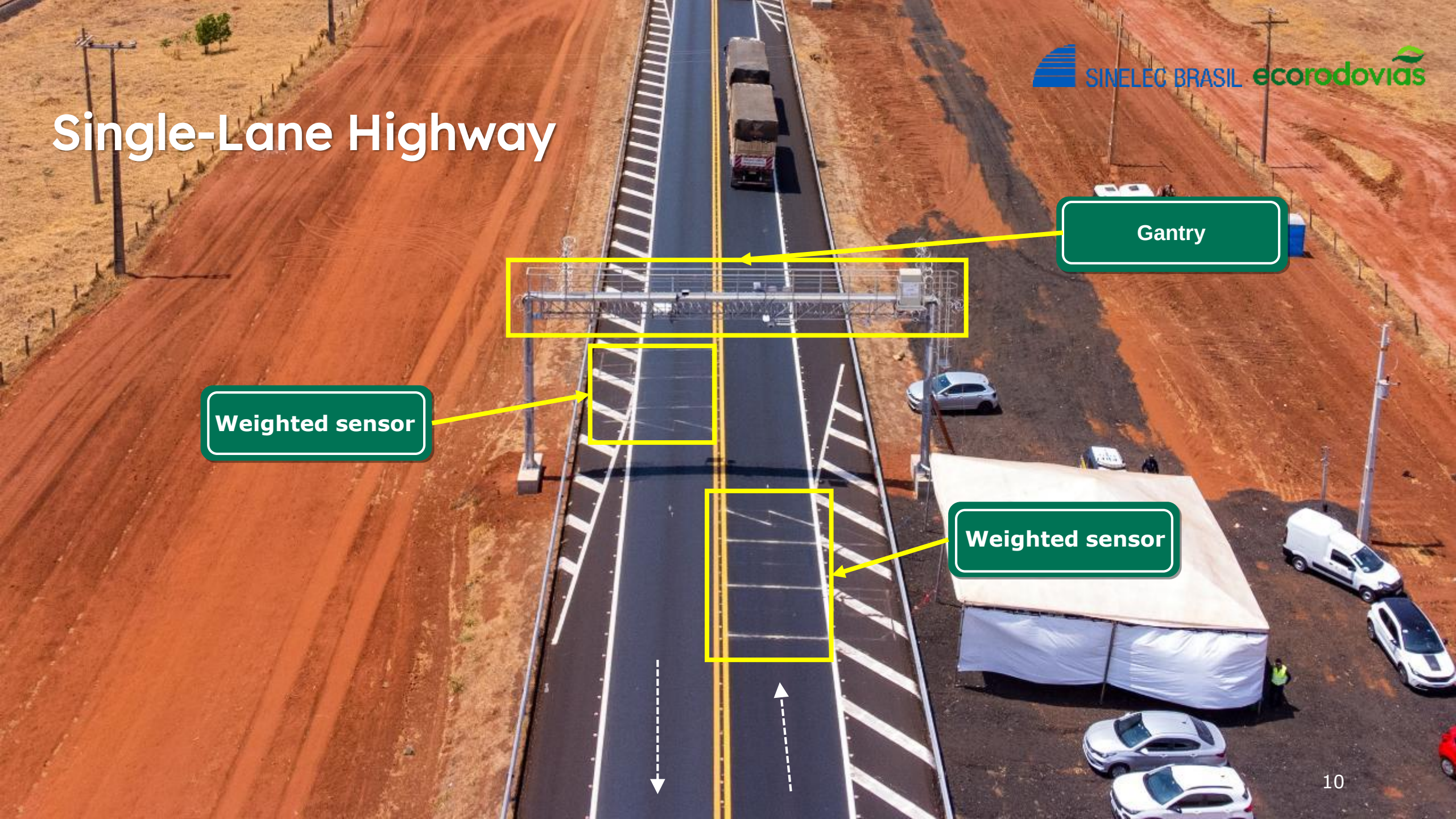
Table 1: Classification and criteria of WIM sites

