EDP Distribuição Experience with Power Quality Monitoring in Portugal

EURELECTRIC – CEER Joint Workshop on Voltage Quality Monitoring

Brussels, 18 November 2009

edp distribuição

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Power Quality Activity Group

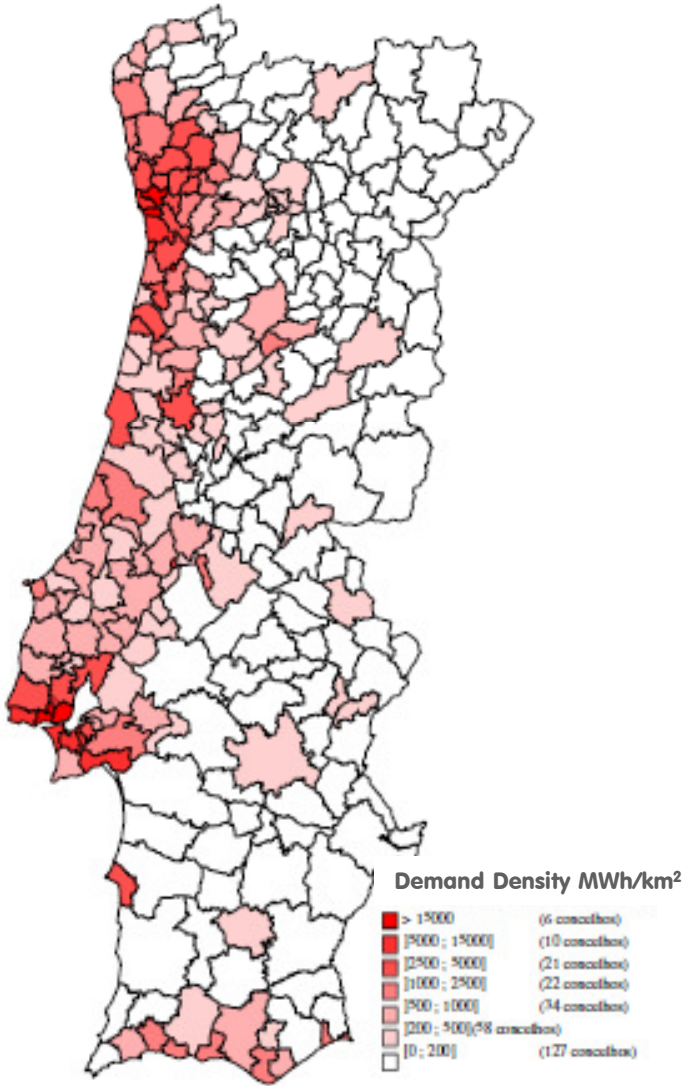
Contents

Introduction to EDP Distribuição

Brief characterization of the distribution network

Installations and equipments operating by the end of 2008

HV/MV and MV/MV Substations		Δ 2007 / 08
Number	397	(+3,9%)
Rated power (MVA)	15 726	(+2,4%)
HV and MV Distribution Lines		
HV lines 60kV, 132kV (km)	8 840	(+3,9%)
MV lines 6kV, 10kV, 15kV, 30kV (km)	72 314	(+1,6%)
Total length (km)	81 155	(+1,8%)
MV/LV Substations		
Number	61 157	(+2,2%)
LV Distribution Grid		
Total length (km)	133 702	(+0,8%)



