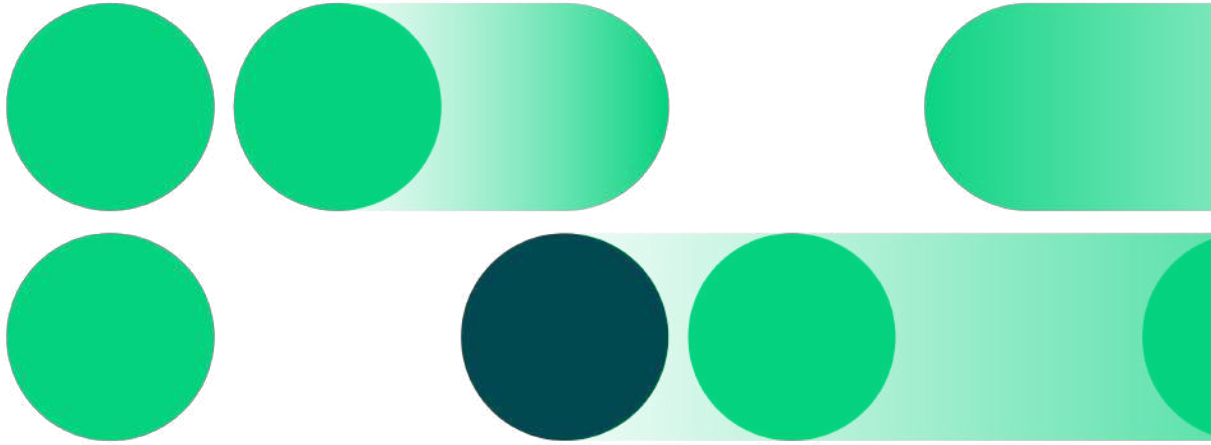
Sustainable strategies to increase the resilience and integrity of REN's Gas and Electricity Infrastructures

Enhancing Climate Adaptation and System Resilience in the ENTSO-E TYNDP CBA Framework

RGI & ENTSO-E Expert Workshop



19 October 2023 I ENTSO-E premises

José Moreira - Asset Management / Asset Integrity

Date: 19/10/23

Version: v1.0

Classification: Restricted

Owner: Asset Management.

Aproved by: Asset Management

Lista de distribuição: NA

REN is an integrated Electricity and Natural Gas Transmission & Distribution Group, operating in Portugal and Chile

	Portugal	Chile
	Sole Electricity and Natural Gas Transmission System Operator (TSO)	
Electricity Transmission	> 9000Km 86 Substations	> 90Km 5 Substations Transemel (100% owned)
Natural Gas Transmission	> 1300Km 1 LNG Terminal Underground Storage	> 160Km ElectroGas (42.5% stake)
Natural Gas Distribution	> 6000Km	n.a.

REN Group 2022 Key Financials

EBITDA: 487.3 M€

Net Income: 111.8 M€

CAPEX: 201.5 M€

REN is committed to enabling a renewable future

2018

Two 70-hour periods **100% renewable**

Renewable production in March **exceeded consumption** of mainland Portugal

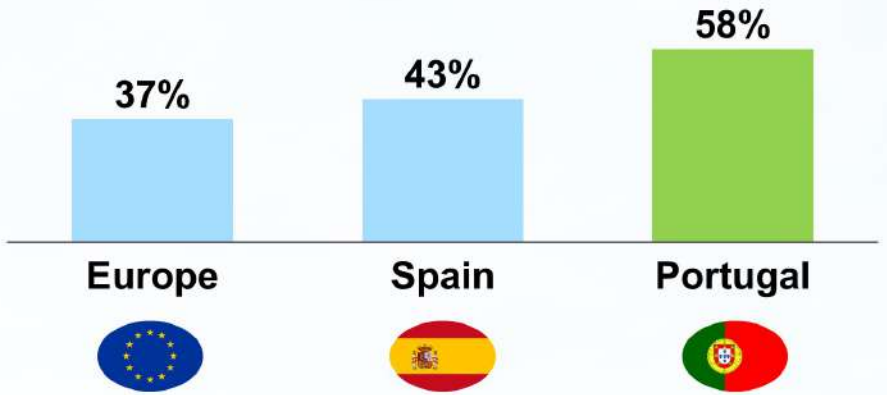
2019

131-hour period with **renewable production exceeding consumption**

2021

Renewable generation supplied 59% of national electricity **consumption**

% Electricity consumption from renewable sources (2020)



% Electricity consumption by source (2021)

Wind 26%	Biomass 7%	Gas 29%
Hydro 23%	Solar PV 3%	Coal 1%

Source: Eurostat; REN

Decarbonisation Roadmap at REN

Emissions

Electricity Transmission Grid Decarbonisation	Natural Gas Transmission Grid Decarbonisation	Decarbonisation of Office Buildings and Technical Facilities	Fleet Decarbonisation	Supply Chain

Systemic Decarbonisation

RES Integration	Renewable Gases Integration	RES Self consumption	Fleet Electrification	Supply Chain cooperation
		CH_4 and SF_6 Leak mitigation		Sustainable Procurement
		Energy Efficiency		

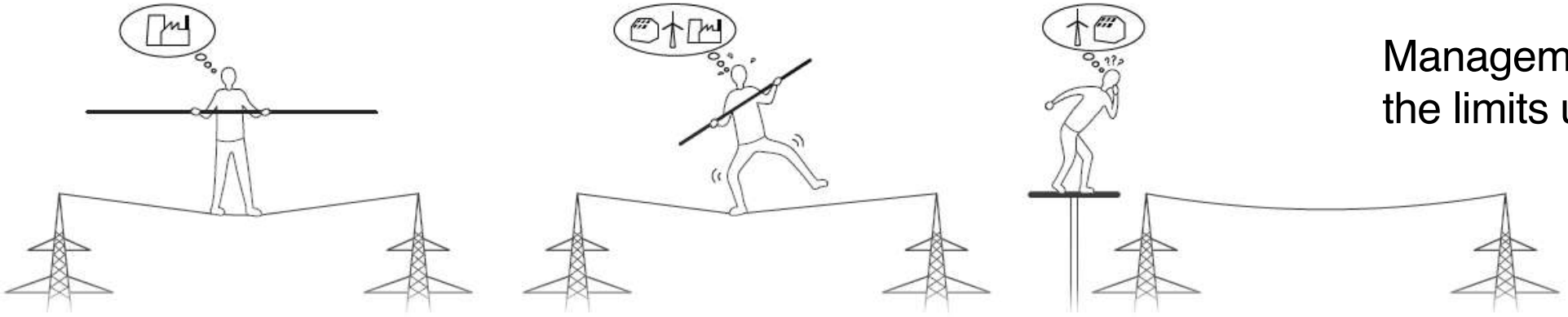
Removal / Capture

RoW Management and technical facilities

The simulation model development for medium and long-term scenarios, mapping the initiatives and modelling the ambition levels, **are essential to estimate the degree of accomplishment of the targets and for the 2030 and 2040 horizons.**

Different aspects of resilience - System

Resilience of the system with new renewable sources



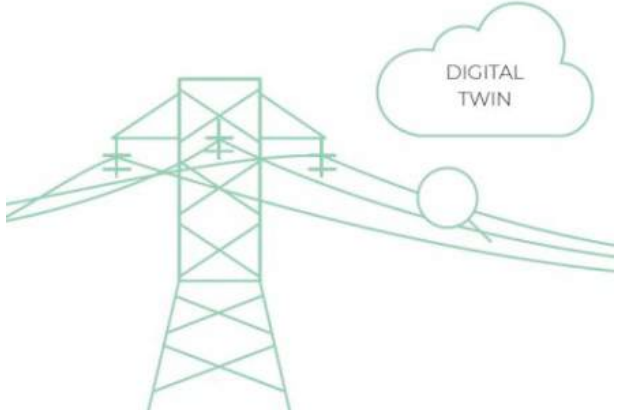
PREVIOUSLY
Inertia of the generators
immediately compensated deviations
(long balancing pole)

TODAY
the synchronous generators
are less and less often connected to the grid –
Inertia decreases
(balancing pole gets shorter and shorter)

IN THE FUTURE
very low levels of inertia will occur
(without balancing pole)

Management of the network at the limits using new technologies.

