Large Power System Failures

Learning the management lessons

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This paper summarises the main issues raised at the World Energy Council's seminar on the above topic held in London on 2nd of October 2006.

The following speakers contributed at the seminar (in alphabetical order):

Luca d'Agnese	Director Italian Operations, TERNA and former Chief Executive Officer of GRTN
Guido Bortoni	Director of the Regulatory Authority for Electricity in Italy
William F. Hederman, Jr.	Executive Director Energy Resources Group Morgan, Lewis & Bockius LLP and former Director Office of Market Oversight and Investigations at FERC
Odd Håkon Hoelsæter	Chief Executive Officer Statnett and Chairman Nord Pool
Gerard Maas	Chairman of the Steering Committee of UCTE
Georges de Montravel	Head of International Affairs, RTE
Richard Sergel	Chief Executice Officer NERC
Nick Winser	Group Director UK and US Transmission operations, National Grid

The seminar was chaired by **Mr Kieran O'Brien**, Chairman of the WEC Irish Member Committee and former CEO of EirGrid

1.0 Introduction

In September 2003, most of the world's electricity industry professionals were discussing three major recent security failures, one in North America and two in Europe which, between them, left almost 100m electricity customers without supply. The scale of these failures was unprecedented in recent times; the fact that they had occurred in the developed world was a major surprise.

Almost immediately several detailed investigations commenced into the causes of these failures. A number of excellent reports have been produced and the technical reasons for the failures have been fully explored and explained.

Nevertheless, concerns about management and governance issues remain. A series of reports on other US failures over the past 50 years, for example, contain recommendations which are quite similar to those in the most recent report. Why are the same issues arising again and again? Given the major changes which are taking place in the electricity industry worldwide, are there new factors to be considered in ensuring the reliability of the world's electricity supplies.

This paper summarises the contributions of a number of expert individuals working at the leading edge of this debate. These contributions were made at the World Energy Council's workshop on this topic held in London on October 2nd 2006.

1.1 Definitions

Given the complexity of the issue at hand it is important to be precise about some critical concepts. The first concept to be clear about is *adequacy*. Adequacy refers to the ability of the power system to supply the total demand for electricity at all times. If, for example, sufficient generation is not available to meet the demand at any particular time then load must be reduced or "shed" in order to maintain a stable system frequency. The transmission infrastructure must also be *adequate* in order to deliver power within prescribed standards.

The second of these concepts is *security* in the sense that it is used in the power industry. Security refers to the ability of the power system to withstand sudden, unanticipated disturbances, particularly sudden failures of any elements of the system. Such failures could include for example the "tripping" or sudden shutdown of a large generator, the sudden failure of a transformer or circuit breaker or the sudden loss of a transmission circuit.

Following such a disturbance or "shock" to a power system which has been operating at a stable equilibrium, the system will become momentarily unstable. Depending on the severity of the "shock" and on system conditions at the time of the disturbance, the system will either revert to a new stable equilibrium or become even more unstable and rapidly collapse. The latter is the worst case scenario and is the type of failure that occurred in North America, Southern Sweden and in Italy in 2003.

In the context of modern power systems, distinguishing between adequacy and security is very important as different organisations may well be responsible for maintaining security on the one hand and adequacy on the other.

The focus of this paper is primarily on system security as security failures have the potential for catastrophic impact on the power system.

1.2 New realities

Today's power networks differ from their predecessors in a number of important ways:

- They are much older as is evident from Fig 1 showing the age of assets controlled by National Grid of the UK. Remedying this requires extensive capital expenditure over an extended period of time and often complicates the operation of the existing system. Today's assets are generally constructed to higher standards than heretofore and there is a strong focus on the overall lifetime serviceability and cost of the physical infrastructure.

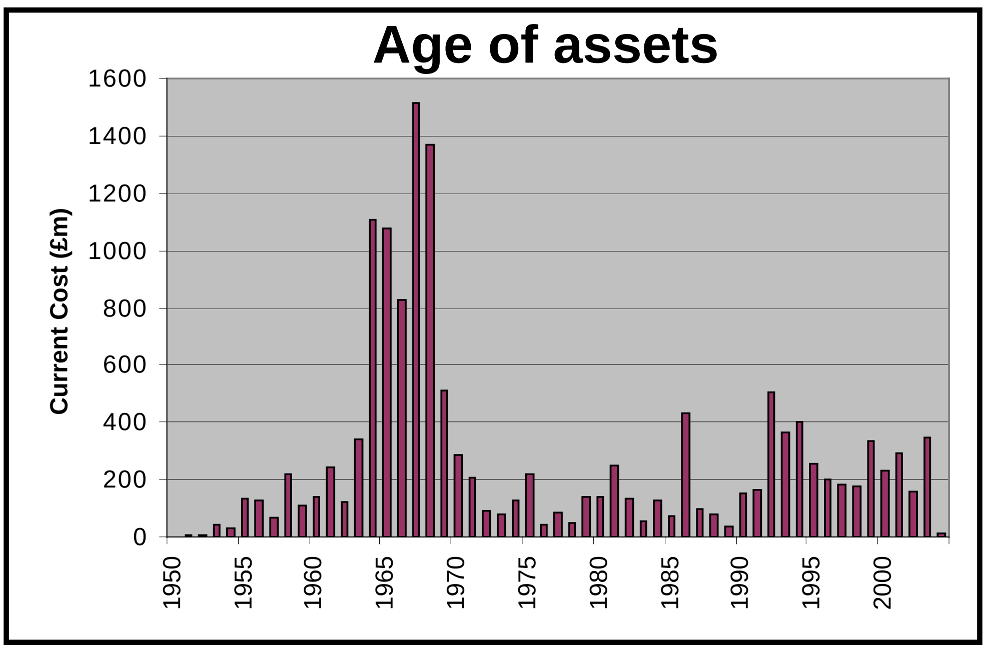


Fig. 1

- Planning and permitting difficulties continue to be a major headache everywhere for those trying to construct new assets. This is particularly true in continental Europe where it can take 15 to 20 years to construct new high voltage circuits.

- Today's networks service much larger markets and these markets themselves impose new operating conditions for which the original networks were not designed. Nevertheless, engineers must get used to the new world of electricity trading. There is today the occasional call for the return to more simple arrangements to facilitate reliability but this is not possible. The economic advantages of today's market led approach to electricity supply are so self evident that there is no possibility of abandoning this philosophy. The challenge for engineers is to maintain reliability in the face of such a rapidly changing world.

