Black out Italia 2003

Lessons learned and improvement of the regulation

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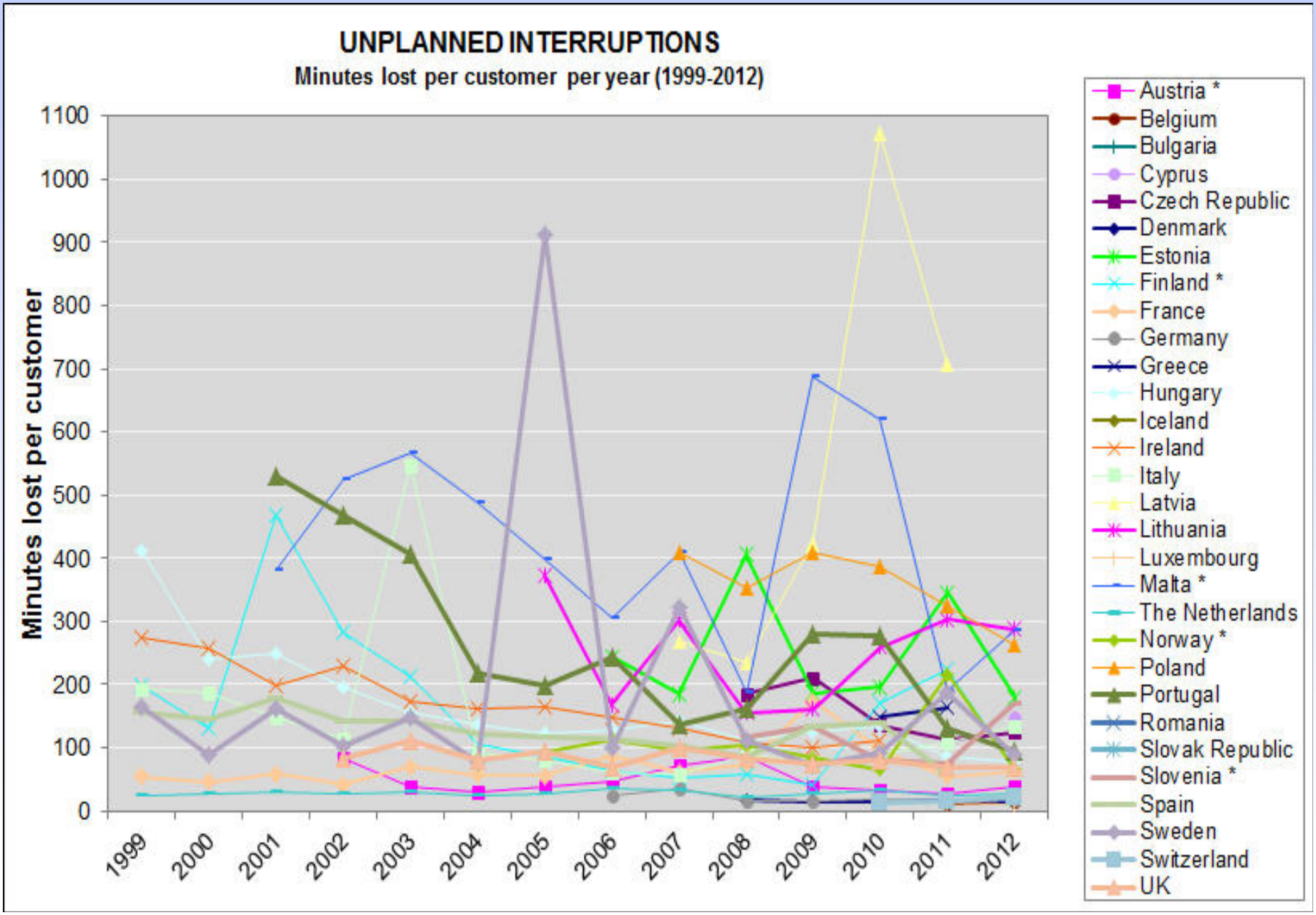
Civil Protection 2015
Congresso Internazionale "Black out"

Bolzano, 19th-20th March 2015

THE ITALIAN REGULATORY AUTHORITY FOR ELECTRICITY GAS AND WATER

- Founded in 1995
- Operating since 1997
- Functions:
  - Price control
  - Quality standards
  - Competition
  - Accounting and administrative unbundling
  - Monitoring and auditing
  - Complaints and appeals
  - Disputes
  - Information and transparency
  - Advice to Government on licensing and market structure
- Fully independent
- Accountable to the Parliament
- From 2012 the Authority has been regulating the water sector

THE CEER BENCHMARK ON QUALITY OF ELECTRICITY SUPPLY



Source: Council of European Energy Regulators

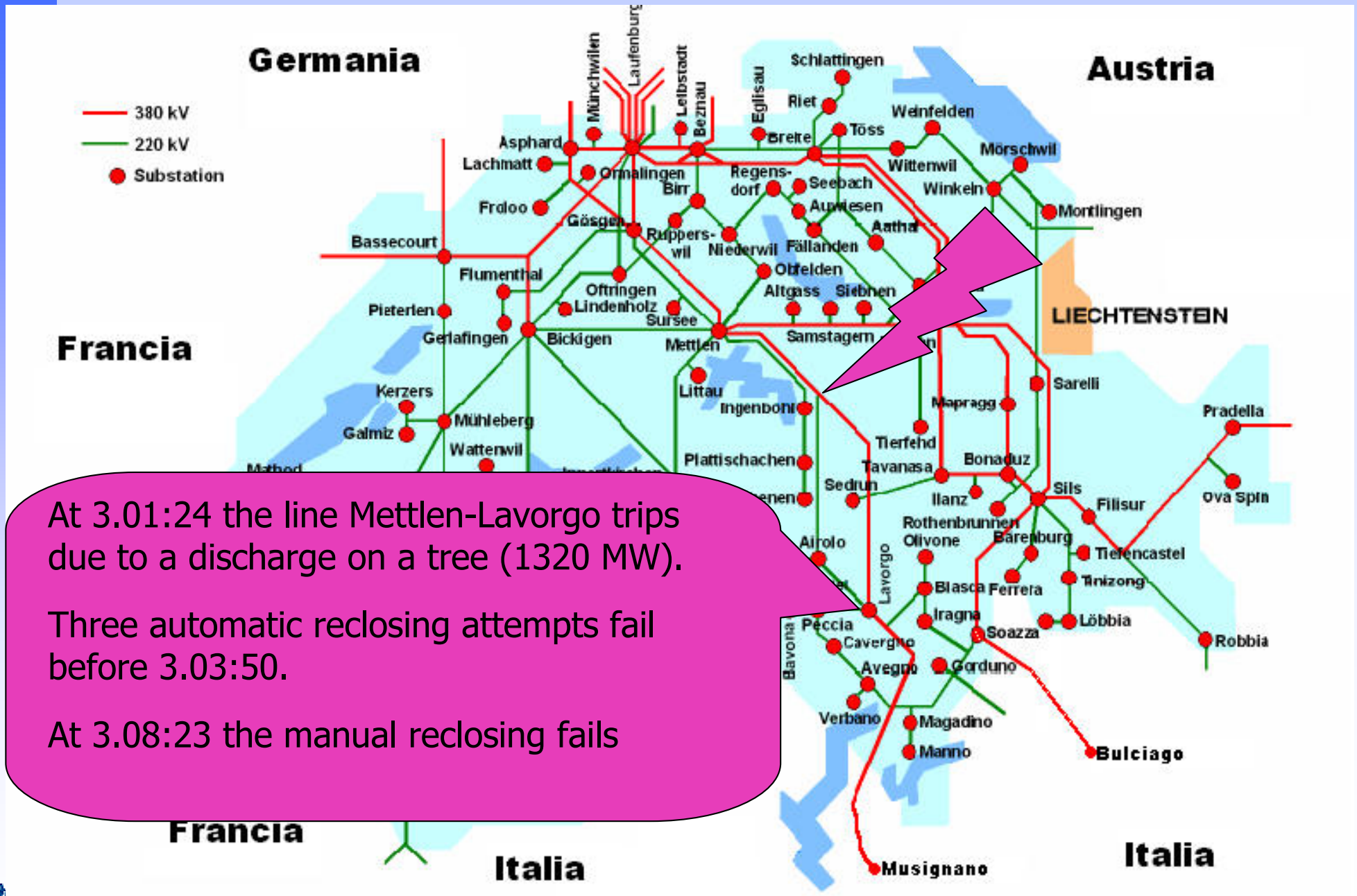
FACTS

From the attachment A to Regulatory Order no. 83/04:

