Analysis of Distributed Generation and Power Losses

Viesgo Distribución

CEER Workshop for the Benchmarking Report on Power Losses
6 October 2016

Agenda

1. **Overview of Viesgo**
2. Distributed Generation in Spain
3. Presentation of ABB & Viesgo’s deep-dive study on Grid Losses
4. Regulatory approach to Grid Losses Calculation
5. Next Challenges

Viesgo in figures

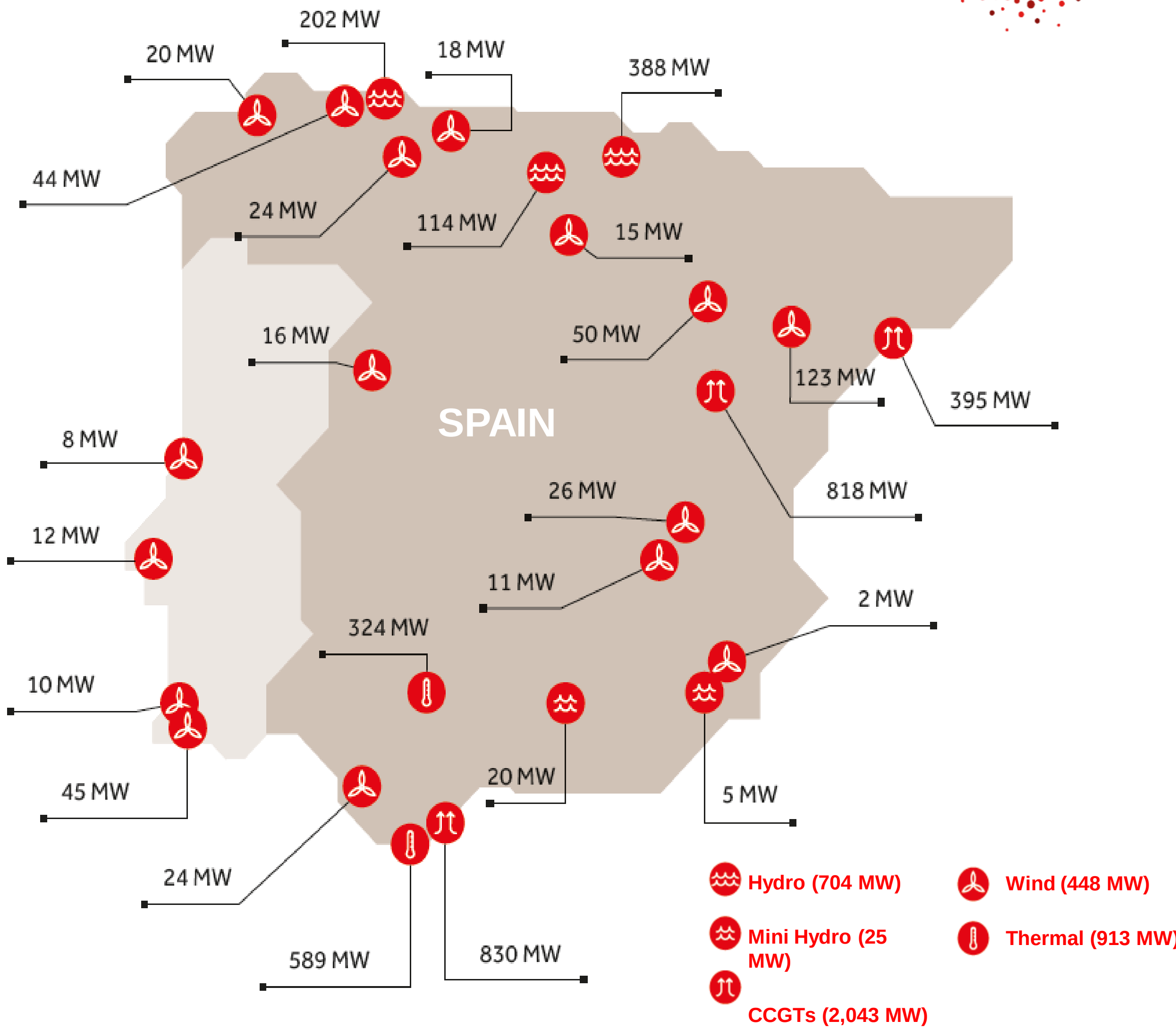
110
YEARS OF HISTORY IN SPAIN

MORE THAN 1.000 EMPLOYEES

31.000 KILOMETERS OF DISTRIBUTION NETWORK

4.150 MW CONVENTIONAL AND RENEWABLE ENERGY

MORE THAN **670.000** CUSTOMERS LIGHT AND GAS



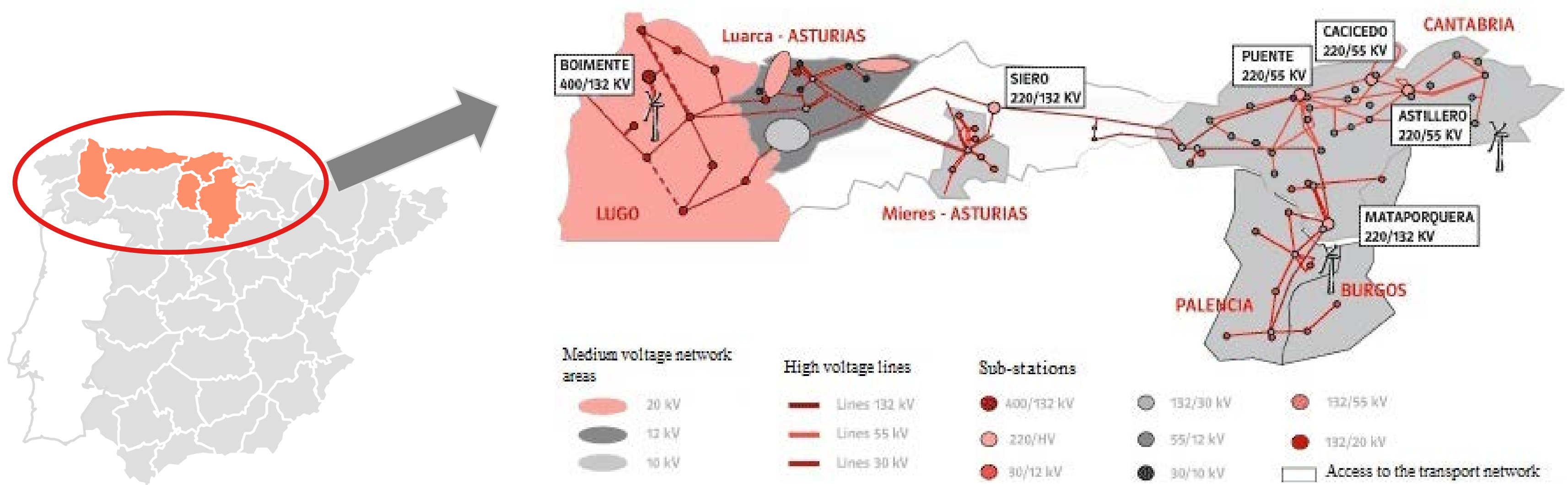
Viesgo Distribution - Overview

Fourth largest distribution network in Spain, with established track record and continued focus on efficiency and innovation

Key Figures

- **Distributed Energy**: **5.8 TWh of electricity** with a **peak demand of 0.9 GW**
- **31,000 km** of lines (of which 17% are High and Medium voltage cables) and **120 substations**
- 688,676 customers..
- **99%** of the customers have a **smart meter installed**.

