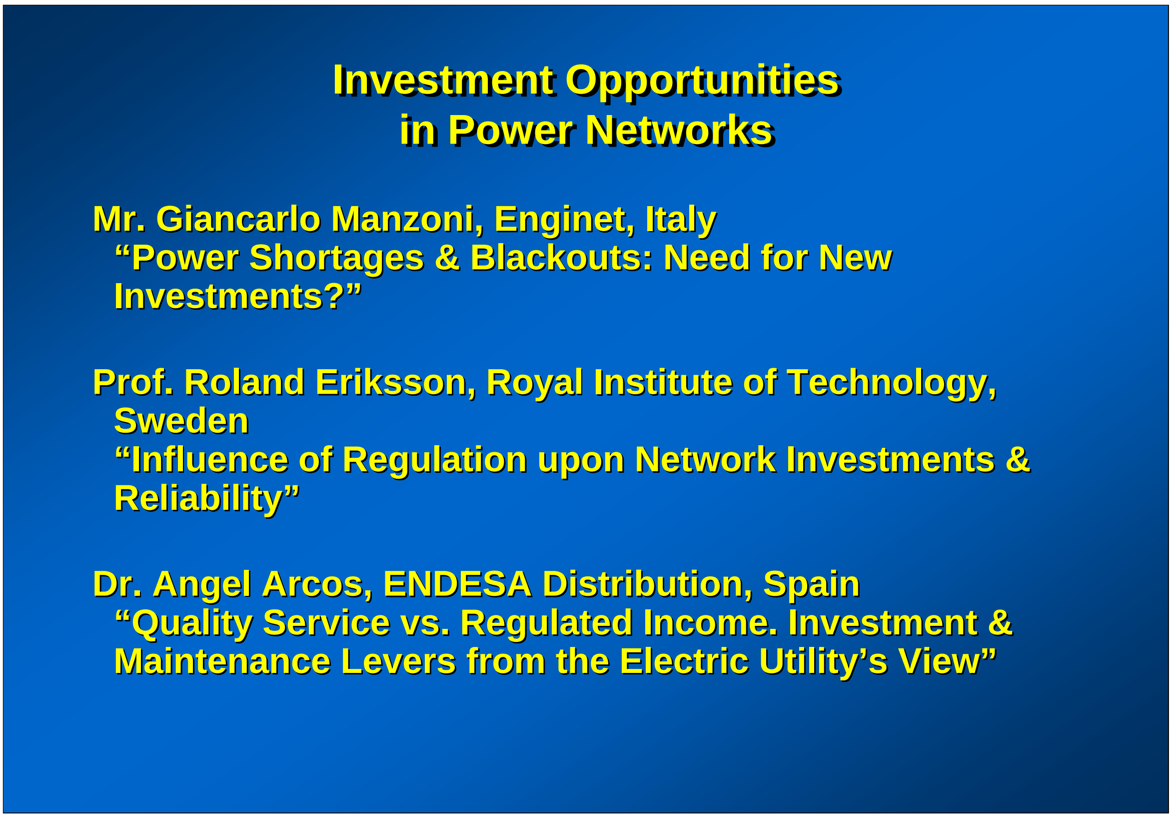
Ladies and gentlemen,

In recent time, we have experienced quite a few power outages in various areas of the world, such as in the United States, in London, in Italy, in Denmark and in Sweden. What was the cause of the blackouts? What can be done to prevent them? Could it be a business opportunity for us? These are questions which can be asked and for which we look for answers.

We have invited three speakers. They will give us a more general explanation for the roots of the blackouts, they will describe the regulators roles in the deregulated network's world. They will also give the network's owner view on the present situation.



The first speaker will be Mr. Giancarlo Manzoni, President of the consulting company Enginet. During most of his career he has been working for ENEL with appointment as Deputy Director of Research and Development as well as responsible for Strategic Planning. He is also active within EuroElectric and CIGRE. His contribution is called: Power shortages and blackouts: Possible remedies and new investments?

After the first speaker we will take a well-deserved coffee break. Thereafter our second speaker will be Professor Roland Eriksson, Competence Center in Electric Power Engineering. He is also active within IEC and CIGRE. Prior to his work at the Royal Institute of Technology he has been working for Vattenfall and ABB. His contribution is called: Influence of regulation upon network investments and reliability.

Our third speaker will be Dr. Angel Arcos from ENDESA Distribution in Spain. He is the Network Quality and Planning Director. Before he started his career in the utility sector, he worked for the consultant company Arthur Andersen. Dr. Arcos is also active in CIGRE. His presentation is called: Quality service versus regulated income. Investment and maintenance levers from the electric utility’s view.

Now, please Giancarlo, can you enlighten the blackouts for us?

Good morning,

in my speech I will address the problems of blackouts and the possibility of remedies to avoid them, as well as the question whether this requires investments or not.

Before I go into the description of the blackouts I would like to give in the first part of my presentation some definitions. It is necessary to get a clear picture of what is a blackout and what is an outage.

Generally we speak of an adequacy and a security of a power system. We say that a system is not adequate when there is scarcity of reserves. This of course calls for new investments.

Different is the case for power systems that are not secure. In such a case the problem mostly arises from the operation and not because of the lack of investment. Therefore I will try to answer in my speech the question: Do blackouts require new structural investments?

In order to answer this question I will give two examples of blackouts, unfortunately one of them happened in Italy.

Finally I will draw some conclusions.

Main causes for customer's disconnection

- outage (incident) of one element
- scarcity of available resources
- blackout of wide areas

Customer's disconnection may be caused by:

- Outage, an incident, of one element in the chain of supply, e.g. in a radial MV distribution network. If one line goes out of service, all the customers downstream will have a lack of supply.

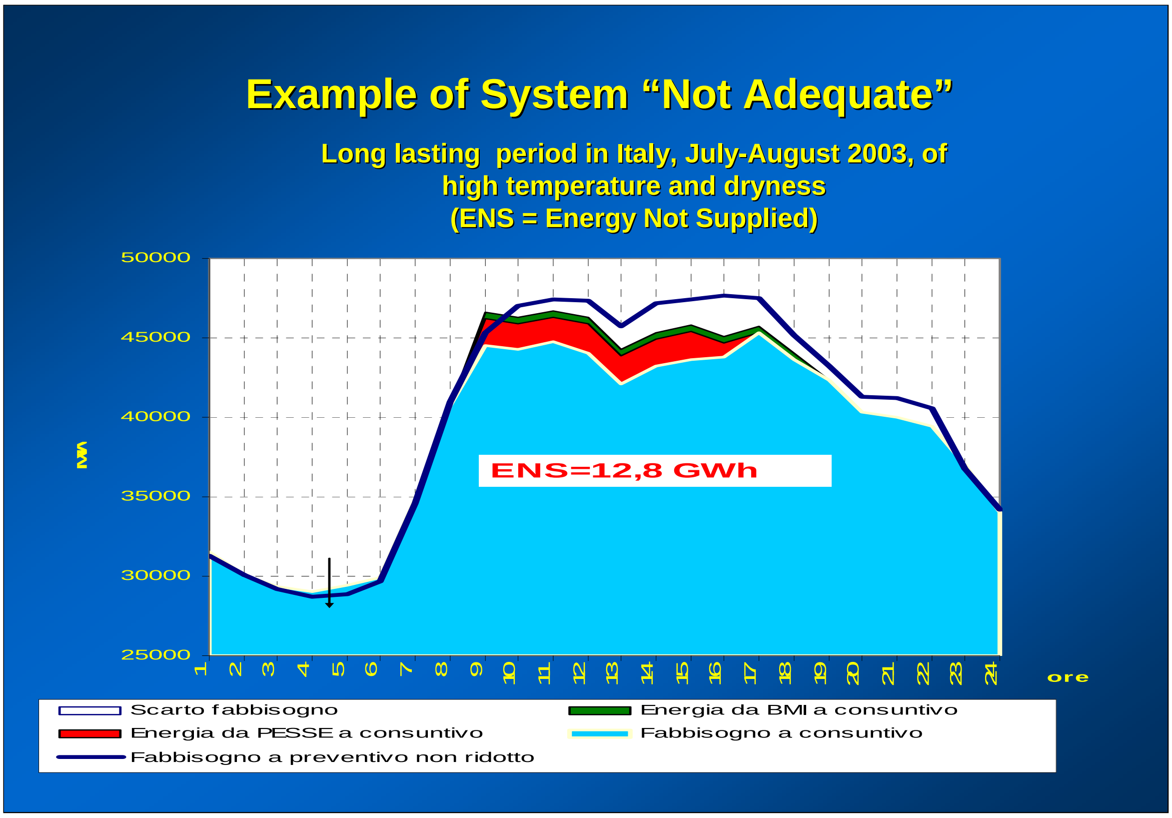
- Scarcity of available resources, i.e. the "reserves" of generation and transmission are not sufficient. If there exists a lack of generation, we are not able to meet the demand.

- Blackout of wide areas, due to cascading events on the EHV transmission network.

The first category is generally accepted, provided that frequency and duration of disconnection are within stated limits.