During the night between 27 and 28 September 2003, a number of malfunctions occurred in the interconnected European power system, caused by faults on power lines of the transmission network of Switzerland, which led to the separation of the Italian electricity system from the rest of the interconnected UCTE1. Following this separation, there was an interruption of the electrical service extended to almost all of the Italian electricity system (with the exception of Sardinia) and, in part, the Swiss electrical system (area of Ticino)

«*Durante la notte tra il 27 e il 28 settembre 2003 si sono verificati, nel sistema elettrico interconnesso europeo, una serie di malfunzionamenti, generati da guasti su linee elettriche della rete di trasmissione della Svizzera, che hanno determinato la separazione del sistema elettrico italiano dal resto della rete interconnessa UCTE1. In seguito a tale separazione, si è verificata una interruzione del servizio elettrico estesa alla quasi totalità del sistema elettrico nazionale (ad esclusione della Sardegna) e, in parte, del sistema elettrico svizzero (area del Ticino).*»

FIRST FAULT: LUCOMAGNO LINE

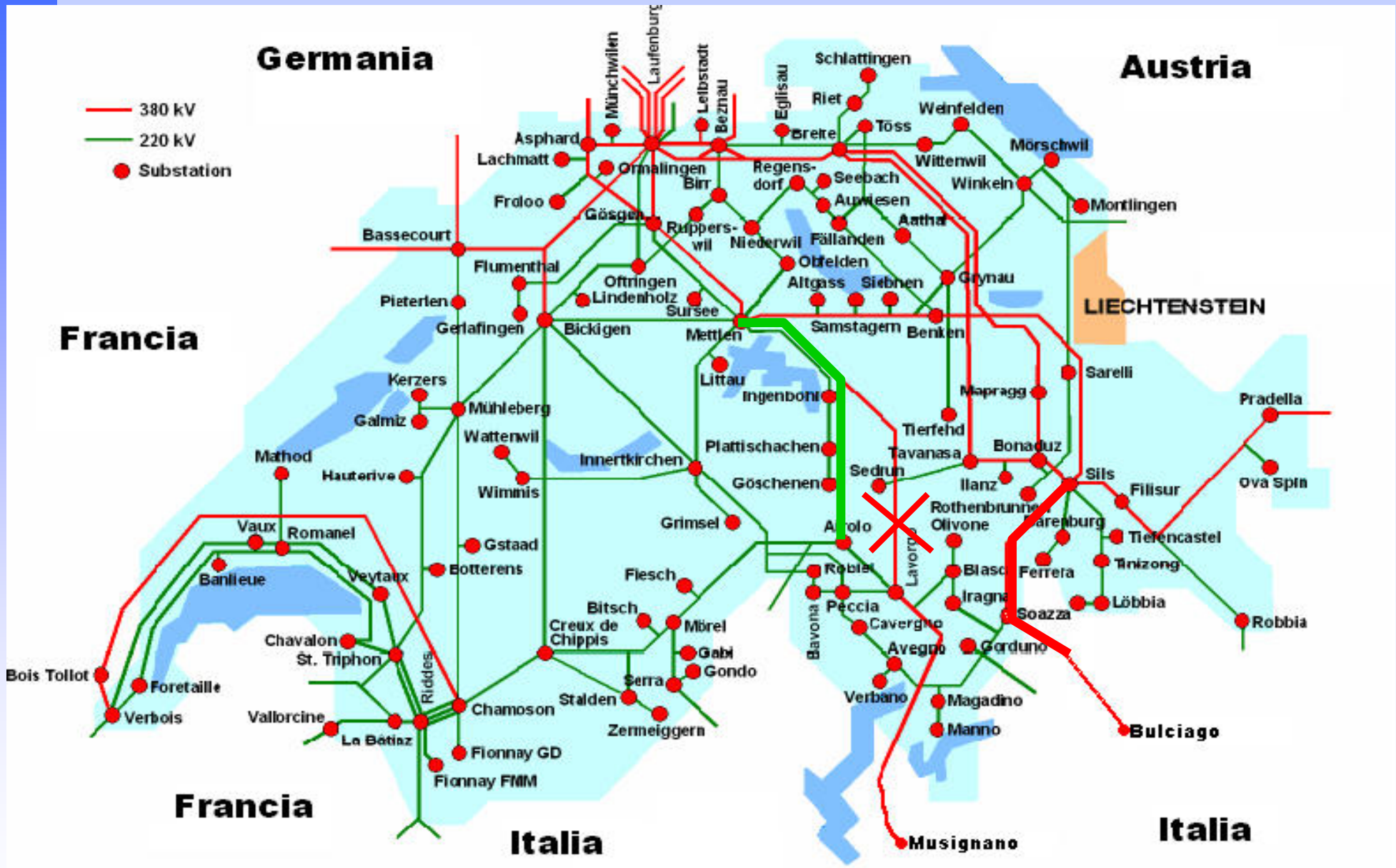


At 3.01:24 the line Mettlen-Lavorgo trips due to a discharge on a tree (1320 MW).

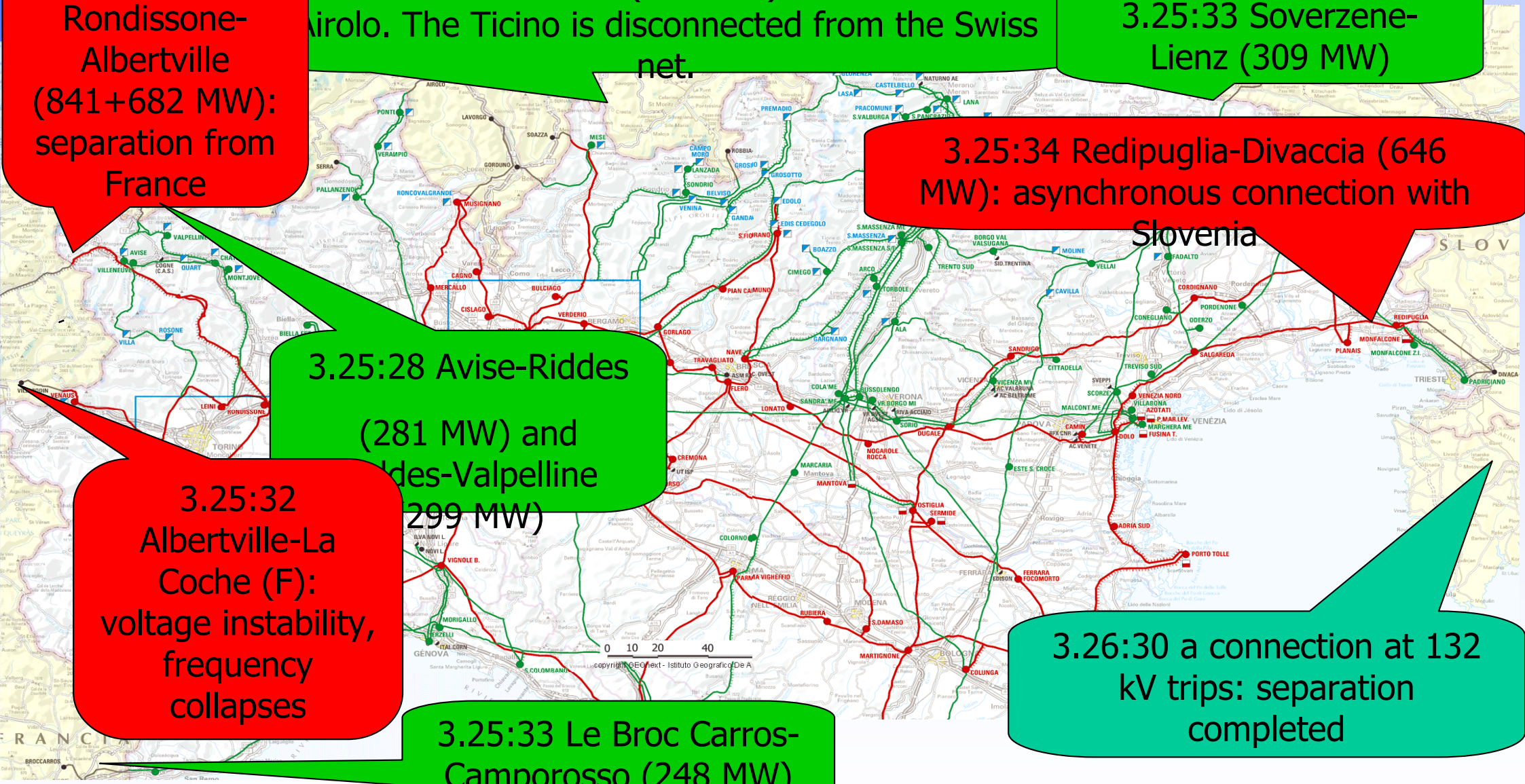
Three automatic reclosing attempts fail before 3.03:50.