Distribution Area Network Map (High and Medium Voltage)



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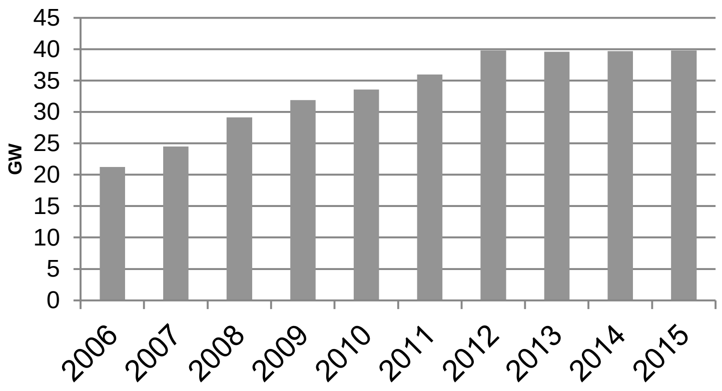
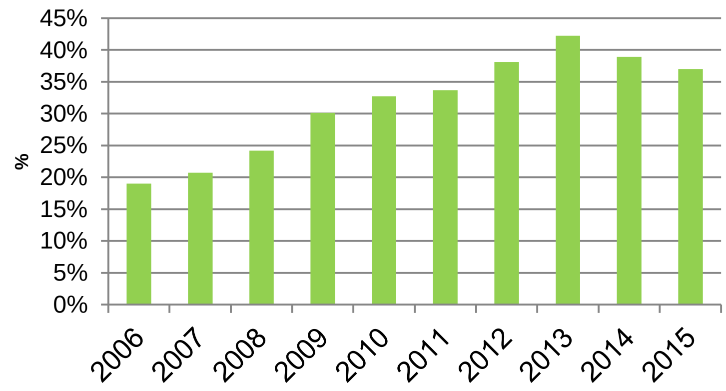
Distributed Generation scenario in Spain

Installed Wind Power – Spanish Energy System



Source: CNMC

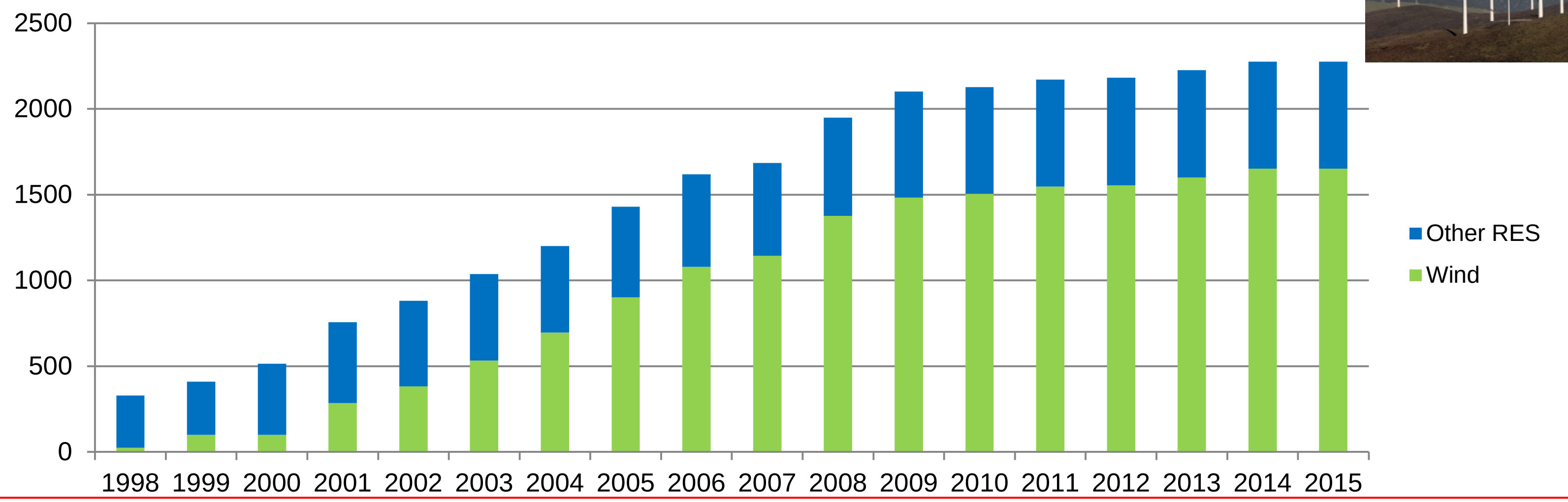
% Renewable / Demand – Spanish Energy System



Source: REE

…where the penetration of Distributed Wind Farms is remarkable for Viesgo

Viesgo - Installed Distributed Generation (1998-2015)