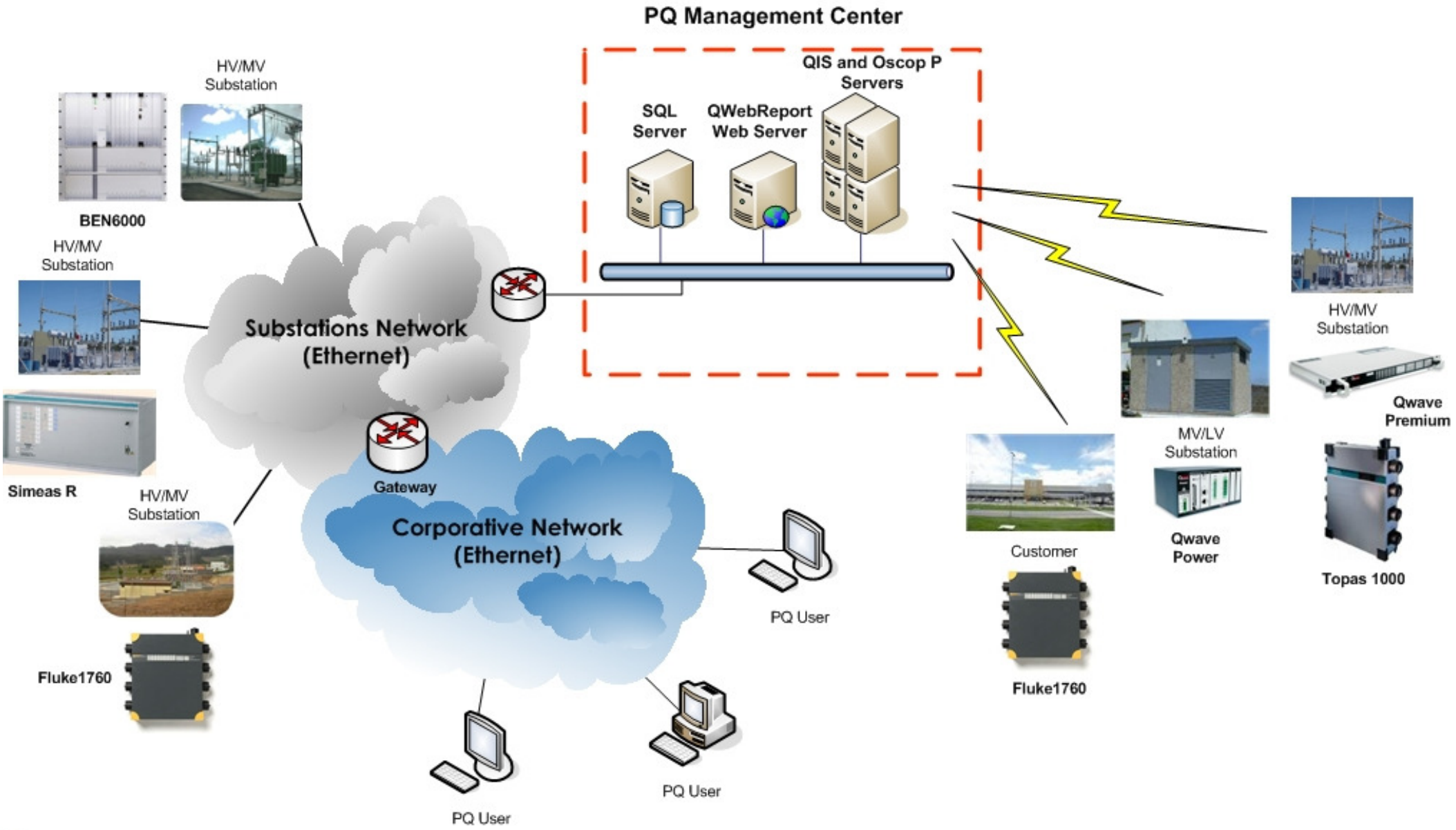
Supplying 6,1 millions of Customers

PQ Monitoring Regulation
Portuguese Quality of Service Code

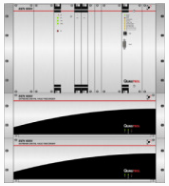
Main requirements of the Portuguese QoS Code, issued in January of 2006

- **Voltage quality monitoring**
  - **HV and MV distribution networks → Monitoring MV busbars of all HV/MV substations during at least 1 week, every 4 years**
  - **LV distribution grids → Monitoring at least 2 MV/LV substations per municipality (total of 278 municipalities in Portugal mainland) during at least 1 week, every 4 years**
- **Annual selection of installations for PQ analysis**
  - **Ensure an yearly balanced distribution (geographic and quantitative)**
  - **Focus on areas of higher concentration of Customers sensitive to PQ disturbances**
  - **Ensure that the number of yearly monitoring weeks is maintained or increased every year**
  - **Coordinated to the monitoring program of the TSO (REN) in order to record correlated PQ data**
- **Customer complaints → PQ measurements at the Customer entrance or in the network shall be performed**
  - **MV and LV Customers → Voltage accordance to the NP EN 50160 standard and voltage dips characterization as defined in the Annex IV of the Portuguese QoS Code**
  - **60kV Customers → Voltage accordance to the requirements of the Annex IV of the Portuguese QoS Code**

Resources and Methodology
PQ Monitoring Platform



Resources and Methodology
PQ Recorders

Model (Manufacturer)	Photo	Basic Characteristics	IEC 61000-4-30 Class	Quantity	Main Applications by EDP
Qwave Premium (Qualitrol)		PQ Recorder 4U+4I or 4U+4U Portable device	Class B	19	3 months campaigns in HV/MV substations
Topas 1000 (LEM)		PQ Recorder 4U+4I or 4U+4U Portable device	Class B	7	3 months campaigns in HV/MV substations
Qwave Power (Qualitrol)		PQ Recorder 3U+3I Portable device	Class B	44	3 months campaigns in MV/LV substations
Fluke1760 (Fluke)		PQ Recorder 4U+4I or 4U+4U Portable device	Class A	11	3 months campaigns and continuous monitoring in HV/MV substations PQ assessment in Customers
Simeas R (Siemens)		DFR and PQ Recorder Up to 64 A. Inputs Rack mount	Class B	33 commissioning	DFR and continuous monitoring in HV/MV substations
BEN6000 (Qualitrol)		DRF and PQ Recorder Up to 192 A. Inputs Rack mount	Class A	15 commissioning	DFR and continuous monitoring in HV/MV substations

Methodology of the 3 months PQ monitoring campaigns

- Installation of portable PQ Recorders in HV/MV and MV/LV substations for monitoring during 3 months
  - Measurement of voltage in MV busbars of HV/MV substations
  - Measurement of voltage and current in LV busbars of MV/LV substations
- Appealing to Customers for PQ disturbances reporting
  - Potential sensitive Customers are asked by EDP to report PQ disturbances during the monitoring campaigns
  - Some Customers perform a short characterization of their machines/processes disturbed by PQ events
- PQ data collection and processing
  - Data are collected locally from all PQ Recorders every 30 days
  - All data are submitted to a comprehensive integrity analysis and stored in a bulk SQL Data Base
  - After each 3 months campaign, all PQ data are processed in order to issue PQ Overview Reports for HV/MV and MV/LV substations, sent regularly to the Portuguese Regulator

Voltage characteristics recorded during monitoring campaigns → As required by NP EN 50160

- Voltage magnitude
- Flicker
- Unbalance
- Frequency
- Harmonics
- Voltage dips
- Overvoltages

Portion of the PQ Overview Report 2009Q3 HV/MV substations – Harmonics spreadsheet