At 3.08:23 the manual reclosing fails

OVERLOADS AFTER THE FIRST TRIP

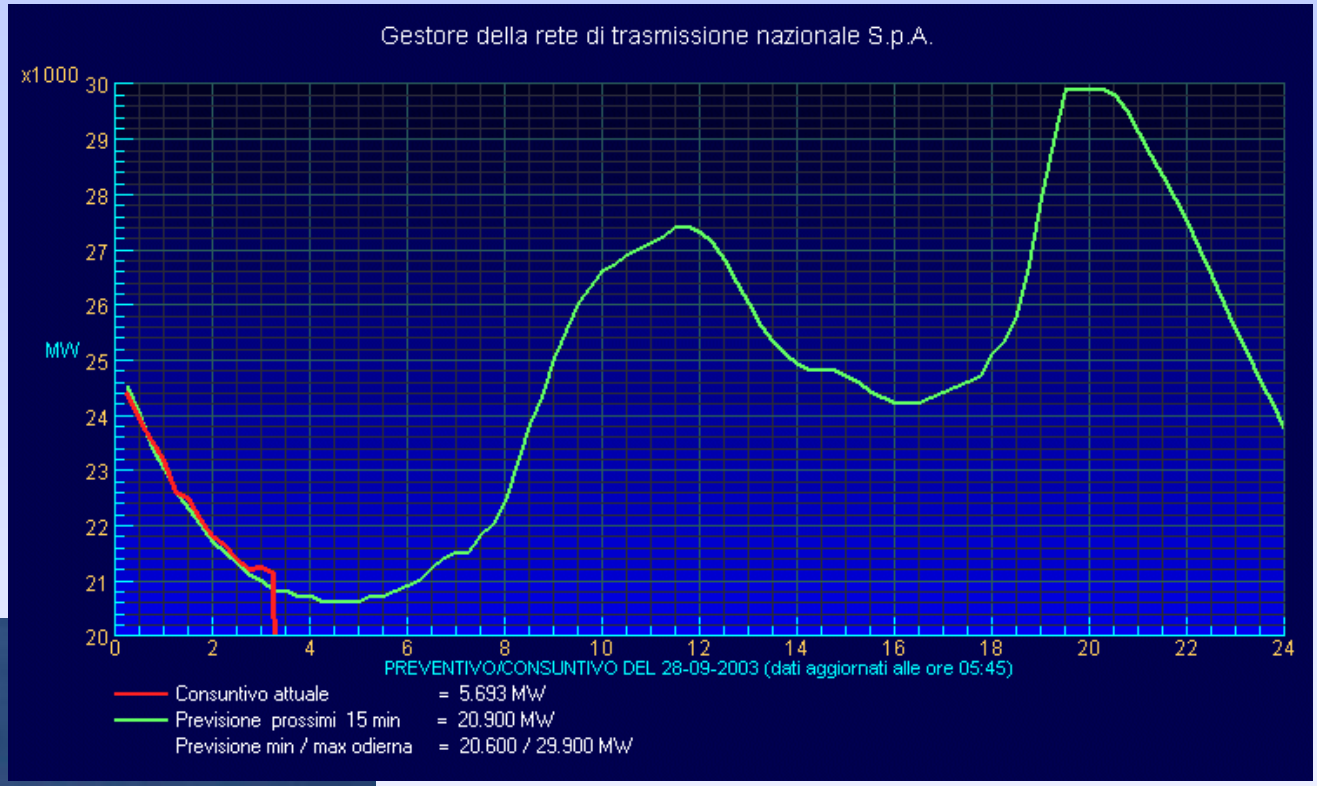


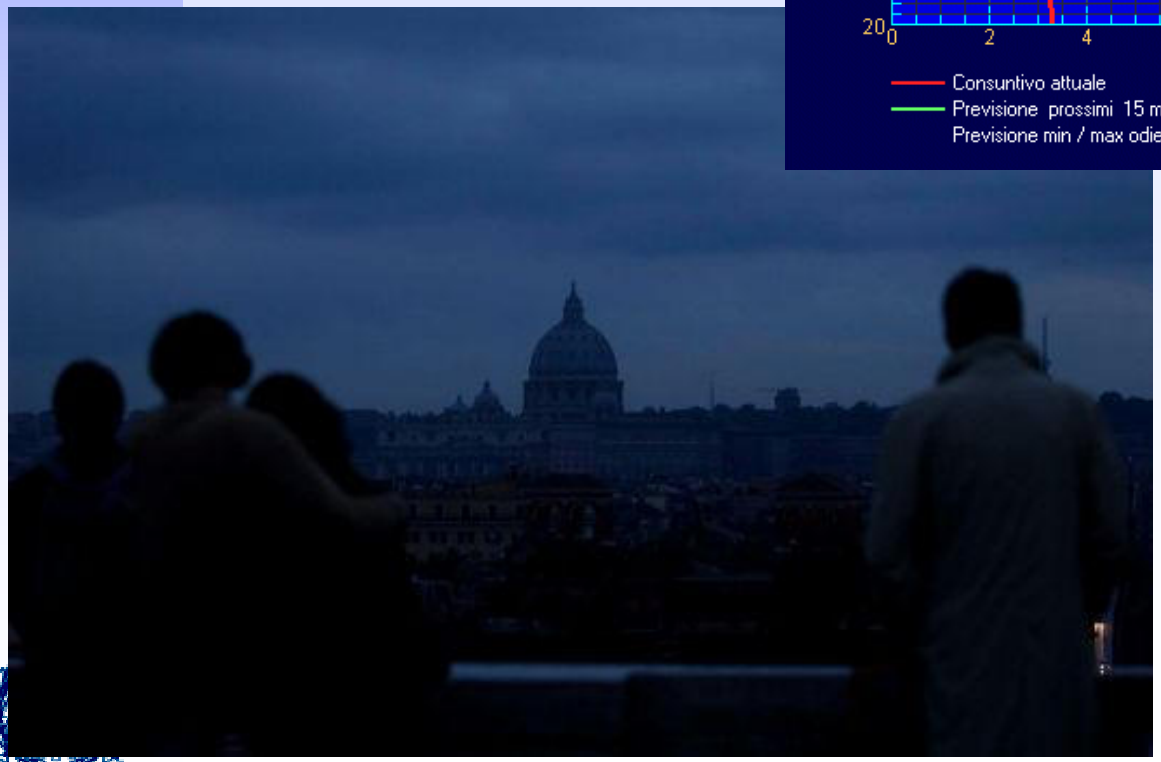
SEPARATION OF THE ITALIAN POWER SYSTEM



EFFECTS OF THE BLACKOUT

28th September 2003
3:30am



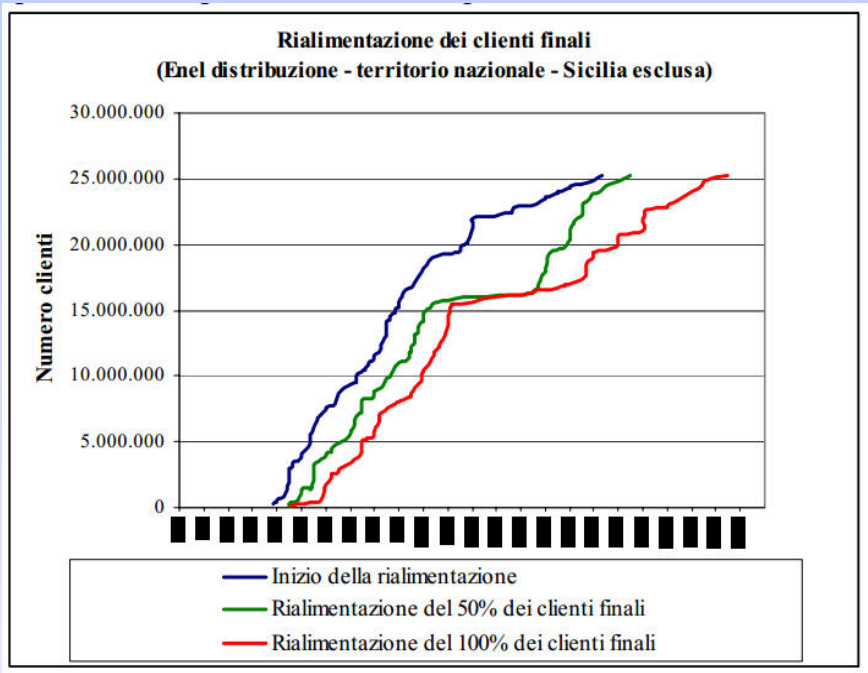


Source: - the Internet,

- GRTN

RE-POWERING OF CONSUMERS

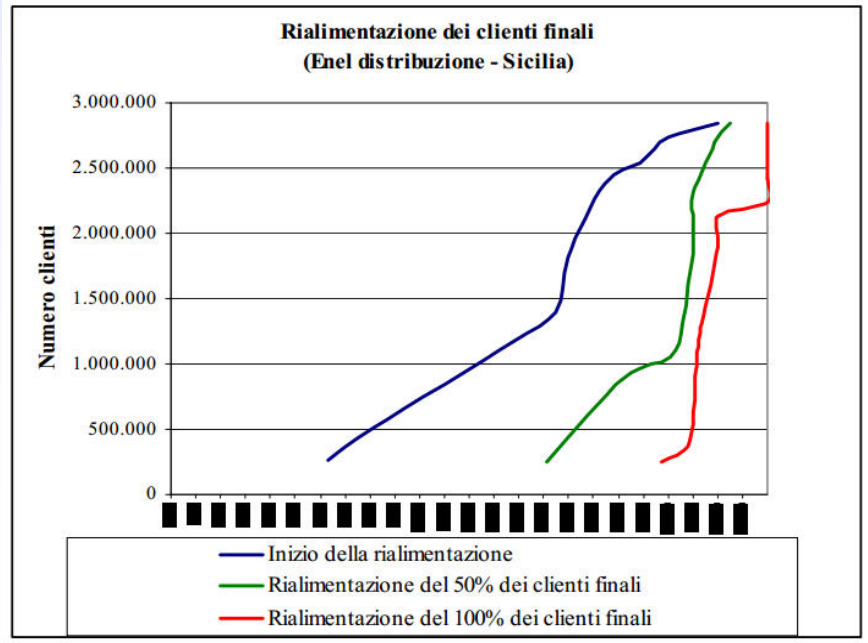
Ora di inizio ripristino			Ora ripristino di circa il 50% dei clienti			ORA di ripristino del 100% dei clienti		
PROVINCIA	CLIENTI		PROVINCIA	CLIENTI		PROVINCIA	CLIENTI	
PAVIA	275867	3.50	IMPERIA	164311	4.30	VERBANIA	125349	4.35
IMPERIA	164311	4.00	VERBANIA	125349	4.30	NOVARA	204997	5.10
VERBANIA	125349	4.00	VERCELLI	88793	4.40	VERCELLI	88793	5.35
BOLZANO	79855	4.04	NOVARA	204997	4.50	BIELLA	120248	5.50
SONDRIO	108898	4.15	VARESE	442530	5.00	MILANO	1179363	6.00
MILANO	1179363	4.30	SAVONA	275273	5.00	SONDRIO	108898	6.00
VARESE	442530	4.30	TRIESTE	16287	5.00	PAVIA	275867	6.10
SAVONA	275273	4.30	SONDRIO	108898	5.15	VARESE	442530	6.15
VERCELLI	88793	4.30	BIELLA	120248	5.25	TRIESTE	16287	6.20
GORIZIA	64839	4.30	MILANO	1179363	5.30	LECCO	193164	6.30
TRIESTE	16287	4.30	VENEZIA	489991	5.30	LODI	104521	6.30
UDINE	198640	4.30	PAVIA	275867	5.45	BERGAMO	573958	7.00
BIELLA	120248	4.40	ASTI	137839	5.50	COMO	321843	7.20
NOVARA	204997	4.40	COMO	321843	6.00	ASTI	137839	7.25
ASTI	137839	4.50	GORIZIA	64839	6.00	BRESCIA	538480	7.30
COMO	321843	5.00	CREMONA	133808	6.15	GORIZIA	64839	7.30
COSENZA	458077	5.05	LECCO	193164	6.15	VENEZIA	489991	7.30
LECCO	193164	5.15	LODI	104521	6.15	CREMONA	133808	7.40
PADOVA	436650	5.20	ROVIGO	129703	6.20	MANTOVA	201635	7.45
VENEZIA	489991	5.20	BERGAMO	573958	6.50	IMPERIA	164311	8.00
ALESSANDRIA	292305	5.25	BRESCIA	538480	7.00	SAVONA	275273	8.00
TREVISO	405041	5.30	UDINE	198640	7.00	CUNEO	401576	8.03
BERGAMO	573958	5.40	ALESSANDRIA	292305	7.10	ALESSANDRIA	292305	8.10
CREMONA	133808	5.40	TORINO	789811	7.15	TORINO	789811	8.18
LODI	104521	5.45	TRENTO	217725	7.24	GENOVA	614842	8.50
BRESCIA	538480	6.00	MANTOVA	201635	7.30	UDINE	198640	9.00
ROVIGO	129703	6.00	CUNEO	401576	7.30	BOLZANO	79855	9.03



Sicilia

Ora di inizio ripristino			Ora ripristino di circa il 50% dei clienti			Ora di ripristino del 100% dei clienti		
