Blackouts: Invest, Intervene or Inveigh?

OIES Research Seminar
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Overview

Where they happened?

Why they happened?

What happened next?

What should happen now?
Where they happened?

**NORTH AMERICA (14 AUG 2003)**

**TIMELINE**

12:05 Conneville 5 trip (375 MW)
13:14 Greenwood 1 trip (785 MW)
13:31 Eastlake 5 trip (597 MW)
14:02 Line trip (a brush fire)
15:05 More line trip (3 touch trees)
15:39 16 lines trip near Akron
16:05 Samis Star line overload
16:06 Rolling blackout begins
16:13 263 power plants down
      1000 power lines tripped
      50 million people cut off

Source: NERC
Where they happened?

**UK (28 AUG 2003 + 5 SEP 2003)**

13:27 Substation fails

18:11 Substation alarm
18:20 NGC switches off

13:29 Faulty APR switch
14:30 Power restored

18:20 Faulty APR switch
18:57 Power restored

Source: National Grid Company
Where they happened?

**SOUTH SWEDEN – EAST DENMARK (23 SEP 2003)**
Where they happened?

ITALY (28 SEP 2003)

1. 380 Metten-Lavoro
2. 380 Sils-Soazza
3. 220 Metten-Airolo
4. 220 Arives-Riddes-Valpelline
5. 220 Lienz-Severzene
6. 380 Albertville-Rondissone 1 + 2
7. 380 Divaca-Redipuglia
8. 380 Lavoro-Musignano
9. 380 Villarodin-Venaus 380 Villarodin-Praz
10. 220 Robiei-Innertkirchen
11. 380 Magliano-Piosasco 380 Magliano-Vado Ligure
12. 220 Bavona-Robiei
13. 380 Soazza-Bulciago 220 Magadino-Soazza

ETRANS ask GRTN to drop 300 MW pumping

GRTN respond

Source: UCTE
Why they happened?

**NORTH AMERICA**

1. Bad luck - system operating closer to limits than normal after Eastlake 5 trip
2. Automatic monitoring systems switched off – poor training / poor procedure
3. Computer failures – lack of real-time data made it impossible to see full picture
4. Failure to clear undergrowth and trees – cut backs in maintenance spend
5. Poor coordination between adjoining SO control rooms – conflicting incentives
6. Lack of contingency plans – pre-liberalisation procedures now inadequate
Why they happened?

UK

LONDON

1. N – 1 operating condition breach by failure of two major components inside 10 mins
2. System vulnerable due to generating deficit in London
3. Liberalised market means little fat left in transmission system to cover extreme events
4. Second failure occurred due to incorrect fuse – poor training / poor procedure

BIRMINGHAM

….. see 1 and 4 above
Why they happened?

**SOUTH SWEDEN - EAST DENMARK**

1. N – 1 operating condition breach by failure of two major components inside 10 mins

2. System vulnerable due to planned outages of lines and plants in rest of system

3. Liberalised market means little fat left in transmission system to cover extreme events

**BUT**

Grid support from Sweden allowed ‘blackstart’ in 2 minutes so full power by 19:00
Why they happened?

ITALY

1. Failure to restore tripped line – poor SO coordination / overestimating system capacity

2. Lack of urgency in Italy to reduce pumping load – poor training / conflicting incentives

3. Instability and voltage collapse in Italy – system tending to operate close to limits

4. Right of way maintenance (tree trimming) – poor procedures / conflicting incentives
Why they happened?

**COMMON CAUSES**

Bad luck – AC interconnected grids vulnerable to multiple outages (N-1 breach)

Less ROR ‘gold plating’ plus load growth so TO/SO more efficient but system more fragile

Multiple adjoining SO/TO organisations now have conflicting commercial objectives

Incentives to free ride on system security (i.e. cut basic maintenance)

Poor training and loss of experienced SO/TO engineers and managers

Pre-liberalisation operating procedures not designed for wholesale markets

Regional transmission coordination bodies have no legal power to enforce standards
Why they happened?

*NOT THE CAUSES*

- Abnormally high demand
- Inadequate transmission capacity investment
- Inadequate generating capacity investment
- Terrorism / sabotage / corporate malpractice
- Market liberalisation
What happened next?

**AMAZEMENT**

Suddenly, knowing a lot about the U.S. power grid became sexy at cocktail parties.

Source: The Oregonian (24 Sep 2003)
What happened next?