			WIM site classes		
			I Excellent	II Good	III Acceptable
Rutting (3 m - beam)		Rut depth max. (mm)	≤ 4	≤ 7	≤ 10
Deflection (quasi-static) (13 t - axle)	Semi-rigid Pavements	Mean deflection (10^{-2} mm)	≤ 15	≤ 20	≤ 30
		Left/Right difference (10^{-2} mm	± 3	± 5	± 10
	All bitumen Pavements	Mean deflection (10^{-2} mm)	≤ 20	≤ 35	≤ 50
		Left/Right difference (10^{-2} mm	± 4	± 8	± 12
	Flexible Pavements	Mean deflection (10^{-2} mm)	≤ 30	≤ 50	≤ 75
		Left/Right difference (10^{-2} mm	± 7	± 10	± 15
Deflection (dynamic) (5 t - load)	Semi-rigid Pavements	Deflection (10^{-2} mm)	≤ 10	≤ 15	≤ 20
		Left/Right difference (10^{-2} mm	± 2	± 4	± 7
	All bitumen Pavements	Mean deflection (10^{-2} mm)	≤ 15	≤ 25	≤ 35
		Left/Right difference (10^{-2} mm	± 3	± 6	± 9
	Flexible Pavements	Mean Deflection (10^{-2} mm)	≤ 20	≤ 35	≤ 55
		Left/Right difference (10^{-2} mm	± 5	± 7	± 10
Evenness	IRI index	Index (m/km)	0 - 1.3	1.3 - 2.6	2.6 - 4
	API [1]	Rating* (SW, MW, LW)	9 - 10	7 - 8	5 - 6

