Reliability and security of electricity supply: the Italian blackout

Alessandro Ortis

President

AEEG

The Regulatory Authority for Electricity and Gas of Italy

5th NARUC/CEER Energy Regulators' Roundtable

Washington, DC, February 12-13, 2005

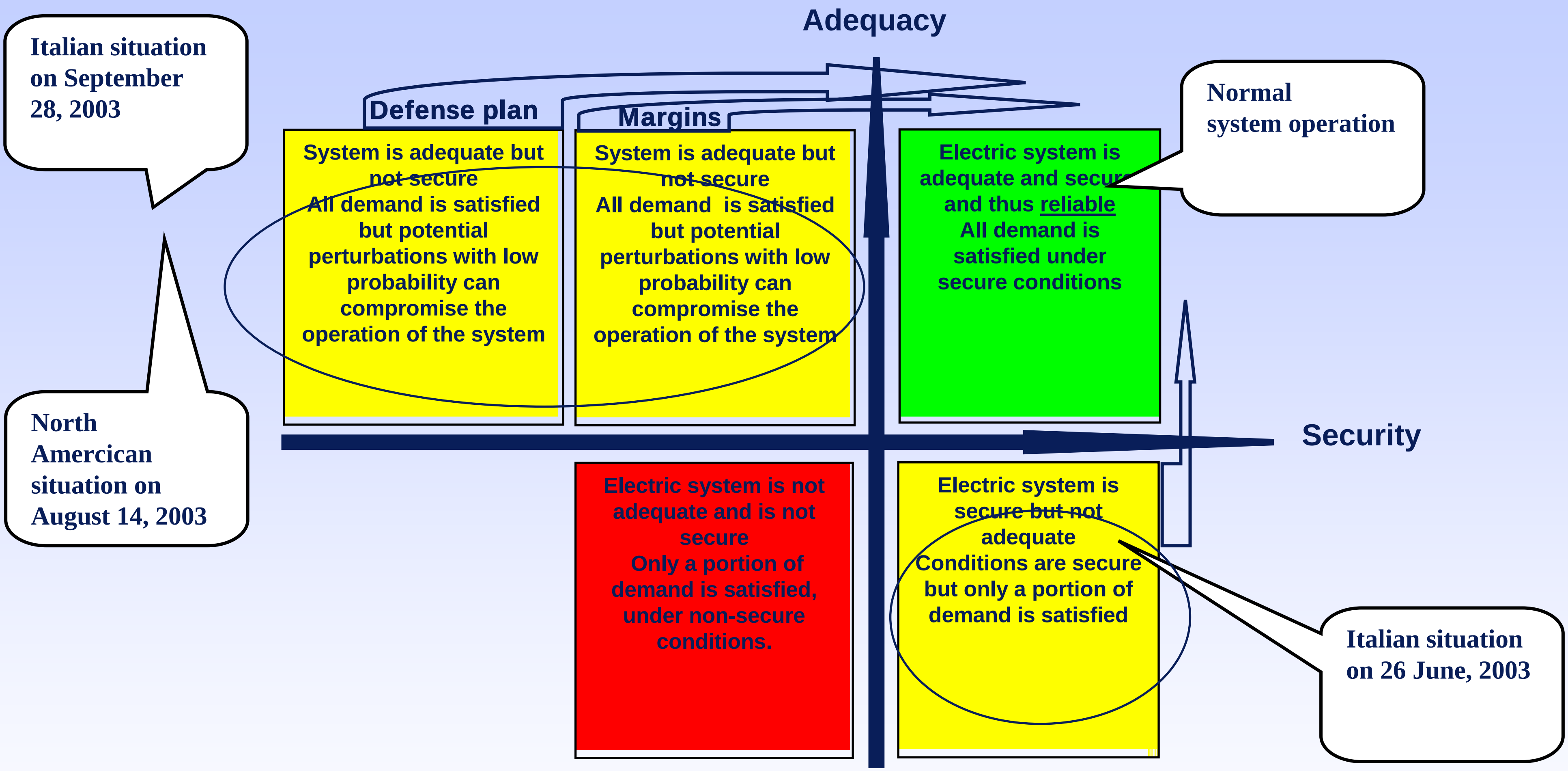
Contents

- Reliability: security and adequacy
- Italian September 2003 blackout
  - AEEG-CRE investigation
  - AEEG inquiries
- Lessons from the blackouts
  - AEEG and Government initiatives
  - CEER and EC response
- Distributed generation