PROVINCIA	CLIENTI		PROVINCIA	CLIENTI		PROVINCIA	CLIENTI	
AGRIGENTO	265379	6.20	TRAPANI	250018	15.09	TRAPANI	250018	19.44
TRAPANI	250018	8.12	PALERMO	649977	18.15	CALTANISSETTA	156596	20.52
PALERMO	649977	13.45	CALTANISSETTA	156596	20.05	PALERMO	649977	21.08
SIRACUSA	227135	15.30	AGRIGENTO	265379	20.36	AGRIGENTO	265379	21.23
MESSINA	418410	16.00	CATANIA	576265	21.00	CATANIA	576265	22.00
CATANIA	576265	17.30	RAGUSA	193089	21.00	SIRACUSA	227135	22.00
CALTANISSETTA	156596	18.54	SIRACUSA	227135	21.00	ENNA[77]	105864	0.06
RAGUSA	193089	20.00	MESSINA	418410	22.00	RAGUSA	193089	0.10
ENNA	105864	22.00	ENNA	105864	22.30	MESSINA	418410	0.35

Tabella 33 – Cronologia di ripristino (per provincia) rete Enel Distribuzione



FINDINGS OF THE AUTHORITY INVESTIGATION (R.O. N. 83/04)

From the beginning of the disturbance to the separation of the Italian power system from the UCTE network

- E1: 28 September 2003, the operation of the Swiss network was unsufficient in terms of predisposition of preventive measures to maintain the safety of operation of the electrical service. This resulted in a situation of risk to the safety of electrical service in the European interconnected systems
- E2: 28 September 2003, the Swiss electricity companies have not fulfilled what required by UCTE rules

FINDINGS OF THE AUTHORITY INVESTIGATION (R.O. N. 83/04)

- E3: 28 September 2003, the insufficient provision of preventive measures on the part of Swiss network operators led, following the out of service of the 380 kV line Mettlen-Lavorgo (Lukmanier line), to the loss of the 380 kV Sils- Soazza (line of San Bernardino) with the subsequent occurrence of a condition N-2, not covered in the operation planning of interconnected electricity systems
- E4: The failure to adopt the planned countermeasures led to the ineffectiveness of logical control of critical sections placed in defense of the integrity of the network interconnection with neighboring countries
- E5: The separation of the national electricity system by UCTE network was characterized by transient instability phenomena of the Italian electricity system as regards the UCTE network.