PAM2009T3SE - Quadro Resumo QEE.xls [Modo de Compatibilidade] - Microsoft Excel

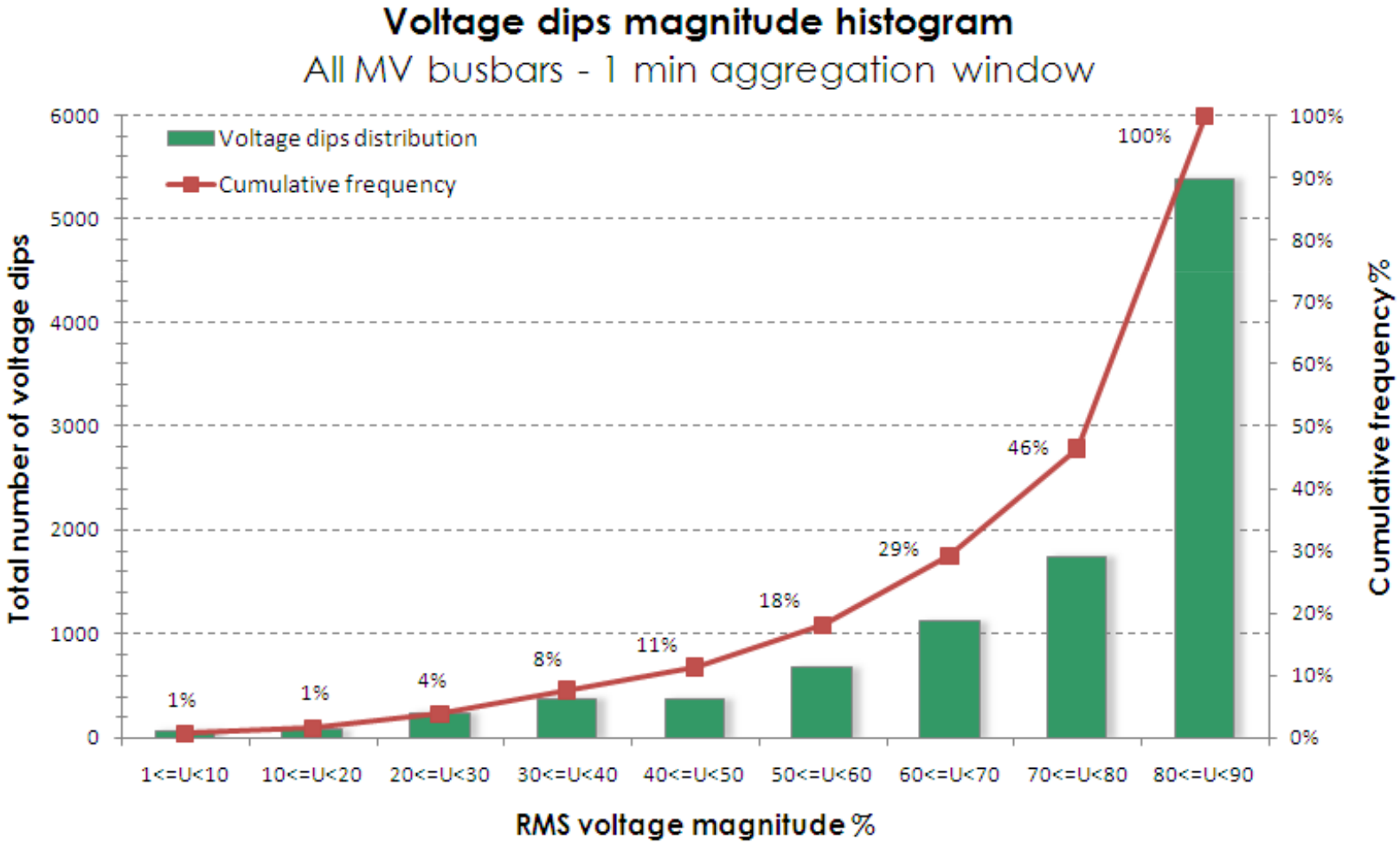
Distorção Harmónica

Período de medição		Tipo de semana	Fase	Distorção harmónica (%)																						N
				Ordem harmónica																				THD_{PSST}	Observações	
De	a			2^{a}_{PSST}	3^{a}_{PSST}	4^{a}_{PSST}	5^{a}_{PSST}	6^{a}_{PSST}	7^{a}_{PSST}	8^{a}_{PSST}	9^{a}_{PSST}	10^{a}_{PSST}	11^{a}_{PSST}	12^{a}_{PSST}	13^{a}_{PSST}	15^{a}_{PSST}	17^{a}_{PSST}	19^{a}_{PSST}	21^{a}_{PSST}	23^{a}_{PSST}	25^{a}_{PSST}			Monitoriz
			L1-L2	0.021	0.115	0.014	1.636	0.011	0.807	0.017	0.037	0.017	0.213	0.005	0.147	0.017	0.089	0.038	0.013	0.063	0.042	1.823		
2009-07-20 00:00:00.0	2009-07-26 23:50:00.0	Representativa	L2-L3	0.023	0.196	0.014	1.525	0.010	0.798	0.017	0.059	0.017	0.224	0.004	0.165	0.017	0.100	0.040	0.011	0.064	0.041	1.721		
			L3-L1	0.022	0.214	0.018	1.659	0.013	0.860	0.022	0.051	0.017	0.222	0.005	0.167	0.015	0.089	0.034	0.011	0.066	0.038	1.863		
			L1-L2	0.020	0.126	0.012	1.451	0.009	0.717	0.015	0.040	0.018	0.219	0.004	0.160	0.025	0.093	0.040	0.013	0.084	0.032	1.610		12
2009-09-07 00:00:00.0	2009-09-13 23:50:00.0	**Mais desfavorável**	L2-L3	0.022	0.204	0.013	1.368	0.011	0.721	0.014	0.048	0.018	0.216	0.004	0.174	0.021	0.131	0.040	0.013	0.106	0.031	1.532		
			L3-L1	0.022	0.194	0.016	1.452	0.010	0.781	0.016	0.041	0.017	0.213	0.005	0.171	0.013	0.118	0.037	0.012	0.101	0.034	1.620		
			L1-L2	0.019	0.125	0.014	2.051	0.013	0.658	0.013	0.045	0.015	0.292	0.004	0.160	0.019	0.112	0.049	0.011	0.052	0.032	2.057		
2009-08-10 00:00:00.0	2009-08-16 23:50:00.0	Representativa	L2-L3	0.022	0.271	0.012	1.958	0.009	0.715	0.009	0.040	0.015	0.273	0.006	0.167	0.017	0.108	0.054	0.008	0.046	0.039	2.025		
			L3-L1	0.020	0.322	0.012	2.027	0.012	0.721	0.012	0.052	0.015	0.315	0.004	0.169	0.016	0.118	0.059	0.010	0.053	0.041	2.098		12
			L1-L2	0.021	0.153	0.013	2.015	0.014	0.629	0.013	0.050	0.014	0.327	0.005	0.143	0.020	0.110	0.041	0.010	0.046	0.029	2.092		
2009-09-07 00:00:00.0	2009-09-13 23:50:00.0	**Mais desfavorável**	L2-L3	0.023	0.252	0.013	1.973	0.014	0.698	0.012	0.042	0.014	0.317	0.004	0.141	0.016	0.109	0.042	0.007	0.039	0.033	2.067		
			L3-L1	0.022	0.310	0.011	2.004	0.010	0.659	0.011	0.063	0.014	0.364	0.005	0.149	0.018	0.115	0.044	0.010	0.045	0.038	2.109		
			L1-L2	0.021	0.123	0.015	1.711	0.013	0.762	0.019	0.055	0.018	0.213	0.004	0.134	0.021	0.096	0.038	0.012	0.087	0.032	1.825		
2009-08-31 00:00:00.0	2009-09-06 23:50:00.0	Representativa	L2-L3	0.022	0.205	0.015	1.626	0.014	0.780	0.019	0.052	0.018	0.222	0.004	0.141	0.020	0.132	0.044	0.012	0.096	0.035	1.748		