2003: the year of security of supply concerns

- Italian and North American blackouts
- Security concerns in other countries
- Structural, managerial and legal framework weaknesses

Italy's two 2003 contingencies



- Adequacy and security both play a role in reliability
- Adequacy is correlated with long-term investment
- Intrinsic security is correlated with the short-term management of available resources

The September blackout: a brief summary

- Storm
- Tree tripping over Swiss EHV line
- Line shuts down
- Inappropriate counter-measures
- Second Swiss EHV line shuts down
- Cascade tripping and disconnection from UCTE system
- Blackout: 55 M citizens affected for up to 20 hours

AEEG’s Inquiry

- Phase 1:separation of the Italian grid from the European UCTE network
  - Swiss Office Fédéral unwilling to cooperate
  - Joint AEEG-CRE investigation (concluded on April 23, 2004)
- Phases 2 and 3: expansion of the interruption and restoration of service
  - preliminary investigations (concluded on June 9, 2004)
  - formal investigations concerning specific operators (ongoing)


...investigations...

Phase 1: Italian situation at 3:00 am vs GRTN forecast

	Foreseen situation h 03:30 (MW)	Real situation h 03:00 (MW)	Difference (MW)	Difference %
Data relevant to electric energy consumption				
Load + losses	23.240	23.930	690	+3.0
Pumping stations	3.288	3.487	199	+6.1
States of San Marino and Città del Vaticano (embedded in Italian national territory)	27	27	0	0
Total supply	**26.555**	**27.444**	**889**	**+3.3**
Data relevant to electric energy production				
Thermal power plants	18.231	18.721	490	+2.7
Hydro power plants	1.051	1.182	131	+12.5
Geothermal power plants	580	551	-29	-5.0
Eolic power plants	10	10	0	0
Total production	**19.872**	**20.464**	**592**	**+3.0**
Data relevant to electric energy import				
Import from the Northern border	6.398	6.678	280	+4.4
Import from Greece	285	300	15	+5.3
Total Italian import	**6.683**	**6.978**	**295**	**+4.4**
			0	
Total electrical energy injected into the Italian power system	**26.555**	**27.442**	**887**	**+3.3**

Table 1

- Everything going according to plan
  - consumption
  - interconnecting lines
  - voltages and currents
  - reserves

Phase 1: Italian situation at 3:00 am vs GRTN forecast

Available reserves and its activation time			
Type of reserve	Activation time		
	5 min	20 min	>60 min
Pumping plant to be disconmetcted	3.279		
Hydric		7.289	
Thermal			3.563
Progressive activation	*3.279*	*10.568*	*14.131*