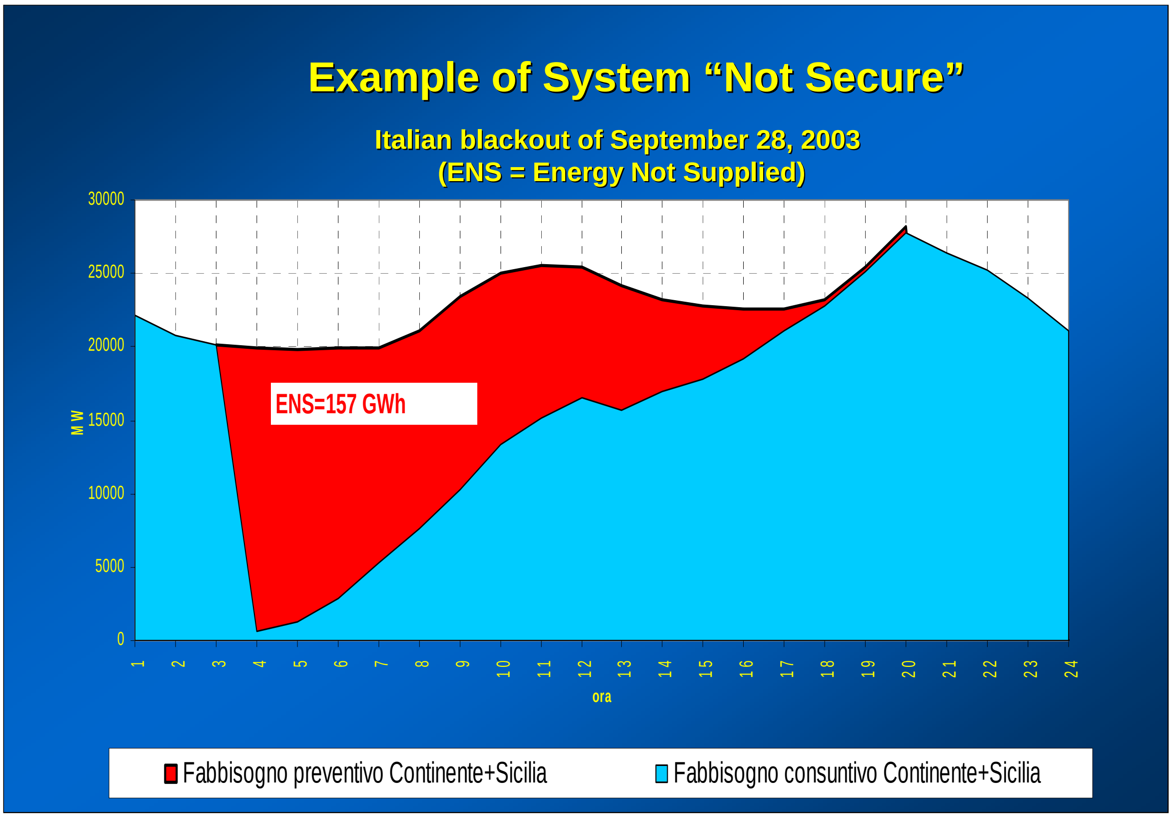
When a power system is affected by shortages of the second category, we say that " it is not adequate" , it has not enough reserves.

For the third category we speak of a "not secure" system.



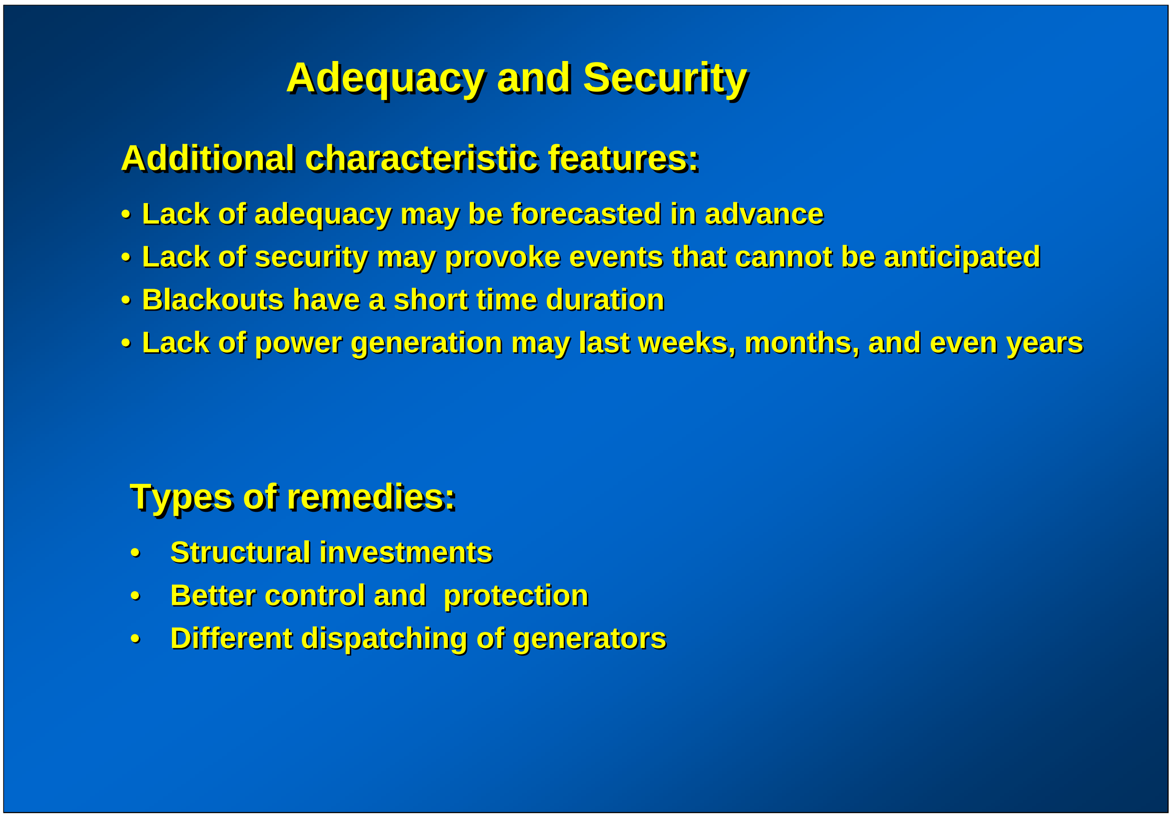
A typical example of a power system not adequate is shown in this slide that reports the energy not supplied (ENS, disconnection of customers) due to a lack of available generating capacity in front of a load demand higher than foreseen (long lasting period in Italy, July-August 2003, of high temperature and dryness). We had to cut off part of the load, indicated in red.

Similarly and long lasting was the case in California a few years ago.



An example of a system that is not secure is given by the case of the Italian blackout of September 28, 2003. A cascade of lines tripping led to a disconnection of all the customers (Energy Not Supplied). All of Italy was out of power. The complete restoration took 18 hours.

The system was adequate, i.e. there were a lot of reserves, but its operation was not secure.



A lack of adequacy may be forecasted in advance, thus allowing a selective customers disconnection, based on rotation, on electricity price and therefore avoiding disconnection that would affect the security of persons in hospitals, public transport, broadcasts, police.

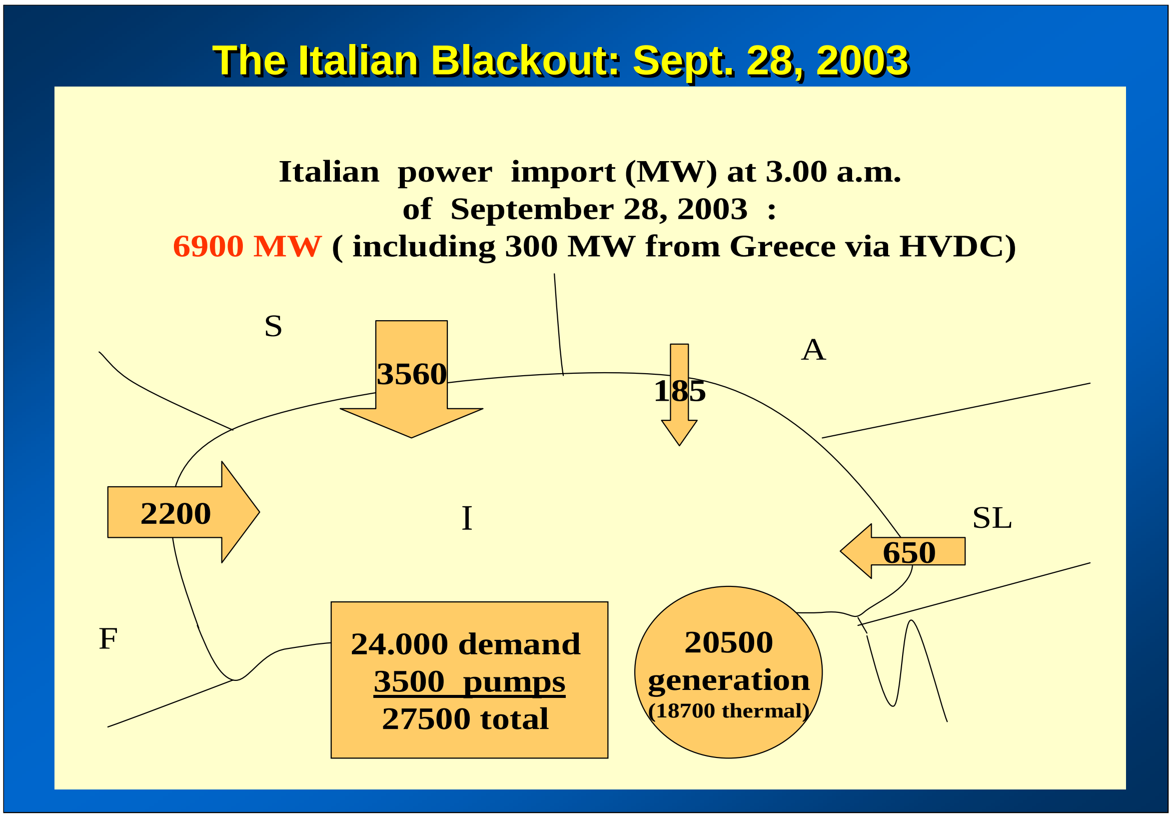
A lack of security may provoke events that cannot be anticipated and that cause the sudden blackout of an entire geographic area with all its customers, irrespective of their importance.