FINDINGS OF THE AUTHORITY INVESTIGATION (R.O. N. 83/04)

The diffusion of the interruption in Italy

- E6: Following the separation of the national electricity system by UCTE network, the diffusion of the interruption of electricity service in the country was caused by a series of concurrent events such as, primarily, the early disconnection of production units as regards the prescribed intervention time and, secondly, an ineffective reaction of the automatic load shedding system
- E7: During the diffusion of the interruption the behavior of 21 production groups was apparently different from what is stated in the Technical regulations for connection to the national grid

FINDINGS OF THE AUTHORITY INVESTIGATION (R.O. N. 83/04)

- E8: The overall action of the automatic load shedding system has not reached the expected levels envisaged by Technical regulations for connection. Furthermore, it was found that a number of distribution companies connected to the national grid is not equipped with devices for lightening the load
- E9: The failure rate of the implementation of the actions of load rejection of production groups was very high. This has seriously affected the restoration of the electricity service

FINDINGS OF THE AUTHORITY INVESTIGATION (R.O. N. 83/04)

The service restoration

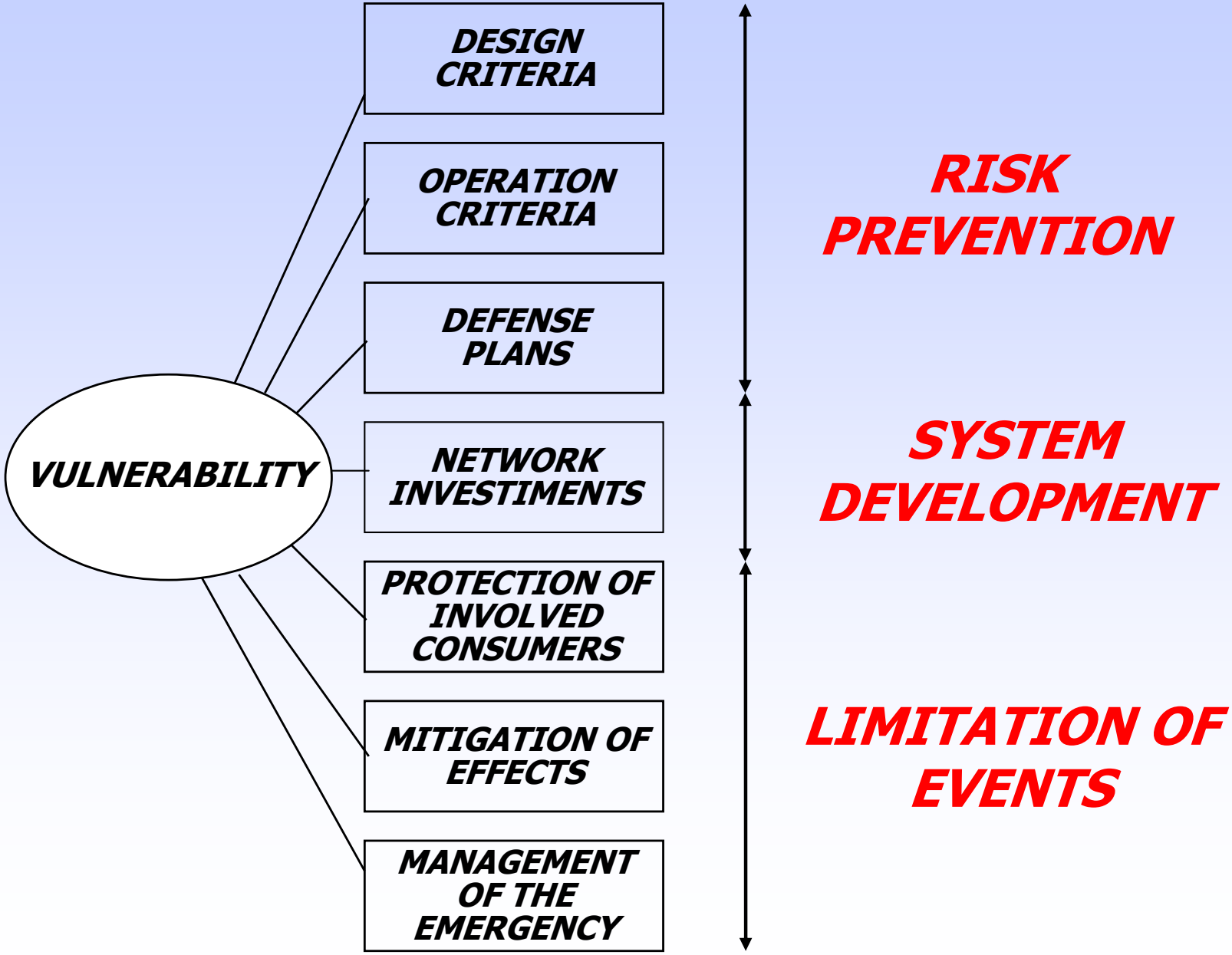
- E10: In most cases the start of autonomous units "of first restarting" did not occur. The GRTN has managed to restore service through the repowering of lines, starting from North. This caused a significant delay in the restoration of the electricity service in the Centre and South
- E11: During the recovery of the electrical service, telecommunications systems for the remote control of the switching elements of the national transmission grid have suffered instability and saturation. Furthermore, the system of emergency power supply of said telecommunication systems has proved unsuitable

FIRST REACTIONS AFTER THE BLACKOUT

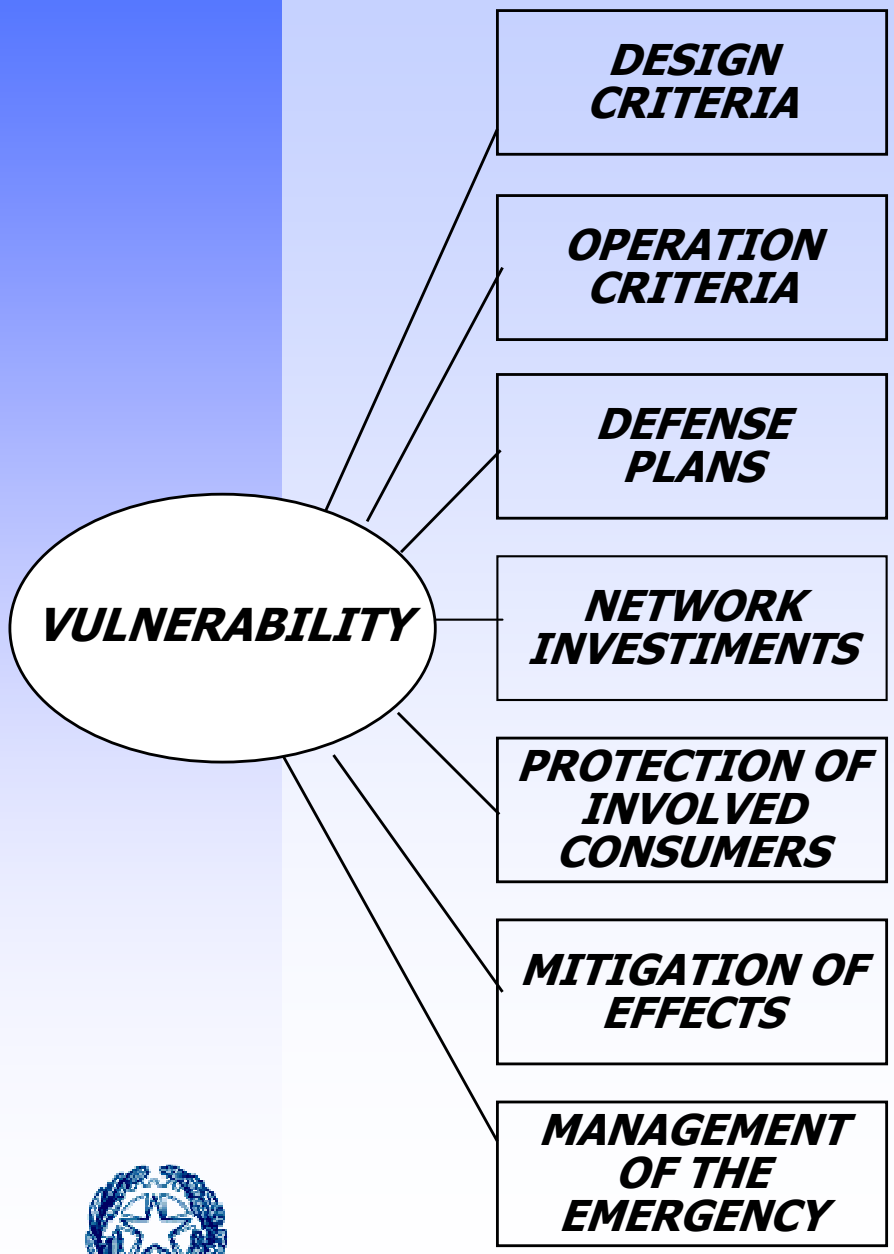
- *Co-ordination among TSOs* shall be reinforced
- *Compliance with UCTE rules* shall be made legally binding
- Wish for *a new regulatory framework in CH* coherent with EU legislation
- Need for *revision of defense plan* and actual enforcement
  (esp. automatic load disconnection and load-reject actions by generators)
- *Black start* procedure to be enhanced and operationally tested
- *Consumer protection tools* (automatic compensation for individual customers)