			L3-L1	0.022	0.213	0.015	1.725	0.013	0.801	0.016	0.047	0.018	0.217	0.004	0.147	0.015	0.127	0.040	0.011	0.086	0.034	1.846		12
			L1-L2	0.021	0.128	0.014	1.576	0.013	0.813	0.015	0.053	0.017	0.149	0.003	0.136	0.017	0.085	0.035	0.008	0.038	0.030	1.751		
2009-09-07 00:00:00.0	2009-09-13 23:50:00.0	**Mais desfavorável**	L2-L3	0.021	0.176	0.015	1.546	0.014	0.835	0.016	0.050	0.016	0.159	0.003	0.128	0.011	0.075	0.041	0.008	0.037	0.033	1.726		
			L3-L1	0.022	0.197	0.013	1.607	0.011	0.796	0.013	0.023	0.017	0.178	0.003	0.133	0.015	0.076	0.041	0.009	0.036	0.038	1.736		
			L1-L2	0.021	0.155	0.012	1.653	0.011	0.757	0.015	0.050	0.020	0.129	0.004	0.088	0.016	0.091	0.051	0.016	0.089	0.035	1.774		
2009-09-21 00:00:00.0	2009-09-27 23:50:00.0	Representativa	L2-L3	0.022	0.173	0.012	1.627	0.009	0.755	0.011	0.040	0.018	0.141	0.004	0.088	0.012	0.106	0.061	0.018	0.087	0.039	1.754		
			L3-L1	0.022	0.074	0.013	1.583	0.010	0.747	0.014	0.035	0.018	0.155	0.004	0.101	0.016	0.114	0.070	0.020	0.083	0.044	1.693		12
			L1-L2	0.020	0.102	0.012	1.312	0.012	0.832	0.012	0.052	0.019	0.126	0.004	0.092	0.017	0.086	0.054	0.016	0.112	0.042	1.540		
2009-09-07 00:00:00.0	2009-09-13 23:50:00.0	**Mais desfavorável**	L2-L3	0.021	0.134	0.012	1.291	0.010	0.855	0.012	0.042	0.019	0.137	0.004	0.103	0.013	0.120	0.073	0.016	0.112	0.046	1.552		
			L3-L1	0.021	0.106	0.012	1.255	0.011	0.867	0.013	0.030	0.018	0.160	0.005	0.117	0.016	0.122	0.073	0.020	0.104	0.048	1.505		
			L1-L2	0.022	0.167	0.020	3.049	0.013	0.759	0.009	0.056	0.006	0.275	0.004	0.161	0.058	0.077	0.034	0.053	0.039	0.059	3.093		
2009-09-21 00:00:00.0	2009-09-27 23:50:00.0	Representativa	L2-L3	0.022	0.163	0.016	3.014	0.010	0.745	0.009	0.047	0.006	0.292	0.003	0.158	0.040	0.070	0.024	0.025	0.023	0.030	3.063		
			L3-L1	0.021	0.137	0.021	3.103	0.013	0.764	0.008	0.034	0.007	0.290	0.003	0.163	0.031	0.044	0.024	0.032	0.023	0.034	3.143		13
			L1-L2	0.022	0.087	0.026	3.284	0.014	0.995	0.011	0.060	0.007	0.306	0.003	0.153	0.057	0.098	0.037	0.058	0.046	0.052	3.302		
2009-08-17 00:00:00.0	2009-08-23 23:50:00.0	**Mais desfavorável**	L2-L3	0.021	0.174	0.020	3.252	0.012	0.977	0.010	0.048	0.006	0.325	0.003	0.139	0.040	0.076	0.030	0.027	0.025	0.026	3.261		
			L3-L1	0.021	0.190	0.021	3.428	0.013	1.018	0.010	0.032	0.005	0.331	0.003	0.144	0.030	0.054	0.025	0.034	0.026	0.028	3.425		
			L1-L2	0.023	0.171	0.022	2.517	0.012	0.946	0.012	0.027	0.006	0.392	0.003	0.110	0.025	0.073	0.032	0.015	0.029	0.023	2.600		
2009-09-28 00:00:00.0	2009-10-04 23:50:00.0	Representativa	L2-L3	0.023	0.166	0.018	2.381	0.014	0.956	0.009	0.050	0.006	0.398	0.003	0.131	0.023	0.071	0.030	0.011	0.014	0.014	2.462		
			L3-L1	0.023	0.105	0.023	2.412	0.014	0.879	0.010	0.047	0.005	0.379	0.003	0.109	0.014	0.061	0.028	0.009	0.018	0.019	2.477		13