However, while blackouts have a short time duration, typically from one hour to 24 hours, on the contrary lack of power due to structural reasons may last weeks, months, and even years although with different extent.

Adequacy may be improved by structural investments in new power plants and new transmission/distribution lines.

Security may be improved by better control and protection and by a different dispatching of generators, e.g. less economic but more secure. Then the question arises: Are new investments needed or beneficial?

Both adequacy and security are evaluated in probabilistic terms. 100% security and adequacy cannot be reached.

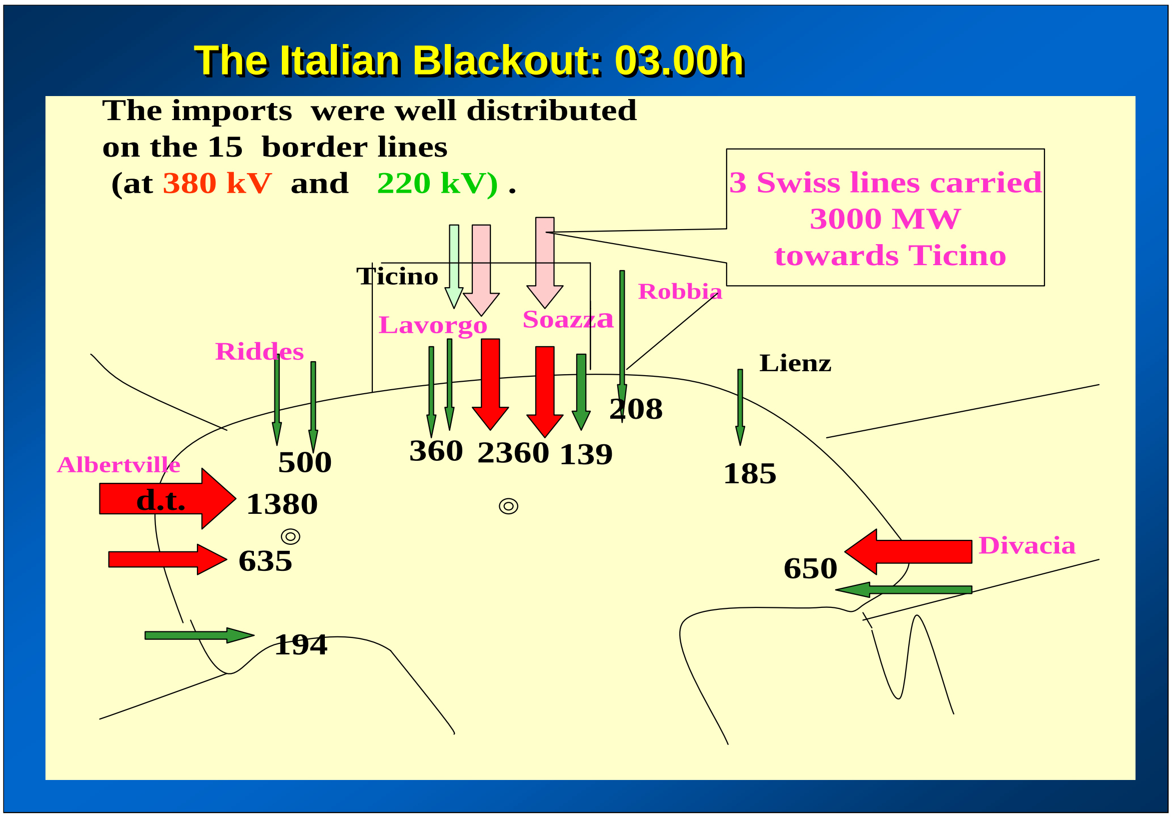


We witnessed an impressive series of blackouts in a few months of 2003: August 14 in USA-Canada, August 27 in Austria, August 28 in UK-London, September 23 in Denmark-Sweden and September 28 in Italy-Switzerland. They have raised concern in the public, mobilized politicians and technical bodies. Should we get accustomed with these types of events? Why have the existing defence plans failed?

A short description of the September 28 Italian blackout may clarify the nature, causes and possible remedies.

In Italy the total demand was 27.500 MW, of which 3.500 were due to pumps, against a domestic generation of about 20.500 MW. The balance was assured by an import of 6.900 MW, consisting of 3.560 MW from Switzerland, 2.200 MW from France, 185 MW from Austria, 650 MW from Slovenia and 300 MW from Greece through a submarine HVDC connection to southern Italy.

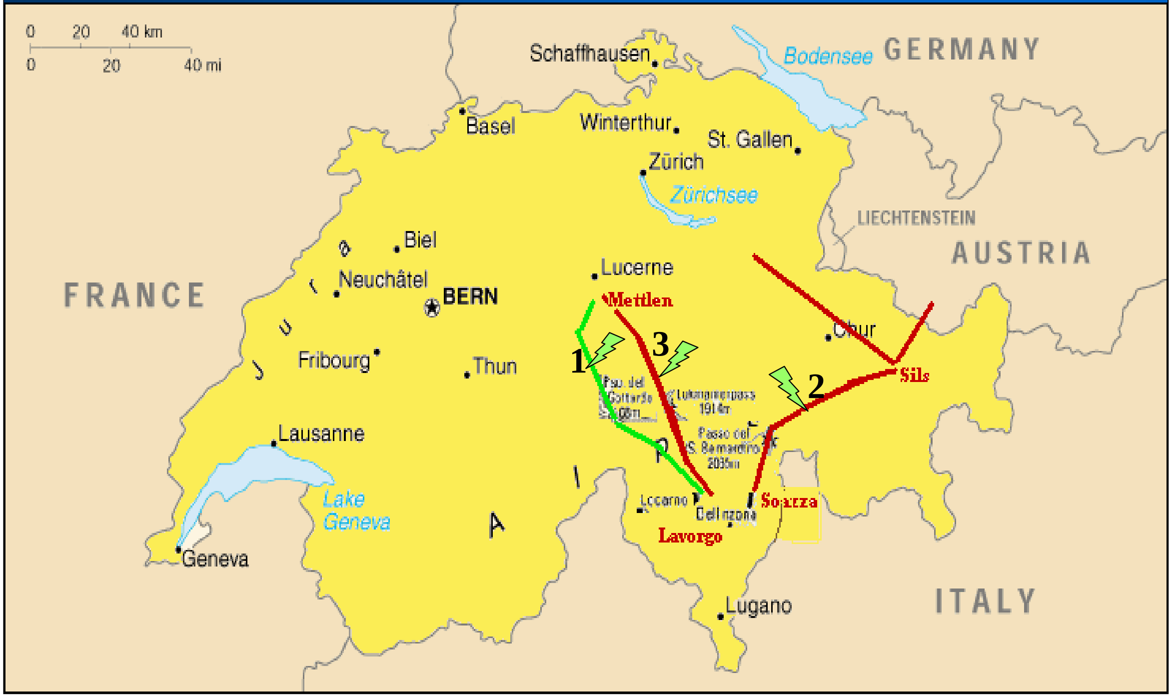
The high value of the import was due to economic reasons and not because of a lack of generating capacity in Italy, i.e. adequacy was given. Cheaper energy was produced mainly in France by nuclear power plants.



Line transits on the 15 lines at the northern Italian border were well distributed and within their transmission capability limits.

In Switzerland three lines carried 3.000 MW through the Alps to the Ticino Area, and from there to Italy. We will see that this type of system operation was not “secure”.

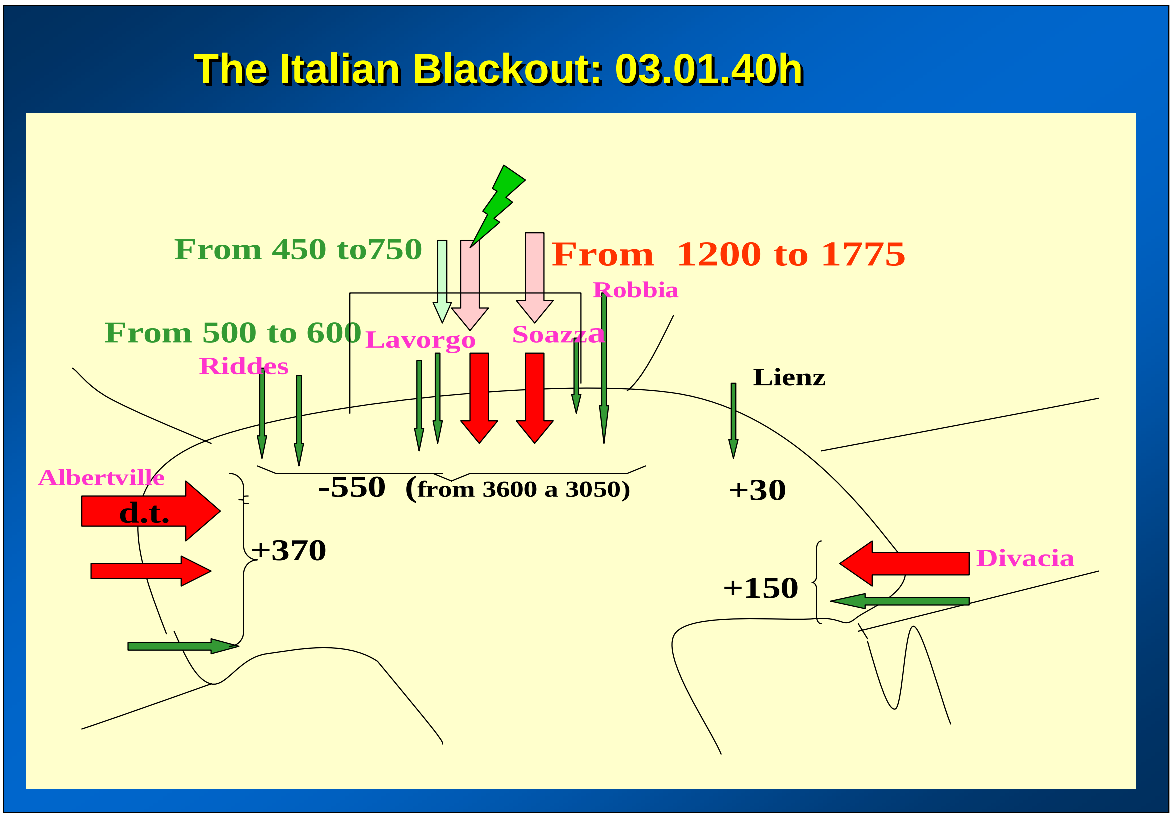
Three main lines connect
Central Switzerland to the "Ticino "