- Meeting this challenge while complying with tight regulatory constraints on expenditure has led to increased sophistication and complication in the operation of today's power systems. This complexity is necessary in order to operate the system close to its ultimate capacity and extract the maximum service from an expensive asset.

- These sophisticated operations require advanced tools, mainly in the form of complex hardware and software as well as a high level of training and skill on the part of operators. While traditional equipment vendors are rising to the challenge, the acquisition and further training of power engineers is proving difficult in many developed countries and requires close and formal cooperation between network operators and educational institutions. It is no longer possible for operators to fall back on simple paper-based systems.

- There is a new challenge today in protecting power systems from malicious attack. Managers spend many hours working with the security services to reduce the vulnerability of the physical infrastructure. Cybersecurity has also to be considered but is felt to be less of a threat at present. Nevertheless the provision of secure and reliable communication systems is essential to the reliable operation of all large power systems.

It is against this background that modern power system security must be planned and managed.

2.0 Issues and principles

Delivering power system security requires the participation and cooperation of different entities and agencies, often with different objectives. At a minimum someone has to:

- Set standards
- Monitor them
- Enforce them
- Provide infrastructure
- Operate the system

In all of this knowledge is critical. While human and analytic knowledge is essential, complex systems can only be properly governed if comprehensive and authoritative data is available to regulators and participants. Good governance requires great transparency, something that often clashes with the commercial objectives of many players. Resolving this conflict is important and requires a strong respect for and observance of the rules. The industry requires its people to demonstrate ethical behaviour.

Building such a consensus requires the development of strong and diverse teams. All the evidence to date indicates that a central command and control structure is not effective. Participation of many disciplines and of private and public sector interests is essential if satisfactory outcomes are to be achieved. In the short term command and control may seem to offer more rapid solutions, but solutions that work in the long term can only be achieved by adopting a consensus approach. Both North American and European experience would tend to support this.

2.1 Governance

A governance system can be characterised as follows:

- Rules
  - Mission
  - for decisions

- Organization
  - structure
  - culture

- Links for information
  - formal
  - informal

- Lines of authority
    - formal
    - informal
- Lines of accountability
    - Clear
    - fuzzy

Good governance systems ensure that accountability aligns with authority and with incentives. Such systems require considerable transparency as well as checks and balances. They also demand a strong culture around the organisation's mission. Accountability in turn demands that both managers and boards can be changed where appropriate.

The operation of the world's power systems is as likely to be under the control of not-for-profit organisations as for-profit corporations. Governance arrangements vary significantly from one form of organisation to another and there is considerable debate on the type of organisation likely to deliver the best results. The following view favours a "for-profit" approach but this is far from unanimous:

For Profit (Corporation)	**Not-for-Profit (Agency)**
Focus: bottom line	Multiple objectives
Economic Value Added	Societal Value Added
Profit maximizing (clear metrics)	Budget maximizing (fuzzy metrics)
Income growth	Mission creep
Owner votes (control shared with managers)	Stakeholders vote (control shared with "independent directors," regulatory oversight)
Potentially innovative (creativity)	Potentially entrenched (entitlement, least common denominator)
Punishment straight forward	Punishment difficult
Sustainable	Unclear

Fig 2

In designing governance arrangements to meet modern requirements trade-offs are inevitable. These will be mainly around the following dimensions:

• Openness	• Security
• Reliability	• Competition
• Choice	• Free-riders
• Rigor	• Adaptability
• Engineering sophistication	• Economic sophistication

In order to establish such a balance it is useful to consider the following matrix:

Desired Characteristics/Capabilities	Status
Independence	
Deep Technical Knowledge - power systems - cyber security - risk analysis - policy analysis - inter-organizational analysis - human factors	
Informed	
Incented	
Strategic	
Experienced	
Insured/Indemnified	

Fig 3

Important further issues to be considered in establishing system reliability oversight are:

- Energy regulatory policy analysis and strategy. Who "does" this?
- Adequate technical capability at regulatory level
- The nature of the staffing. Are expert "volunteers" provided from industry really independent?
- "Near miss" analysis. Who does this?
- Provision of customer options on reliability

3.0 New approaches

The lessons learned from the recent failures have prompted:

- Clear definitions of rights and duties
- Binding and contractual rules
- Harmonised approaches across different jurisdictions

North American and European approaches differ in some respects and this is hardly surprising given the many differences between the approaches to the industry in both regions. Nevertheless, there is evidence of considerable convergence developing at the principles level over the past few years although progress in Europe may be slightly slower than in North America.

3.1 Europe

In addition to the “normal changes” experienced over the past decade, Europe’s electricity industry has encountered particular complications stemming from the following sources:

- Higher public and environmental constraints for the construction of new transmission infrastructures
- The fast growing development of renewable energy sources like wind power
- The market is now at the size of the European interconnected system
- The development of the synchronous system towards new systems, southwards and eastwards.

The latter point is illustrated by the map below showing the various synchronous systems in Europe

