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Der Umgang mit systemischen Risiken – Das Angebot des International Risk Governance Council

Präsentation in der Vortragsreihe „Umgang mit gesellschaftsrelevanten Risiken“

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Prof. Dr. Wolfgang Kröger
ETH Zürich
Gründungsrektor IRGC

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Setting the Scene

- Increase of life expectancy in most of the industrialized countries, e.g. in Switzerland by 3 months per year over the last 30 years up to about 80 years now.
- „Risk seems to matter more than ever, …partly because the sheer speed of change in science and technology“ (T. Blair, foreword Strategy Unit Report, UK).
- Raising public concerns about both the risks themselves and the manner in which they were managed (mainly governments and the corporate sector).

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Reflections on the Risk Landscape (I)

"BSE"	decision making in absence of comprehensive scientific evidence; loss of public confidence, image and money (> £ 4.3 billion in UK in control and disposal costs); number of casualties over next few years vary between a few hundred and 1 Mio cases
"GenEng"	dealing with uncertainties / ambiguities; implementation of the precautionary principle (EU) underly a EU – US trade war
"Y2K"	emerging (perceived) global risk; cyber-quake one of the most damaging scenarios, e.g. computer virus could trigger collapse of entire markets and industries within hours
"Sept. 11"	losses from (destructive) man-made events (> € 40 bn) exceed natural hazards; vulnerability of open society
"blackouts"	interconnected critical infrastructures subject to multiple threats; major breakdowns with rippling effects
"SARS"	spread of infectious diseases (from China to 27 countries); increasing fear of (bio-)materials' misuse

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Reflections on the Risk Landscape (II)

- Increased number of natural and technological disasters over last ten years (478.100 people killed, more than 2,5 billion affected, USD 690 billion economic losses); worsened by devastation of recent tsunamis.
- In 2003 60.000 people killed by catastrophes (44.000 by earthquakes), financial losses total to USD 70 billion (about ¼ insured), USD 15 billion caused by man-made disasters (50% by US blackout, only 2.5% insured).
- Globalization and liberalization as shaping factors:
  - Augmented economic concentration (the market value of some highest earning companies is higher than the GDP of many countries),
  - Further increased urbanization and adverse settlement patterns in general (23 megacities have 375 Mio inhabitants),
  - Growing geopolitical disparities and unfair burden sharing between nations and between communities within nations,
  - Higher concentrantions (pot. Tokyo earthquake € 1000 -3000 bn).
- Shell Riskworld 2020: purely technological risks less important, social and systemic risks increasing; global vulnerabilities (e.g. climate change).

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Excursion: What are (systemic) risks?

- "Risk" from the technical perspective refers to two variables – the probability/frequency of a specific instance of damage and, secondly, the extent of that damage. These variables and associated uncertainties are regarded as being quantifiable. Additionally, "the social science perspective focuses on aspects of societal and psychological risk experience and risk perception," [WBGU].
- ⇨ Risk must be understood as a dynamic concept linked to context and, therefore, subject to continued changes.
- " 'Systemic risks' are closely embedded in, and inter-linked with, a larger context of social, economic and technological structures and conditions as well as the natural environment. These interdependencies imply that a particular hazard could snowball into a chain of events which eventually cripples the very vital functions or systems – on which our society depends." [OECD, IRGC]

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Excursion: What are (critical) infrastructures?

- Are a network of independent, large scale man made systems that function … synergistically to produce a continuous flow of services essential to … society as a whole, e.g. electric power, telecom, water supply, transportation, health care;
- Are subject to multiple threats (technical-human, physical, natural, cyber, contextual) and pose risks themselves, e.g. EMF;
- Are highly dynamic and complex, are inter-dependent, both physically and through a host of info & com tech ("system of systems");
- Disruptions may have cascading effects (recall "blackouts");
- Have no single owner/operator/regulator; are based on different goals and logics; adhere to different rules and principles.

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Challenges to Appropriate Institutional Response

- Increasing gaps between actors and regions, e.g. US, EU-25
- Pace of developments (driven by science/technology, societal values/perception, discrepancies); detection or fear of new risks, e.g. nanotechnology
- Inconsistencies (among technologies, sectors/industries, nations/cultures), inefficiencies, lack of transparency
- Shift in responsibilities (from public to private sector), new limits of insurability (e.g. against terrorism)
- Unfair burden sharing (beneficiaries and risk takers, differently developed regions), non-flexible structures

⇨ Bridge gaps and overcome insular risk management communities by fostering governance approach

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Excursion: Governance in a Nutshell

- "Governance" refers to the processes, conventions and institutions that determine how
  - power is exercised in the management of resources and interests;
  - important decisions are made and conflicts resolved;
  - various stakeholders are accorded participation.
- Principles of "good governance" include
  - Accountability
  - Effectiveness/Efficiency
  - Participation
  - Strategic Vision/Focus
  - Transparency
- Risk Governance "is the sum of political, social, legal, ethical, scientific and technical components that allow the operation of hazardous activities" (Trust Net).