These lines were heavily loaded (UCTE report) :

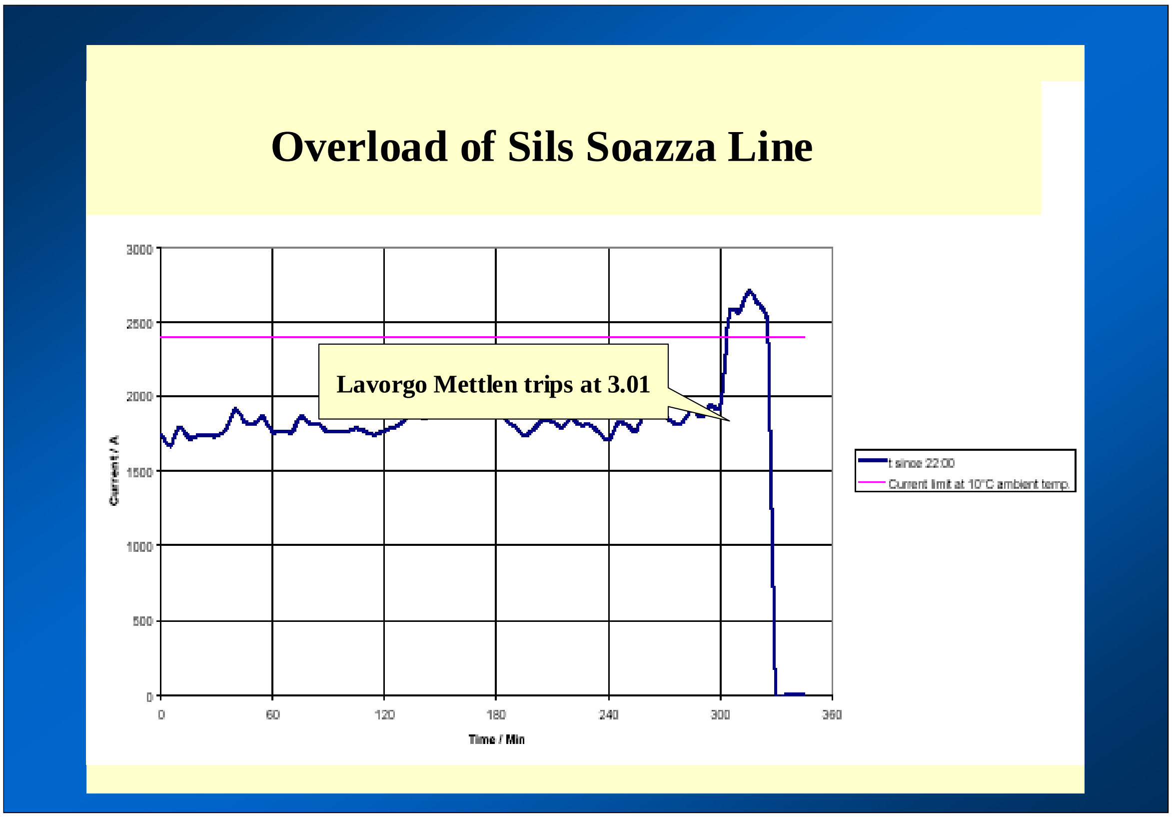
1) Mettlen Lavorgo	380 kV	(Lucomagno pass)	1.300 MW
2) Sils Soazza	380 kV	(San Bernardino pass)	1.200 MW
3) Mettlen Airolo	220 kV	(Gottardo pass)	450 MW

The 3 lines tripped in sequence, thus originating the blackout:
1) 3.01.40h 2) 3.25.21h 3) 3.25.24h



At 3.01.40h a flashover to a tree causes the opening of the Mettlen Lavorgo 380kV and consequently an overload (110%) of the Mettlen Soazza from 1200 to 1775 MW.

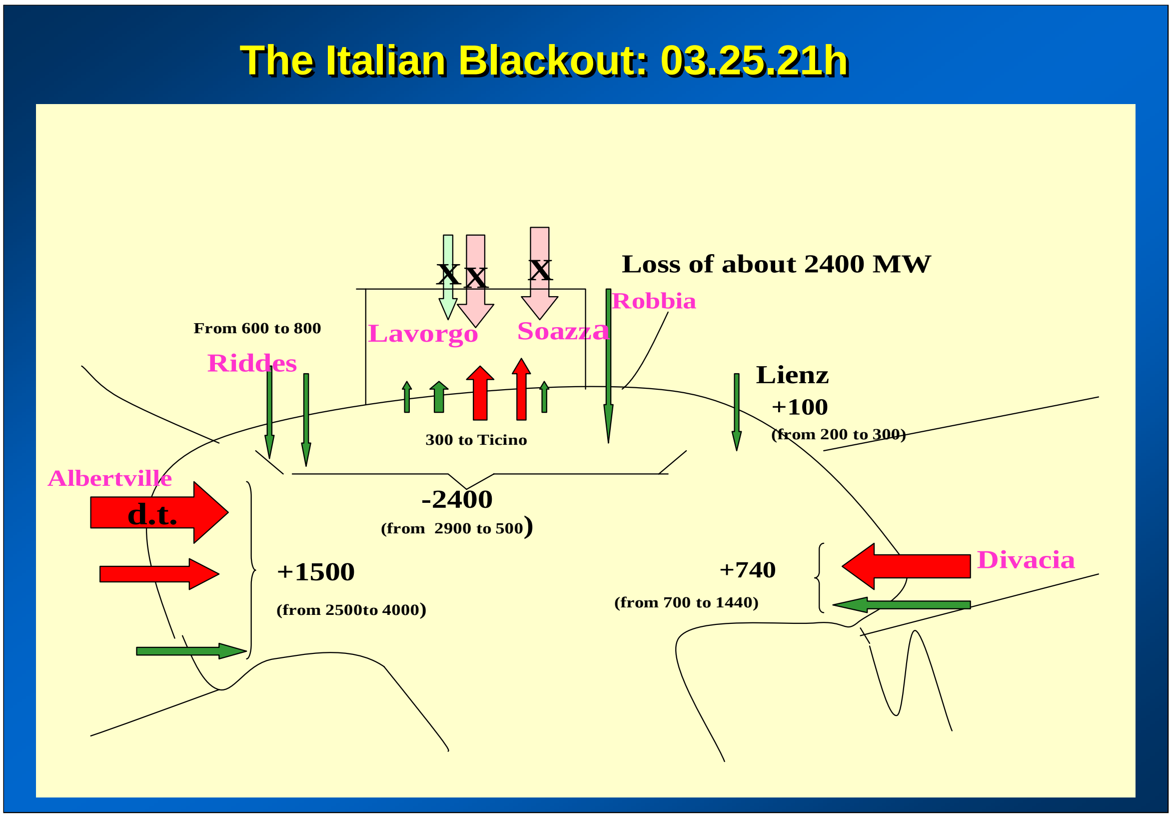
In total, transits to Italy changed but were still quite acceptable.



Here you can see the current on the second line Sils-Soazza.