			L1-L2	0.022	0.102	0.019	2.611	0.014	1.017	0.016	0.044	0.008	0.352	0.004	0.160	0.023	0.080	0.041	0.022	0.041	0.027	2.757		
2009-08-03 00:00:00.0	2009-08-09 23:50:00.0	**Mais desfavorável**	L2-L3	0.022	0.174	0.016	2.479	0.013	1.053	0.012	0.039	0.007	0.345	0.004	0.168	0.022	0.058	0.026	0.013	0.020	0.015	2.645		
			L3-L1	0.021	0.146	0.019	2.555	0.014	1.050	0.012	0.057	0.007	0.337	0.004	0.143	0.021	0.064	0.033	0.011	0.025	0.023	2.710		
			L1-L2	0.020	0.069	0.018	2.686	0.017	0.870	0.012	0.038	0.011	0.341	0.005	0.109	0.010	0.036	0.028	0.005	0.019	0.010	2.728		
2009-07-27 00:00:00.0	2009-08-02 23:50:00.0	Representativa	L2-L3	0.021	0.174	0.015	2.675	0.015	0.838	0.011	0.034	0.009	0.331	0.004	0.118	0.012	0.033	0.027	0.005	0.017	0.010	2.715		
			L3-L1	0.020	0.180	0.018	2.632	0.015	0.878	0.011	0.050	0.008	0.384	0.005	0.117	0.018	0.040	0.028	0.007	0.017	0.012	2.695		12
			L1-L2	0.022	0.094	0.022	2.901	0.018	1.075	0.015	0.044	0.012	0.322	0.005	0.093	0.012	0.037	0.030	0.005	0.021	0.013	2.966		
2009-08-03 00:00:00.0	2009-08-09 23:50:00.0	**Mais desfavorável**	L2-L3	0.023	0.192	0.017	2.867	0.018	1.077	0.013	0.044	0.010	0.323	0.004	0.102	0.009	0.036	0.029	0.006	0.019	0.011	2.919		
			L3-L1	0.022	0.183	0.022	2.826	0.018	1.091	0.014	0.060	0.009	0.365	0.006	0.100	0.018	0.041	0.030	0.006	0.018	0.013	2.878		
			L1-L2	0.021	0.101	0.018	2.467	0.017	1.062	0.014	0.032	0.016	0.687	0.005	0.218	0.015	0.068	0.056	0.009	0.025	0.018	2.649		
2009-07-20 00:00:00.0	2009-07-26 23:50:00.0	Representativa	L2-L3	0.022	0.199	0.017	2.437	0.014	1.076	0.014	0.065	0.011	0.659	0.005	0.214	0.022	0.054	0.057	0.007	0.024	0.018	2.587		
			L3-L1	0.020	0.159	0.016	2.496	0.015	1.031	0.014	0.063	0.010	0.649	0.005	0.223	0.020	0.053	0.058	0.007	0.026	0.018	2.627		12
			L1-L2	0.023	0.132	0.022	2.676	0.017	1.226	0.015	0.041	0.020	0.586	0.006	0.261	0.022	0.082	0.050	0.008	0.023	0.021	2.857		
2009-08-03 00:00:00.0	2009-08-09 23:50:00.0	**Mais desfavorável**	L2-L3	0.022	0.233	0.019	2.641	0.014	1.297	0.011	0.069	0.014	0.580	0.006	0.261	0.031	0.068	0.051	0.008	0.023	0.021	2.820		
			L3-L1	0.021	0.160	0.017	2.677	0.016	1.230	0.014	0.064	0.011	0.504	0.005	0.280	0.019	0.055	0.043	0.005	0.024	0.022	2.845		
			L1-L2	0.021	0.113	0.019	2.227	0.013	1.468	0.022	0.063	0.008	0.339	0.004	0.150	0.025	0.119	0.030	0.010	0.035	0.013	2.562		
2009-08-31 00:00:00.0	2009-09-06 23:50:00.0	Representativa	L2-L3	0.022	0.180	0.014	2.287	0.015	1.501	0.015	0.114	0.010	0.421	0.003	0.150	0.013	0.123	0.029	0.007	0.039	0.015	2.514		
			L3-L1	0.021	0.162	0.022	2.212	0.016	1.708	0.017	0.066	0.007	0.336	0.003	0.162	0.025	0.110	0.027	0.008	0.032	0.016	2.686		12