By comparing these two methods (Digital Twin and DLR), REN intend to identify their benefits and advantages to the optimized management of the network in real time.



Dynamic Line Rating

Different aspects of resilience - Asset

Resilience of the assets and the design standards

I. A significant part of the overall overhead line assets in the world with 40 and 60 years old now, were constructed with design standards considered appropriate at that time;

II. All the current standards compute extreme winds from annual records of synoptic winds, from which 50-year wind speed or wind pressure maps are developed;

III. In general most recent design loading standards are based on a the severe weather events having a 3% or 5% probability of exceedance over the design life, so there is always some risk of failure during the design life;

IV. Typical coordination strength criteria have a 90% confidence level that the major components will not fail first, however due to the random distribution of material properties, it is theoretically impossible to guarantee with 100% confidence level that the sequence of failure will be met in all cases;

Source: Cigré and EN 50341

Primary climate drivers

I. Temperature – changes in average temperatures and the frequency and magnitude of extreme temperatures;

II. Precipitation (rain, snow, etc.) – changes in average precipitation and the frequency and magnitude of extreme precipitation events;

III. Sea level – change in relative sea level;

IV. Wind speeds – changes in average wind speeds and maximum wind speeds;

V. Humidity – changes in the amount of water vapour in the atmosphere;

VI. Solar radiation – changes in the energy from the sun.

Changes in these factors result in a diverse set of climate hazards that may impact on a project:

Some Typical Climate Hazards	Description
Average air temperature increase	Increases in average temperatures over time
Extreme temperature occurrences (including heat waves)	Changes in the frequency and intensity of periods of high temperatures, including heat waves (periods of extremely high maximum and minimum temperatures)
Maximum wind speed	Increases in the maximum force of gusts of wind
Average wind speed	Changes in average wind speeds over time
Wild fire	Unwanted, unplanned and damaging fires such as forest fires and fires of shrub and grasslands
Water availability	The relative abundance or lack of water
Storms (tracks & intensity)	Changes in the location of storms, their frequency and intensity

Source: JASPERS, 2017

Overhead Lines Major Incidents

Freezing Rain at 28 Feb 2018 - 7 towers affected (~4km) at altitude above 700 m

According to IPMA (Portuguese Weather Institute), the Freezing Rain phenomena occurs when at a certain place there is a cold air mass (<0°C), and a warmer air mass (>0°C) comes over and causes rain. The rain freezes when in contact with solid objects or ground, due to the negative ambient temperature.

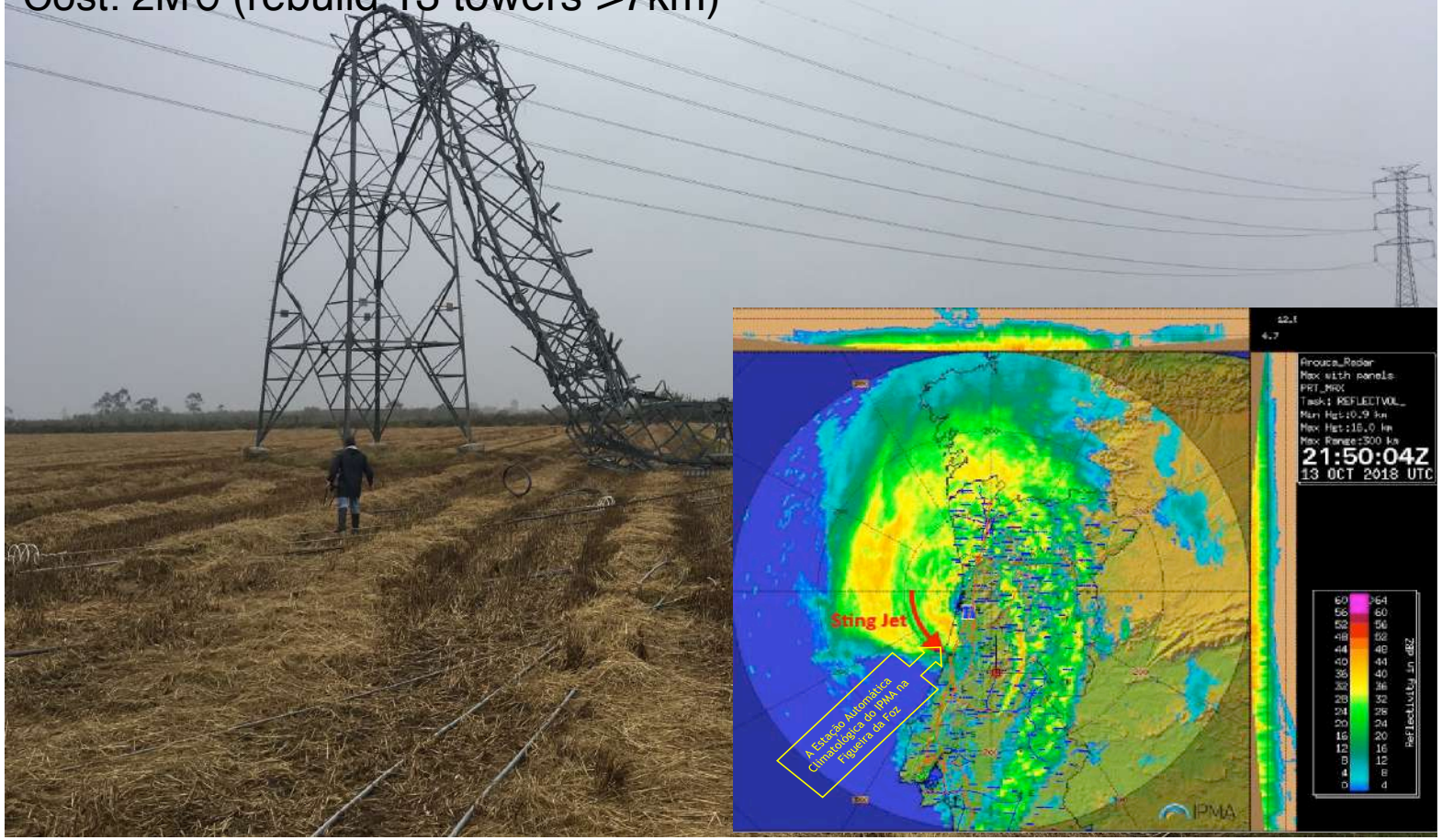
Cost: 2,6M€ (rebuild 21 towers->10km)