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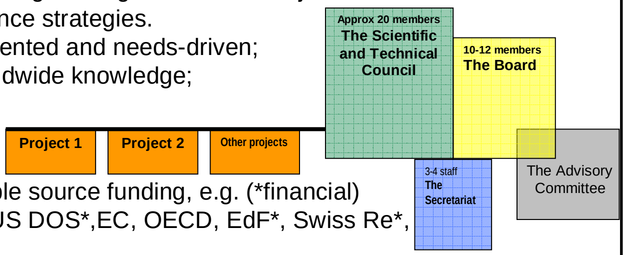
Mission and Approach of IRGC

- Creates values for various actors as it
  … offers a platform for global debate on (emerging) risk governance issues and authoritative knowledge;
  … elaborates generic guidelines on major risk issues and balanced governance strategies.
- Is problem-oriented and needs-driven; based on worldwide knowledge; not for profit.



- Aims at multiple source funding, e.g. (*financial) Swiss Gov*, US DOS*,EC, OECD, EdF*, Swiss Re*, WBCSD.
- The **S&T Council** as the basis for deliverables; outstanding individuals. from different disciplines, sectors and regions.

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Genuine Programme for Pro-active Dealing with Risks (shopping list)

Problem fields

1	**Critical infrastructure** (energy / water supply / IC-systems; interdependencies)
2	**Food safety** (issues related to classical food)
3	**Genetic engineering** (of crops and food; holistic approach)
4	**Biodiversity**
5	**Climate change** (sequestration; holistic approach)
6	**Governance in large organizations**
7	**Infectious diseases** (spreading mechanisms)
8	**Materials misuse** (biological/chemical/nuclear)
9	**Nuclear power systems** (waste management)
10	**Transportation** (dangerous goods)
11	**Artificial intelligence & robots**
12	**Management of chemicals**
13	**Nanotechnology** (balance benefits and risks)

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Genuine Programme for Pro-active Dealing with Risks (shopping list) **(II)**

Cross-cutting overriding issues

1	**Databases & methodologies for comparative assessment** *(harmonization)*
2	**Landscape of risks & related governance approach**
3	**Early warning & emergency preparedness**
4	**Uncertainties & complexity**
5	**Terrorist attacks**

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Ongoing Projects in Three Prioritized Areas

- Survey on the European electric power system as a critical infrastructure and its linkages to and interdependencies with…
- Development of a “generic framework” for risk governance strategies, based on a characterization of different kinds of risk, taking factual and perceptive elements into account, including the provision of adequate safety principles and management approach, incorporating both the opportunities and risks and ensuring the adherence to such principles as stakeholder participation and transparency.
- Review of the benefits and risks of nanotechnology and particularly of the existing risk governance strategies, leading to common views amongst key actors of the most appropriate risk governance approach to be applied in all countries.

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Current Project on the European Electric Power System

- An examination of this critical infrastructure **both** from a technical and socio-economic perspective, and its linkage to and interdependencies with other vital systems, in particular IC-systems;
- An assessment of weaknesses and vulnerabilities within the "mega-infrastructure", and foreseeable trends;
- The identification of potential technical and non-technical solutions to certain threats and vulnerabilities, including how best to avoid end-user disruptions;
- The identification of areas requiring further research and urgent actions at different levels.
- Project team: ETH Zurich, EC JRC Ispra, TU Delft

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Most Recent Major Power Blackouts – 115 Mio People Affected

- August 14, 2003 – North East blackout over the US and Canada;
- August 28, 2003 – Southern London distribution;
- September 23, 2003 – Danish/Swedish blackout;
- September 28, 2003 – Italian transport grid collapse;
- July 12, 2004 – Hellenic blackout

⇨ Increased probability of „major" outages with rippling effects as systems are under stress.