Multi-Lane Highway

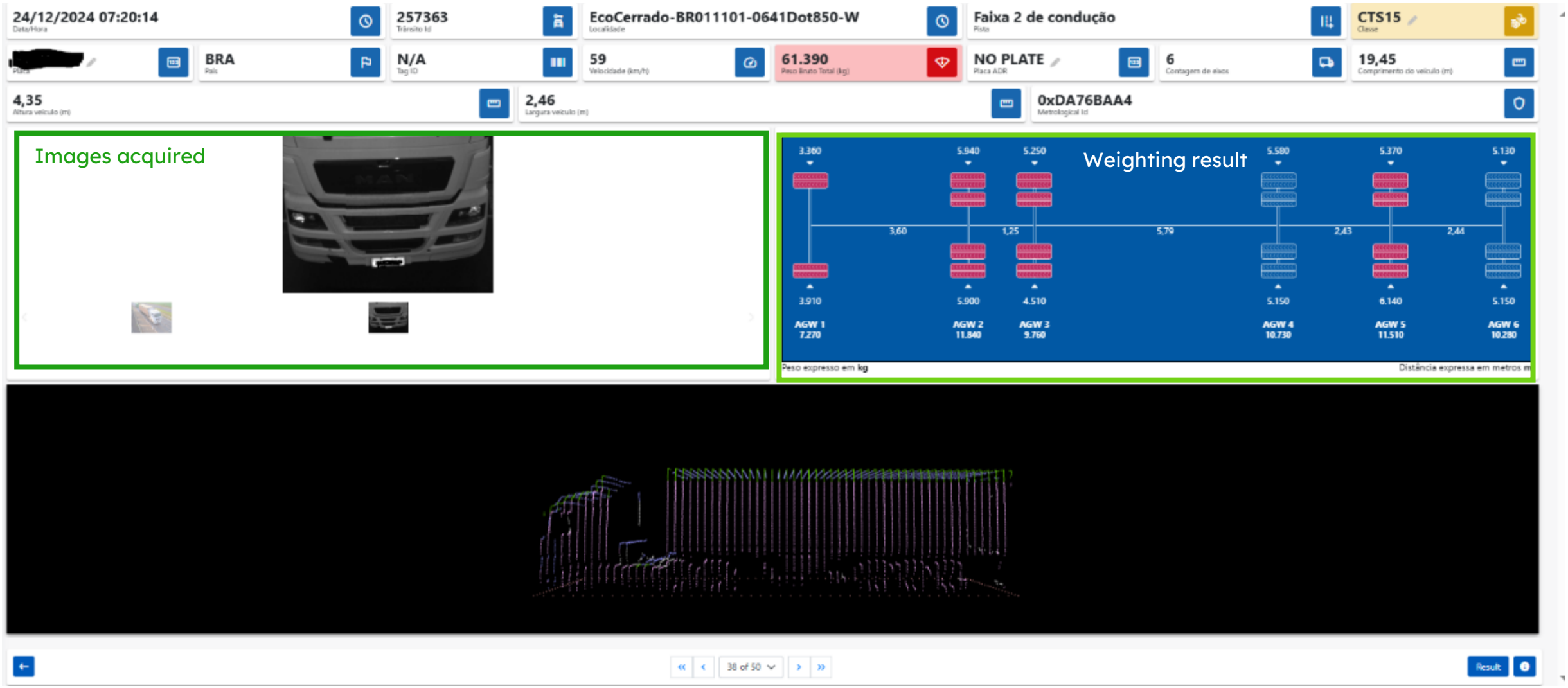


Single-Lane Highway

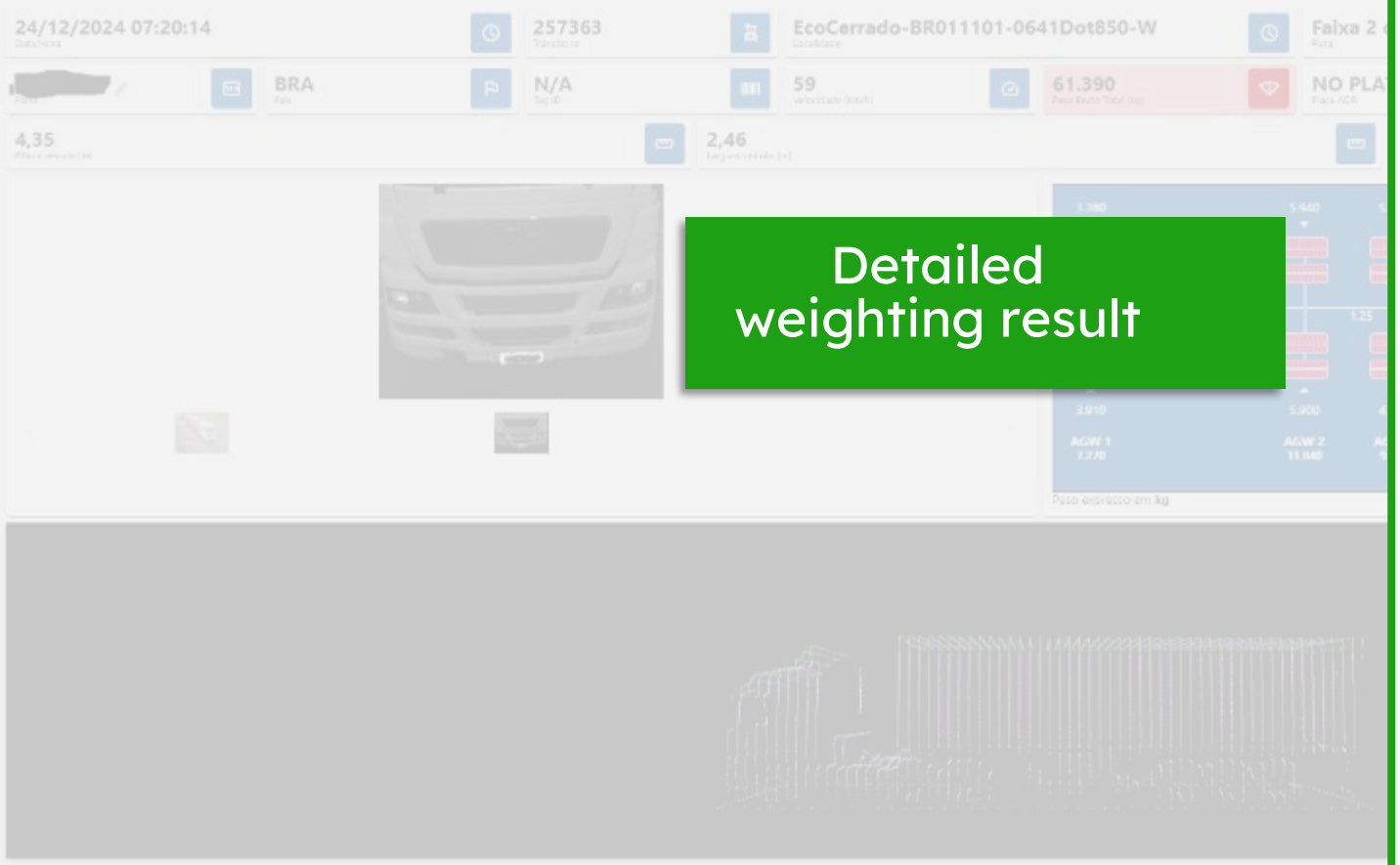


System Display – HSWIM [1/2]

SINELEC BRASIL ecorodovias



System Display – HSWIM [2/2]



Detailed weighting result

ANOMALIAS

Data/Hora	Id Anomalia	Descrição Anomalia
24/12/2024 07:20:14	1	OverWeightT
24/12/2024 07:20:14	2	OverWeightS
24/12/2024 07:20:14	7	OverWeightAxleGroup

INMETRO SIGNATURE

3f51baa7e8e0b0c98d530eaea2ad4ebbd888079462236efbbae59f7cb58107b47305914abbf7acbdc4141c67c362e8c03490
3863f33ec0bf46891ea8f1a7f534

DETALHE EIXOS

Eixo ID	Peso	Peso da roda esquerda	Peso da roda direita	Desequilíbrio do eixo esquerdo	Desequilíbrio do eixo direito	Distância do eixo	Tipos de Rodas esquerdas	Tipos de Rodas direitas	Posição esquerda	Posi dire
7691846	7.270 kg	3.910 kg	3.360 kg	46,217 %	53,783 %	0,00 m	S	S	3,06	0,99