- Nowadays the ice formation zone classification standards report to every area above 600 m of altitude while before it was fixed above 700 m (EN 50341-3-17- National Normative Aspects (NNA) for Portugal);
- So, today these OHL would be designed for ice formation, with reinforced structures (foundations, towers and eventually conductors)
- **The ice phenomenon was observed even below the 600 m;**
- The thickness of the ice sleeve was observed at the early morning was at least the same diameter of the conductor (Zebra - 28,62mm – estimated ice weight about 0,7 to 1 kg/m). The Zebra cable can support 1,1 kg/m theoretically;

Overhead Lines Major Incidents

Storm Leslie at 13 Oct 2018 - 13 towers affected (~7km) between 7-10km coastline

On the 13th October 2018, around 22h40, the IPMA weather station registered in this coastal area the highest wind gust ever in Portugal – 176km/h. This value is due to a phenomenon designated as sting jet (scorpion effect).
Cost: 2M€ (rebuild 13 towers->7km)



- For REN OHL we adopted the maximum level of reliability (level 3), which corresponds to return period of 600 years (practically not adopted by other companies in Europe, only some with snowfall problems use this level);
- Different wind conditions are set for Zone A and Zone B (5km from coastal area), according to EN 50341-3-17;
- For example, according to EN 50341-3-17 a 65m high DLS8 tower, identical to one that collapsed, must withstand forces resulting from a reference wind speed of 157km/h in Zone A and 172km/h in Zone B.

In this area we registered the highest wind gust ever in Portugal 176km/h, **but looking at the damages on the field, IPMA estimated 200km/h!!**

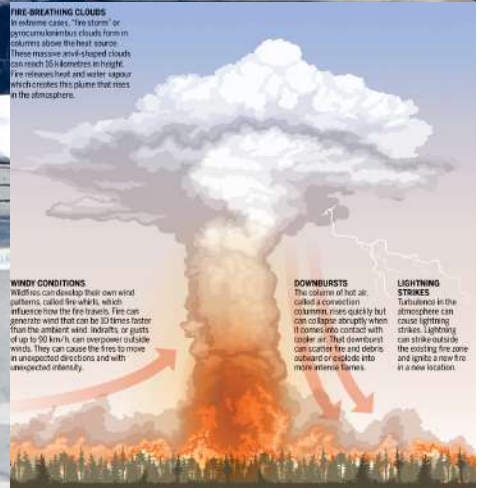
Other events related to strong winds and tower problems in the recent years: 1996 / 12-2009 / 12-2010 / 01-2013.

Major Wildfire Incident in Portugal

Pedrógão Grande Fire at 18 June 2017 - 66 deaths and 204 injured people

On the 18th June 2017, around 20h00, at high temperatures, the rupture of the convective column caused a local 'downburst' which dramatically changed the fire behavior. Witnesses reported a sudden 'bomb' of fire spreading tongues of flames and sparks in all directions.

Estimated direct cost of almost 200M€ (2017).



- The collapse in altitude from 13km to 6km of the convection column, resulting in "rain" of projections in interaction with the propagation front, resulted in the majority of fatalities;
- At 18:36 UTC it was observed by radar the highest wind speed value in the area, approximately 117km/h at 650m altitude (IMPA Report);
- Convective outflow spreading of the fire caused by the 'downburst' may have reached 70 to 90km/h at 18UTC, depending on the type of terrain (IMPA Report);
- This sudden and extreme event triggered the escape of villagers and overwhelmed those already on the roads;

Wildfires impact on REN infrastructures

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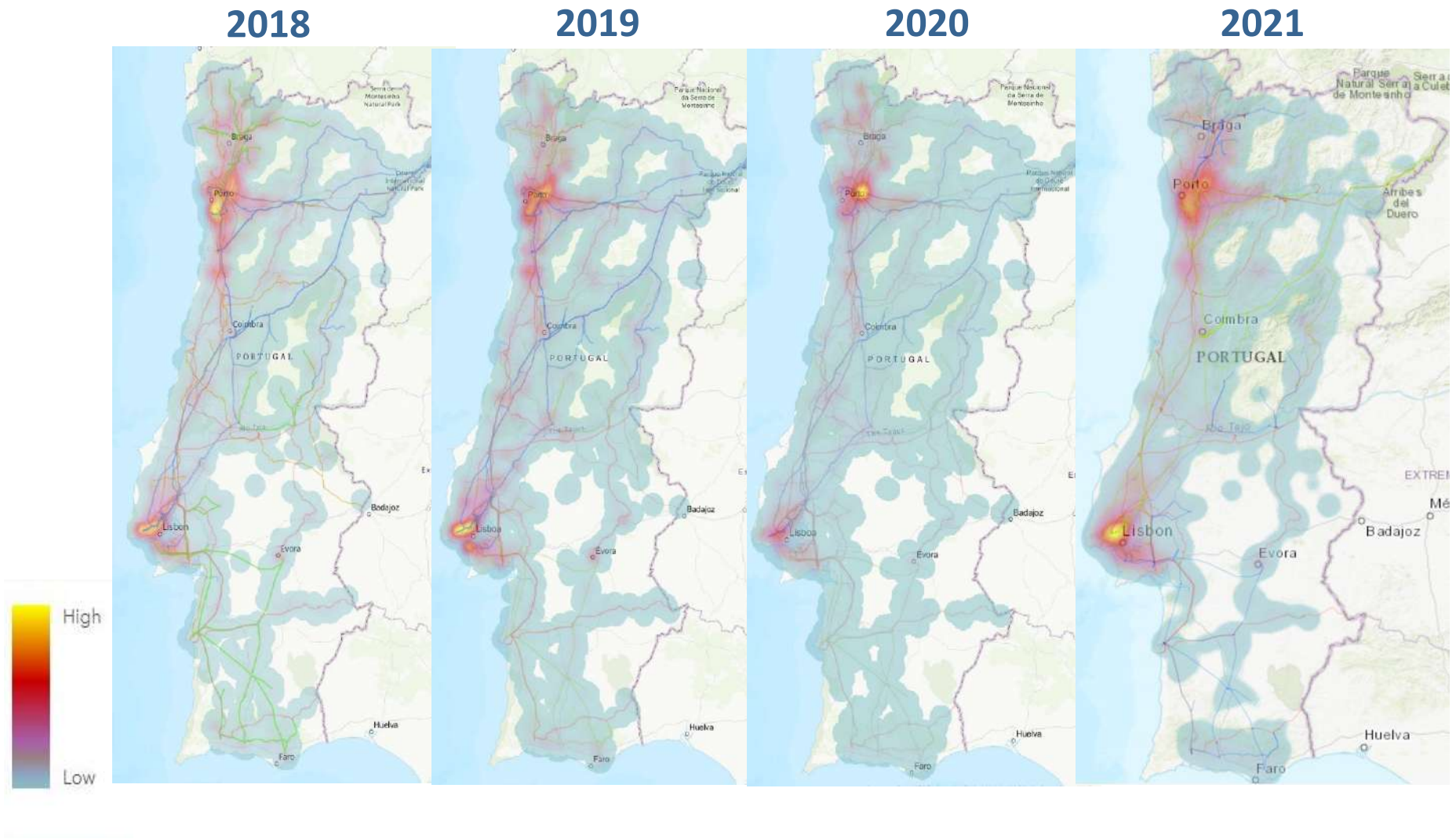
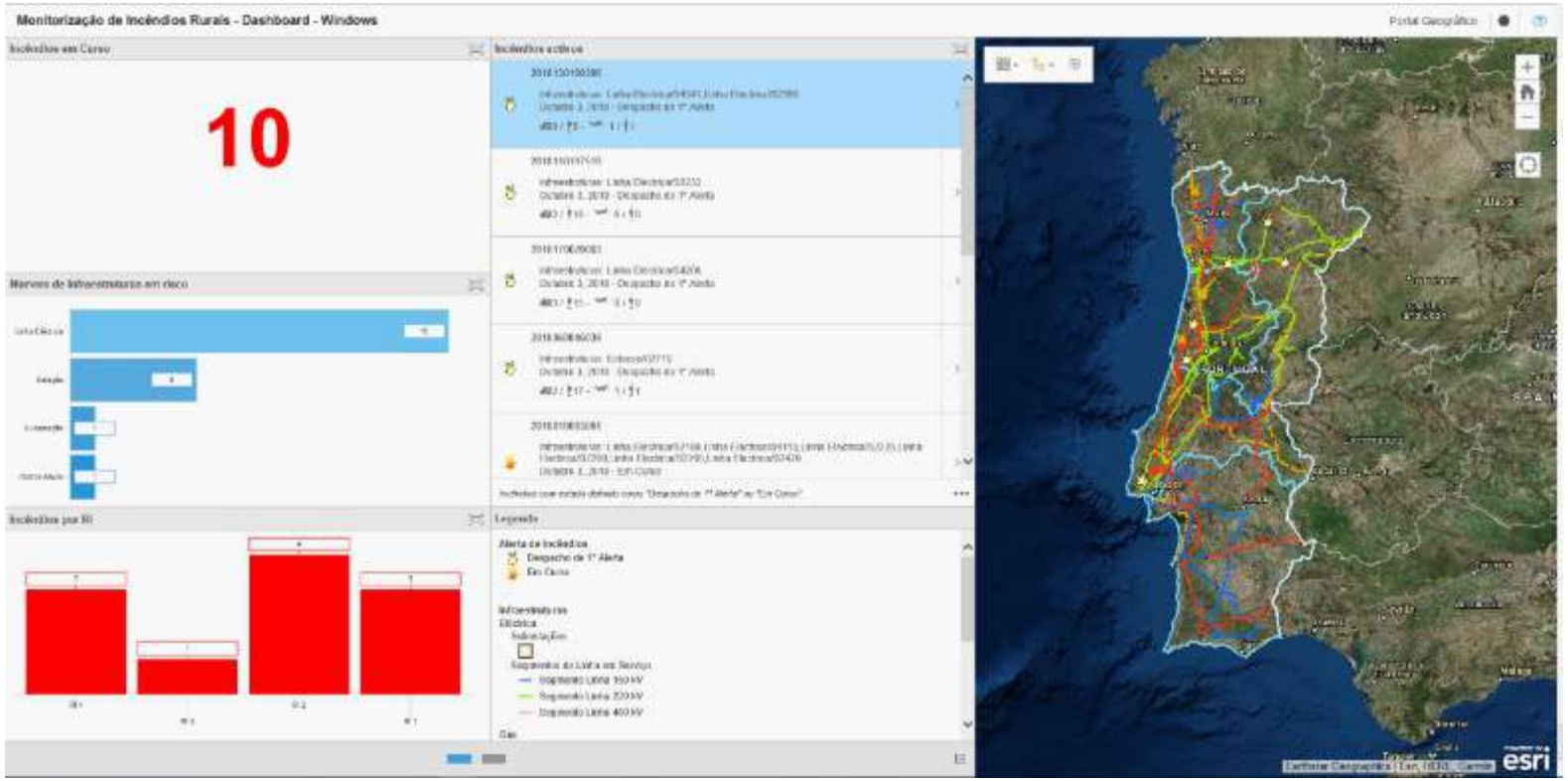
Heatmap of rural fire occurrences inside a 5km buffer of REN infrastructures