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Stress Factors (I): Discrepancy between System Design and Trading / Operational Practices within synchronized UCTE-Grid

- **Historically:**
  Self-sufficient, vertically integrated utilities serving native (national) load; interconnection at corporate level designed to:
  - Provide mutual support in maintaining system reliability, set security and reliability standards
  - Share generation reserves to increase economic efficiency
  - Allow international trade (limited coordinated exchanges)
- **Currently** (liberalisation, political development – extension towards Eastern Europe)
  - Drastically higher (and uncoordinated) cross-border trades (Italian imports increased by factor 10 from 1970 to 2002)
  - Unbundling of the generation-transmission-distribution chain, of electricity traders and transmission system operators
  - Transmission systems run closer to the limits (little investment in new transmission capacity, environmental concerns)
  - Security criteria ("N-1 rule") still the same
  - Institutional structure within UCTE quite the same (12 decentralized control blocks)

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Stress Factors (II): Contrasting Strategic Objectives and Attitudes in Europe

- Political regulatory models (EC Directives, Regulations) aim at the removal of the remaining obstacles to a competitive market and, together with the approaches of national regulators, continue to put pressure on prices.
- Industry itself stresses the importance of security of supply and the investments needed to achieve it and warns against complacency.
- The public believes that continuous supply of cheap electricity is guaranteed and lacks awareness of increasing risks to its supply.

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Learning from the Italian Blackout Sept 28, 2003 (I)

Sequence of Events

- **3:00** **Italy imports 6.9 GW,** 25% of the country's total load, 300 MW more than scheduled
- **3:01** **Trip of the 380 kV line Mettlen-Lavorgo** caused by **tree flashover** (no adequate tree cutting); overload of the adjacent 380 kV line Sils-Soazza
- **3:11** **ETRANS (CH) informs GRTN (I)**: Request by phone to reduce the import by 300 MW (not enough), GRT responded within 10 min.
- **3:25** **Trip of the Sils-Soazza line** due to tree flashover (at 110% of its nominal capacity)
  Italian grid looses its synchronism with the UCTE grid; almost simultaneous tripping of all the remaining connecting lines
- **3:27** **Breakdown of the Italian system,** which was not able to operate separately
- **21:40** **Restoration of the Italian system completed**

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Learning from the Italian Blackout Sept 28, 2003 (II)

Stage	Time	Country	Events
Casca-ding Line Tripping	Sept. 28, 2003 03:01:42	CH	➢ Trip of the 380 kV line Mettlen - Lavorgo caused by tree flashover (at 86% of the maximum capac-ity) ➢ Unsuccessful manual and automatic re-closing because of a too high phase angle difference (42°) ➢ 1'300 MW are re-routed through the nearby 380 kV transit line Sils-Soazza which becomes overloaded (110% of its nominal capacity, allowable time period for this overload 15 minutes)
	03:11	CH/I	➢ Phone call between ETRANS and GRTN: ETRANS requests to reduce the Italian import by 300 MW to meet the overall agreed schedule
	03:21	I	➢ GRTN reduces the Italian import by about 300 MW
	03:25:21	CH	➢ Causal trip of the overloaded 380 kV line Sils-Soazza by tree flashover
Loss of Angle Stability and Voltage collapse	Sept. 28, 2003 03:25:26	I / UCTE	➢ The Italian grid looses its synchronism with the UCTE main grid ➢ Almost simultaneous disconnection of all remaining interconnection lines towards Italy ➢ Angle instability
	03:25:33	I / UCTE	➢ Separation of the Italian grid ➢ Instability phenomena in the northern part of the Italian network leading to voltage collapse ➢ Increased frequency and unpredicted flow patterns within the UCTE main grid due to the sudden power surplus (former export to Italy) leads to a precarious situation; some generator units shut down
Blackout	Sept. 28, 2003 03:27	I	➢ Though about 10 GW of load was disconnected by automatic load shedding, the voltage drop within the Italian grid cannot be mastered and generation plants start to trip; the blackout spreads over Italy
Restora-tion Process	Sept. 28, 2003 03:28 - 08:00	I	➢ North-western Italy completely re-energized and connected to the UCTE main grid ➢ No significant progress in the central-southern area, most of the thermal plants still out of service
	08:00 - 12:00	I	➢ Load in the northern area practically restored
	21:40	I	➢ Whole power system under control and cessation of the emergency conditions

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Learning from the Italian Blackout Sept 28, 2003 **(III)**

Impact on the Population - strong

- About 56 Million people have been affected, five elderly persons killed;
- Hundreds of people have been trapped in elevators.