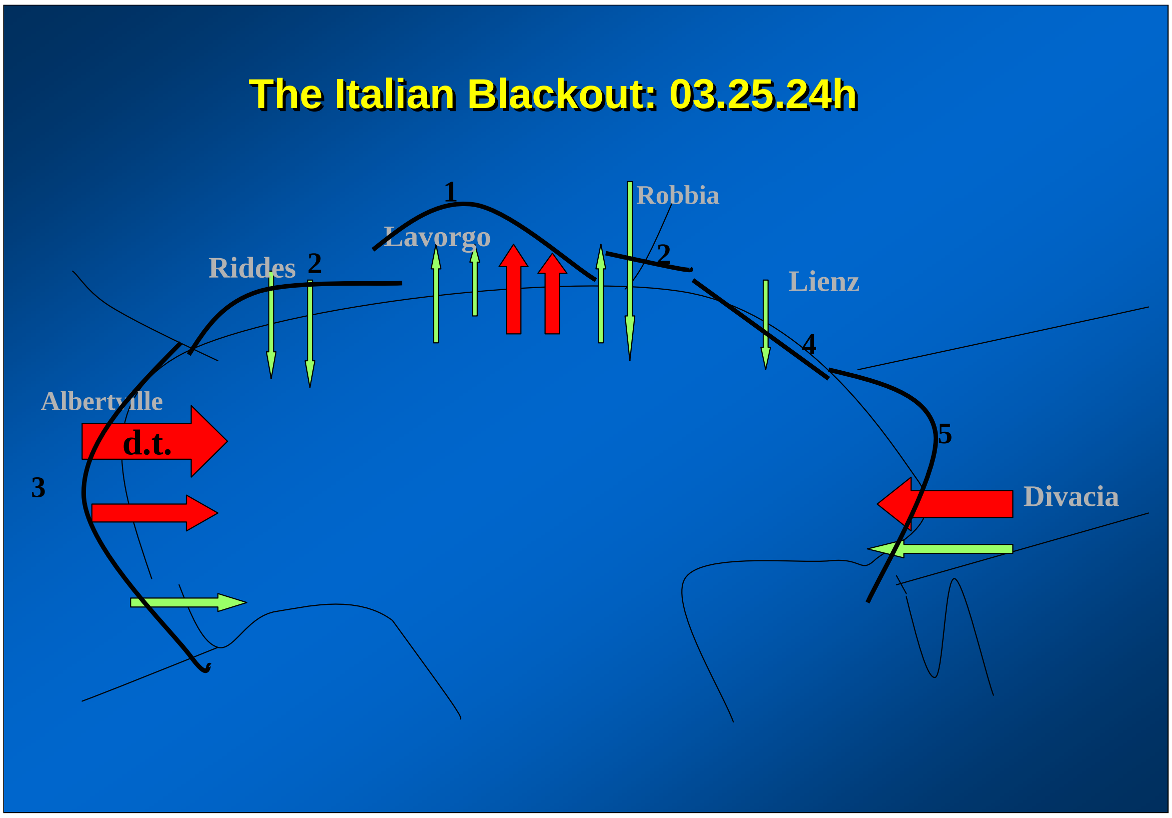
The attempts to re-close the line Lavorgo Mettlen were unsuccessful (excessive angle) and other remedies attempted by the Swiss Grid Operator were ineffective.

After 24 minutes of high current (peak of 2750 A) the Sils Soazza line trips due to another tree-flashover, caused by the increase in conductor temperature and subsequently the larger sag of the line.



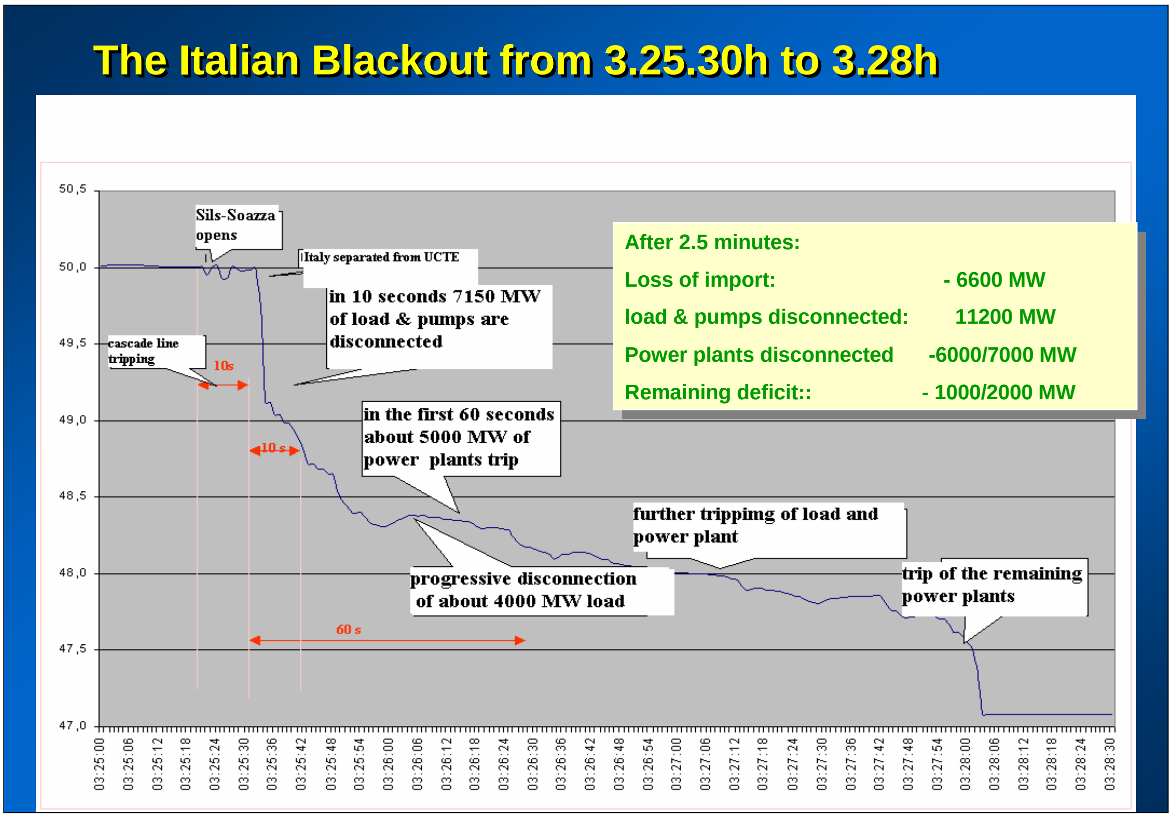
After the trip of the Sils Soazza line at 3.25.21h and of the Mettlen Lavorgo 220kV, 3 seconds later the Ticino area is isolated from the North and begins to import from Italy.

The total Swiss transfer to Italy is greatly reduced (-2400 MW) while power transits from France, Austria, Slovenia increase by the same global value.



A cascade tripping of the 15 border lines begins .

In 10 seconds the Italian system is isolated from the European network and its frequency begins decaying.



The transient of frequency lasts 2.5 minutes, during which there is a sudden decrease of the frequency in 10 seconds, accompanied by the disconnection of about 7.000 MW of pumps and loads, activated by frequency relays in accordance with the defence plans.

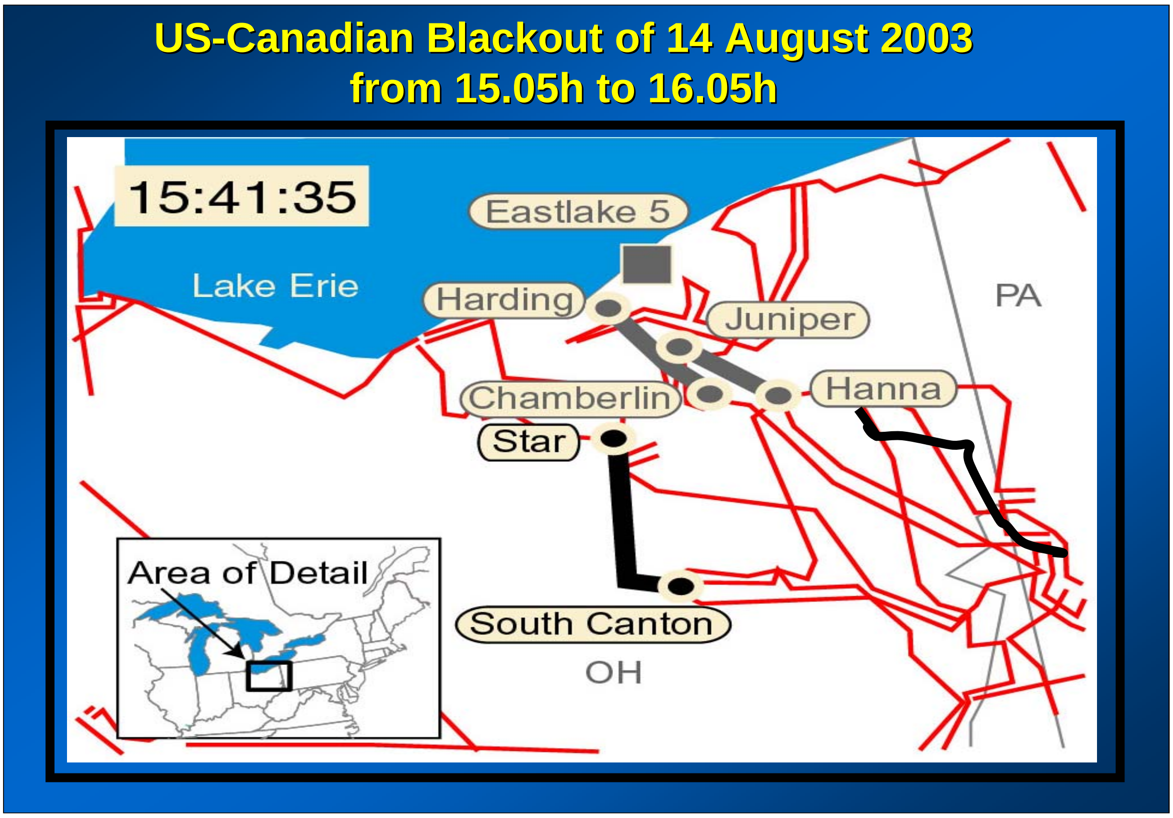
The frequency tries to recover but it is prevented by intentional and anticipated tripping of about 5.000 MW of power plants, which are not enough balanced by the progressive disconnection of additional 4.000 MW of loads. At 3.28h all plants are disconnected and Italy is in darkness.

At 3.28h all plants are disconnected and Italy is in darkness.

System restoration took a few hours in Northern Italy and up to 18 hours in the South.

The immediate causes of the Italian blackout were:

1. Inappropriate and not effective remedial measures after the first line tripping
2. Inadequate communication among system operators
3. Insufficient tree trimming and line corridor maintenance
4. Anticipated tripping of too many generating units during the frequency decay.



The area effected by the power failure was in the south of Lake Erie. There operates the power company FirstEnergy (FE).