Average of 5000 occurrences each year.

In one day (13 July 2022) we had more than 195 occurrences near REN infrastructures!

Forest Fire Alert System – Develop in 2017 with ESRI tools



Forest wildfires dashboard
< 5 km critical infrastructures

Incoming SMS (text message) when at less than 2km

Innovative ways: Infrastructures Monitoring

Hardware and demonstration zones

As part of this project, REN is installed **eight (8) infrastructure monitoring systems**…

Ultrasonic Anemometer
For wind speed and direction (at 10 and 40m from ground level)

Main Camera
Ignitions and smoke columns detection based on IR and visible cameras

Secondary Camera
Tracking events based on visible camera

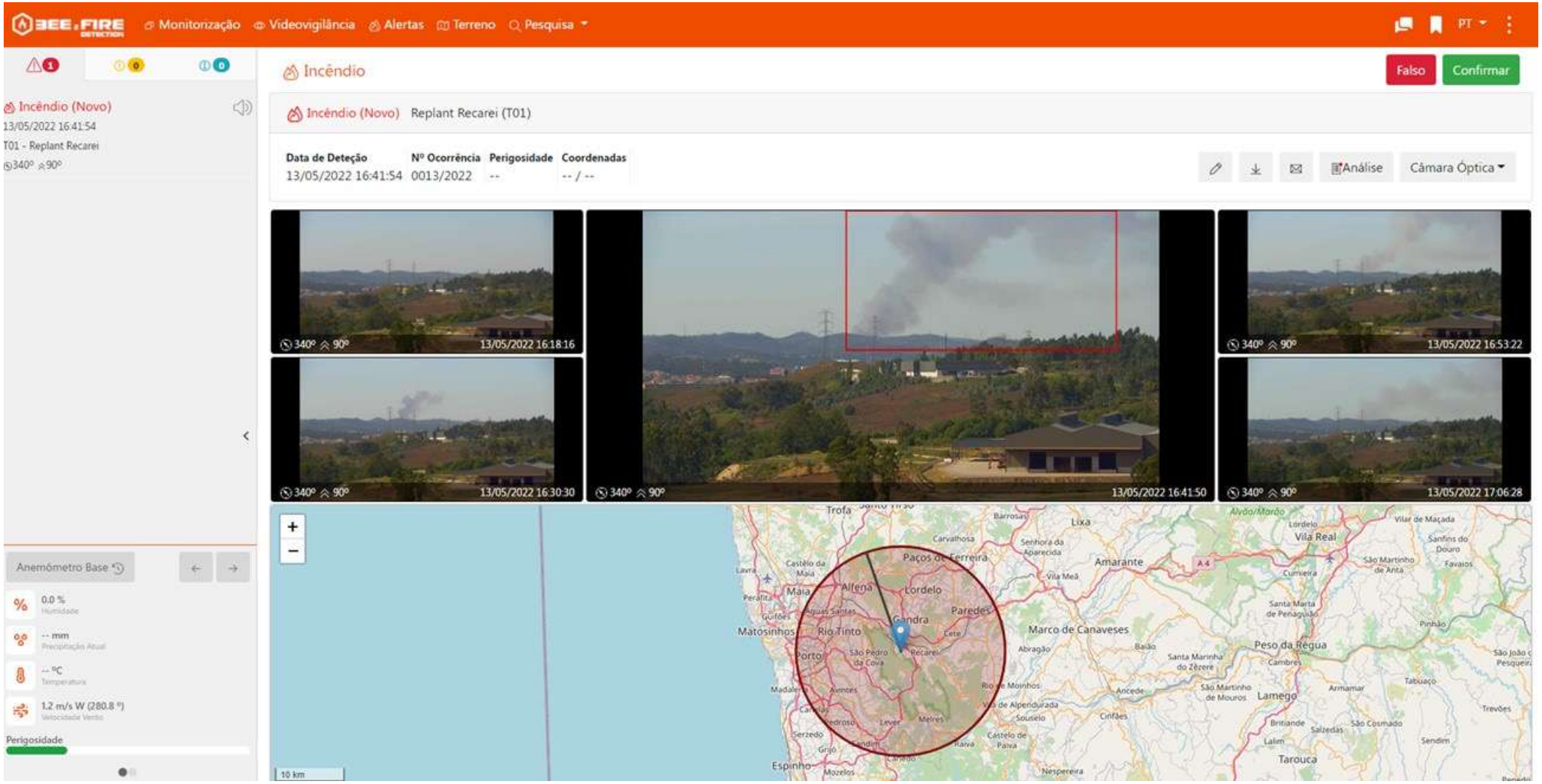
Weather Station
For wind speed, air temperature, air moisture, atmospheric pressure, rain fall, bearing, solar radiation and electrical discharges detection (at 2.5m from ground level)

Demonstration zones

… in three demonstration zones, which represent three different types of territories, but all subject to the pressure of rural wildfires.