Economic Losses - moderate (several hundred k€)

Impact on Dependent Critical Infrastructures - varying

Transportation	About 110 trains with more than 30'000 passengers stopped as well as subways in Rome and Milan. Flights cancelled or delayed.Outage of traffic lights partly led to chaotic situations in major cities, no severe accidents.
Water supply	In southern regions the water supply was interrupted for up to 12 hours.
Info & Com	Telephone network and mobile phones were operable but in critical state. Internet providers shut down their servers (data transfer rate went down to 5% of normal).
Health services	Hospitals without serious problems due to use of diesel-driven generators.

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Learning from the Past: Blackouts Follow Common Pattern

- A minor single event (e.g. tree flashover; loss of one generating unit) may snowball into massive problems for a highly loaded or burdened electric power system with long transmission distances.
- Malfunction of critical equipment (inadequate diagnostic support) and behaviour of protective devices complicated the management of the events; system automation turned out to be insufficient to cope with this kind of scenarios.
- Aggravating factors are human-related, economic and contextual, including a general lack of awareness of potentially far-reaching failures and short-term emergency preparedness.
- "Measures to avoid another blackout" cannot be limited to "technical-fixes" area but have to take into account the sum of political, socio-economic, organizational and legal aspects.

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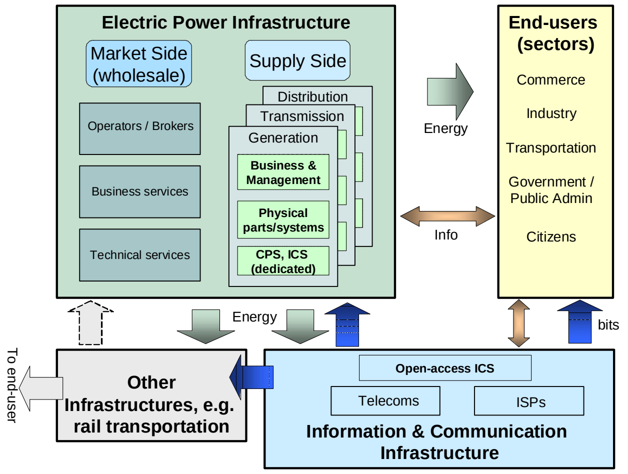
Challenge for Analytic Instruments: Dealing with Complexity and Infrastructures (I)



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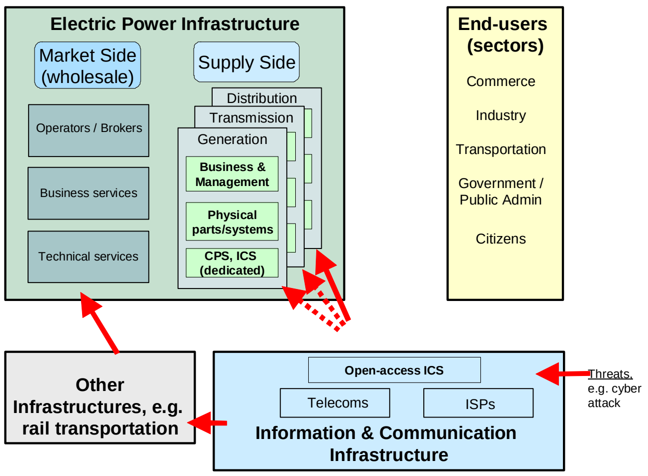
Challenge for Analytic Instruments: Dealing with Complexity and Infrastructures (II)