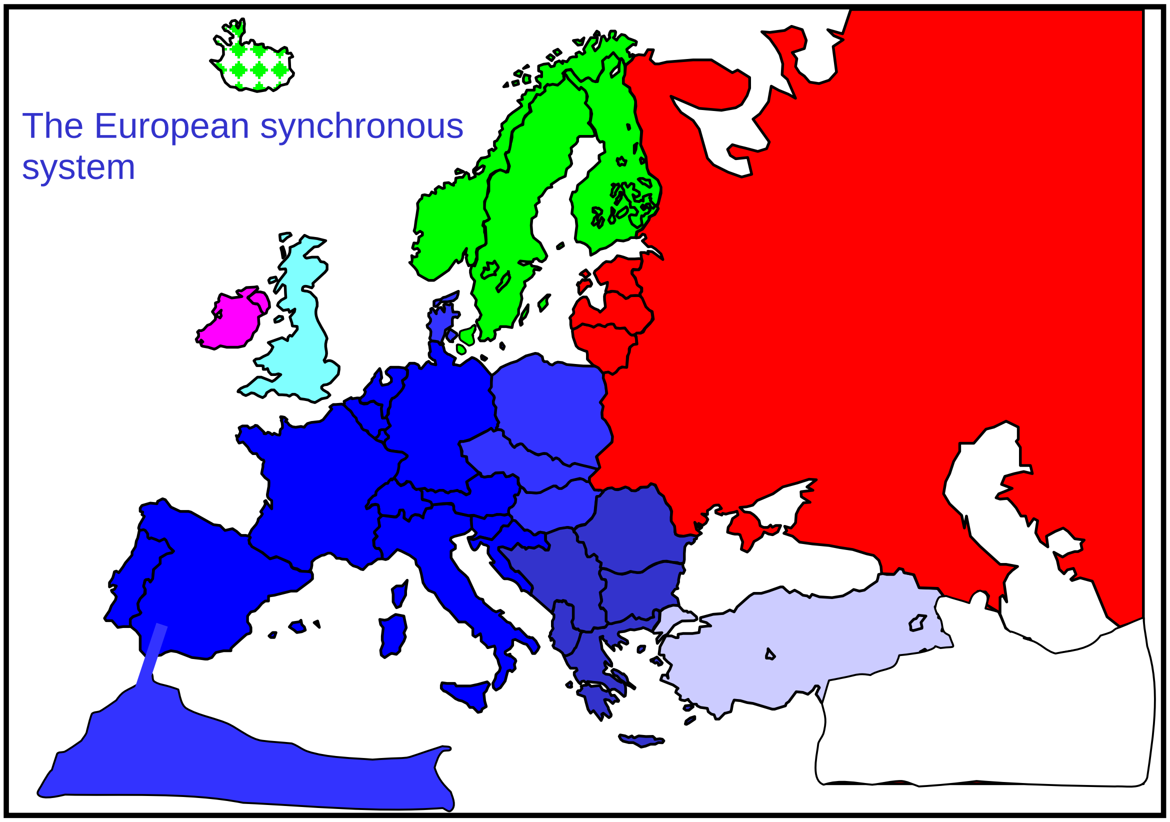


Fig 4

At present there are ongoing studies to expand the continental European synchronous area to Turkey, parts of the Middle East and North Africa and to the countries of the former Soviet Union.

At the national level in Europe the global framework of the electricity sector is well defined thanks to the European directives:

- Each member state has a Regulator
- All the TSOs are legally unbundled
- The level of opening of the market is defined
- The access to the transmission network is regulated

Europe has by and large adopted the Transmission System Operator (TSO) model where the system operator owns the transmission assets. North America has utilised the Independent System operator (ISO) model much more. TSOs in Europe are expected to be fully independent of market players, be fully responsible for the security and reliability of the power system and, as owners of the network, be responsible for its maintenance and development.

The importance of staff training is now well recognised in Europe. RTE (France), for example, operates a 2 day “real time” off-line simulation of major system incidents each year for its operators and includes public authorities, media and customers in the exercise. The importance of good communication and media training is well recognised.

As with most power systems, the grid code imposes obligations on those using it. Other contractual agreements necessary for the secure operation of the system are also necessary. The TSO must ensure compliance with the grid code and all other agreements.

Accountability and authority is usually fairly clear at the national level but this is no longer sufficient, there is room for further improvement at the European level. The traditional approach to this has been self regulation through a cooperative organisation, UCTE.

3.1.1 UCTE

Europe’s continental power system (excluding Scandinavia, the UK and Ireland) is currently characterised as follows:

• Transmission System Operators	33
• European Countries	24
• Customers	430 mil.
• Installed capacity	560 GW
• Electricity consumption/year	2500 TWh
• Electricity exchanges betw. countries/year	270 TWh
• Length of high voltage lines	230.000 km

UCTE, which came into existence in 1951, gained civil status in 2001. Its main mission today is:

- coordinating operational issues in the UCTE synchronously interconnected area
- short-term security issues concerning frequency control, interconnections and stability;
- medium to long-term system adequacy between generation and load (3, 5, 10 years)
- system development - assessing the operational feasibility of any request for extension or connection
- coordinated planning of development of the transmission UCTE network

Recently UCTE has responded to increasing security concerns by:

- Developing a detailed operations handbook for UCTE members

- Developing and implementing a multilateral contract between TSOs based on the handbook.

- Commencing a compliance monitoring and enforcement process.

This particular approach was adopted in order:

- to support the definition of comprehensive common reliability and security standards to be complied with by TSOs

- to solve the problem arising from the lack of harmonisation of different TSOs' national laws and regulations

- to give a legally enforceable basis to UCTE activities

- to support unanimous decision making by UCTE members

Europe's power industry has five separate synchronous areas of which UCTE is by far the largest. Each synchronous area has its own characteristics and within those areas there are more than 30 regulators with differing legal powers, areas of responsibility and areas of interest. There is no real federal regulation of these activities in Europe. The European Commission (EC) confines itself to high level policy directives which are in turn implemented separately and with considerable variation by individual jurisdictions.

So far these variations have included the following:

- most countries have 1 and some have more than 1 TSO (and control area)

- there are private and public TSO companies

- differences in national market characteristics in terms of import/export

- grid enlargement not really in step with development of renewables (wind)

- building new transmission lines demands long lead times (5 – 15 years)

- physical flows not (never) in line with commercial flows

Despite these difficulties great strides have been made in meeting the objectives of efficient markets. Some issues are causing concerns at present:

- more and more intermittent generation and long distance electricity exchange programs

- transit flows, loop flows and parallel flows are jeopardizing N-1 security conditions

- different congestion management solutions have been accepted by different regulators

- more and more regional approaches and solutions and intra-regional initiatives are emerging

- regional market-integration is being forced by trading.

