Issues of Secure Energy Supply under Environmental constraints

Wolfgang Kröger, ETH Zürich and IRGC Geneva

ECF Annual Conference 2007, Berlin, March 26-27

WG 1. „Investment Requirements“
Global Installed Capacity versus Plant Age

source: ALSTOM
Worldwide Investment Needs in the Energy Sector until 2030
(EU25: 695 bill € in electricity sector)

16 trillion ($10^{12}$) translate to 1% of projected GPD
* E&D: exploration & development
** T&D: transmission & distribution

source: IEA Outlook, 2005
## Electric Power Supply Systems: Recent Major Blackouts

<table>
<thead>
<tr>
<th>Blackout</th>
<th>Loss of load [GW]</th>
<th>Duration [h]</th>
<th>People affected</th>
<th>Main causes</th>
<th>Cascade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 14 Great Lakes, NY</td>
<td>~ 60 ~ 16 50 Mio</td>
<td></td>
<td></td>
<td>Inadequate right-of-way maintenance, EMS failure, poor coordination among neighboring TSOs</td>
<td>X</td>
</tr>
<tr>
<td>Aug. 28 London</td>
<td>0,72</td>
<td>1</td>
<td>500’000</td>
<td>Incorrect line protection device setting</td>
<td></td>
</tr>
<tr>
<td>Sept. 2: Denmark / Sweden</td>
<td>6,4 ~ 7 4,2 Mio.</td>
<td></td>
<td></td>
<td>Two independent component failures (not covered by N1 rule)</td>
<td></td>
</tr>
<tr>
<td>Sept. 2: Italy</td>
<td>~ 30 up to 18</td>
<td>56 Mio.</td>
<td></td>
<td>High load flow CH, line flashovers, poor coordination among neighboring TSOs</td>
<td>X</td>
</tr>
<tr>
<td>July 12, Athens</td>
<td>~ 9 ~ 3</td>
<td>5 Mio.</td>
<td></td>
<td>Voltage collapse</td>
<td></td>
</tr>
<tr>
<td>May 25, Moscow</td>
<td>2,5 ~ 4</td>
<td>4 Mio</td>
<td></td>
<td>Transformer fire, high demand leading to overload conditions</td>
<td></td>
</tr>
<tr>
<td>June 22 Switzerland</td>
<td>0,2 ~ 3 200’000 passengers</td>
<td></td>
<td>200’000 passengers</td>
<td>Non-fulfillment of the N rule, wrong documentation of line protection settings, inadequate alarm processing</td>
<td></td>
</tr>
<tr>
<td>Aug. 14 Tokyo</td>
<td>? ~ 5</td>
<td>0.8 Mio households</td>
<td></td>
<td>Damage of a main line due to construction work</td>
<td></td>
</tr>
<tr>
<td>Nov. 4, Western Europe</td>
<td>~ 14 ~ 2 15 Mio. households</td>
<td></td>
<td>15 Mio. households</td>
<td>High load flow DNL, violation of the N rule, poor inter TSO coordination</td>
<td>X</td>
</tr>
</tbody>
</table>

Source: Kröger and Schläpfer, 2007
IRGC Risk Governance Framework

Management Sphere: Decision on & Implementation of Actions

Assessment Sphere: Generation of Knowledge

Pre-Assessment
- Problem Framing
- Early Warning
- Screening
- Determination of Scientific Conventions

Risk Management
- Implementation
  - Option Realisation
  - Monitoring & Control
  - Feedback from Risk Mgmt. Practice
- Decision Making
  - Option Identification & Generation
  - Option Assessment
  - Option Evaluation & Selection

Risk Appraisal
- Risk Assessment
  - Hazard Identification & Estimation
  - Exposure & Vulnerability Assessment
  - Risk Estimation
  - Concern Assessment
    - Risk Perceptions
    - Social Concerns
    - Socio-Economic Impacts

Communication

Tolerability & Acceptability Judgement
- Risk Evaluation
  - Judging the Tolerability & Acceptability
  - Need for Risk Reduction Measures
- Risk Characterisation
  - Risk Profile
  - Judgement of the Seriousness of Risk
  - Conclusions & Risk Reduction Options