7691847	11.840 kg	5.900 kg	5.940 kg	50,169 %	49,831 %	3,60 m	D	D	2,89	1,13
7691848	9.760 kg	4.510 kg	5.250 kg	53,791 %	46,209 %	1,25 m	D	D	2,90	1,17
7691849	10.730 kg	5.150 kg	5.580 kg	52,004 %	47,996 %	5,79 m	D	D	2,94	1,03
7691850	11.510 kg	6.140 kg	5.370 kg	46,655 %	53,345 %	2,43 m	D	D	2,93	1,06
7691851	10.280 kg	5.150 kg	5.130 kg	49,903 %	50,097 %	2,44 m	D	D	2,94	1,03

GRUPO DE EIXOS

Classe de trânsito CTS15	Grupo 1	Grupo 2		Grupo 3	Grupo 4	Grupo 5
	Eixo 1	Eixo 2	Eixo 3	Eixo 4	Eixo 5	Eixo 6
Eixo	7270 kg	11840 kg	9760 kg	10730 kg	11510 kg	10280 kg
Grupo	7270 kg	21600 kg		10730 kg	11510 kg	10280 kg

HISTÓRICO DE MUDANÇAS

Nome da tabela ID	Coluna	Tipo de Mudança	Usuário	ID da Empresa do Usuário	Alterar dados	Valor antigo	Valor Atual
Dw001DataMaster	ClassId	Modified	Alessandro	2	26/12/2024 06:47:54	CTSR4	CTS15