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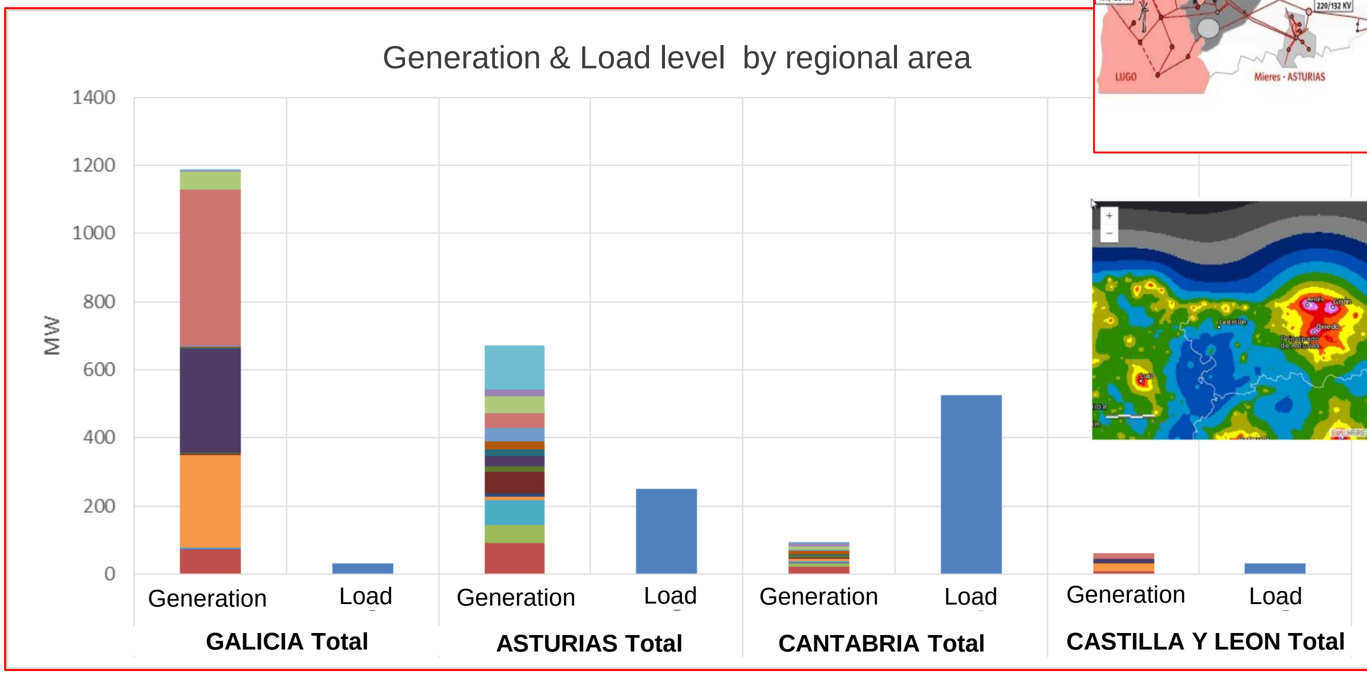
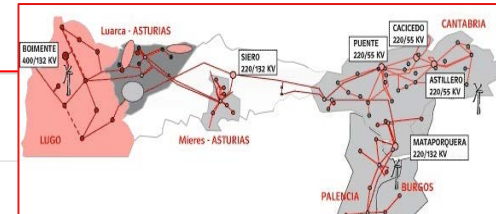
Rationale for a study about grid losses (I)

The real situation of a DISCO leader in renewables integration with…

1 **Demand far from generation sites.**





Galicia Subsystem 1: Generation & No Consumption

Asturias Subsystem 2

Cantabria Subsystem 3: Consumption & No Generation

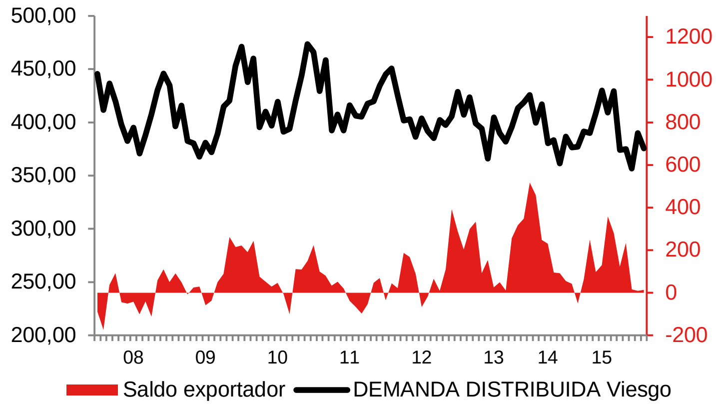
Castilla y Leon Subsystem 4

2 **Asymmetric Demand Characterization**:

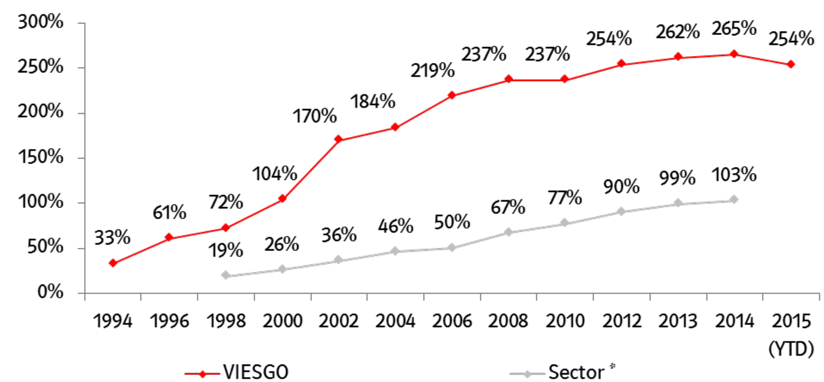
40% in HV/MV (distribution) & 60% flow to Transmission grid (Distribution grid as a TSO-like grid)

Rationale for a study about grid losses (II)

3 It was necessary to analyze losses behavior to test our experience in order to show **that losses depend on the level of renewables integration** (**Viesgo integration rate: 2,5 vs 1 Spanish DISCOS**)



Viesgo Network Export / Import Balance



RES Integration Ratio *

Impact on Grid Operation and Assets Lifetime !!

* Integration rate defined as: Renewable power connected to the grid / consume in the hourly peak

Case Study Inputs (I)

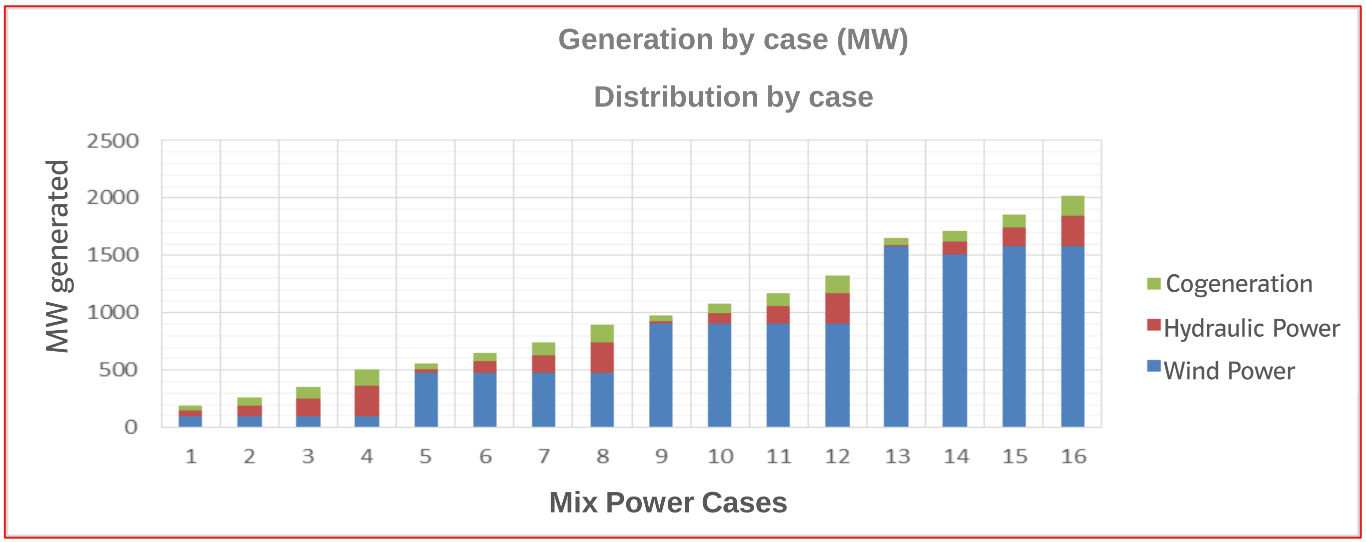
1. **Voltage levels considered in the analysis: 132 kV, 55 kV, 30/20 kV & <20 kV**
2. **26 Cross Borders considered. XB losses allocated to Viesgo. No MV/LV considered**