Amplitude | Flicker | Desequilíbrio | Frequência | **Harmónicas** | Cavas | Cavas Quadro | Sobretensões | Interrupções

An independent audit carried out concerning to the year 2008 has stated that procedures and controls adopted by EDP are effective to fulfil the requirements of the Portuguese QoS Code

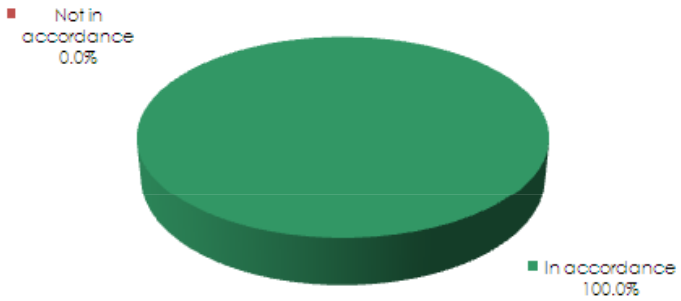
Overview of voltage dips recorded in the 285 MV busbars (HV/MV substations) analysed in 3 months campaigns during the 4 quarters of 2008 and the first 3 quarters of 2009



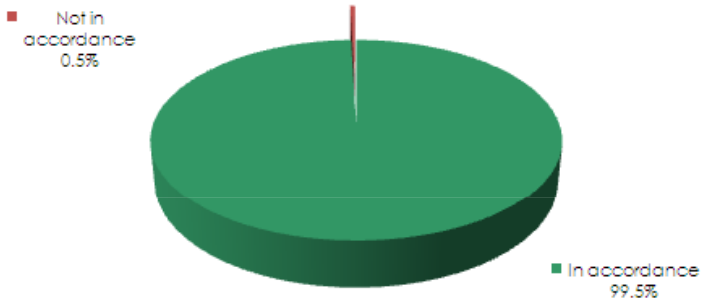
PQ Monitoring Results
HV/MV Substations

PQ results from the 285 MV busbars (HV/MV substations) analysed in 3 months campaigns during the 4 quarters of 2008 and the first 3 quarters of 2009 → Total of 3021 monitoring weeks

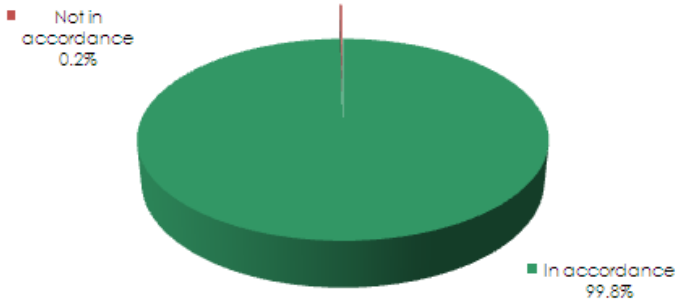
Voltage variations
Weeks in accordance to the NP EN 50160



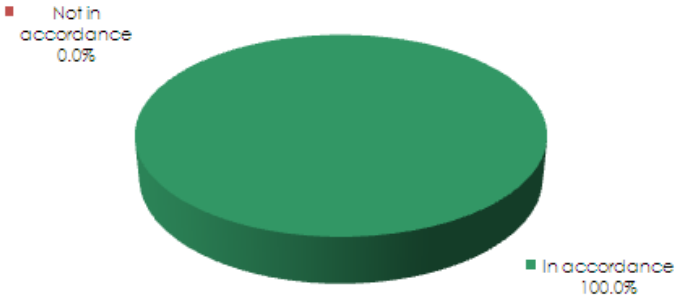
Long term flicker
Weeks in accordance to the NP EN 50160



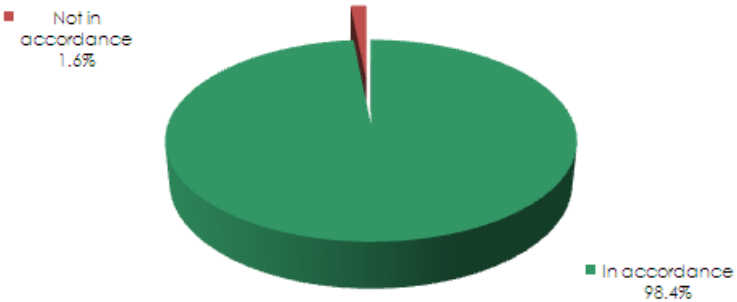
Voltage unbalance
Weeks in accordance to the NP EN 50160