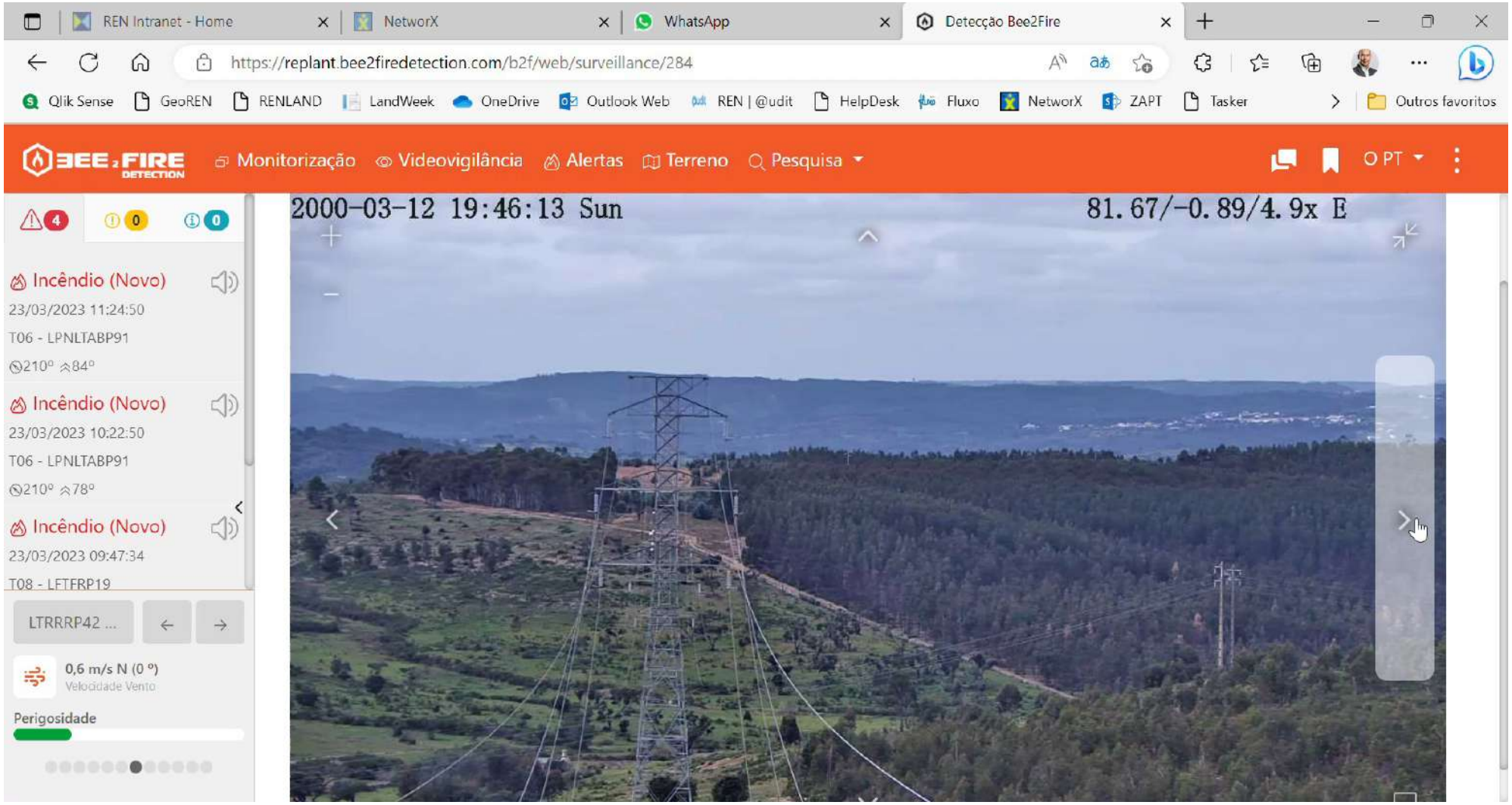
Innovative ways: Infrastructures Monitoring

Main Camera - Fire detection AI and Timelapse



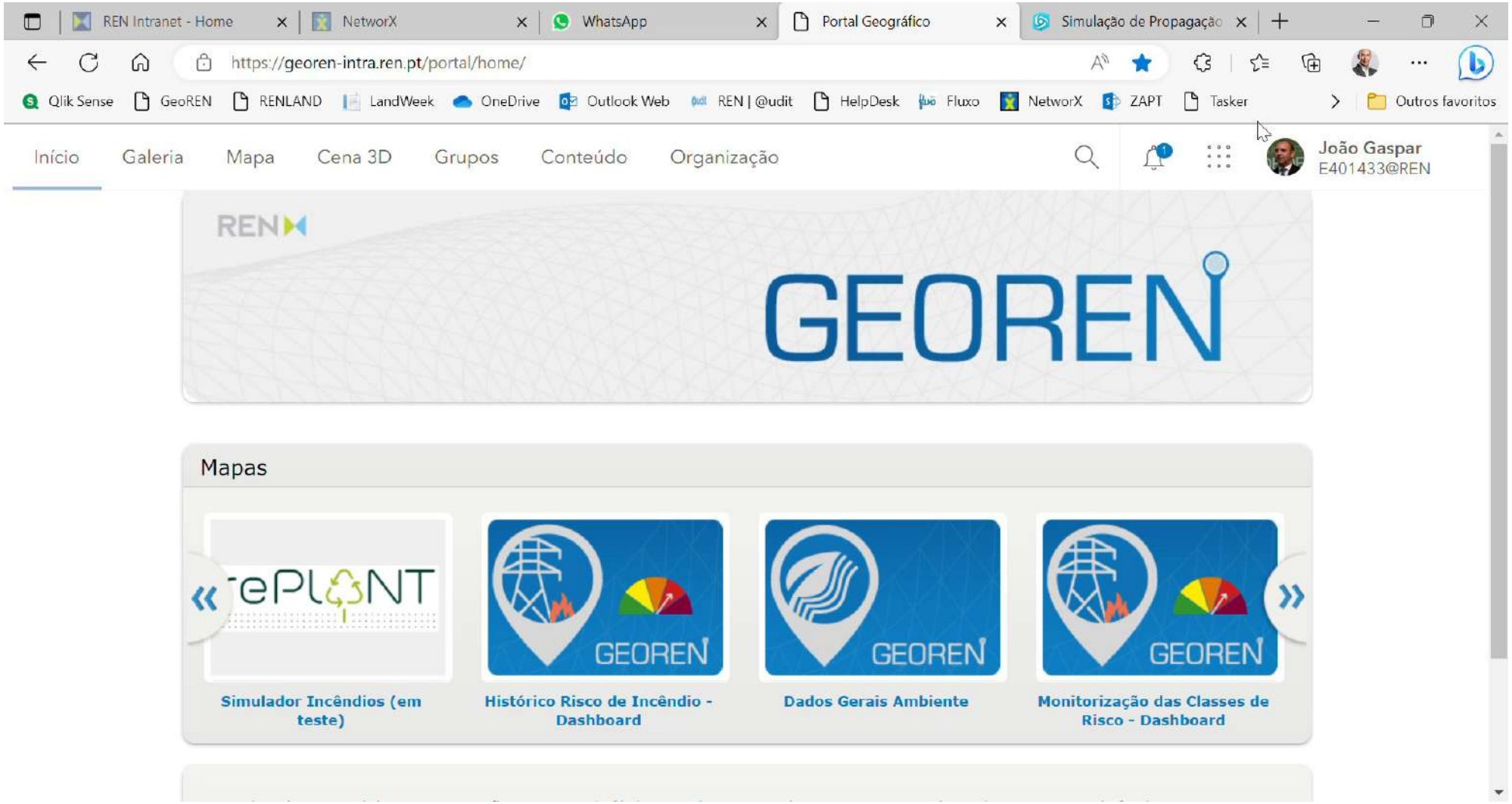
Innovative ways: Infrastructures Monitoring