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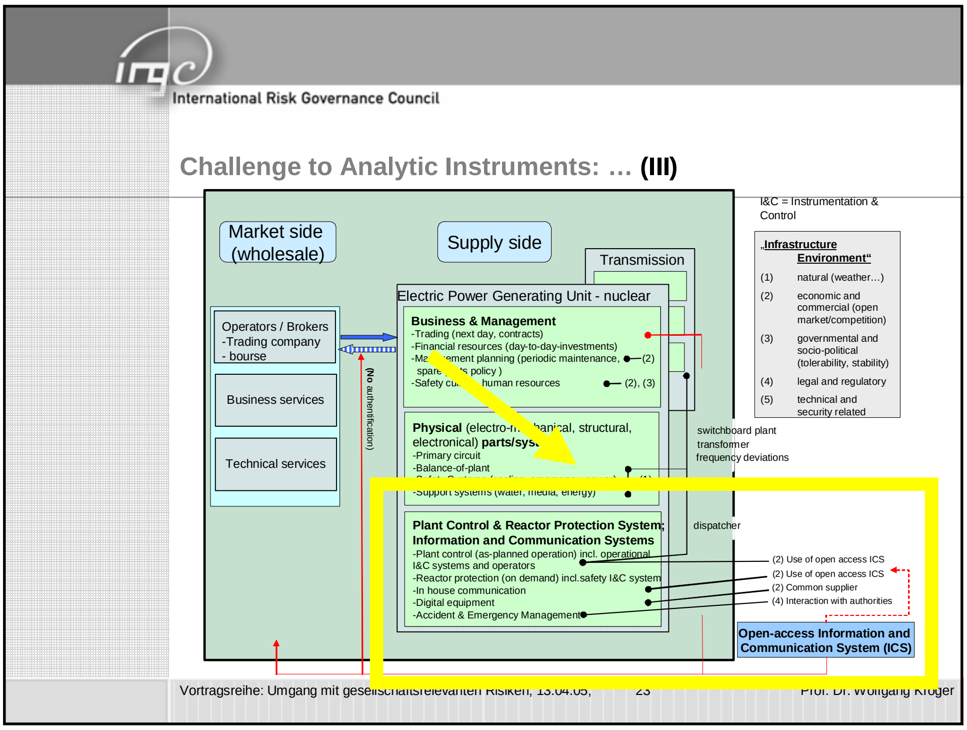
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Challenge to Analytic Instruments: … (III)
I&C = Instrumentation & Control
Market side (wholesale)
Supply side
Transmission
Electric Power Generating Unit - nuclear
Operators / Brokers
-Trading company
- bourse
Business services
Technical services
(No authentification)
Business & Management
-Trading (next day, contracts)
-Financial resources (day-to-day-investments)
-Management planning (periodic maintenance, spare parts policy)
-Safety culture, human resources
(2)
(2), (3)
Physical (electro-mechanical, structural, electronical) parts/systems
-Primary circuit
-Balance-of-plant
-Support systems (water, media, energy)
Plant Control & Reactor Protection System; Information and Communication Systems
-Plant control (as-planned operation) incl. operational I&C systems and operators
-Reactor protection (on demand) incl.safety I&C system
-In house communication
-Digital equipment
-Accident & Emergency Management
„Infrastructure Environment“
(1) natural (weather…)
(2) economic and commercial (open market/competition)
(3) governmental and socio-political (tolerability, stability)
(4) legal and regulatory
(5) technical and security related
switchboard plant
transformer
frequency deviations
dispatcher
(2) Use of open access ICS
(2) Use of open access ICS
(2) Common supplier
(4) Interaction with authorities
Open-access Information and Communication System (ICS)
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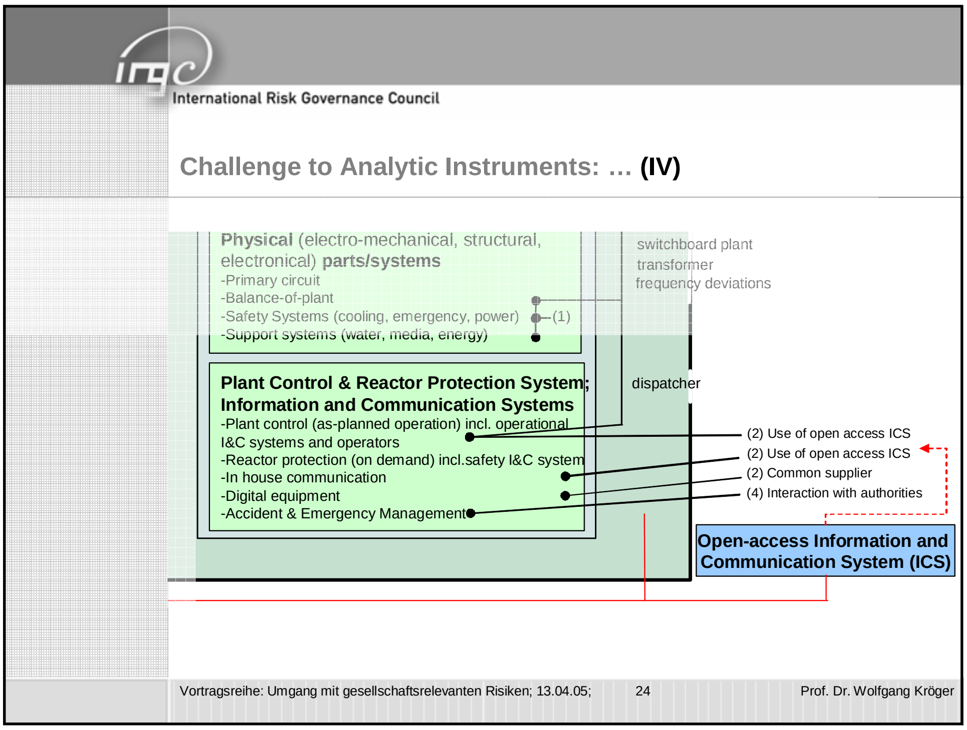
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Challenge to Analytic Instruments: … (IV)
Physical (electro-mechanical, structural, electronical) parts/systems
-Primary circuit
-Balance-of-plant
-Safety Systems (cooling, emergency, power)
-Support systems (water, media, energy)
(1)
switchboard plant
transformer
frequency deviations
Plant Control & Reactor Protection System; Information and Communication Systems
-Plant control (as-planned operation) incl. operational I&C systems and operators
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Preliminary Conclusions - Based on Executive Summary (Drafted by Principal Investigators) (I)