3.1.2 The example of Italy

The dramatic 2003 failure in Italy highlighted a number of areas of concern, perhaps the most important of which was the reliance which Italy placed on imported electricity while simultaneously not paying sufficient attention to the management of network stability at its northern border. The exports and imports of a number of continental European countries are shown in Fig 5

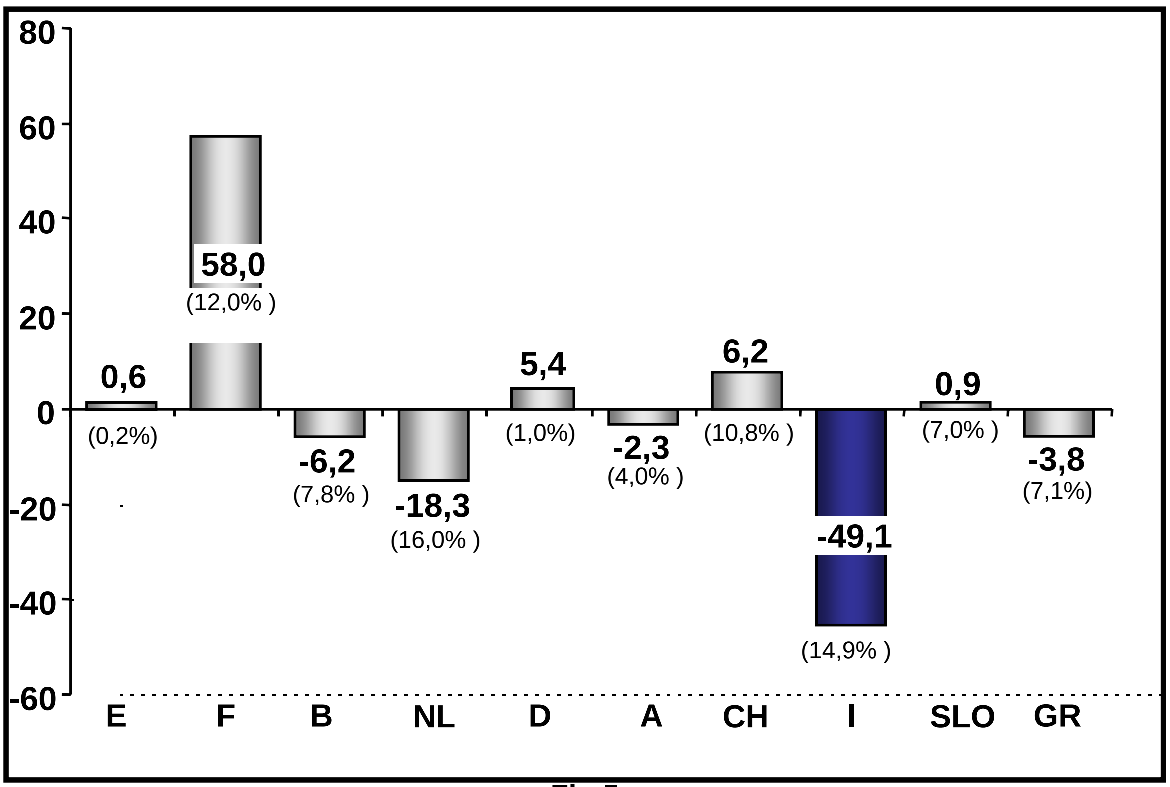


Fig 5

Since the incident Italy has:

- Moved to increase its own level of generation, particularly at times of peak demand

- Put in place joint operational procedures with its neighbouring TSOs which have improved the reliability of the network at its border

- Moved to increase network capacity at its border

The investigation into the incident revealed inadequacies in many areas:

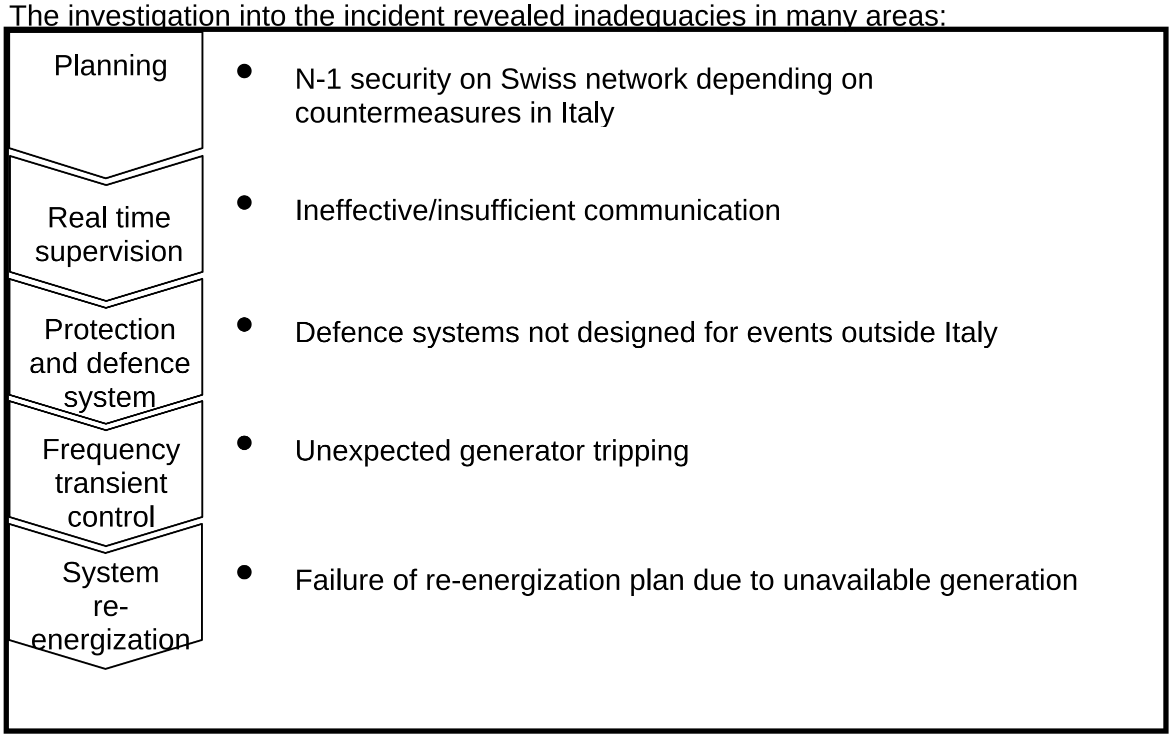


Fig 6

From the point of view of inter connection security, a new approach was adopted and implemented under three headings:

- Joint assessment of transfer capacity between five TSOs

- Day ahead congestion forecast

- Real-time joint security management

The last measure in particular provided operators on both side of the border with information on key parameters for each of their individual systems and allowed coordinated management of security on both systems depending on conditions on either one. Provision for arrangements such as this are provided for in the UCTE rules

The Italian regulator commented at the time on three aspects of the failure:

- Shortage of capacity, both generation and transmission was a contributory factor (adequacy failure)

- Mismanagement of available resources was also a significant contributor (security failure)

- The efficiency of the restoration programme was questioned

In respect of UCTE rules the regulator concluded that:

- On the whole the rules were adequate if they were correctly applied

- However, in 2003, UCTE rules were left entirely in the hands of TSOs and were not binding

- There was non-compliance with UCTE rules both in the operation planning timescale and in real-time operation.