Secondary Camera - Real-time data



Innovative Solution: Decision Support System

GIS (frontend) and Fire Propagation Simulator (isochronous lines)



Innovative Solution: Decision Support System

Increasing resilience of REN's Infrastructure

- No longer **focus** on the wildfire ignition point, but on the **time and place** where it will likely **impact** the gas and electricity transmission network.
- Knowing which forest wildfires can really impact our network we can have a **reduction of alerts**.
- Is possible to monitor forest wildfires that start **outside the 5 km buffer** and from there, **make new simulations**.
- **Have a better efficiency** in activating prevention and surveillance teams and other support staff, in dispatch and operation rooms.
- **Providing services to other entities, helping companies and communities.**

Infrastructures Monitoring

Decision Support System

rePLANT

754k€

transform

6.3M€

2023 → Dez/2025

Wildfire risk → Other environmental risks and natural disasters (scale up to 80 cameras+integration of other systems+control center)

PRR Plano de Recuperação e Resiliência
Financiado pela União Europeia NextGenerationEU

Sustainable strategies

Right-of-Way

- More than 35000ha to manage;
- 66% of our Right-of-Way are in forest areas;
- Vegetation management in 9000ha/year;
- + 200 active partners employees (daily average) in vegetation management;

Main goals

- Protect our Assets
- Create territories more resilient to rural fires

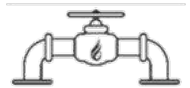
Other objectives

- Creating value for owners;
- Increased biodiversity;
- Job creation at local/regional level;

Sustainable strategies

Increasing resilience of REN's Infrastructure to Extreme Weather Events

More resilient infrastructures



More resilient territories

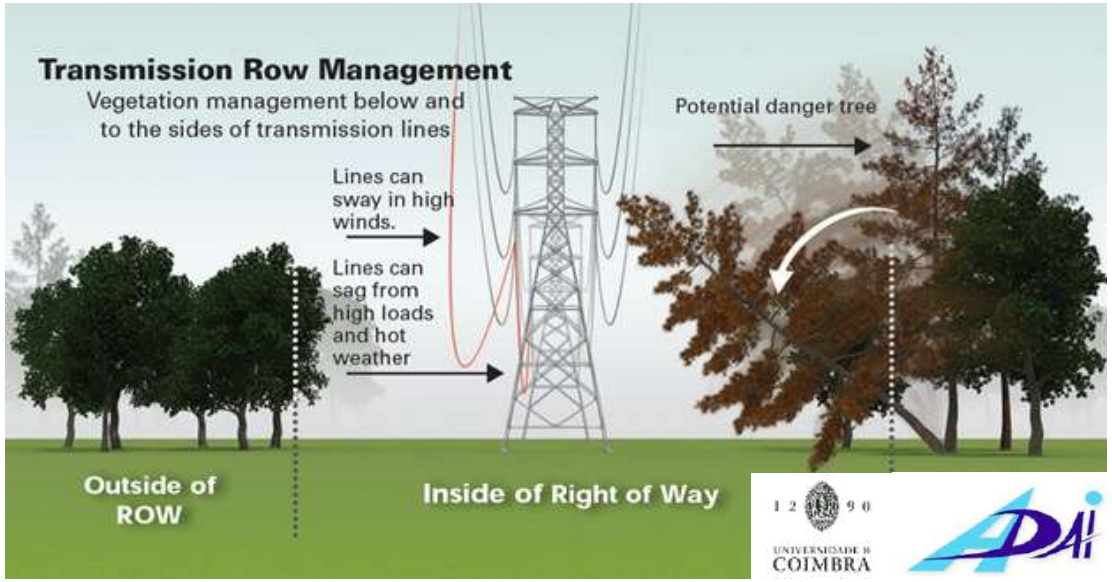
Extreme Weather Events → Territories and energy infrastructures adaptation → Ensuring uninterrupted supply of electricity and natural gas

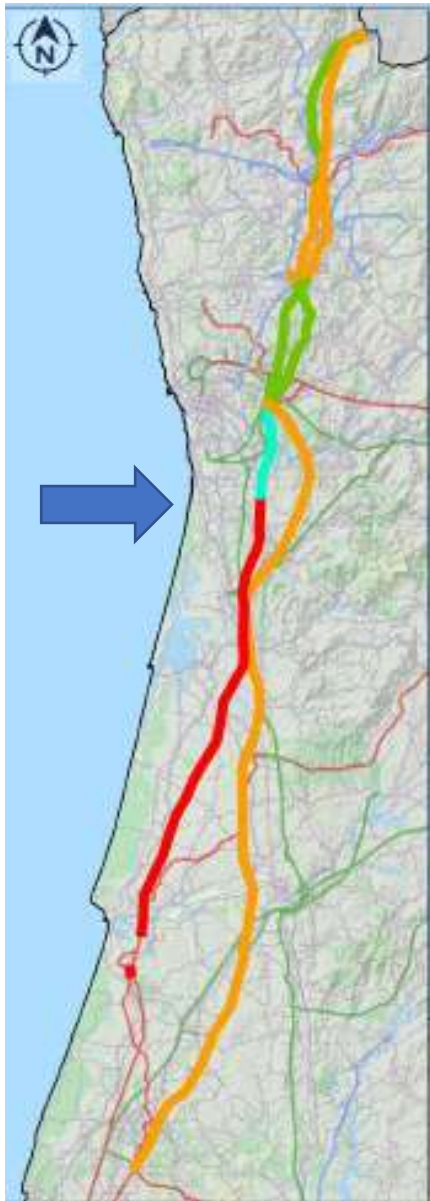
- ✓ Eliminating trees that are outside the ROW but with potential to affect conductors;
- ✓ Land reconversion;

Sustainable strategies - Increasing resilience

Eliminating trees that are outside the ROW but with potential to affect conductors