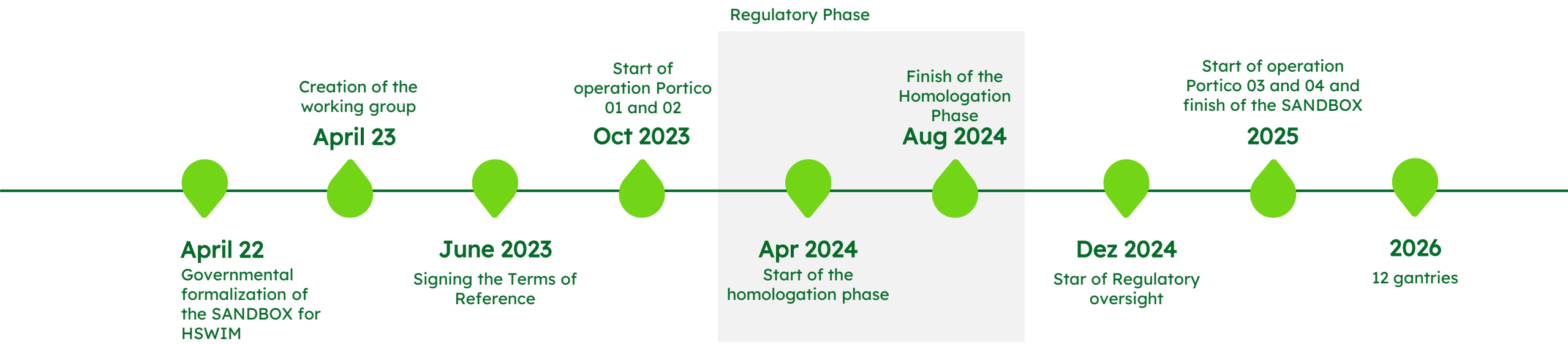
OTHERS ANOMALIES

Data/Hora	Type Anomaly	Name Anomaly	Descrição Anomalia
24/12/2024 07:02:52	warning	Single track vehicle	The vehicle was driving only one side of the system. Either a motorcycle or only one side of the vehicle was measured.

RESULT ENFORCEMENT

Data/Hora	Usuário	Empresa	Validation Code	Validation Date	Response
24/12/2024 07:20:14	[redacted]	2	[redacted]		200 OK

HSWIM Roadmap



First company in Brazil certified by INMETRO[1] with the classification to operate as HS-WIM with direct enforcement.

[1]National Institute of Metrology, Quality and Technology.

Multi-Lane Free Flow

MLFF – A new era of Brazilian Tolling

Initial Context

- **Pressure for tariff exemptions in bordering municipalities**, reflecting concerns over territorial fairness and local mobility impacts
- **Need for a fair, proportional, and transparent tariff model**, aligned with user pay principles, social acceptance, and regulatory guidelines
- **Requirement to ensure traffic fluidity, road safety, and enforcement integrity**, without physical toll barriers
- **Expectation of full traceability and data governance**, supporting regulatory oversight, auditability, and integration with national mobility systems

MLFF – A new era of Brazilian Tolling

ecorodovias

SINELEC BRASIL

Regulatory Challenges – MLFF (Free Flow)

- Ensuring **robust enforcement,** accurate **identification, minimal evasions** and clear penalties;
- **Weakness of legacy toll** regulation to accommodate barrier-free charging models;
- **Need for contractual, economic and legal frameworks that** support MLFF without jeopardizing concession balance;
- **Integration with vale-pedágio** and transport law requirements;
- Creating simple, **accessible payment options for occasional users**;

Key Normative Milestones

- Lei 14.157/2021 – legal basis for Free Flow
- CONTRAN 984/2022 – initial regulatory procedures
- CONTRAN 1.013/2024 – technical and procedural framework
- ANTT sandbox & consulta pública 2025 – experimental and final norm harmonization
- ARTESP