Authority black-out report
(decision 83/04)

VULNERABILITY DIMENSIONS OF A POWER SYSTEM



SOME ACTIONS CARRIED OUT BY THE AUTHORITY AFTER THE 2003 BLACKOUT



2011: update tech. std. CEI 11-04 – construction of overhead power lines

2004/2005: Guidelines for Grid Code and New Grid Code

Remote disconnection services (for large consumers) [*interrompibilità*]

2000 on: reinforced awards/penalties reg. for DSOs
2003: incentives for transm. investments
2008: awards/penalities regulation for transm.
2010: innovation in smart networks

2009: standards and automatic compensations for long interruptions

2008: back feeding services

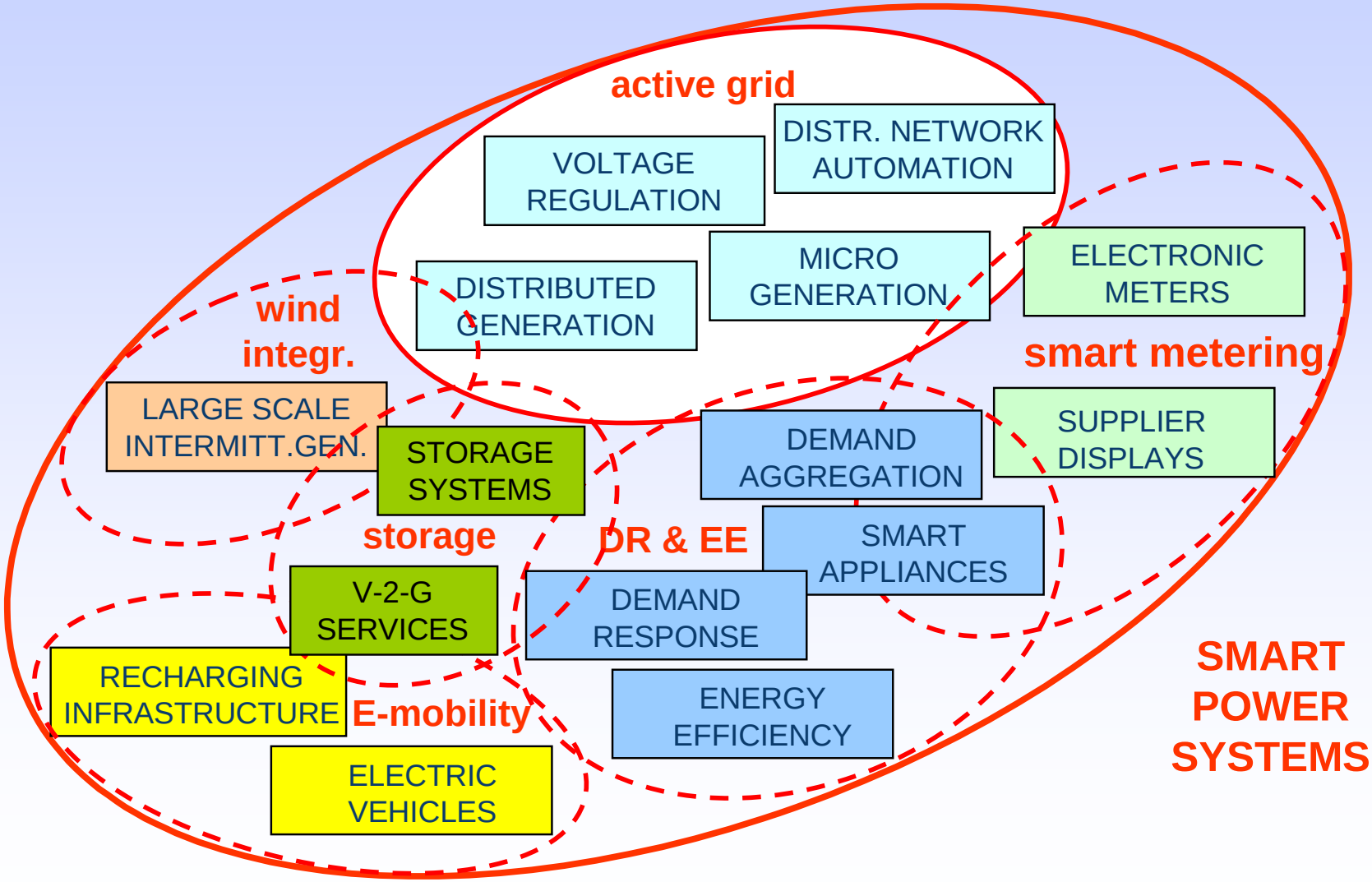
2008: publication of guidelines CEI 0-17 for the preparation of DSOs' emergency plans

AUTOMATIC COMPENSATIONS

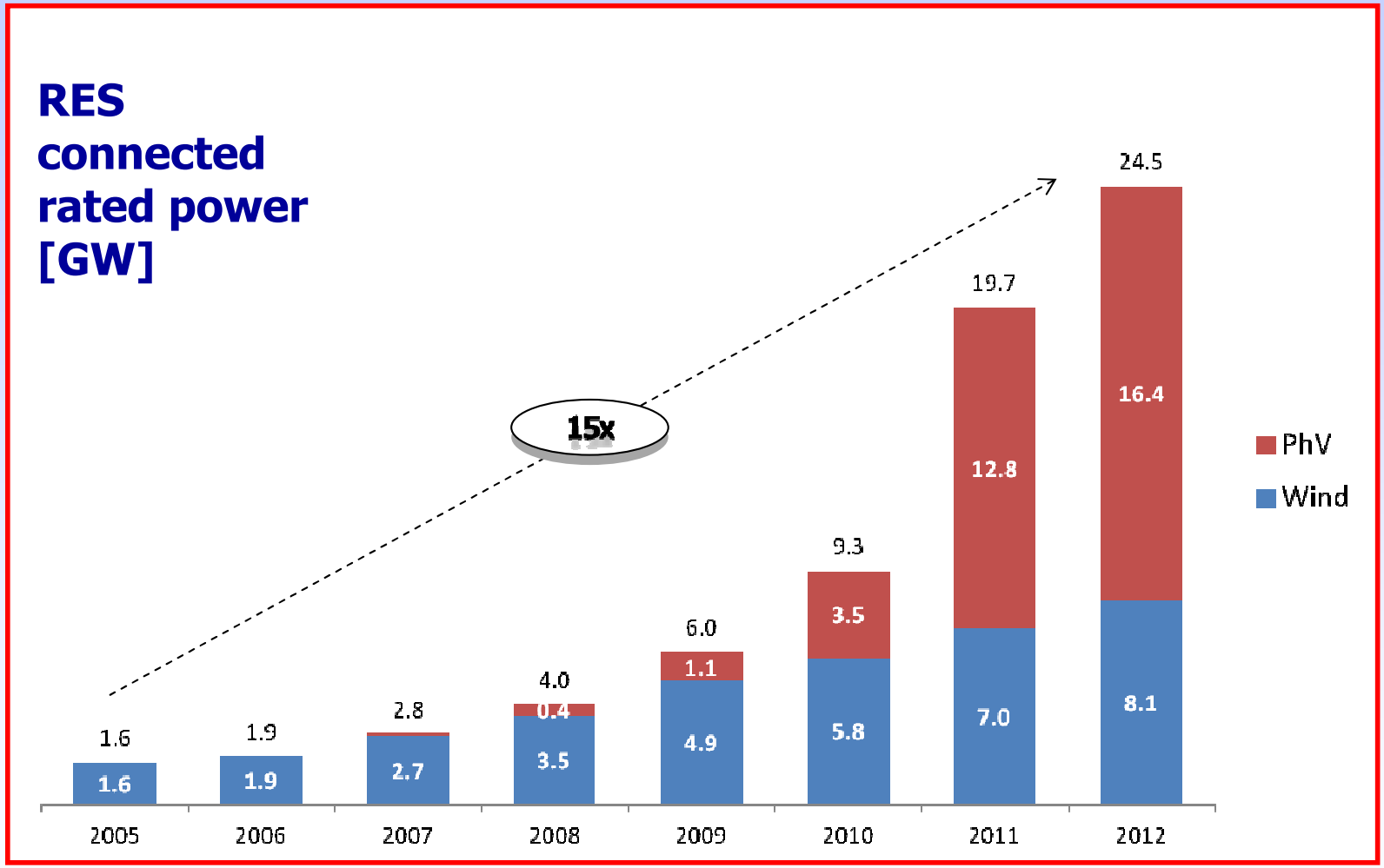
Type of interruption	Territorial classification	Standard for LV customers	Standard for MV customers
Unplanned	• Urban • Sub-urban • Rural	**8h** **12h** **16h**	**4h** **6h** **8h**
Planned	All	**8h**	**8h**