- New risks are confronting the European electricity systems (partly new in nature); assumption of complete reliability unfounded:
  - ❑ Terrorism, cyber attacks (new kind of common mode initiating events / failures)
  - ❑ Cascading blackouts as a result of minor technical failures due to stressed operational state and growing complexity of the system
  - ❑ Discouragement of investment in generation and transmission capacity
  - ❑ Socially optimal fuel mix which may result in market distortions (as well as liberalization with different speeds)

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Preliminary Conclusions - Based on Executive Summary (Drafter by Principal Investigators) (II)

- Changes / trends are making European electricity systems more vulnerable, e. g.
  - ❑ Liberalization under the constraints of distributed control (while an adequate response to a contingency requires relatively fast, centrally coordinated action)
  - ❑ Internationalization which presses additional challenge to contingency management (large differences to jurisdictions, technologies and economics at countries‘ level still exist)
  - ❑ Evolutionary unsuitability (systems used in ways not initially designed for, stability problems due to decentralized units with stochastic, rapid operational changes (e.g. wind power))
  - ❑ Ubiquitous application of modern (digitalized) IC-technology at the level of switches up to operational network control (new opportunities and vulnerabilities incl. malicious attacks)

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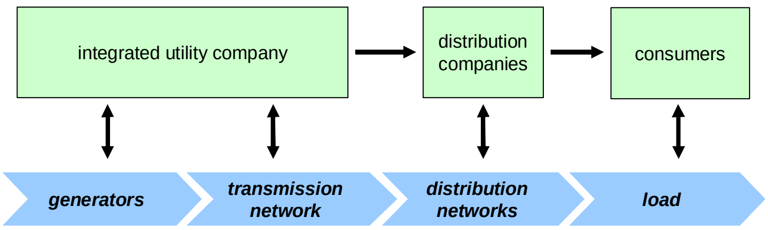
The organizational structure of the electricity system before liberalization



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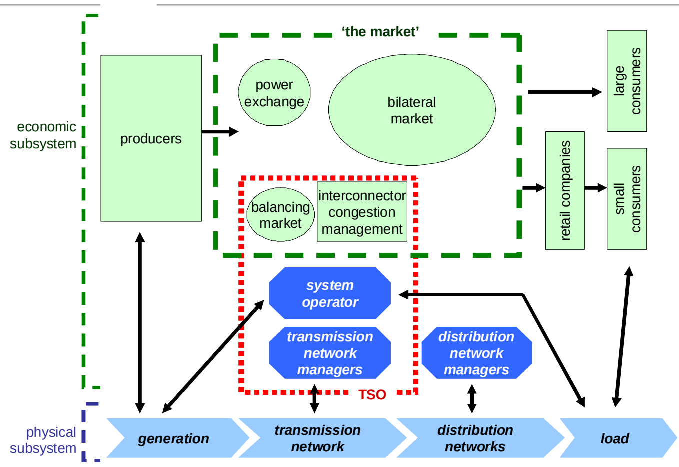
The organizational structure of a liberalized electricity system (decentralized model)



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Preliminary Conclusions - Based on Executive Summary (Drafter by Principal Investigators) **(III)**

- Traditional methods of risk management insufficient to cope with new challenges
  - ❑ Need for new form of decision making at many different levels (among various actors); discussions at the Florence Forum not sufficient
  - ❑ Protection strategies and contingency defense plans outdated (e.g. N-1 criterion and application, management of security issues)
  - ❑ Insufficient R&D; lack of research and model development at level of highly integrated, interdependent systems

⇨ Need for risk governance approach (partnership of public and private actors)