132/55kV power lines (km)	2.046
30/20 MV power lines (km)	**9.779**
Interconnections with HV (nº)	6
Generation connected (MW)	2.500
Installed Power (MW)	2307

132 kV power lines (nº)	8
55 kV power lines (nº)	**1**
220/132 kv transformer point	3
400/132 kv transformer point	6
220/30 kv transformer point	1
220/55 kv transformer point	6

3. **16 Power mix generation cases**: standard operational states in Viesgo Grid

…Although Wind generation is generally much higher that other sources



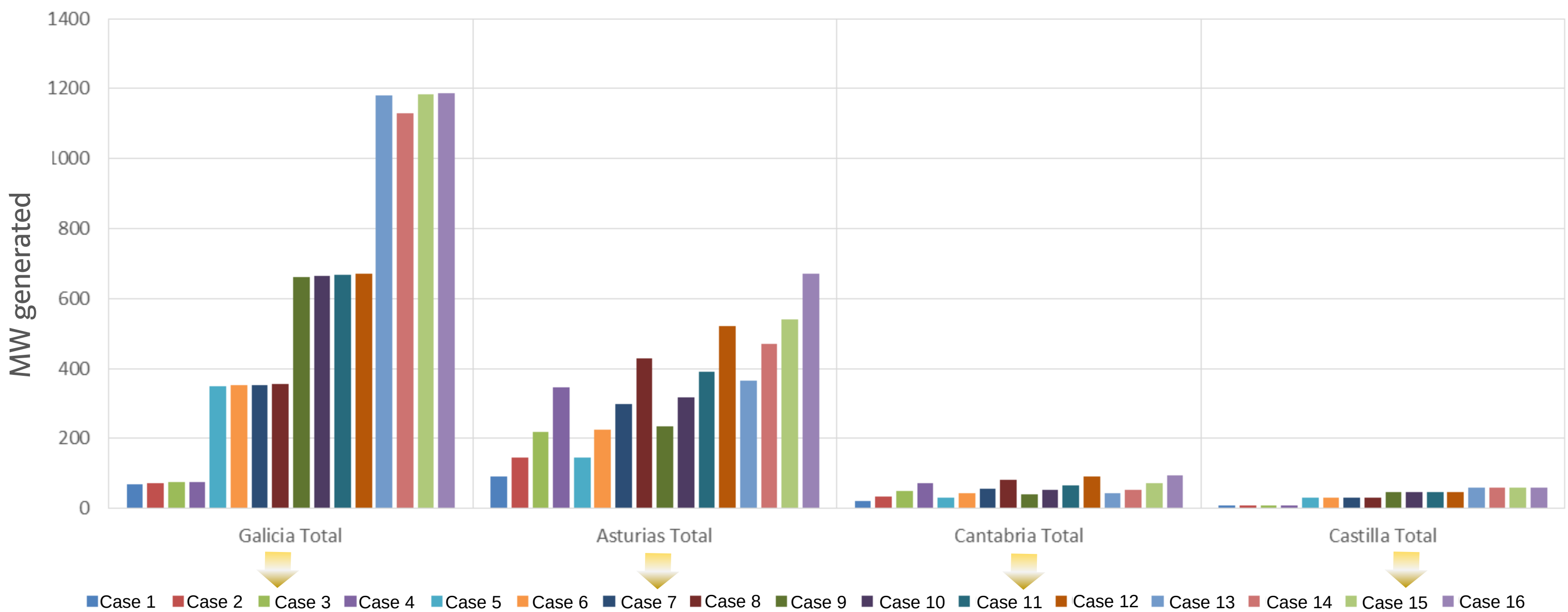
Wind	Hydraulic	Cogen.	case
0%	0%	100%	1
	30%	70%	2
	60%	50%	3
	100%	30%	4
30%	0%	70%	5
	30%	50%	6
	60%	30%	7
	100%	20%	8
60%	0%	50%	9
	30%	50%	10
	60%	30%	11
	100%	20%	12
100%	0%	50%	13
	30%	30%	14
	60%	20%	15
	100%	20%	16

Case Study Inputs (II)