Power frequency
Weeks in accordance to the NP EN 50160

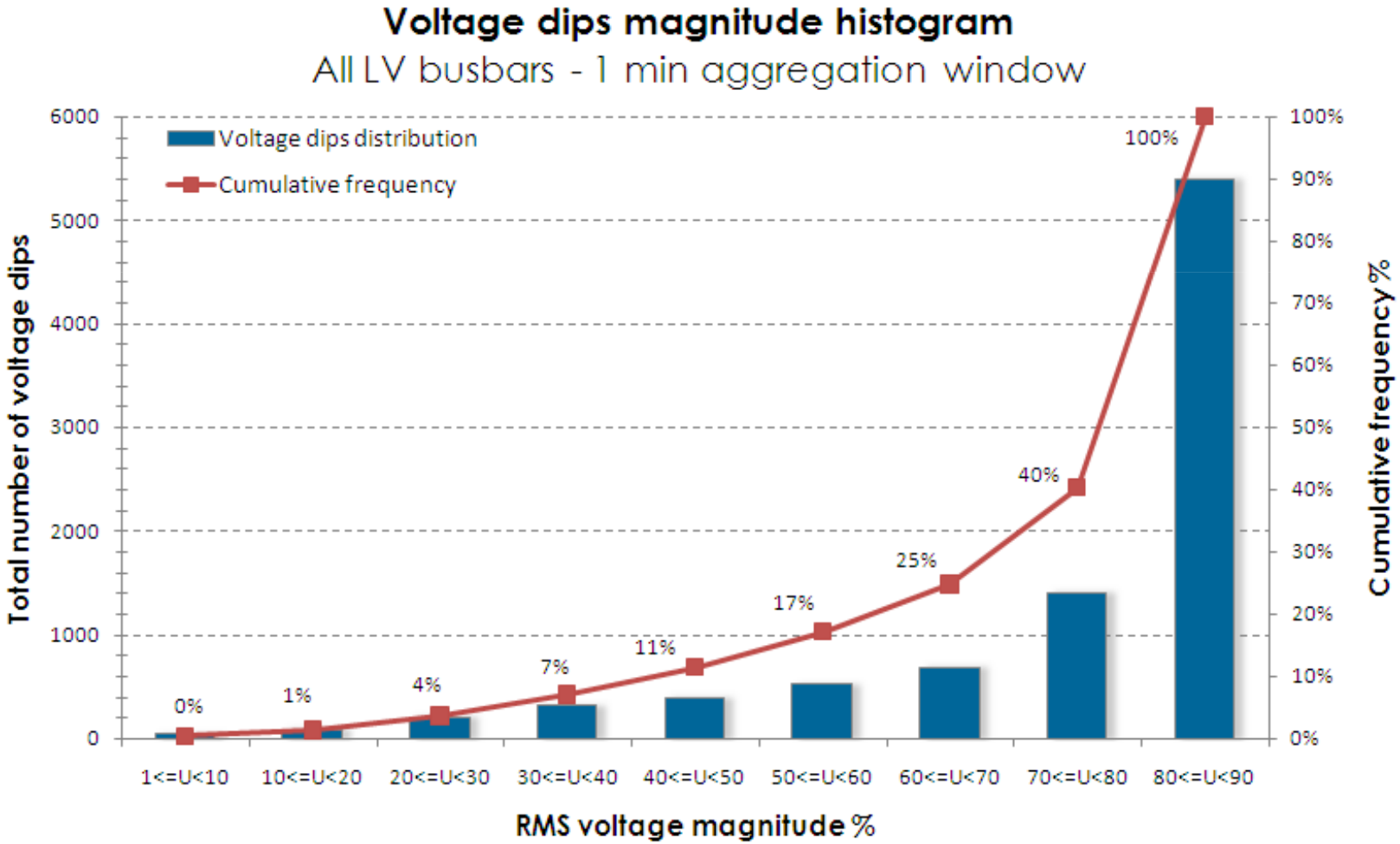


Harmonics
Weeks in accordance to the NP EN 50160



Excluding isolated recordings of 15th harmonic due to public lighting control

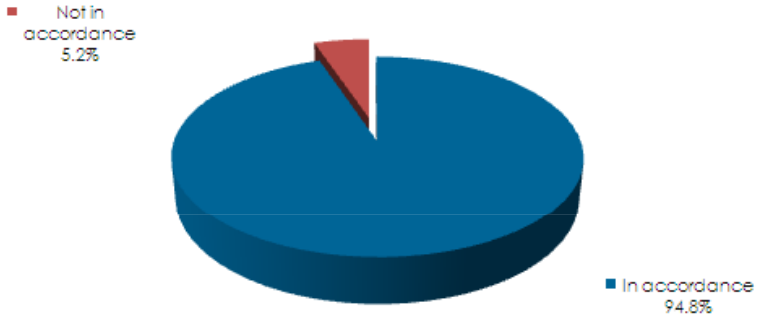
Overview of voltage dips recorded in the 277 LV busbars (MV/LV substations) analysed in 3 months campaigns during the 4 quarters of 2008 and the first 3 quarters of 2009



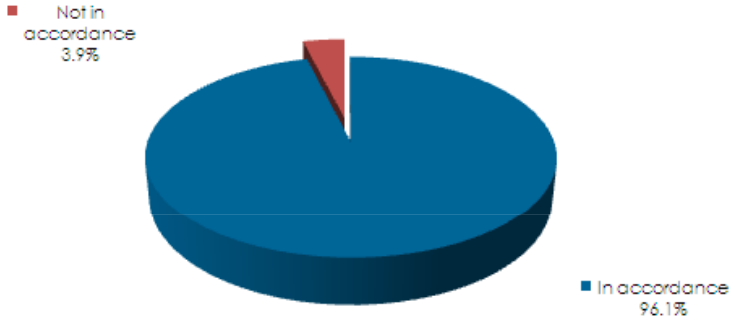
PQ Monitoring Results
MV/LV Substations

PQ results from the 277 LV busbars (MV/LV substations) analysed in 3 months campaigns during the 4 quarters of 2008 and the first 3 quarters of 2009 → Total of 2772 monitoring weeks

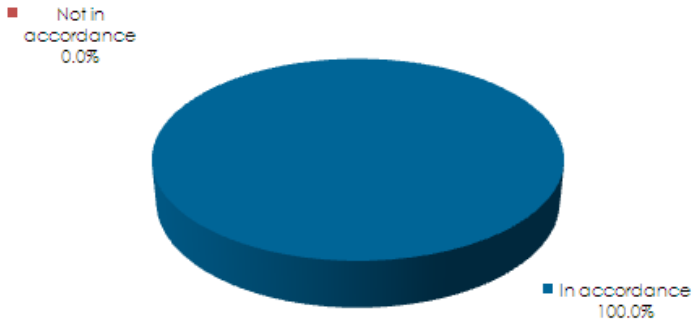
Voltage variations
Weeks in accordance to the NP EN 50160