- Starting at 3:05 pm EDT, three 345 kV lines in FE's system failed – within normal operating load limits -- due to contacts with overgrown trees:

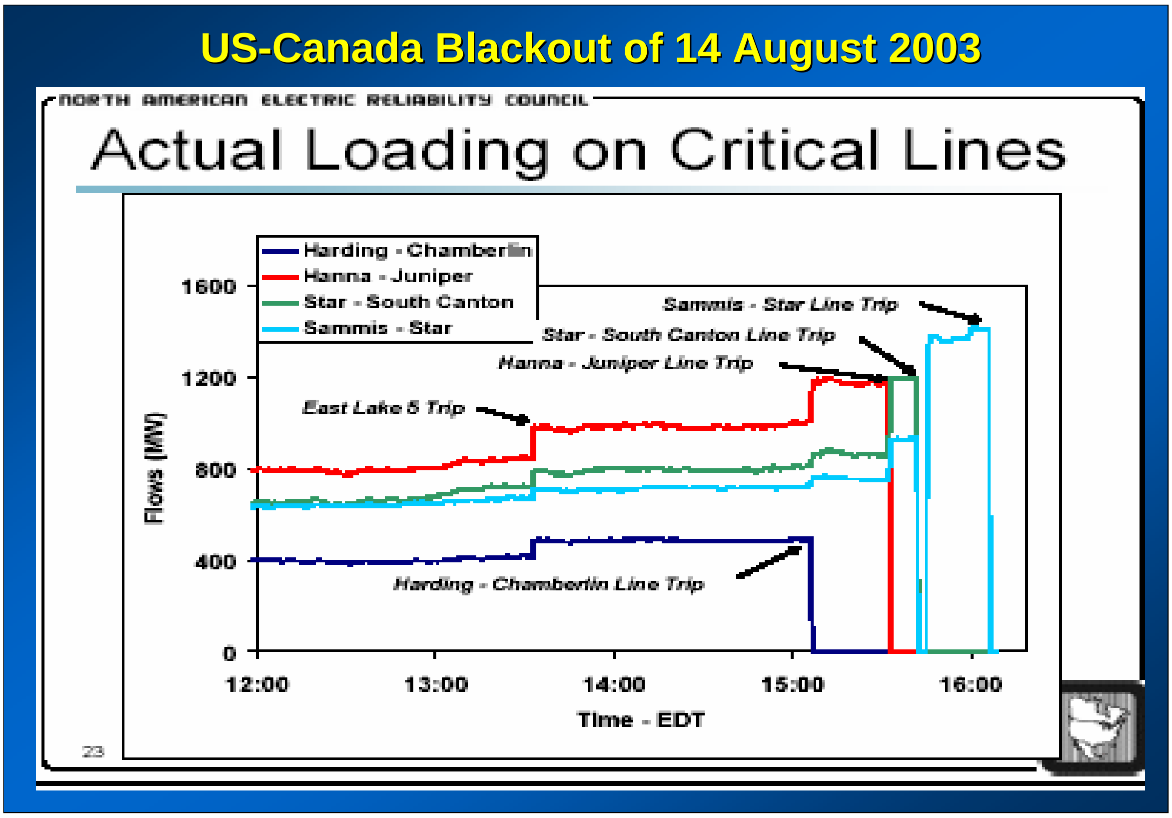
1. Chamberlin-Harding 15.05
2. Hanna-Juniper 15.32.
3. Star-South Canton 15.41.

The system operators did not realize that the situation was progressively degrading, because they had the control system out of service.

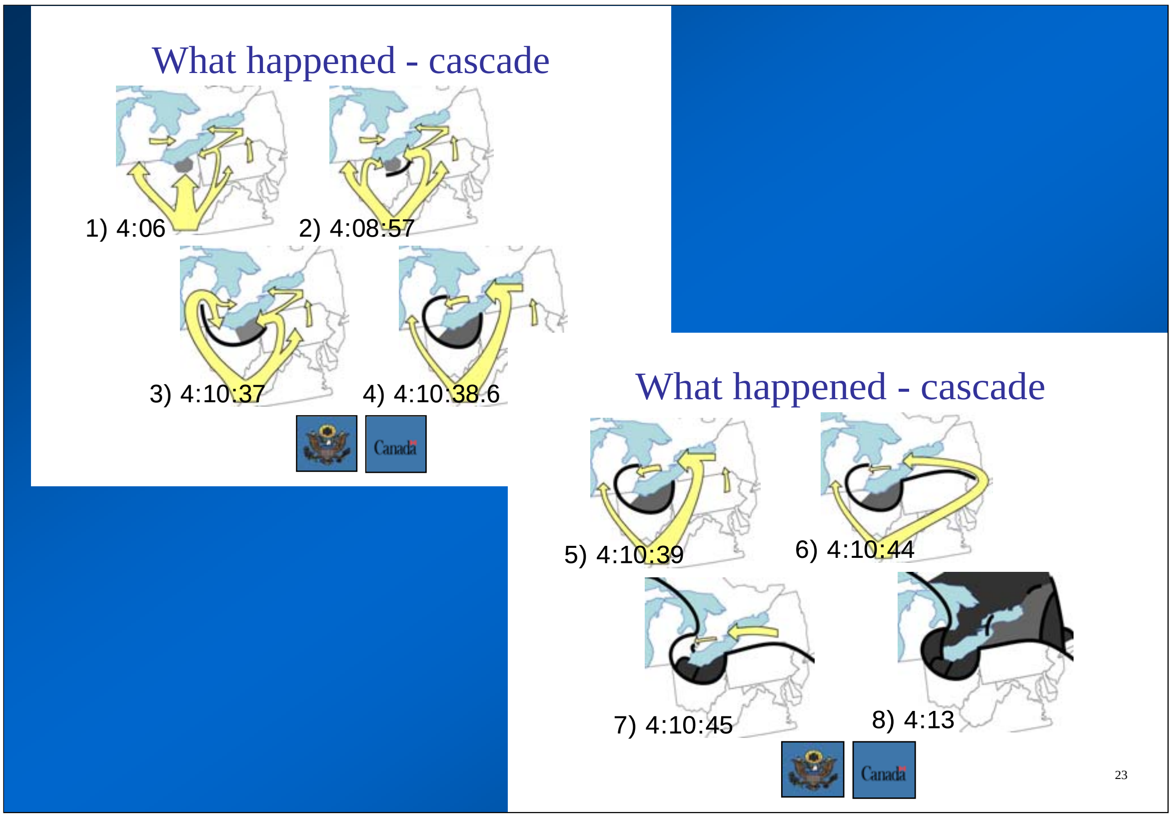
- At 4:05 pm, a fourth line Sammis-Star 345 kV failed due to severe overload.

4. Sammis-Star 16.05

After this event a cascade tripping started.



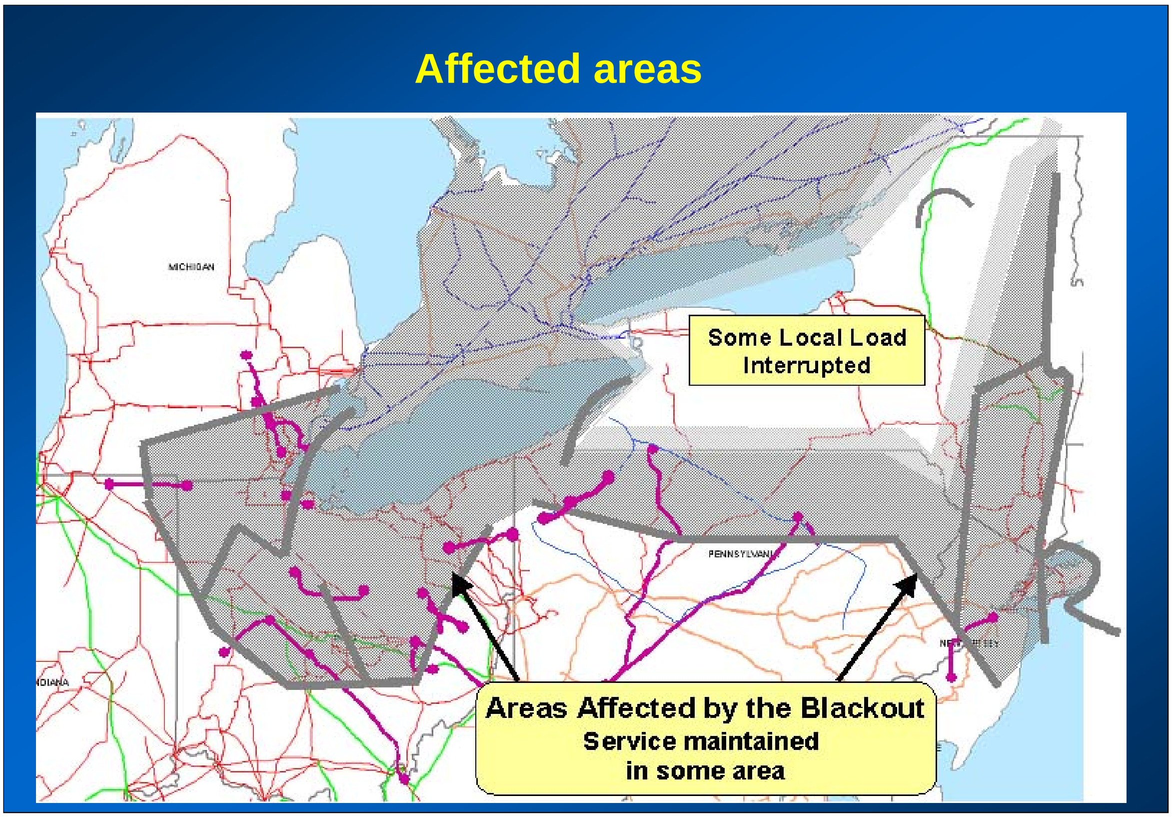
Similar to the Swiss line failure this figure shows that when a line trips , the power transits on the nearby lines increase. Consequently the high current heats the line conductors and causes an increase of the sag. The distance from conductors to nearby trees decreases and a flashover may occur that causes the opening of the line.