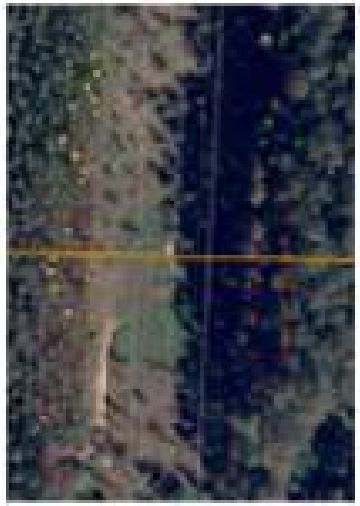
- REN as overhead lines located in the Atlantic cost, characterized by strong winds and sandy soils, which offer little resistance to trees;
- These zones are characterized by strong winds that blow preferably from the northwest quadrant (perpendicular to the direction of the line);
- The existence of large trees (eucalyptus) along these lines on sandy soils (with poor support capacity for the tree root system), which combined with strong winds, increases the risk of large trees with 40m or more, colliding with the conductors;
- The trees on the border of the ROW, can grow faster than the others inside the forest (border effect);

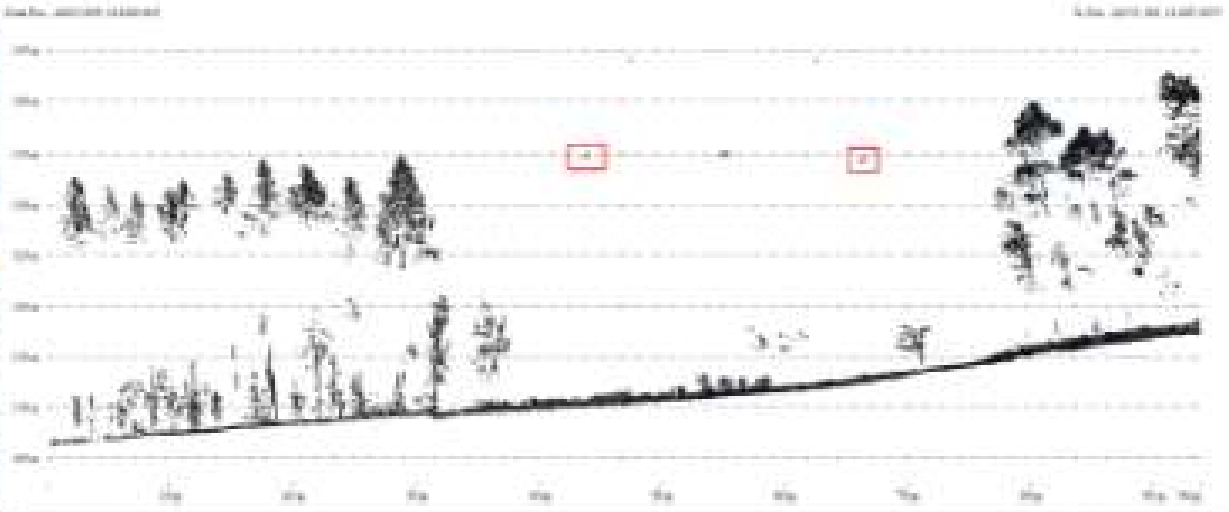


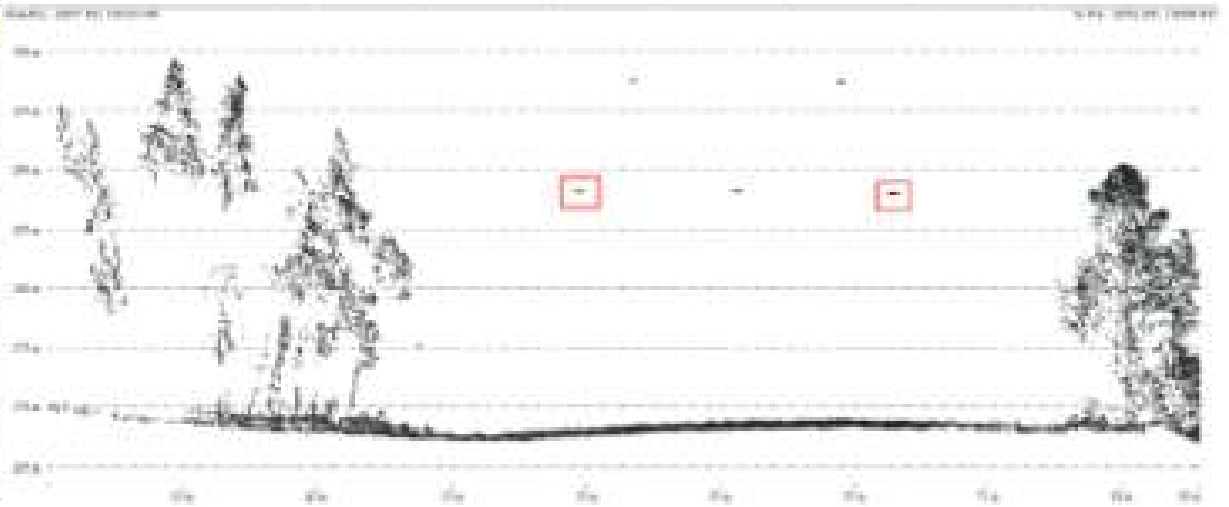


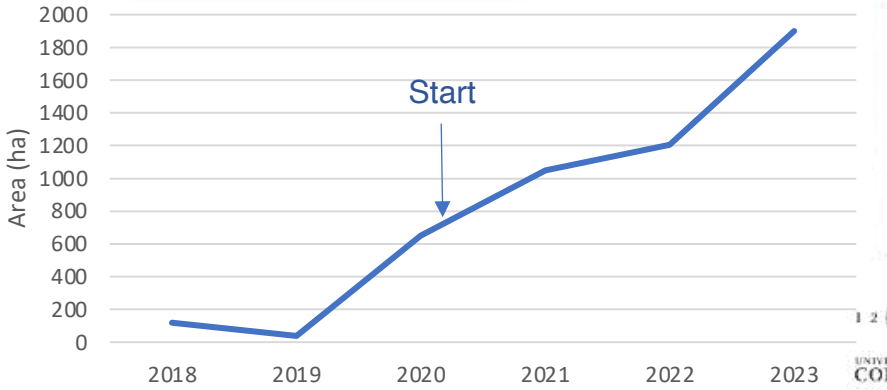
Sustainable strategies - Increasing resilience

Eliminating trees that are outside the ROW but with potential to affect conductors