Table 2

Phase 1: how the problems began and unfolded

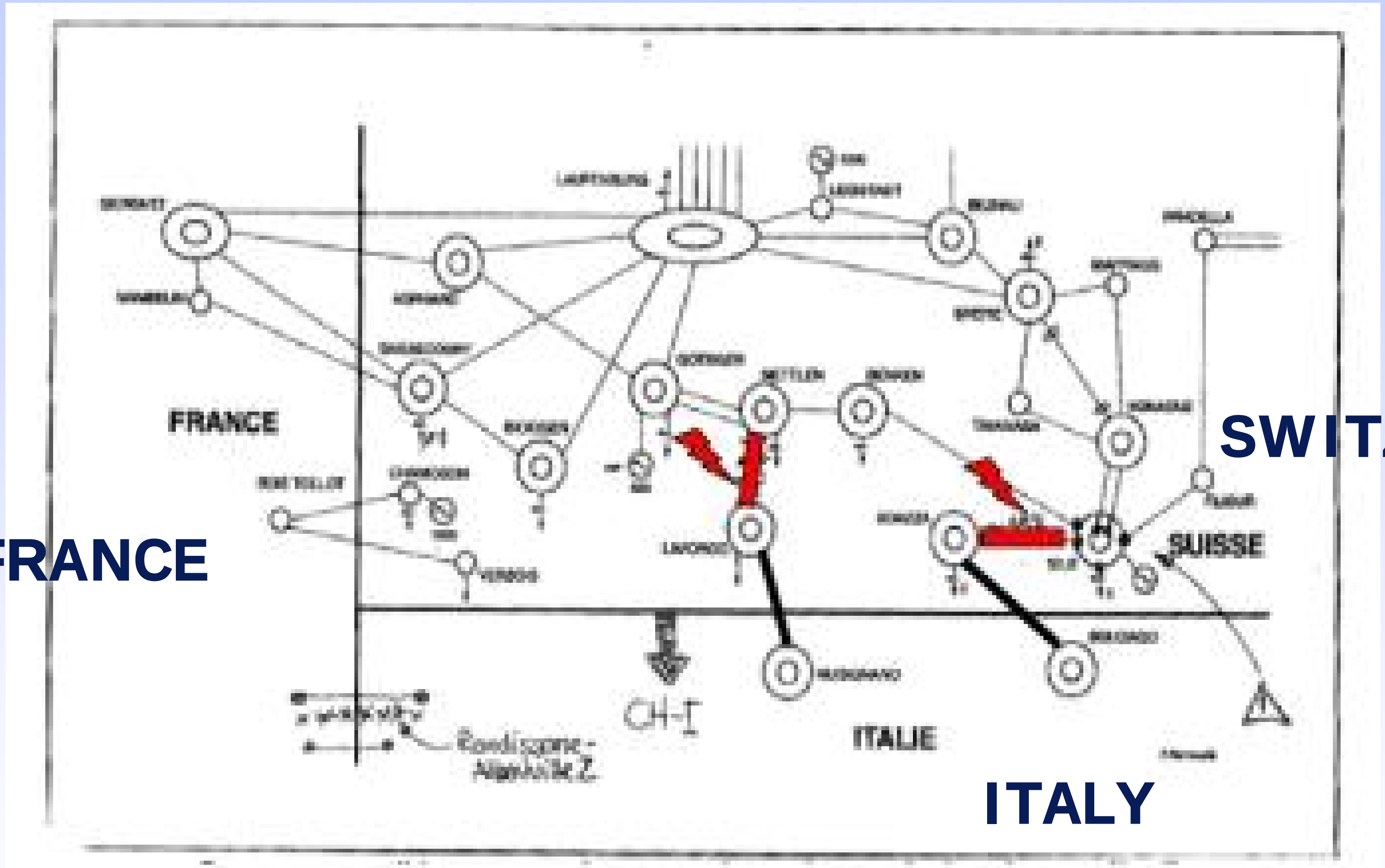


Figure 1 – Swiss interconnection transmission system

Phase 1: how the problems began and unfolded

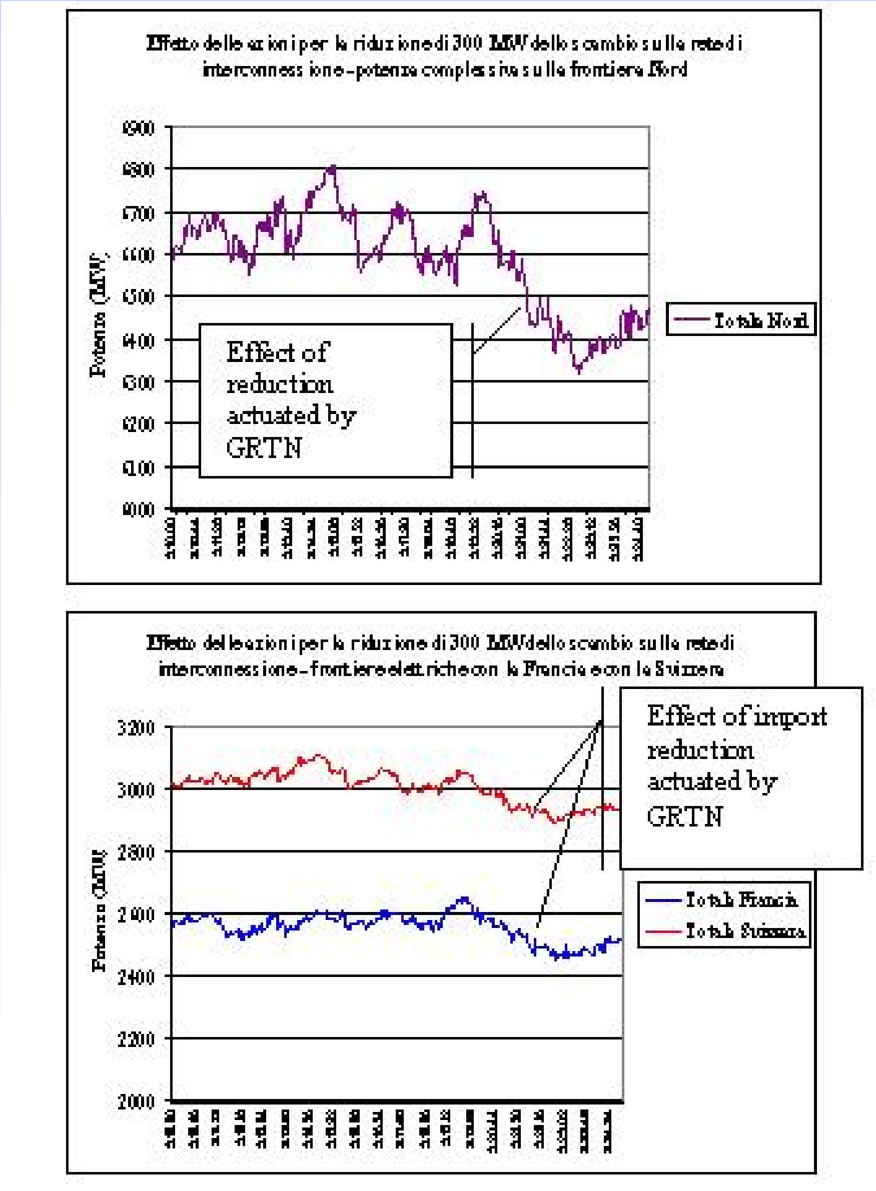


Figure 2 – Power exchange request carried out by GRTN[1] on request of Swiss system operators

Phase 1: how the problems began and unfolded

		Event
1	03:01	Trip of the 380 kV line Mettlen Lavorgo (Lukmanier line - CH). Attempts to re-close the line until 3.03:50 automatically. Also manual re-closure fails at 3:03:50.
2	03:02-3:08	Attempts to re-close the Mettlen - Lavorgo line. Information exchanges between ETRANS and ATEL and EGL dispatchers.
3	03:10	ETRANS requests a reduction of 300 MW in Italian imports to scheduled values.
4	03:18-3:22	Exchange of information between ETRANS, ATEL and EGL and changes in topology of the Swiss system.
5	03:21	Italian imports are reduced to 6400 MW
6	03:25	Trip of the Sils-Soazza 380 kV line (San Bernardino line CH).
7	03:25	Trip of the Airolo Mettlen 220 kV line (CH)
8	03:25	Cascading effect: trip of all the interconnection lines from Italy to the remaining part of the UCTE system.

Table 3 – List of "cascade events"

Phase 2: the main problems

▪Sudden negative imbalance and very rapid decrease in frequency worsened by:

- plant shutdowns
- failed load rejection logics
- load-shedding functions as expected but insufficient