	Household customers	LV and MV consumers with power <= 100kW (excluded households)	Non household LV consumers with power > 100kW	Non household MV consumers with power > 100kW
Standard not fulfilled	30€	150€	2€/kW	1,5€/kW
For each further period	15€ every 4 hours	75€ every 4 hours	1€/kW every 4 hours	0,75€/kW every 2 hours
Cap	300€	1,000€	3,000€	6,000€

FROM A VERTICALLY INTEGRATED POWER SYSTEM TOWARDS SMART GRIDS



2010> THE NEW ENERGY TRANSITION
RES penetration in Italy



Italian Power System:

54 GW (peak), 36 million users,

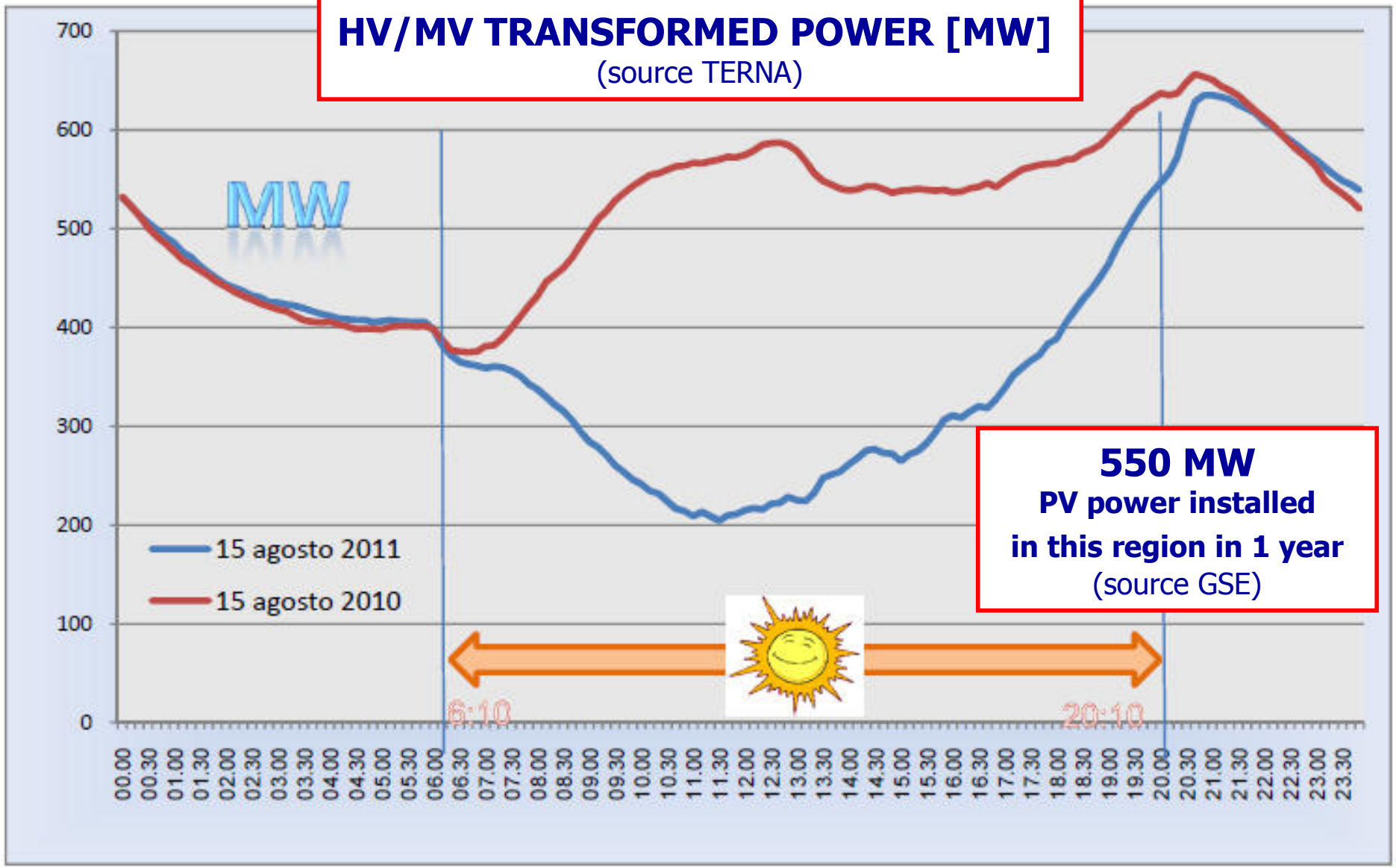
328 TWh/y (incl.losses)

THE NEW ENERGY TRANSITION
Effect of RES penetration on load curve

Central Italy Region MARCHE

HV/MV TRANSFORMED POWER [MW]

(source TERNA)