Sustainable strategies - Increasing resilience

Land reconversion

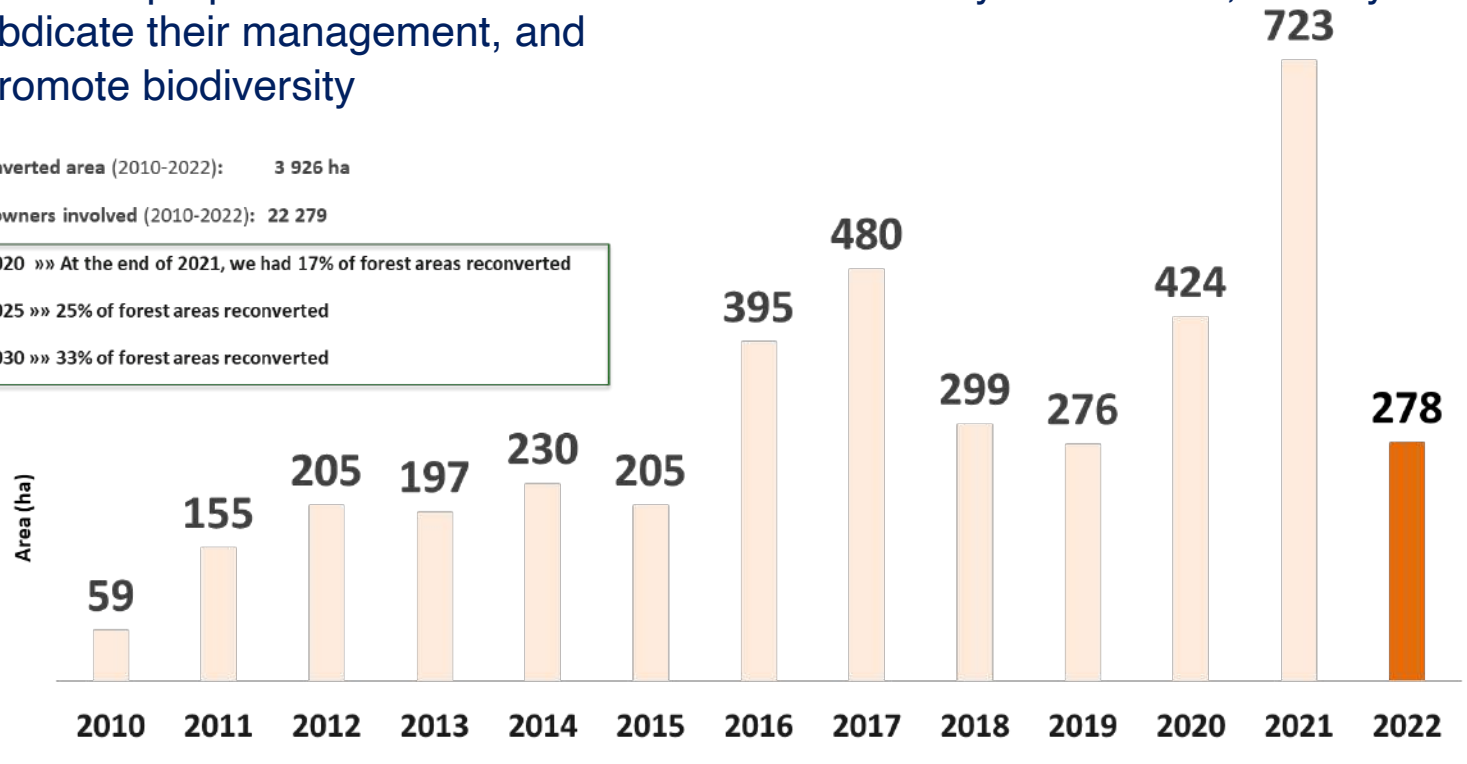
In collaboration with official authorities and with the involvement of local communities and landowners, REN proceeded with the land reconversion of forested area, mainly occupied with eucalyptus trees, involving 22,279 landowners (2010-22). The reconversion arose from the need to:

- increase the resilience of our powerlines in areas occupied by fast-growing forest species;
- reduce maintenance costs;
- increase properties value that are often abandoned by landowners, as they abdicate their management, and
- promote biodiversity

Reconverted area (2010-2022): **3 926 ha**

Landowners involved (2010-2022): **22 279**

- 2020 »» At the end of 2021, we had 17% of forest areas reconverted
- 2025 »» 25% of forest areas reconverted
- 2030 »» 33% of forest areas reconverted



Sustainable strategies - Increasing resilience

Land reconversion

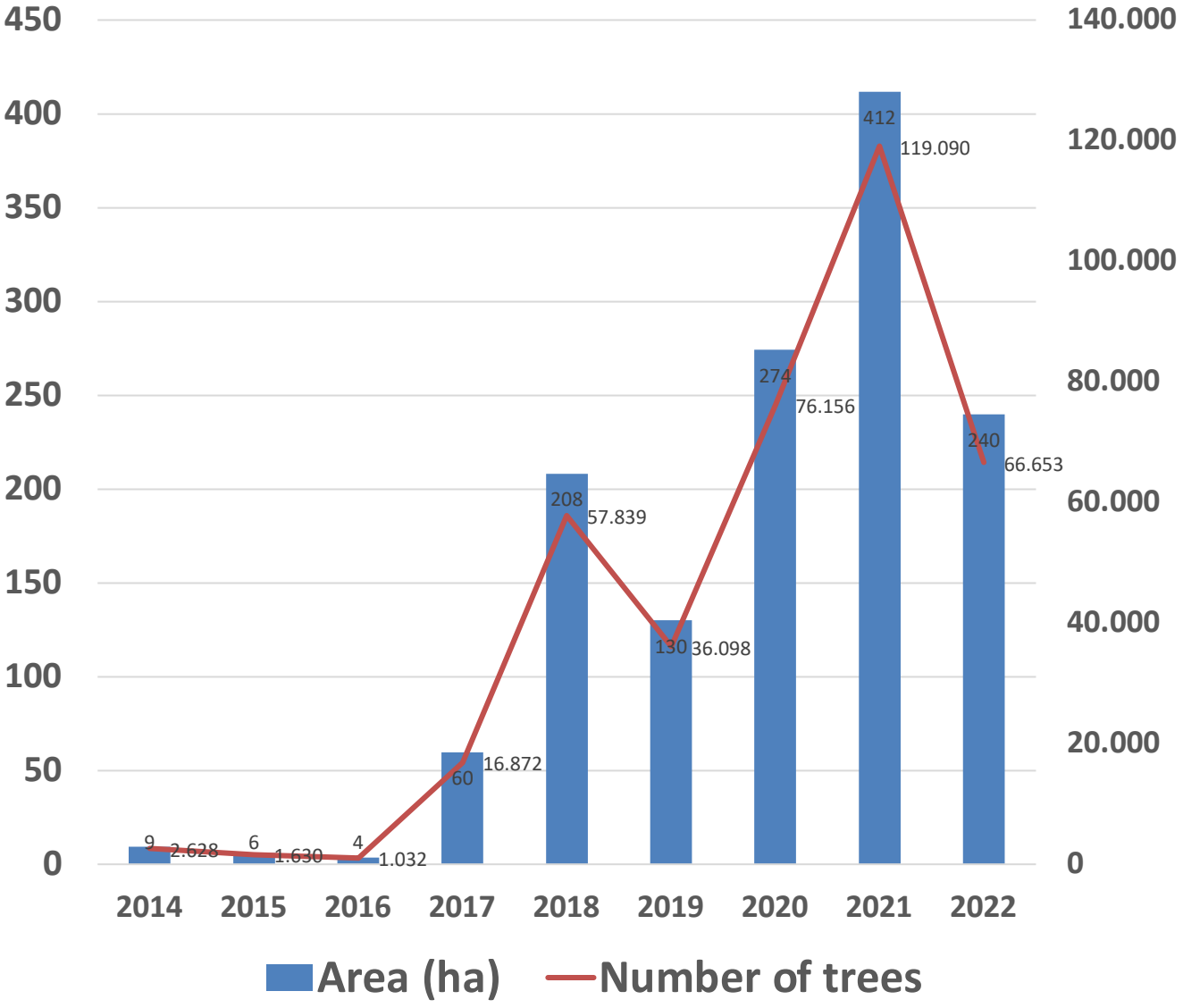
From the last tenders we are observing 25% reduction in cost per hectare.





Sustainable strategies - Increasing resilience

Land reconversion



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Thank you

OBRIGADO