Following the issue of the regulator's report a number of changes were made in the management of security on the Italian power system:

- Coordination between TSOs was improved

- The monitoring and data flow on the interconnected system was improved

- New UCTE procedures were adopted

- The ownership and operation of the Italian grid was unified under a single organisation

- A new national security plan was instigated

- The grid code was modified in order to increase transparency in the management of the power system

The combination of increased native generation, improved physical infrastructure and revised governance is considered adequate to ensure a very low risk of a repeat of the 2003 incident

3.1.3 Europe in the future

In addition to UCTE, Europe's TSOs have formed, at the request of the European Commission, the European Transmission System Operators Association (ETSO) which plays a major role in the day to day management of the power system. ETSO operates:

- The inter-TSO compensation mechanism

- Capacity allocation on cross border lines

- Congestion management

The principles underlying these arrangements are now incorporated in European regulations and guidelines.

In terms of improving investment in new transmission, the European Commission (EC) has:

- Developed a priority plan for trans-European interconnections
- Designated European coordinators to facilitate the necessary consensus between TSOs, regulators, public etc.

Europe is unusual however in having countries like Switzerland which lie at the heart of the UCTE power system yet are not part of the EU and are not bound by EU directives. Despite these difficulties, Europe has the most open market in the world in terms of consumer choice and has at the same time one of the world's most reliable power systems.

If adequate security is to be maintained in the future actions will be required by both TSO associations like UCTE and by individual TSOs. Associations like UCTE will have to:

- engage successfully with regulatory associations (ERGEG) in relation to security standards and the legal framework for self regulation
- take up seriously the watchdog function for compliance monitoring
- investigate possible solutions to enforcement in case of non-compliance
- improve security standards generally

Individual TSOs will have to:

- implement measures to solve non-compliance issues as identified by UCTE
- joint forces with neighbouring TSOs to achieve regional solutions for market integration
- educate their regulators
- Improve real-time information exchange in day-to-day business

In Europe, relations with regulators have become a key priority for TSOs as they strive to implement a self regulatory model. Developing a more aggressive approach to non compliance with UCTE rules will be necessary in order to convince policymakers and regulators of the effectiveness of such a regime. Europe also has work to do in improving transparency and information flows.

In the future the necessity to develop more transmission infrastructure will become ever more critical as demand increases, and both long distance trading and intermittent generation (wind) lead to uncertain network flows. In commercial transactions, gate closure times are moving ever closer to real time, leading to operational complexity and an ever increasing demand for skilled and well trained operators.

The greatest challenge facing Europe's power system however reflects directly its greatest political challenge; large scale extension to the South and East. Decision making processes for this enlargement are as yet only evolving but will be critical for future effectiveness.

3.2 North America

The North American grid consists of the United States, Canada and a small part of Mexico. It has:

- three synchronous grids
- Eight regional security organisations
- A demand of 800GW in total
- 200,000 miles of transmission lines
- A population of approximately 325 million

The geographical extent of the North American system is shown in figure 7

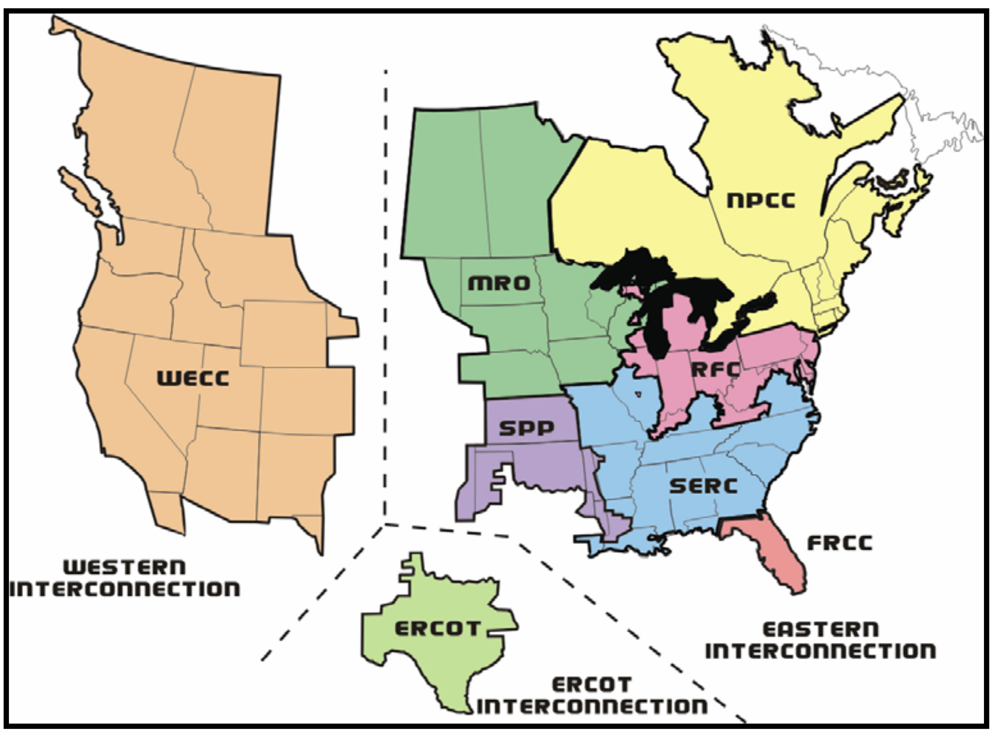


Fig 7

The industry refers to the years 1965 (Northeast blackout) through 1977 (New York Blackout) to 1996 (Western States Blackout) as the years of “blissful ignorance”. This came to an end in 1996 following the Western States Blackout and in 1999 legislation to rectify perceived security governance failures was introduced. Progress at legislative level was slow and it was only after the 2003 Blackout that policymakers moved rapidly to enact the Energy Policy Act (EPA) in 2005.