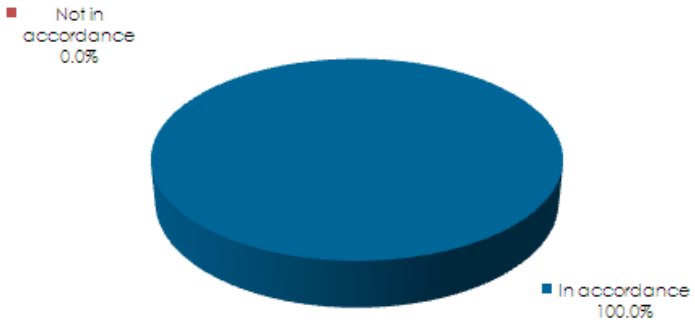
Long term flicker
Weeks in accordance to the NP EN 50160



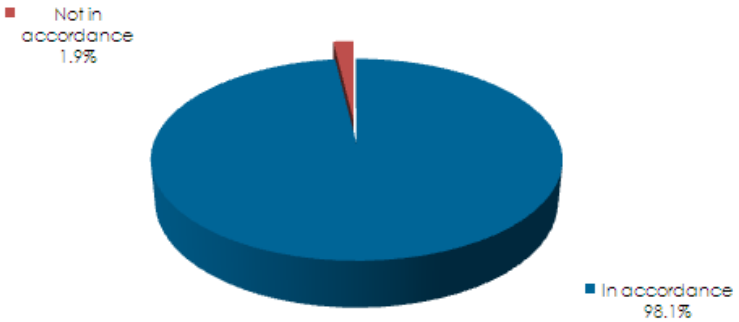
Voltage unbalance
Weeks in accordance to the NP EN 50160



Power frequency
Weeks in accordance to the NP EN 50160



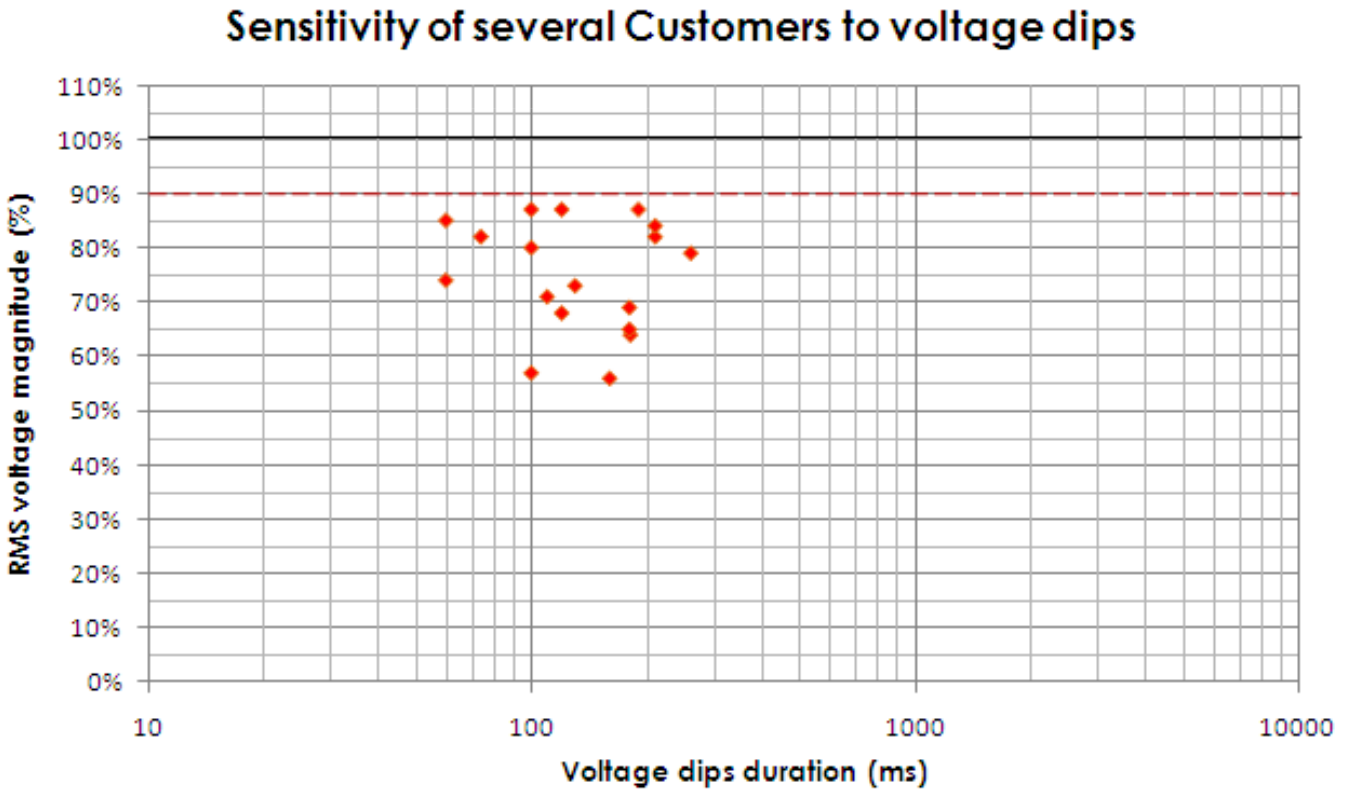
Harmonics
Weeks in accordance to the NP EN 50160



Customers Sensitivity
Main Challenge

Mostly, Customers report production disturbances facing to voltage dips

- **Continuous processes supported by PLC, ASD and other electronic devices are very sensitive to voltage dips**
- **Long downtime periods associated to voltage dips**
- **Typical difficulties to adopt immunization solutions and re-engineering strategies to improve the process reliability**



Thank you for your attention

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