MLFF – A new era of Brazilian Tolling

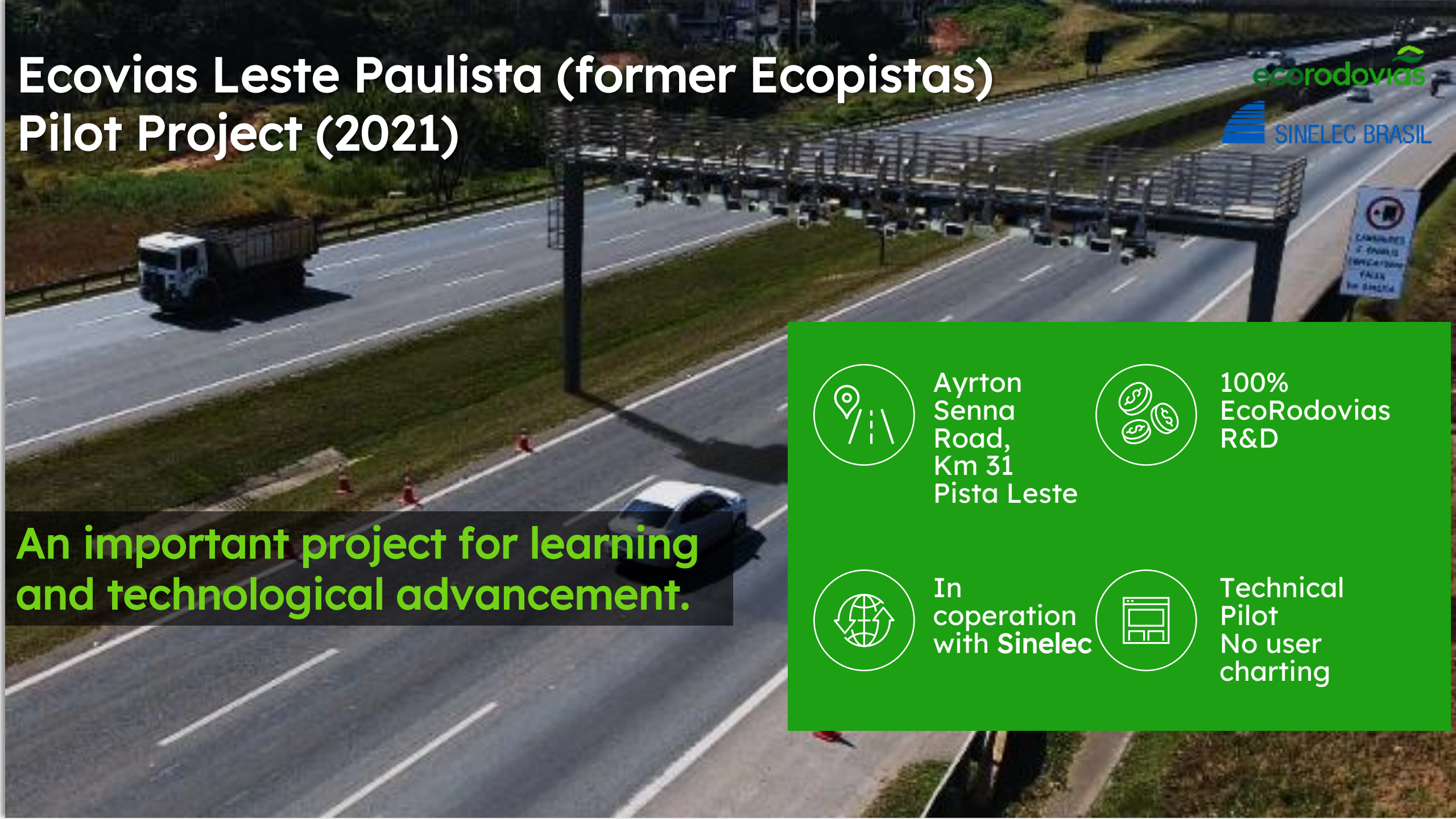
ecorodovias

SINELEC BRASIL

Technical Challenges

- **Suspended axles** and correct tolling.
- Congestion and **queue**;
- **Motorcycles** (shifting lanes)