The EPA mandated the establishment of an Electricity Reliability Organisation (ERO) which would set and monitor mandatory reliability standards. Prior to this the North American Electricity Reliability Council (NERC) had provided a standard setting service on a voluntary and non mandatory basis. NERC operated through eight regional security organisations.

The new arrangements envisaged the ERO operating under the jurisdiction of the Federal Energy Regulatory Commission (FERC) based in Washington. Rule making authority would continue to reside with FERC. It was expected that the ERO would be the centre of technical expertise and would develop and propose standards for adoption by FERC.

This solution was a considerably more centralised approach than that proposed in Europe and did have to face the drawback that FERC authority did not extend to other countries, Canada in particular. In fact electricity policymaking and regulation is very much a provincial rather than a federal activity in Canada. It was expected that the new ERO would negotiate agreements with the Canadian authorities which would give legal status to the security standards.

In July 2006, NERC was appointed as ERO and expects to have mandatory standards in place by June 2007. Considerable progress is also reported in establishing legal agreements with Canada and its provincial authorities.

North American policymakers foresaw the ERO as an audited self-regulatory organisation where industry supplied the necessary expertise for the drafting and developing of standards, operating criteria and best practices. Similar models existed in the New York Stock Exchange and the American Medical Association.

The ERO (NERC) would have:

- An independent Board
- Full-time staff
- Eight regional organisations

It would fulfil its mission to “improve the reliability of the North American bulk power system by:

- Setting standards
- Monitoring compliance

- Taking enforcement actions where necessary
- Promoting readiness and situation awareness
- Encouraging training where necessary

NERC attaches great importance to communication and to transparency and believes in executing its mandate in a very open and non-discriminatory way.

3.3 Experience from Norway

The Scandinavian power system has long benefited from close cooperation between the various jurisdictions, from the complementary nature of the primary fuels used for generation and from the introduction of one of the most successful electricity markets in Europe.

Norway however is not without major challenges in the area of supply security as is evident from figure 8

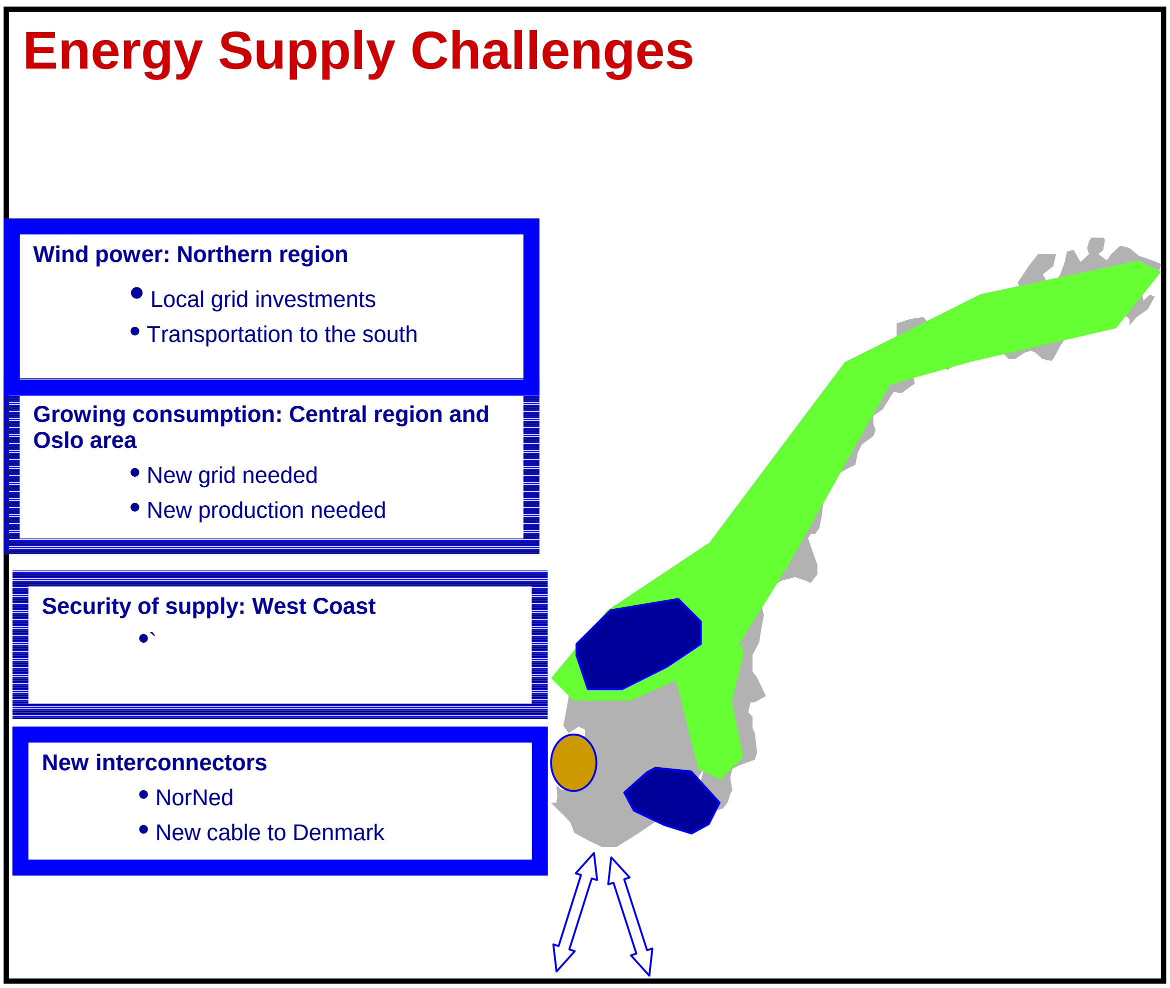


Fig 8

In fact transmission bottlenecks are common in the larger Scandinavian system. See fig 9 below