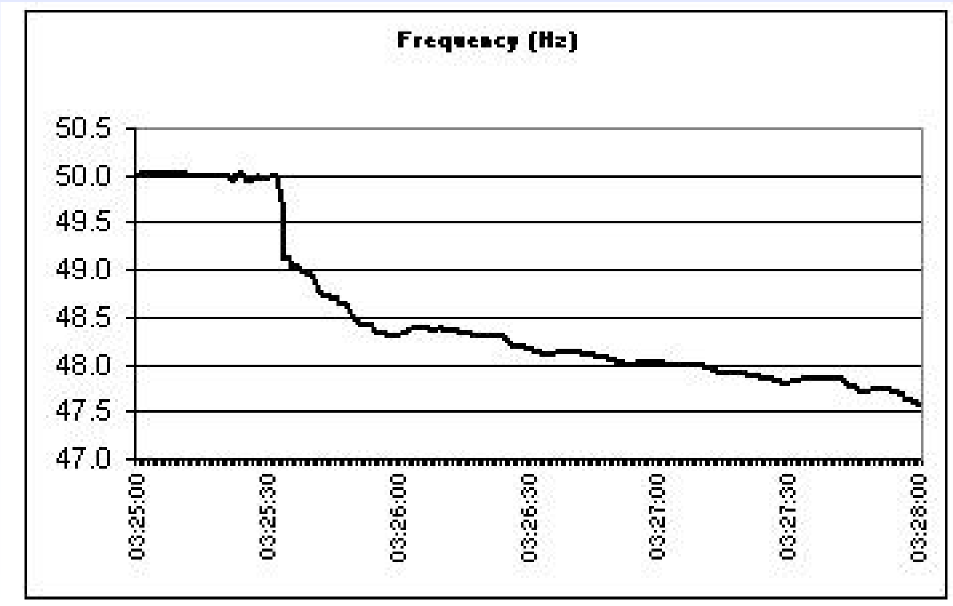


Figure 3 – Frequency decrease

Phase 2: attempts made to solve the situation and results

- **System Operator attempted**
  - **primary frequency regulation**
    - **pumping storage plant shutdowns**
    - **load shedding actions**
- **But**
  - **imbalance remained negative**
  - **frequency fell below the minimum 47,5 HZ threshold**
- **Thus leading to an almost total blackout**

Phase 3: the main problems

- Analysis made more difficult by absence of recordings
- 3 main problems:
  - unavailability of black start functions
  - TLC communications inefficiencies
  - scarcity of load rejection actuations

Phase 3: North-South differences

Restoration time of transmission stations

time	North-West	North-East	Centre-North	Centre-South	South
4.08	Venaus				
4.09	Musignano				
4.41	Rondissione				
4.42	Trino				
4.47		Salgareda			
4.53					Rossano
5.05		Venezia			
5.10		Fusina			
5.30	Turbigo				
5.37		Dolo			
5.47	Baggio				
5.50	Tavazzano				
5.52	Lachiarella				
5.55	Piacenza				
6.03		Camin			
6.09					
6.13	Casanova		Parma		
6.13	Caorso				
6.30					Bari T.
6.32	Lachiarella				
6.50	Vado L.				
6.50					Benevento
6.57	La Spezia				
7.00		Porto Tolle			
7.09		Nogarole R.			
7.12			Martignone		
7.33			Ferrara		
7.45					S. Sofia
8.15			Colunga		
8.27					Laino
8.55			Suvereto		
9.33				Aurelia	
					Napoli
9.45					Levante
9.52				Montalto	
10.08				Roma Nord	
10.15					Montecorvino
10.40				Valmontone	
11.29			Fano		
11.36				Roma Sud	
11.52			Rosara		
12.16				Villavalle	
13.16					Garigliano
13.21					Bari
15.09					Rizziconi
15.20					S. Maria
15.22				Ceprano	
16.08					Brindisi Sud
17.30					Galatina

Figure 4 – Restoration process for the main transmission stations (Sicily isle not included)