PANIC

“We will view this rolling blackout as a wakeup call, a wakeup call for the need to modernize our electricity delivery systems, and we'll respond.”

George W. Bush (US President)

“Our system is vulnerable because we depend on foreign supply,…”

Andrea Bollino (Chairman of GRTN, Italy)

“I am very concerned that between 10.10 and 10.52 on 5 September another power failure should have occurred in the Midlands, this time affecting some 200,000 consumers. Again although I understand power was quickly restored, this second incident does raise questions about the reliability of the Transmission network that I am pursing as a matter of urgency with NGT”.

Patricia Hewitt, Secretary of State for Trade and Industry, UK)
Why they happened?

**BLAME**

“…the blackout was not Italy's fault”
Andrea Bollino, chairman of GRTN (Italian Grid Company)

“The reaction by Italy was not fast enough,”
ETRANS spokesperson (Swiss Grid Company).

“The French electricity network was not the source (of the Italian blackout)…”
André Merlin, RTE director (French Grid Company).

“The Italians …. did not react properly,”
Rolf Schmid, ATEL spokesman (Swiss Grid Company)

“The source is an outage in a northeastern United States power plant,”
Shane Diaczuk, spokeswoman for John Macallum (Canadian Defense Minister)

“In the United States, officials were looking at a power transmission problem from Canada as the most likely cause of the outage”
George Pataki, spokeswoman for New York Gov.
What happened next?

**MISDIAGNOSE**

“We're the superpower of the world--the best military, a booming technological economy--but we've got a grid that is antiquated, that is Third World, that needs beefing up. We've got very weak power transmission lines and generation capacity. That's because there hasn't been investment in our electricity grid…”

*Bill Richardson, Governor of New Mexico (Former US Energy Secretary)*

“Under-investment in the National Grid must not be allowed to cause this kind of chaos in a city like London.”

*Ken Livingston (Mayor of London)*

“The construction of new power stations must not be delayed any longer.”

*Carlo Azeglio Ciampi (Italian President)*

“It proves that the system is frail and it needs more investment.”

*Professor Ian Fells (Energy adviser to the UK government and the World Energy Council)*
What happened next?

EXPLOIT

Commission proposes decisive action on Infrastructure and Security of Supply

“The Commission proposed today a new legislative package to promote investment in the European energy sector to both strengthen competition and help prevent the reoccurrence of the blackouts that took place this summer”.

“Although the incidents affecting supplies this summer were nothing to do with the market opening process, we must ensure that Member States should have a clear and unambiguous approach to these questions.”

“This new framework is decisive for reinforcing the European Energy Single Market and preventing Europe having to face a situation like the so-called California experience”.

Extracted quotes by Loyola de Palacio (European Commission Vice President) 10 December 2003
What happened next?

**LEGISLATE**

*Proposed Directive on Electricity Infrastructure and Security of Supply*

- Require national supply - demand balance policy (targets for reserve capacity or demand side measures)
- Require national defined standards for security of the transmission and distribution networks;
- Require each TSO submit an (multi)annual investment strategy to its national regulator;
- Require regulators to submit a summary of these investment programmes to the Commission
- Rights for regulators to intervene to accelerate the completion of projects and, where necessary, to issue a call for tender on certain projects in the event that the TSO is unable or unwilling to complete

*Revision of the TENs guidelines for electricity and gas*

- **introduce the** Declaration of European Interest for some key cross-border projects and enable nomination of a European co-ordinator for a project;
What should happen now?

AN ALTERNATIVE NON-INVESTMENT SOLUTION

Create Regional Transmission Organisation (RTOs)
  • Remove conflicts in vertically integrated firms (esp. generation and transmission)
  • Legal minimum power quality standard and automatic unserved load compensation

Mandatory plant divestment by dominant incumbent generating firms
  • Removes potential for exercise of market power and reduces overall prices
  • Reduces locational price differences, arbitrage trading flows and hence congestion

Implement real-time balancing markets in each RTO
  • Provides powerful locational marginal spot price signals to generators
  • Allocates constrained transmission capacity via simultaneous implicit auction

Impose obligations on planning authorities to ensure generation adequacy
  • Allows investors to locate generation capacity closer to fast growing urban loads
  • Eliminate/reduce need to build new transmission capacity and speed up planning
What should happen now?

**ETSO MEMBERS**

Source: SUDEL Annual Report
What should happen now?