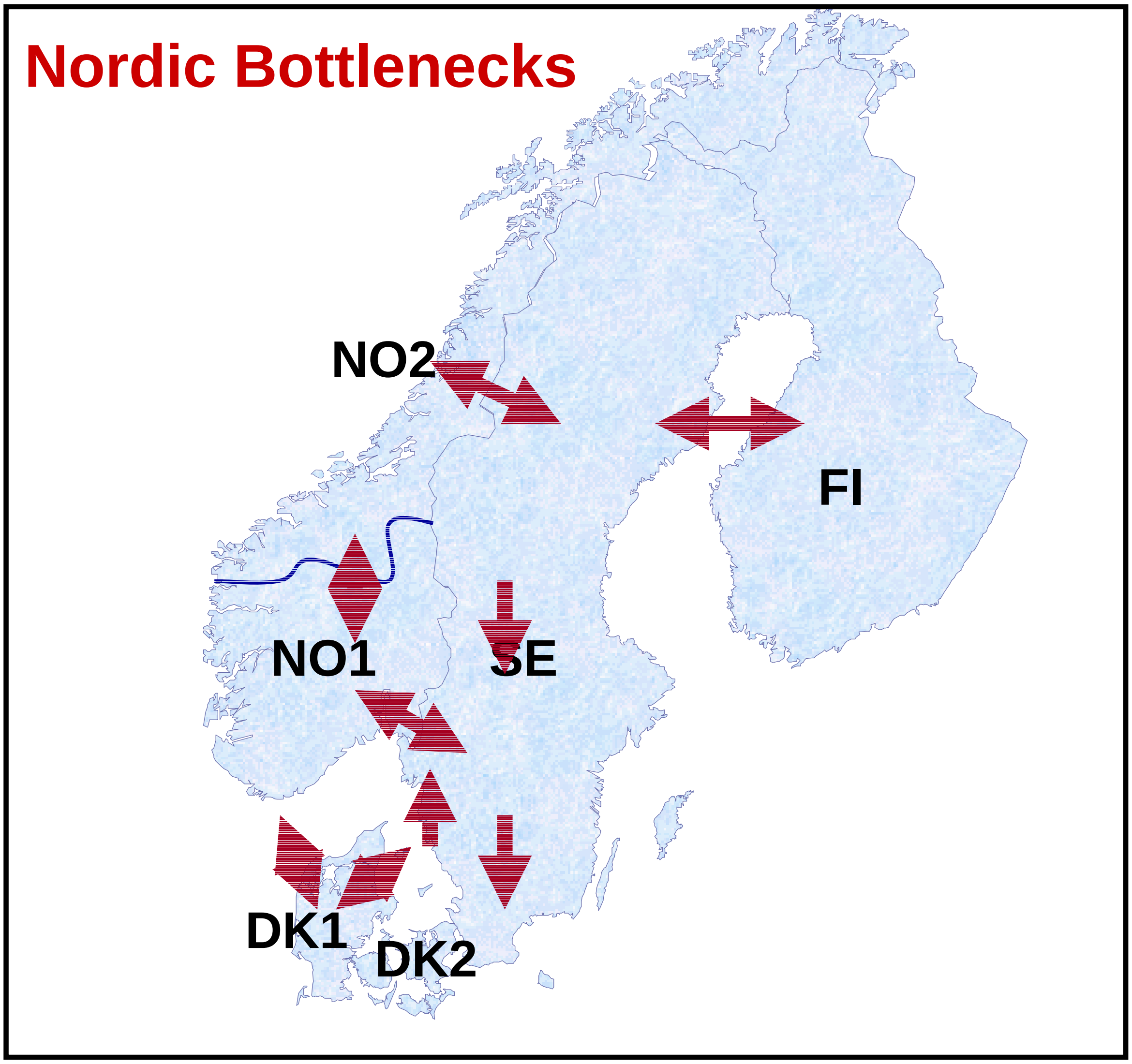


Fig 9

Against this background the Nordic market has been very successful. It has produced:

- A liquid market - Nordpool
- A stable industry framework
- The ability to manage financial risk

- More efficient use of resources
- Lower overall cost of electricity

Very often as a consequence of such success it has faced a number of challenges:

- High electricity consumption
- Tight power balances
- Higher grid utilisation
- New and less flexible production (mainly wind)
- Higher generation costs in some areas
- Concentration of ownership

As Norweigian TSO Statnett is responsible for:

- The physical grid
- System operations
- Market based solutions for setting electricity prices

Statnett's approach to its mandate is based on socioeconomic considerations:

- Maximising the socioeconomic value of the overall power system, grid, production and consumption
- Ensuring competition through market based solutions

Statnett is highly incentivised to invest in and manage the power system so as to minimise customer interruptions for whatever reason. This is done using the concept of "the cost of energy not supplied" (the Norwegian acronym is KILE)

- The KILE mechanism is designed as an incentive for grid companies to maintain good quality on their services.
- The grid company's income is capped by the regulator
- The income cap includes an expected value of the cost of energy not supplied ("KILE-cost")
- The difference between actual and expected KILE-cost causes either reduced or increased income caps for the following year.
- Incidents causing KILE-cost in excess of that allowed will result in a reduced income for the grid company the next year.