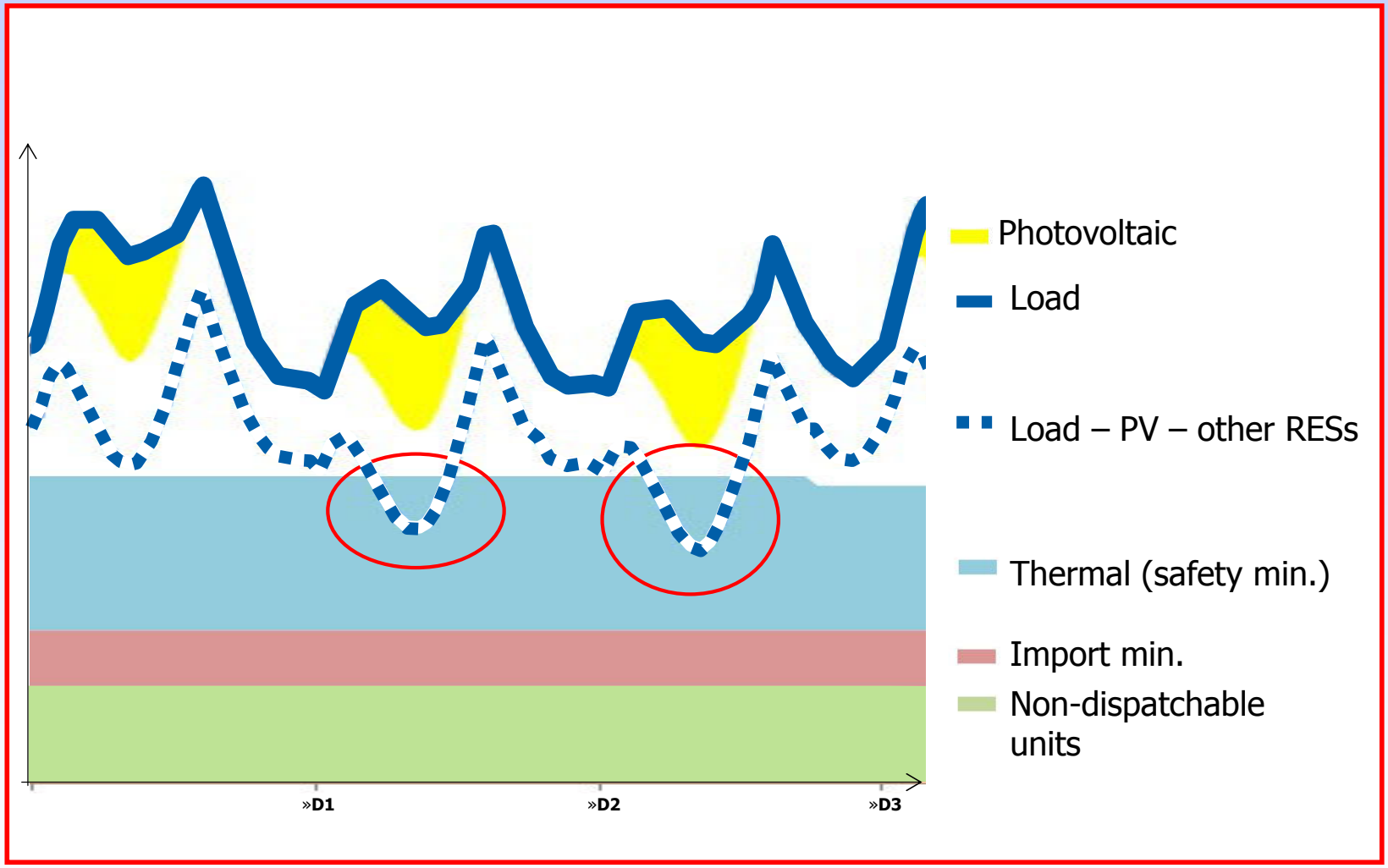
550 MW

PV power installed

in this region in 1 year

(source GSE)

THE NEW ENERGY TRANSITION
Effect of RES penetration on security

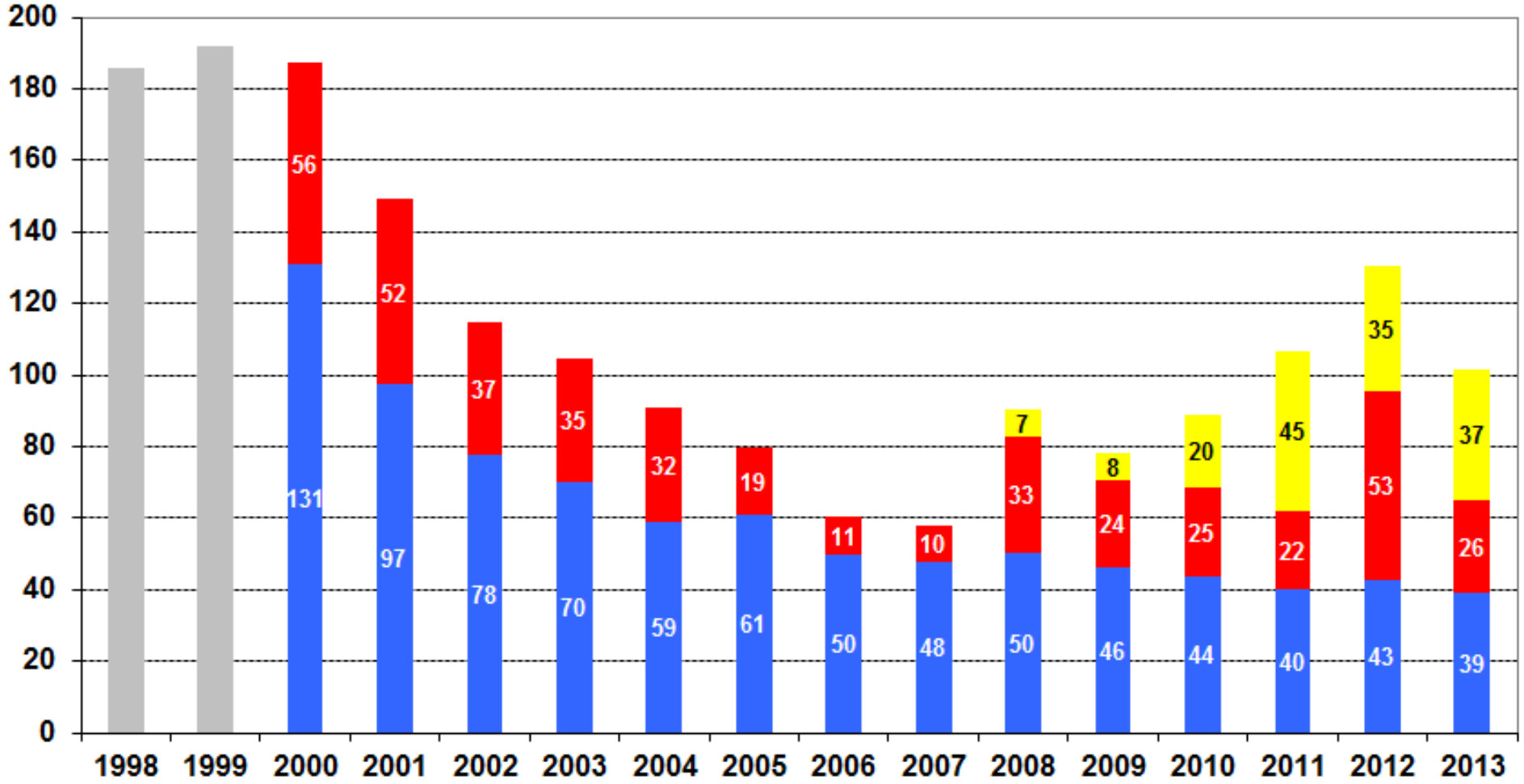


Risk of RES curtailment in Sunny Summer Sundays!

Defending the system to avoid further risk on load:
from 2012 new frequency limits for generation (incl. RES)

ITALY - CUSTOMER MINUTES LOST

Minutes lost	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Automatic load shedding + large incidents on HV	441,51	0,46	0,30	3,26	11,07	0,11	0,35	0,13	1,09	2,34	3,64



EXAMPLES OF CRITICAL EXPERIENCES

- **2001, 13-14 December**
  North Italy (drifting snow)
- **2004, 29 February and following days**
  Padova, Ferrara, Rovigo (sticky snow)
- **2005, 20-30 June**
  Milano (hot - MV/LV substations)
- **2006, 17 July**
  East Sicilie (disconnection of production units)
- **2006, 4 November**
  Load shedding (frequency variation in EU)
- **2009, 10 August**
  Ischia (simultaneous events)
- **2012, 3-4 February**
  Center / South Italy (sticky snow)
- **2013, 26 December**
  Cortina d'Ampezzo (sticky snow)

VULNERABILITY OF THE ELECTRIC SYSTEM: STILL A CHALLENGE FOR THE AUTHORITY

Proposals for the fifth regulatory period (beginning in 2016 – see document 48/2015/R/eel):

Assessment of regulatory mechanisms aimed at reducing the impact determined by the out of service of large portions of networks:

- acceleration to overcome the gap between the existing HV and MV overhead lines and design criteria provided by CEI 11-4 (2011) for new lines
- strengthening of the mesh of the HV grid in the areas most exposed to adverse weather events of particular severity
- removing the ceiling to reimbursements to MV and LV users charged to the Fund Exceptional Events, by requiring to DSOs and Terna to pay the surplus from the current ceiling
- introduction of elements of incentive regulation aimed at reducing the duration of interruptions attributable to force majeure, paying particular attention to aspects that can stimulate both DSOs and Terna to a fast restoration of the service

CONCLUSIONS

- Power grids are vulnerable, both electrically and mechanically
- Important attacks to power grids can come from:
  - some types of faults (combined with contingent states of the grid)
  - frequency variations / voltage disturbances on EHV-HV networks
  - severe events (weather or other)
- The grid resilience depends on how it has been designed and it is operated
- Service restoration time depends as well on the resources made available by DSOs and TSOs
- The Authority's task is to identify the "optimal level of vulnerability": a right balance between grid reliability and what paid by consumers in the bill

Thank you for your attention!

For further information:
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