The cascade tripping lasts 10 minutes. Before the loss of Sammis-Star, the blackout was only a local problem in Ohio.

The local problem became a regional problem, because FE did not act to contain it nor did they inform their neighbours and Midwest Independent System Operator (MISO) about the problem.

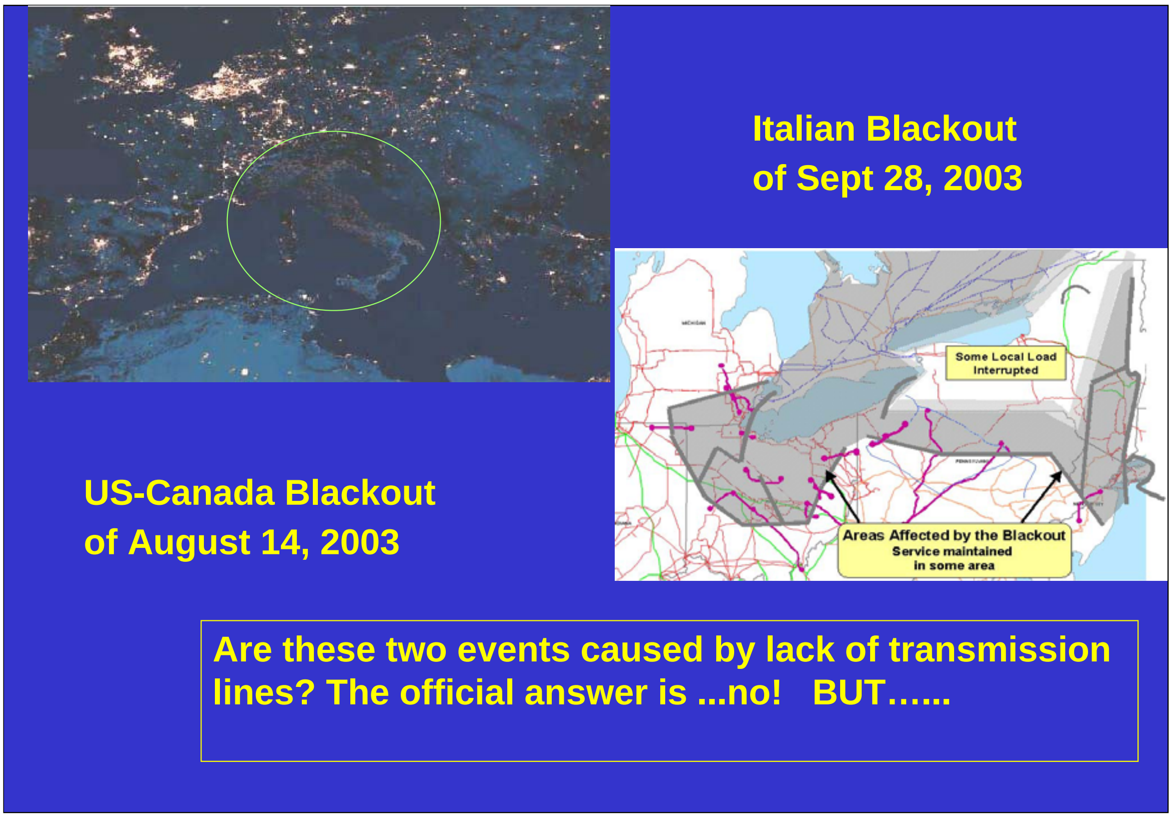
After Sammis-Star fell at 4:05:57, northern Ohio’s load was shut off from its usual supply sources to the south and east and the resulting overloads on the broader grid began an unstoppable cascade that flashed a surge of power across the northeast with many lines overloading and tripping out of service.



When the cascade was over at 4:13pm, over 50 million people in the northeastern part of the USA and the province of Ontario were out of power.

The main causes for the US-Canadian blackout of August 14, 2003 were:

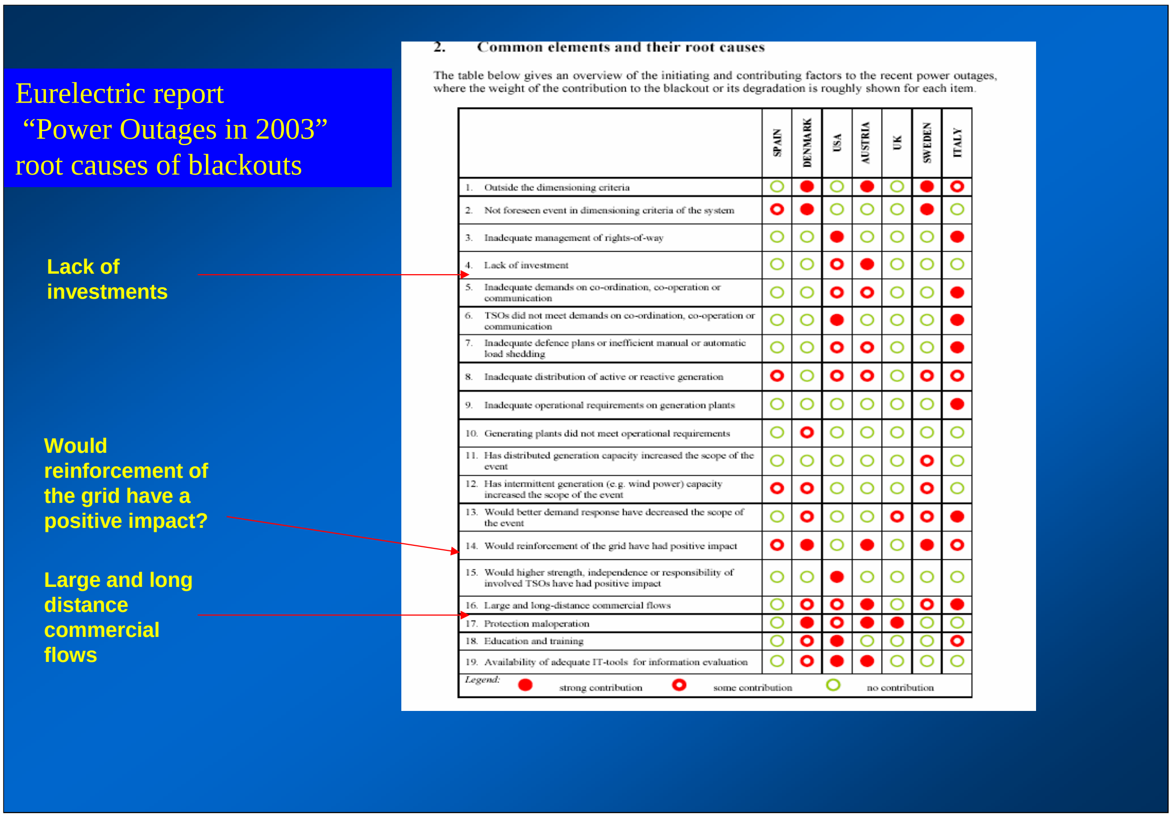
1. The trees were overgrown, i.e. lack of corridor maintenance
2. First Energy didn't understand the progressive degradation of its system. FE lost its system monitoring alarms and lacked procedures to identify that failure.
3. The Reliability Coordinator (MISO) did not provide adequate diagnostic support to compensate for FE's failures. MISO's state estimator failed due to a data error.
4. Inadequate communication, co-operation, co-ordination. PJM and MISO lacked joint procedures to coordinate problems affecting their common boundaries.



The remote and structural causes, evidenced in public debates in various countries, were:

Loss of technical expertise in the electric sector due to the reduction of personnel, which in turn was due to exacerbate competition.

Scarcity of new investments in EHV lines exacerbated by the authorisation difficulties and opposition due to environmental and visual impact.



2. Common elements and their root causes

The table below gives an overview of the initiating and contributing factors to the recent power outages, where the weight of the contribution to the blackout or its degradation is roughly shown for each item.