NERC REGIONAL RELIABILITY COUNCIL MEMBERS

Source: NERC
What should happen now?

**LEGALLY ENFORCEABLE STANDARDS**

“The users and operators of the electric systems who used to cooperate voluntarily on reliability matters are now competitors without the same incentives to cooperate with each other or comply with voluntary reliability standards. Little or no effective recourse exists today under the current voluntary model to correct such behavior — not a single bulk electric system reliability standard can be enforced effectively today by NERC or the Federal Energy Regulatory Commission (FERC).”

“To ensure the continued reliability of the interconnected bulk electric systems throughout North America in the face of these changes, reliability standards must be made mandatory and enforceable, and fairly applied to all participants.”

NERC Reliability Assessment Report of 2002
What should happen now?

COMPETITIVE MARKETS AND TRANSMISSION CONGESTION

Competitive Market

\[ P_i = \text{€}30 \]

Generation Capacity = 50000
Demand = 35000
Marginal Cost = €30

\[ T_{ij} = \text{€}5 \]

Independent
TO/SO

Competitive Market

\[ P_j = \text{€}25 \]

Generation Capacity = 50000
Demand = 35000
Marginal Cost = €25

Line Capacity = 5000
Line Flow = 5000
What should happen now?

**GENERATION SECTOR CONCENTRATION IN EUROPE**

Largest Generator Net Output as % of Net National Output in 2002

Source: Company Annual Reports and OIES estimates
What should happen now?

**HORIZONTAL MARKET POWER AND CONGESTION**

**Duopoly Market**

\[ P_i = \€60 \]

Generation Capacity = 50000
Demand = 35000
Marginal Cost = €30

**Competitive Market**

\[ P_j = \€25 \]

\[ T_{ij} = \€35 \]

N = 2

Generation Capacity = 50000
Demand = 35000
Marginal Cost = €25

Line Capacity = 5000
Line Flow = 5000

Independent TO/SO
What should happen now

**VERTICAL + HORIZONTAL MARKET POWER AND CONGESTION**

- **Duopoly Market**
  - $P_i = €90$
  - $T_{ij} = €65$
  - $N = 2$
  - Generation Capacity = 50000
  - Demand = 32000
  - Marginal Cost = €30

- **Competitive Market**
  - $P_j = €25$
  - $N = 9$
  - Generation Capacity = 50000
  - Demand = 35000
  - Marginal Cost = €25

- **Line Capacity** = 2000
- **Line Flow** = 2000

Vertically Integrated TO/SO
What should happen now?

PLANNING OBLIGATIONS

Figure 9.1  Opportunities for New Generation Without Major National Grid Development Between Zones

Low
Up to 0.75GW
1  North
2  Humberside
3  N Yorks & N Lancs
5  North Wales
7  Rest of Mids & Anglia

Medium
Up to 1.5GW
4  S Yorks & S Lancs
6  West Midlands

High
Up to 2GW
8  South Wales
9  Wiltshire
11  Estuary
13  South Coast

Very High
Up to 3.2GW
10  Greater London
12  Inner London
14  Wessex
15  Peninsula

Source: National Grid Company
Speaker

Biography
Dr. John Bower is a Senior Research Fellow at the Oxford Institute for Energy Studies (OIES), an associate research institute of Oxford University, which he joined in November 2001. His research interest is regulation and design of efficient pricing and investment mechanisms for electrical energy, transmission capacity and emissions abatement in electricity and generation fuel markets. This includes integration of cross-border and cross-commodity energy markets as well addressing issues facing developing countries in liberalising electricity markets.

Before joining the OIES, John completed his PhD at London Business School and his previous career was in the commodity industry. His experience ranges from energy trading, at Marc Rich & Co, to risk management consultancy, with Coopers & Lybrand, advising commodity traders, producers and processors in base metal, precious metal, ‘softs’ and energy markets. Immediately prior to his PhD he was Global Controller Metals/Commodities at Deutsche Morgan Grenfell.

Current / Forthcoming Projects

OECD Economies
- Impact and implications of EU Emissions Trading Scheme (EU ETS)
- Electricity system security (fuel availability, generation and transmission capacity)
- Future generation capacity mix (coal, gas, nuclear and renewable)

Developing/Transition Economies
- An alternative ‘bottom-up’ model of electricity sector reform (with Chris Hansen)

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