Ecovias Leste Paulista (former Ecopistas) Pilot Project (2021)

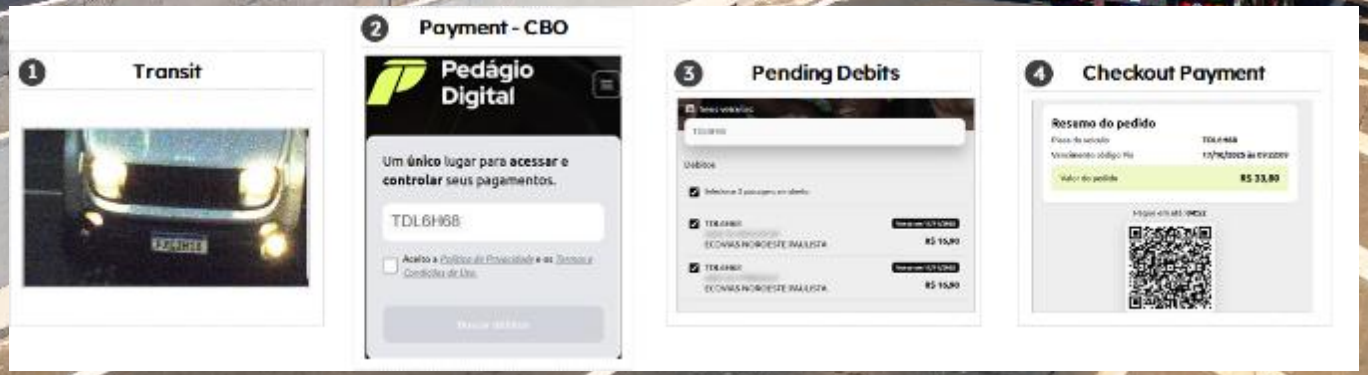


An important project for learning and technological advancement.

- Ayrton Senna Road, Km 31 Pista Leste
- 100% EcoRodovias R&D
- In coperation with **Sinelec**
- Technical Pilot No user charting

Ecovias Noroeste Paulista
1st MLFF project charging in São Paulo

- 85%- 90% users with tag;
- Less than 4% of evasions / violations;
- Gantry with Sinelec Technology;
- 85% of non tagged users pay with Pix at PedagioDigital.com



Operational BackOffice | SIGA

ecorodovias

SINELEC BRASIL

SAP | Power BI | DFe | Plataforma de Conciliação | Enforcement

FADAMI Software & Innovation

TAG Operators

- Mensageria
- DBT, DUF e MDFe

SEM PARAR | Conect Car | veloe | Taggy | move mais

SIGA/Toll (BackOffice Operacional)

Tariff Rules	Financial Consolidation	Revenue Collection	Revenue Assurance
Tolls	Evasion	Monthly Closings	Consolidated Analyses and Comparisons
Classes	Disputes	Operational Monitoring	Revenue Recovery
Discounts	Billing Monitoring	Revenue Loss Control	
Exemptions	Acquirers	Tax and Accounting Integration	Operational Audit
Payment Methods	Manual Transit Validation		

Intelligent Validation

- Rules
- Monitoring
- AI Validation
- Extenal Queries
- Reports

CBO | Pedágio Digital

Integration

SINELEC

Gantry

StarGate / Toll Host

- Gantries
- Classes
- Classification Logic
- Equipment Integration
- Transactions
- Images
- Dashboards

MIP
Toll Information Module
Free Flow

ARTESP | ANTT

Operation

MLFF | Program Overview

Year	QTY accumulated	Monthly Traffic	Business Unit
2025	8 gantries	985k	Noroeste Paulista (8)
2026	12 gantries	3.88MM	Noroeste Paulista (8) Imigrantes (4)
2027	75 gantries	38.2MM	Noroeste Paulista (14) Imigrantes (4) Raposo Castello (22) Rio Minas (35)
2028...2033	93 gantries	60.5MM	Noroeste Paulista (20) Imigrantes (4) Raposo Castello (34) Rio Minas (35)