	SPAIN	DENMARK	USA	AUSTRIA	UK	SWEDEN	ITALY
1. Outside the dimensioning criteria	○	●	○	●	○	●	◉
2. Not foreseen event in dimensioning criteria of the system	◉	●	○	○	○	●	○
3. Inadequate management of rights-of-way	○	○	●	○	○	○	●
4. Lack of investment	○	○	◉	●	○	○	○
5. Inadequate demands on co-ordination, co-operation or communication	○	○	◉	◉	○	○	●
6. TSOs did not meet demands on co-ordination, co-operation or communication	○	○	●	○	○	○	●
7. Inadequate defence plans or inefficient manual or automatic load shedding	○	○	◉	◉	○	○	●
8. Inadequate distribution of active or reactive generation	◉	○	◉	◉	○	◉	◉
9. Inadequate operational requirements on generation plants	○	○	○	○	○	○	●
10. Generating plants did not meet operational requirements	○	◉	○	○	○	○	○
11. Has distributed generation capacity increased the scope of the event	○	○	○	○	○	◉	○
12. Has intermittent generation (e.g. wind power) capacity increased the scope of the event	◉	◉	○	○	○	◉	○
13. Would better demand response have decreased the scope of the event	○	◉	○	○	◉	◉	●
14. Would reinforcement of the grid have had positive impact	◉	●	○	●	○	●	◉
15. Would higher strength, independence or responsibility of involved TSOs have had positive impact	○	○	●	○	○	○	○
16. Large and long-distance commercial flows	○	◉	◉	●	○	◉	●
17. Protection maloperation	○	●	◉	●	●	○	○
18. Education and training	○	◉	●	○	○	○	◉
19. Availability of adequate IT-tools for information evaluation	○	◉	●	●	○	○	○

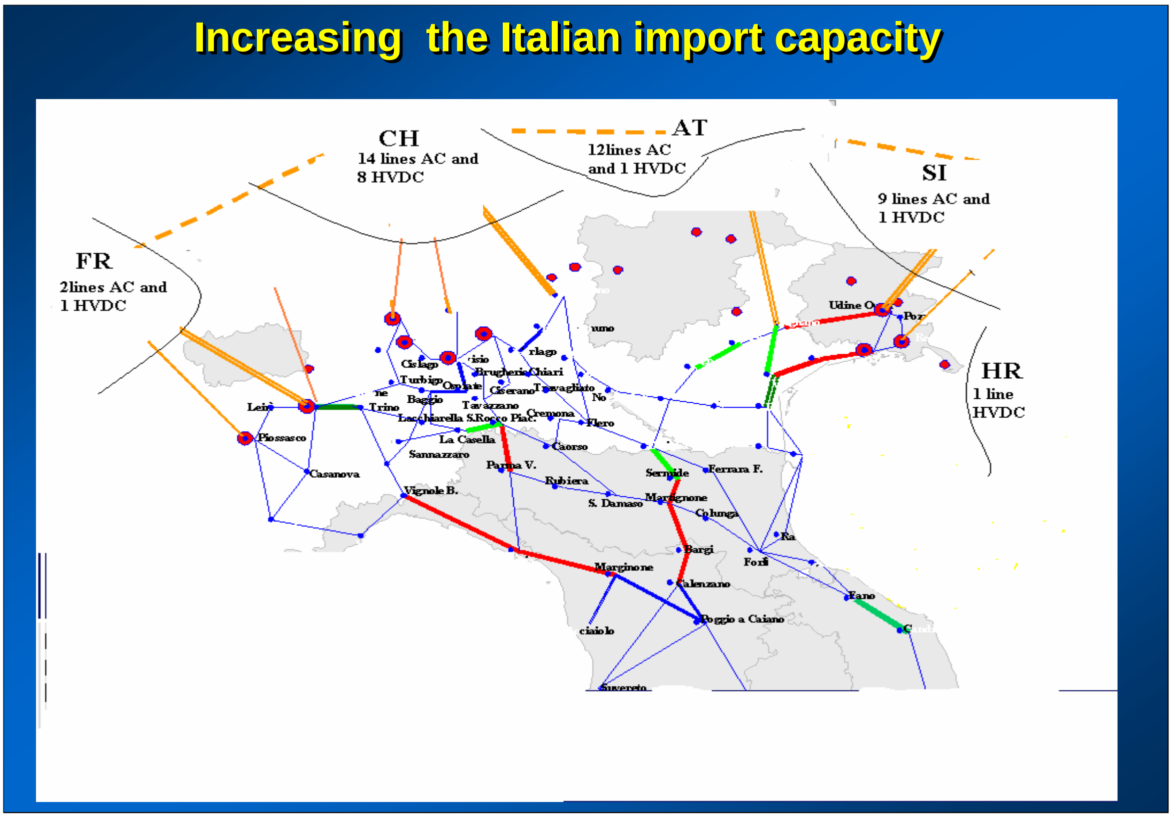
Legend: ● strong contribution ◉ some contribution ○ no contribution

Here you can see a page of the Eurelectric report on the power outages in 2003. Among the causes of blackouts there is mentioned in line 4 the lack of investments in 2 cases.

In line 14 the question is listed: Would reinforcement of the grid have a positive impact? The answer is that some lines were operated clearly close to their limits. It is obvious that a reinforcement of the grid would have had a positive impact.

On the subject of large and long-distance commercial flows on line 16 the answer is: Such flows induce instability and difficulties for the power plants to cope with that situation (e.g. Italy, US, Sweden), as well as for system operators to reconnect lines due to angle differences (e.g. Italy).

The recommendation is: Against the background of increasing long-distance load flows, it is important to take adequate reliability margins into account and to make sure that today's well proven system will be continually developed in the future.



The EU Commission and parliament have defined “measures to safeguard security of electric supply and infrastructure investment”.

The Barcelona Summit in March 2002 endorsed the target for Member States “to have a level of electricity interconnection equivalent to at least 10% of their installed production capacity by 2005/7”.

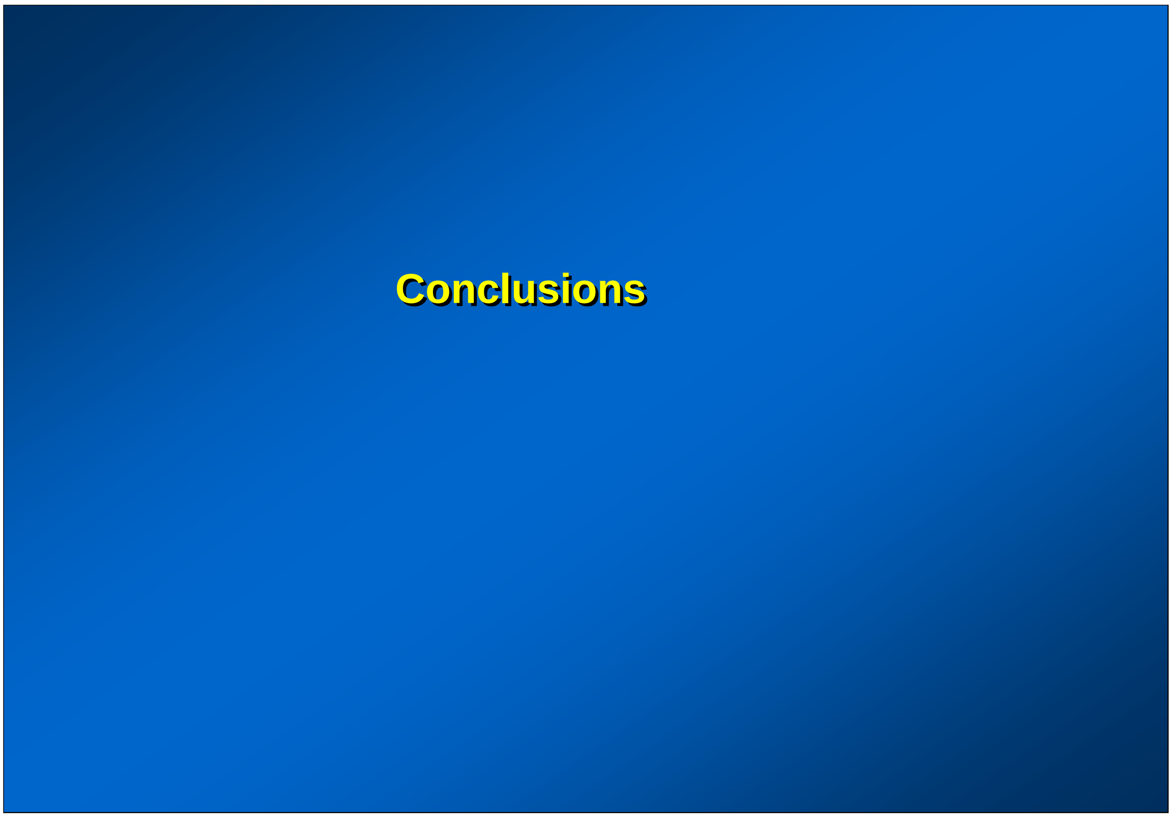
The Commission proposes increasing EU financial support for Trans-European Networks (TEN’s) in the energy and transport fields. A proposal tabled to the European Parliament and Council of Ministers in mid-July would raise spending to €340 million over the period 2007-2013, i.e. €49 million a year compared with €22 million under the previous accord.

Additionally, to foster the construction of new interconnections, “Private Lines” are now permitted.

The EU (Directives 2003/54 and 1228/2003, June 26, 2003) introduces the possibility of new direct connections, especially of HVDC type, to be built by private undertakings and not submitted to TPA rules. The benefits of the additional capacity are for the investors.

The Italian law n.290 of October 27, 2003 and the directive 73/04 of the Italian Regulator (AEEG) specify the rules to be followed for proposals and assignment

As a consequence 43 new private lines between Italy and Fr, CH, AT, SL, HR are under study. Among them 12 are HVDC projects with long stretches of underground cables.



Blackouts are generally not caused by scarcity of infrastructures. A system may be adequate but exploited close to security limits.

Power transits on the existing network may be forced for economical reasons at values that increase the risk of a blackout. This situation is more frequent nowadays, under the pressure of competition and the consequence of liberalisation.

Recognizing this situation the EU Commission and Parliament ask for more investments in new cross border and internal transmission links in order to avoid limitations in power transits that may reduce the risk of blackouts but decrease the overall economy.

Recognizing the difficulties in building new lines, e.g. because of local opposition, a recent EU directive has enlarged the number of potential investors, by introducing the possibility of direct lines built and owned by private undertakings.

As a consequence in Italy, several new private cross border interconnections are being studied. Several of them with long parts in underground cables, to reduce environmental impact and local opposition. The effective feasibility of these new links is still under examination.

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2)Report of the Federal Inspectorate for Heavy Current Installations on the event of 28 Sept.03 available at http://www.energie-schweiz.ch/imperia/md/content/energiemrkteetrgertechniken/elektrizitt/strompanne03/12.pdf

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