4 **Simulation of Viesgo system topology :**

- 4 subsystems with different levels of generation & interconnected

Total Generation by regional areas



High Wind power, exporter subsystem

Importer or Exporter subsystem depending on Wind powerº

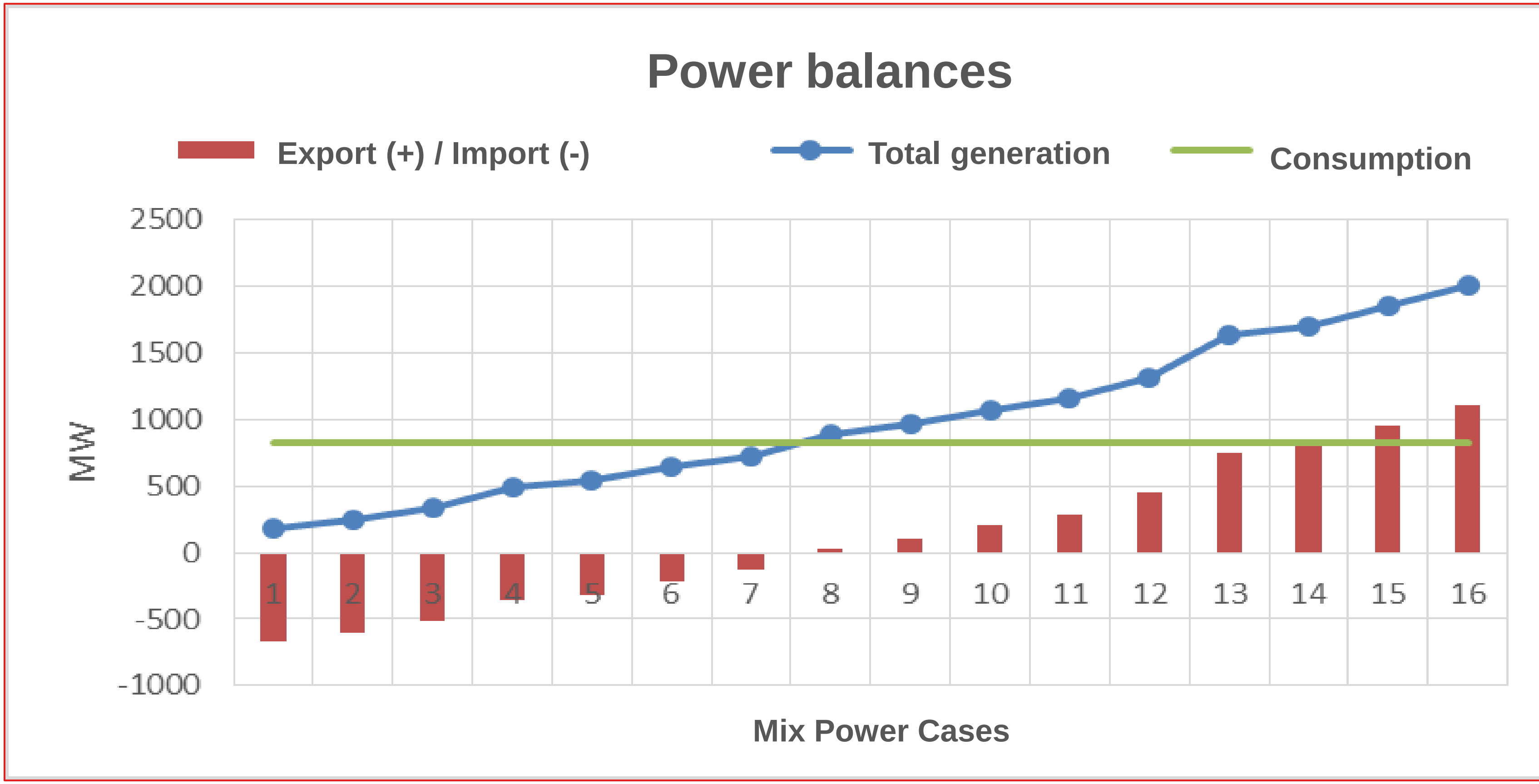
WO Generation Importer subsystem

Importer or Exporter subsystem depending on Wind power

Case Study Inputs (III)

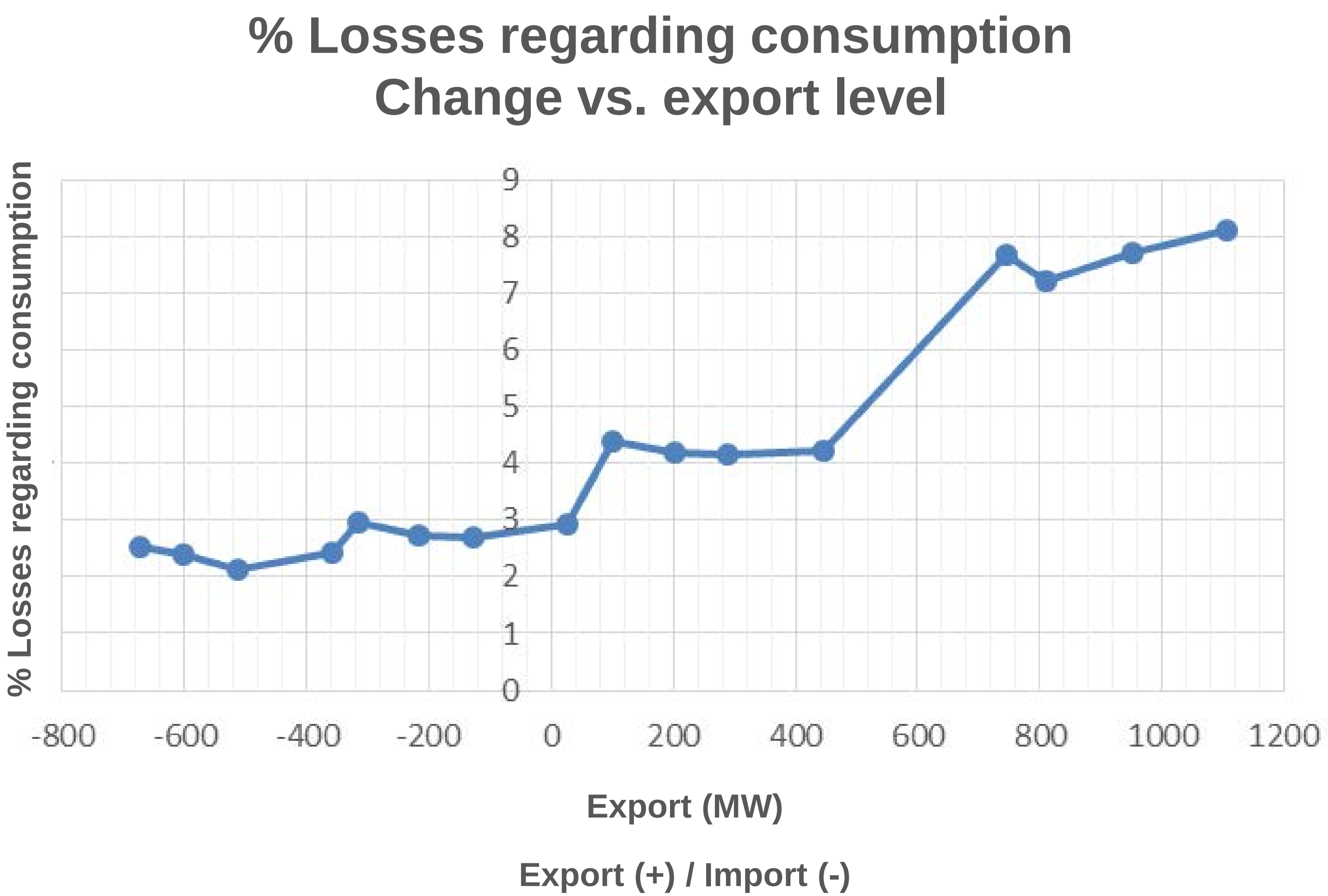
5 **Power balance simulation:**

- ✓ Status by mix power case
- ✓ **Steady peak demand considered = 880 MW**



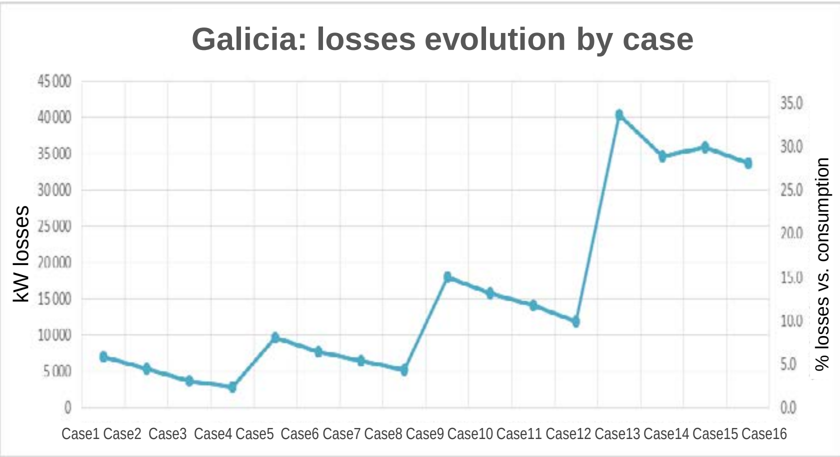
Case Study Simulation Results (I)