MLFF TECHNOLOGY CHALLENGES - GOALS

- ✓ Brazilian Classification System - AVC
- ✓ Lifted Axel and Dual Tire – Diferent Toll charge
- ✓ LPR Accuracy (users Without TAG) - toll evasion
- ✓ Real time data collection – 24/7 - revenue guarantee

Free Flow | Pórtico

Devices

Laser Comark

1

-Tattile Tolling+85
- Axle Counter

2

Start System Titan

3

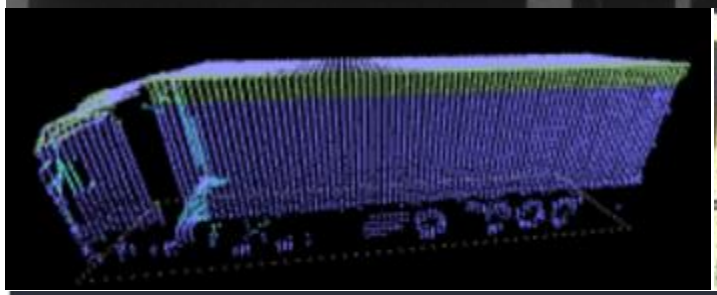
Kistler

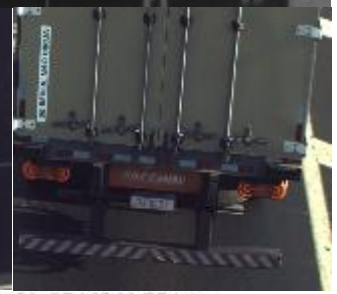
4

Example – Category and data

SINELEC BRASIL ecorodovias

	CATEGORIA	EIXO	
DUAL TIRE →	Automóvel, caminhonete e furgão (rodagem simples)	2	R$ 16,40
DUAL TIRE →	Caminhão leve, ônibus, caminhão -trator e furgão (rodagem dupla)	2	R$ 32,80
	Automóvel e caminhonete com semirreboque	3	R$ 24,60
	Caminhão, caminhão-trator, caminhão -trator com semirreboque e ônibus	3	R$ 49,20
	Automóvel e caminhonete com reboque	4	R$ 32,80
	Caminhão com reboque, caminhão -trator com semi-reboque	4	R$ 65,60
	Caminhão com reboque, caminhão -trator com semi-reboque	5	R$ 82,00
	Caminhão com reboque, caminhão -trator com semi-reboque	6	R$ 98,40
	Caminhão com reboque, caminhão -trator com semi-reboque	7	R$ 114,80
	Caminhão com reboque, caminhão -trator com semi-reboque	8	R$ 131,20
	Motocicletas, motonetas e bicicletas moto	-	R$ 00,00





2026-01-12_17-21-40-156_SRA6D63-BRA.jpg


```
TransactionID: 325529
Timestamp: "2026-01-12T17:21:43.697-03:00"
CreationTimestamp: "2026-01-12T18:27:15.7081567-03:00"
LastUpdateTimestamp: "2026-01-12T18:27:15.7081567-03:00"
TransactionStatus: null
TransactionType: "FreeFlow"
TransactionSource: null
TollTagID: "1303403513"
TollPlate: "SRA6D63"
TollPlateFrontRear: "F"
Class: "Heavy Truck"
LaneDirection: "Running"
GateOpStatus: 1
AmountDue: null
▶ IntrinsecValidation: { Primary: 13, Secondary: 3 }
▶ Transit: { RelIndex: 0, WrongWay: false, EntryLaneId: 2, ... }
```

ecorodovias | ecosystem ecovias

SINELEC BRASIL

ecorodovias.com.br