Phase 3: North-South differences

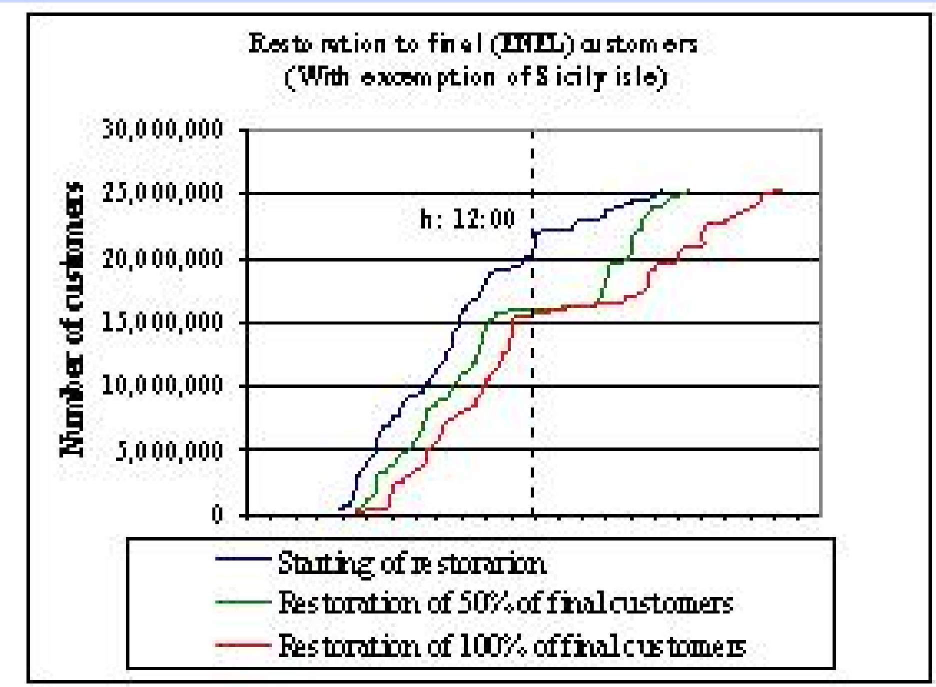


Figure 5 – Restoration process for final customers (excluding Sicily)

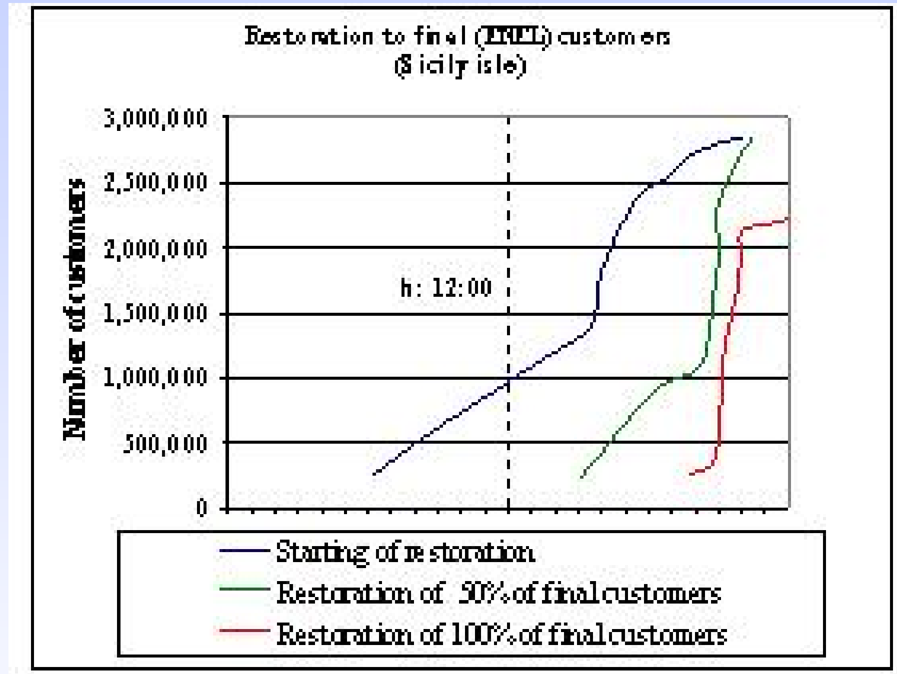


Figure 5 - Restoration process for final customers (Sicily)

Lessons from the blackout

- Phase 1
  - failed application of UCTE rules and operational procedures
    - need for rules to be made more explicit
    - need for rules to be made mandatory and monitored
- Phase 2
  - non compliance
    - need for stricter enforcement
  - need for improvement of the rules
    - load shedding
    - load rejection logics
- Phase 3
  - non compliance
  - need for improvement of the rules
    - clarity
    - testing

Government initiatives

- “Anti-blackout” decree
  - speeds up and simplifies authorisations procedures for the construction of new power plants
    - single authorization process
    - clear timetable for the concession or denial of permits
- Higher remuneration for new transmission lines
- Capacity payment for electricity generation
- Greater power to central government over authorisations
- Incentive mechanism to improve energy efficiency in final energy use

AEEG Initiatives

- Participation in the legislative process
- *Ad hoc* secondary legislation
  - temporary capacity payment mechanism
  - boost to investment in networks
  - demand side
    - remuneration of interruptible service
    - white certificate mechanism for efficiency in final energy use
  - potential advantages (and costs) of distributed generation need to be examined