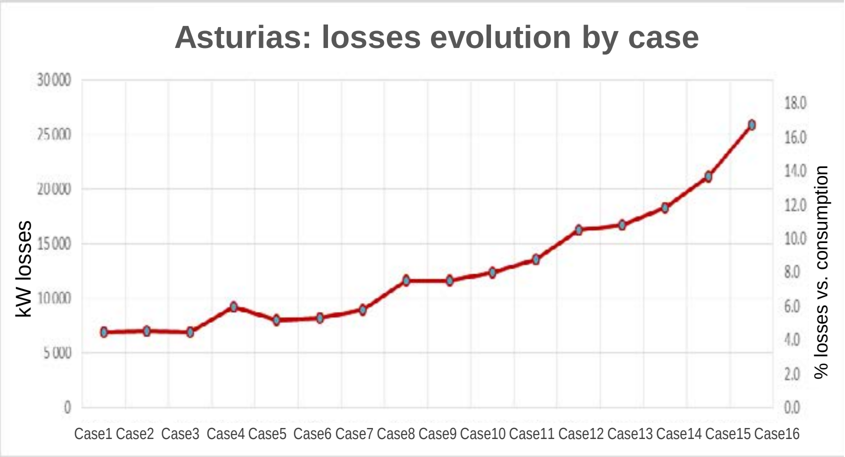
Losses vs. export level



Case Study Simulation results (II)

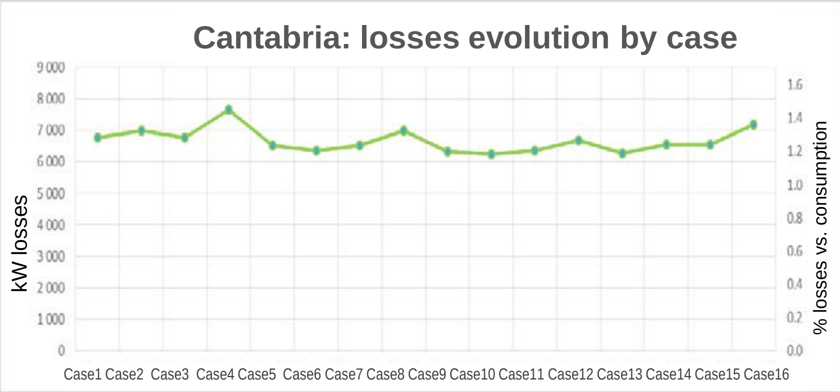
Losses distribution by Viesgo Subsystem

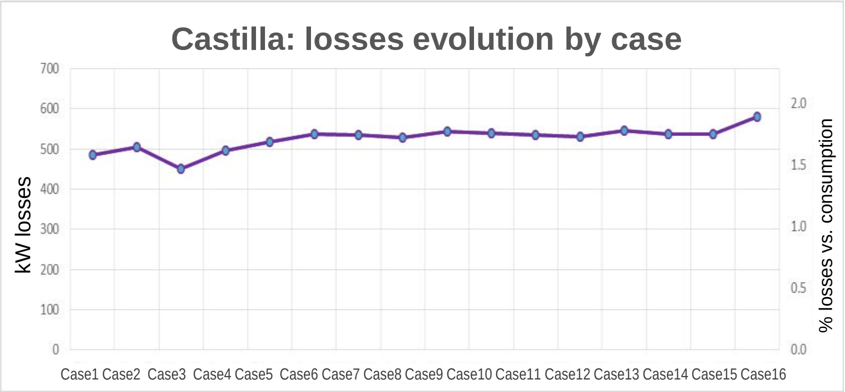




Galicia subsystem: High Wind power, exporter subsystem :**1.200 Wind MW**

Asturias subsystem : Importer or Exporter subsystem depending on Wind power **450 wind MW**





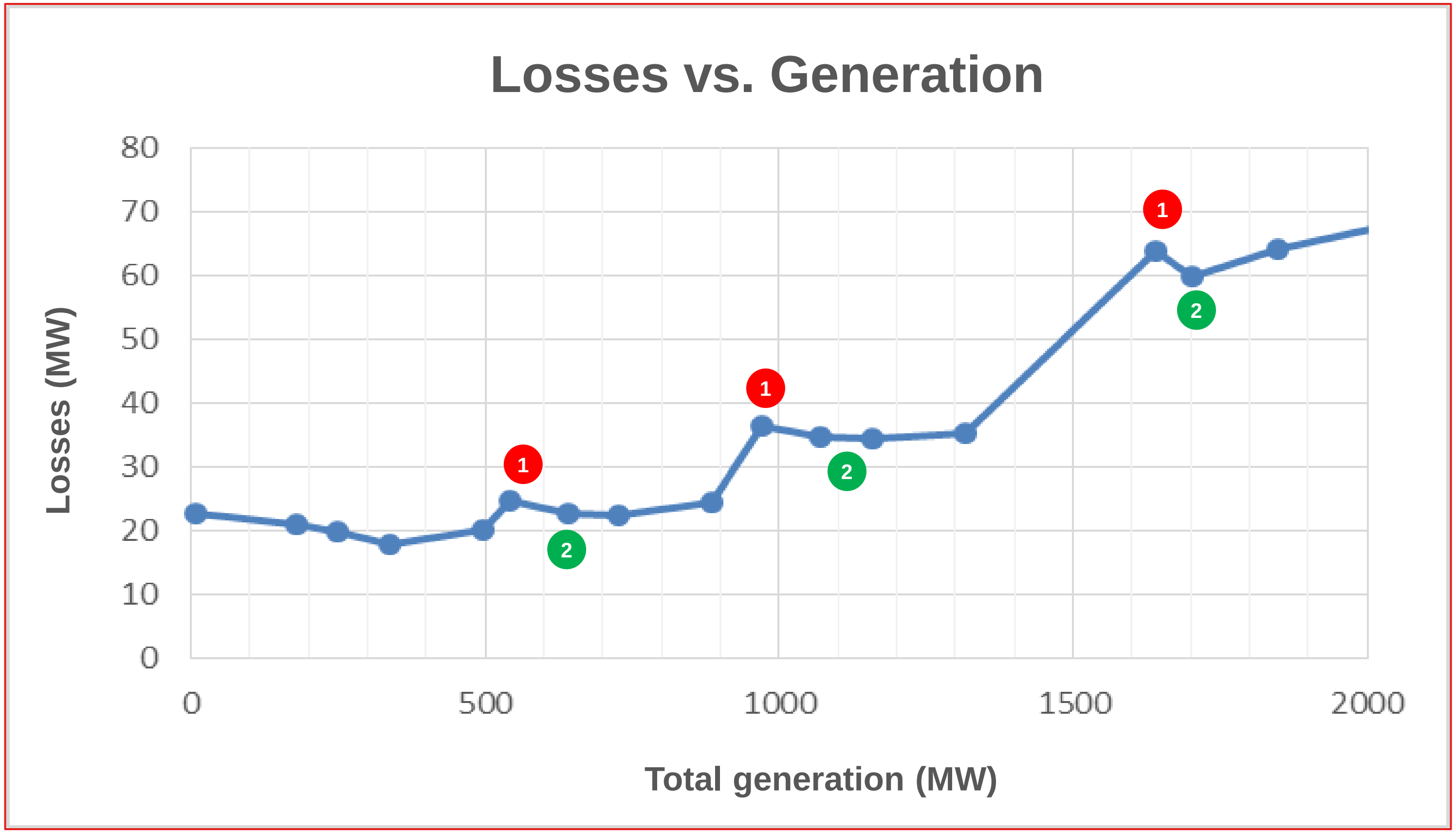
Cantabria subsystem : WO Generation shingly importer subsystem