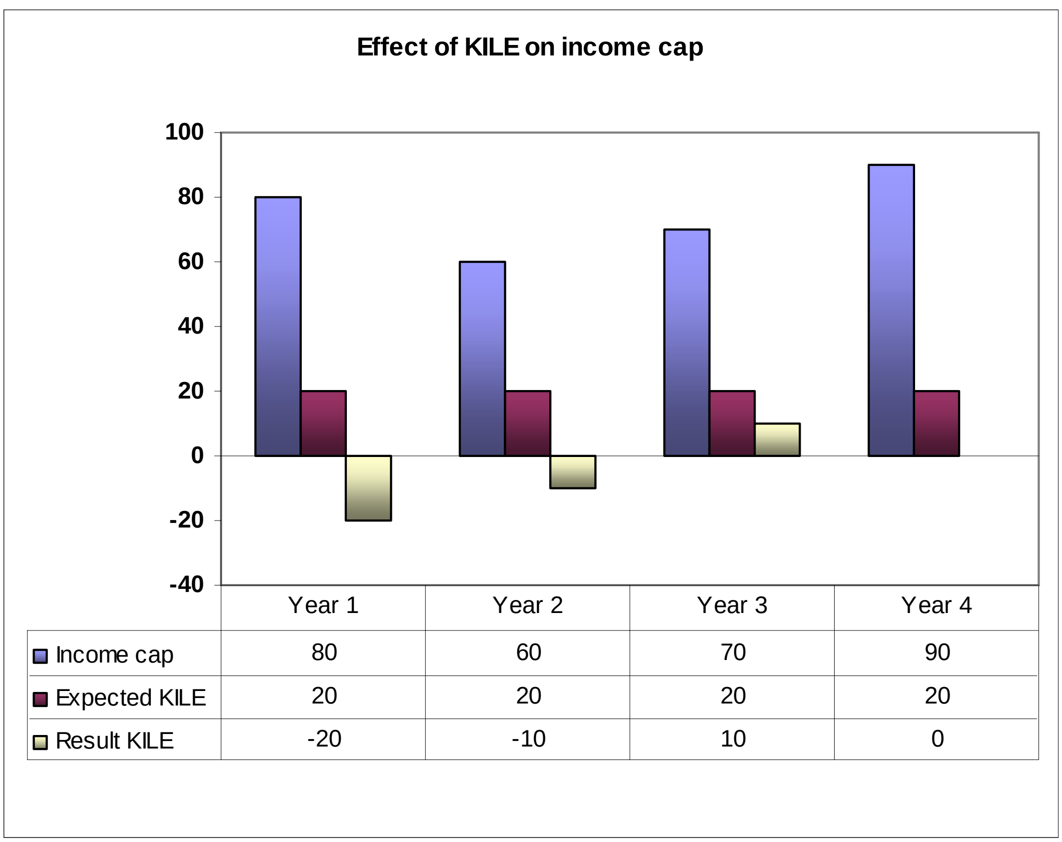
- The primary benefit to the consumer is a more reliable power supply over time

The key to success in this mechanism is the setting of the “cost of energy not supplied”. In Norway this is set at a very high level and acts as a powerful incentive toward performance.

Consumer group	KILE-cost [euro/kWh]	
	Not noticed	Noticed
Industry	8	5.6
Trade and commerc	12	8.3
Agriculture	1.8	1.2
Households	1	0.9
Public services	1.6	1.2
Large industry	1.6	1.3

Fig 10

It should be emphasised that these are costs per **kWhr** and are very high. Actual results are shown in Fig 11 and illustrate the strong commercial pressure to improve performance



	Year 1	Year 2	Year 3	Year 4
Income cap	80	60	70	90
Expected KILE	20	20	20	20
Result KILE	-20	-10	10	0

Fig 11

At Statnett a large level of authority is delegated to grid operators and the control centre takes all key decisions on a continuous basis. It is Statnett practice to hire / train all its operators to master degree level.

4.0 Conclusions

The problem of power industry governance is **the** major consideration in both North America and Europe as each region seeks to reduce the risk of system failure.

Both regions are in the midst of major change at present and important lessons can be learned from their respective actions

There are new realities that must be confronted in establishing new governance arrangements. Among these are:

- The age of existing assets and the great difficulty in constructing new infrastructure

- The impact of consumer choice and trading on modern power systems. The increased security risk resulting from these is not an excuse to revert to former pre-market arrangements but rather a challenge to operators to maintain reliability in a changing world.

- The effect of tight regulatory constraints on investment and operation and the need for increasingly complex systems and tools to manage in this environment

- The management of system vulnerability at a time of heightened global tensions and increased risk of malicious attack

- The difficulty of recruiting highly skilled and qualified technical staff into the industry

The provision of adequate system security requires:

- The development of appropriate standards

- Adequate monitoring of these standards

- Robust enforcement of the standards

As with many complex industries the best technical expertise resides in the industry and there is a considerable advantage in using this. Hence the proposals in both North America and Europe for industry self-regulation.

Self-regulation however is only feasible where stakeholders are confident that conflicts of interest do not exist and that standards will be developed, monitored and enforced in the interests of consumers rather than shareholders.

Establishing a regulatory regime where stakeholders are assured of adequate performance in respect of reliability is proving to be both complex and difficult.

In North America, the existence of strong federal regulation has permitted the emergence of proposals which may ultimately be implemented with central regulatory support. The existing regulatory regime (FERC) has a long history of dealing in a highly transparent manner with the industry and generally has the confidence of consumers. The current industry arrangements are also fairly stable. The necessary extension of these arrangements to other countries, mainly Canada, does pose some problems but these are being tackled through the provision of separate legal agreements.

Europe's problems are different. It has a very weak, if indeed any, central regulatory authority in the normal sense of the word. Its current industry arrangements are evolving faster than the US and in particular it is involved in a large expansion to the South and East. Most of Europe's national regulators are young institutions with a short track record and are still coming to terms with their national responsibilities.

Continental Europe's regional security is provided by associations which have traditionally been voluntary and which have been very slow to offer criticism of any individual member failings. This is changing as these institutions take on responsibility for the administration of legally binding agreements. While such legally binding agreements are now in place, it would appear that monitoring and enforcement, while provided for, have as yet quite some way to go before they become fully effective.

It is probable that suggestions from the European Commission supporting the establishment of a "European" regulatory agency are aimed at providing the sort of formal backstop to enforcement that FERC provides in the US. There are mixed industry views on this with national authorities generally opposing it but with some support coming from large pan European companies which have emerged from the recent rounds of industry consolidation and which find it difficult to deal with a multitude of national authorities.

The European approach of establishing TSOs rather than ISOs probably permits much stronger financial incentives to be put in place around system security. This is evident in the approach taken in Norway. Nevertheless, if such entities are established as not-for-profit organisations, the incentive is greatly reduced. On the other hand it has been suggested that not-for-profit organisations are less threatening to commercial players and can "cross boundaries" that commercial organisations cannot.

There is a suggestion that the TSO approach delivers more accountability and that transparency is a bigger issue with the ISO model

North America's more centralised approach may deliver results faster than Europe's more fragmented approach, but for real progress there still has to be a search for a reasonable consensus.

European TSOs sense a major lack of transparency in the necessary free flow of information and data across jurisdictions and are supportive of efforts being made by the EC to improve this. NERC is also calling for increased transparency.

The success or otherwise of the current set of initiatives in both regions will depend on the detailed implementation methodology underlying the principles already mentioned. There is great scope for variation here and for tailoring solutions to fit particular circumstances. Learning from these experiences is important and is highly relevant to the other major electricity networks of the world.

The World Energy Council hopes to continue to play a role in identifying and communicating best practice in this important area of the world's energy industry.