CEER's response

- Endorsement of AEEG-CRE inquiry
  - bilateral EU-CH agreement
    - obligation to legally unbundle and create independent TSO
    - liberalized framework in line with European internal market
    - adoption of the principles of the EU Regulation on Cross Border Exchanges
- October 2003 position paper
  - new investment in generation
    - market methods
    - distributed generation
  - investment in transmission capacity and maintenance
  - cooperation and coordination among TSOs
  - interruptibility
  - energy savings; demand-side initiatives

European Commission's response

- December 2003: draft Directive on Electricity Infrastructure and Security of Supply
  - clear policy to ensure supply and demand balance
  - definition of network security standards (non compliance can lead to financial penalties)
  - TSOs to submit regular investment plans to national regulator
  - regulators to submit a summary of these investment programs to the EC for consultation with ERGEG
  - right for regulators to intervene to speed up the completion of projects

CEER's reaction to the EC's proposal

- September 2004: position paper on draft Directive
  - need for network and generation adequacy
  - market design and market structure reforms
  - need for properly designed and regulated network activities and competitive markets
  - contributions from demand side measures and renewable generation in a non-discriminatory and market-based manner
  - clear and transparent definition of roles and responsibilities of all stakeholders and market participants
  - increased renewables and CHP pose new challenges
  - definition and publication through a transparent and co-operative regulatory process of security of supply indexes, and reliability standards and operational rules for interconnected systems
  - permanent monitoring and reporting under regulatory supervision

Conclusion

- Liberalisation of electricity markets creates a decentralised decision-making process → need for greater coordination and communication and supervision
- Emergence of regional markets → additional challenges for system operators
- Need for generation investment; promotion through market methods
- Need for transmission investment and efficient network performance
- Need for appropriate harmonised incentives and legal frameworks
- Need for transparent and sound regulation
- New challenges for enhanced international collaboration among regulators

DG applications
...also a regulatory challenge..

- Cogeneration (CHP)
- Standby operation
- Peak shaving
- Grid support
- Power quality applications

...difficult regulatory decisions...

- Connection tariffs
- Reconciliation procedure
- Balancing and reserve costs

Examples of DG technologies

- Internal combustion engines (30 – 6.000 kW, η = 30-38%)
- Industrial gas turbines (500 – 20.000 kW, η = 25-40%)
- Microturbines (25 – 300 kW, η = 20-30%)
- Fuel cells (3 – 3.000 kW, η = 36-60+%)
- Renewables (hydro > 50 kW, photovoltaic cells 1 – 1.000 kW, wind 50 – 1.000 kW, transformation into electric energy from organic and industrial residue (biogas, etc…) 100 – 10.000 kW)
- Energy recoupments (turbo-expansors, recoupments from fuels other than commercial fossil fuels, heat process, etc…)
- Combined or simple configurations (combined cycle, hybrid, etc…)

DG plant technologies

- Technologies aimed at utilizing renewable sources (mini-hydro, photovoltaic, wind turbines, biomass driven plants)

- Innovative technologies aimed at utilizing fossil fuels (gas microturbines, internal combustion engines, fuel cells)

- Technologies aimed at utilizing renewable sources or fossil fuels for the combined production of electric and thermal energy (cogeneration plants and micro-cogeneration)

AEEG’s first initiatives with regard to distributed generation

Resale prices for mini-hydro plants (<3MW)

- prices are differentiated according to a progressive scale of production brackets

- this method has already been applied for 5 years and has proved efficient

Net metering for photovoltaic plants of up to 20 kW

Net metering is currently provided for captive customers who install **photovoltaic plants with nominal capacity of up to 20 kW**

For such plants:

- delivered electric energy (injected onto the grid) and electric energy uptake compensate each other on an annual basis, indipendently of time brackets;
- if positive, net balance is transformed into a credit usable during subsequent years;
- if negative, net balance is billed using normal supply contract charges.

Recognition of the lower losses connected to distributed generation

For plants connected to distribution networks
the producer receives from the distributor a credit of:

F1 bracket	**0.77 c€/kWh**
F2 bracket	**0.49 c€/kWh**
F3 bracket	**0.32 c€/kWh**
F4 bracket	**0.14 c€/kWh**

Uptake modalities and prices for energy produced from plants with capacity < 10 MVA and >= 10 MVA fueled by non-programmable renewable sources