Castilla subsystem : Importer or Exporter subsystem depending on Wind power

Main Conclusions (I)

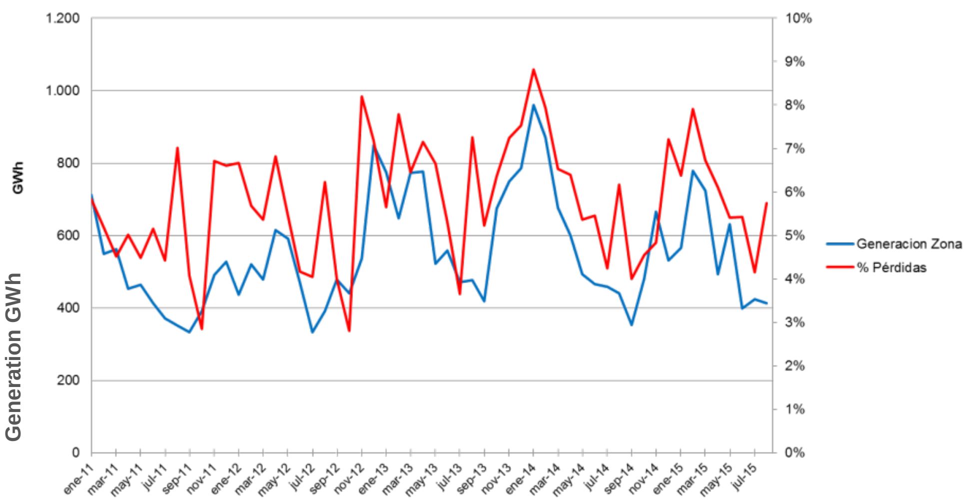
1. Increase on Distributed generation implies an increase on losses

- ✓ Peaks related to increases on wind Power generation & almost wo hydraulic generation. 1
- ✓ Slopes after peaks are affected mainly by the increase of hydraulic generation 2

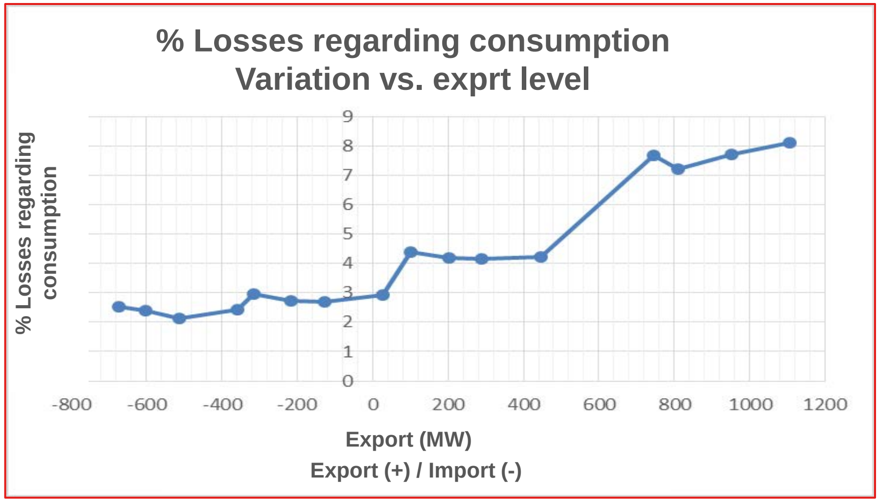


Main Conclusions (II)

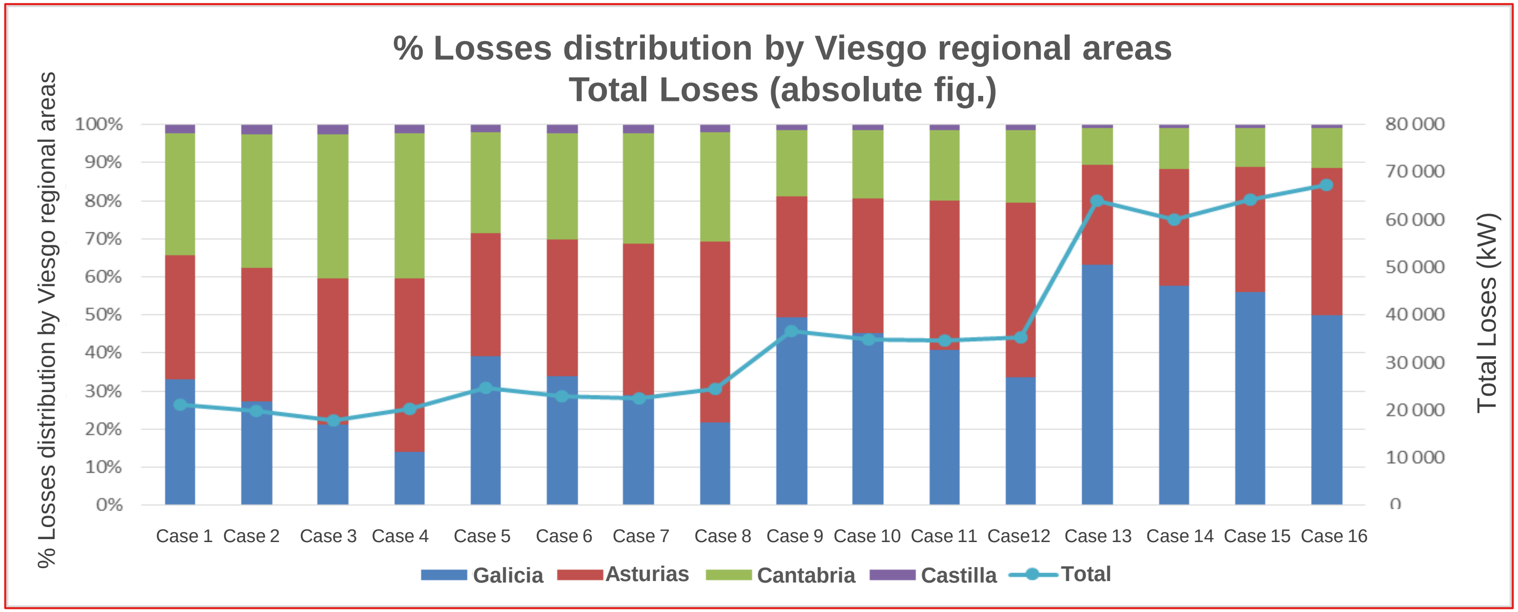
2 **Wind power generation implies a distortion on grid losses (HV/MV) for a higher generation to consumption ratios**



Generation % Losses



Main Conclusions (III)



3 **132 kV voltage level concentrates grid losses** (wind Power connected to it)

4 Increase of Wind power indicates an increase on losses (e.g. Galicia subsystem)

5 Lower wind power combined with hydraulic indicates a progressive increase on losses

6 In general: **<u>Losses levels are similar without generation inflow</u>** to the grid

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Proposal to review Grid Losses calculation basics

1 Current Grid Losses Methodology

Losses = ∑ Borders - ∑ Demand

% Losses = Losses / ∑ Losses

ENERGY BALANCE EXAMPLE

GWh	IN	OUT	NET
DSO-TSO	115	400	-285
DSO-DSO	400	850	-450
GENERATION	500	0	500
WIND-DSO	2.255		2.255
TOTAL BORDERS	**3.270**	**1.250**	**2.020**
CUSTOMERS		1.850	**-1.850**
		LOSSES	**170**

2 Methodology Proposal

Losses = ∑ Borders - ∑ Demand

% Losses = Losses / (∑ Borders + ∑ Borders (OUT)

1. CURRENT METHODOLOGY

ENERGY NET (IN-OUT)	2.020
CUSTOMERS	1.850
Losses	170
% Losses	**8,42%**

2. PROPUESTA CALCULO % PÉRDIDAS

ENERGY IN	3.270
CUSTOMERS + ENERGY OUT	3.100
Pérdidas	170
% Pérdidas	**5,20%**

Conclusions / Proposals

- **Grid Losses increase as energy flows increase in the network** (Customers demand, generation, XB between DSOs and TSOs)
- Grid Losses % should **only consider Distribution losses** in the energy distribution process to customers.
- Mid Term: **NRAs** should develop **Grid Losses schemes** that consider State Estimation in Distribution Grids to **calculate optimal energy flows** and compare to reality in order to avoid the effect of Renewable.

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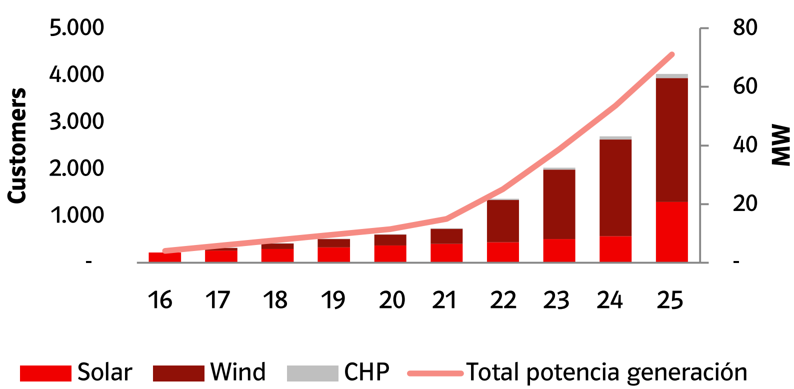
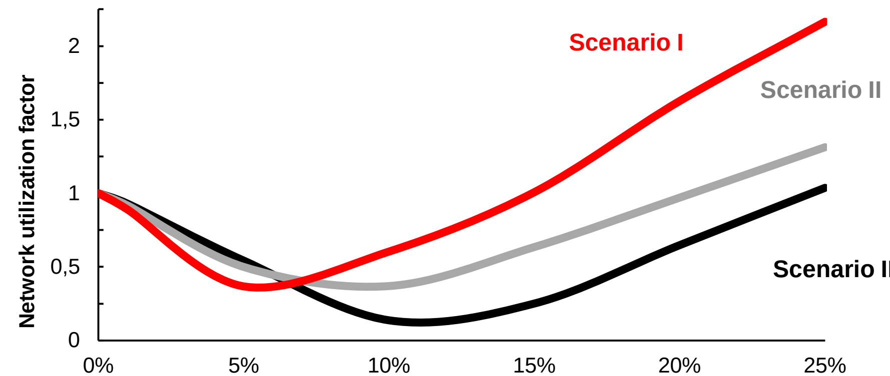
New operational challenges in a Distributed Generation

✓ *ST-MT Scenario: The Distributed energy wave is here to stay*

Distributed generation current operational scenario for Viesgo



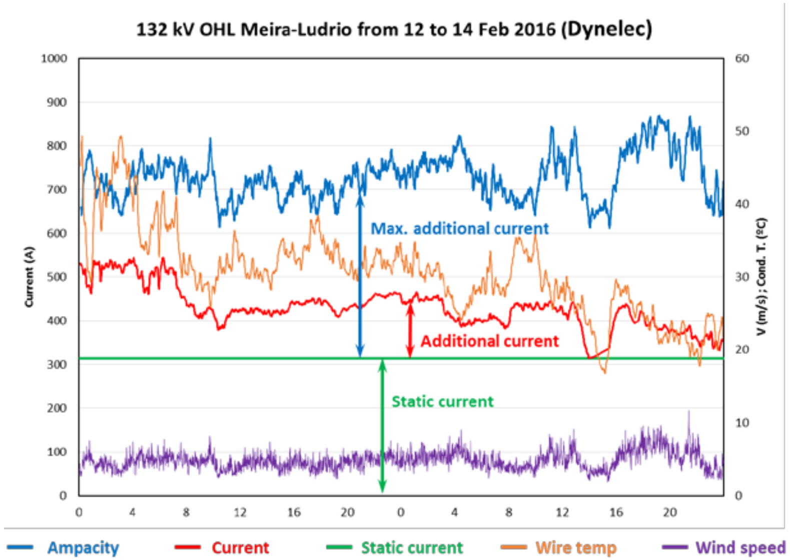
Impact of Distributed Generation for DISCO Network



LV Distributed Generation penetration (% customers)

Viesgo / KPMG 2016 simulation. 25k supply points MV/LV network

✓ *New Operational Changes. E.g. Dynamic Line Rating to improve Lines capacity*



Meteo Stations

Temperature Sensors

Thank you!

For additional information, please contact:

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