Transmission Management

An International Review

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1st November 2011

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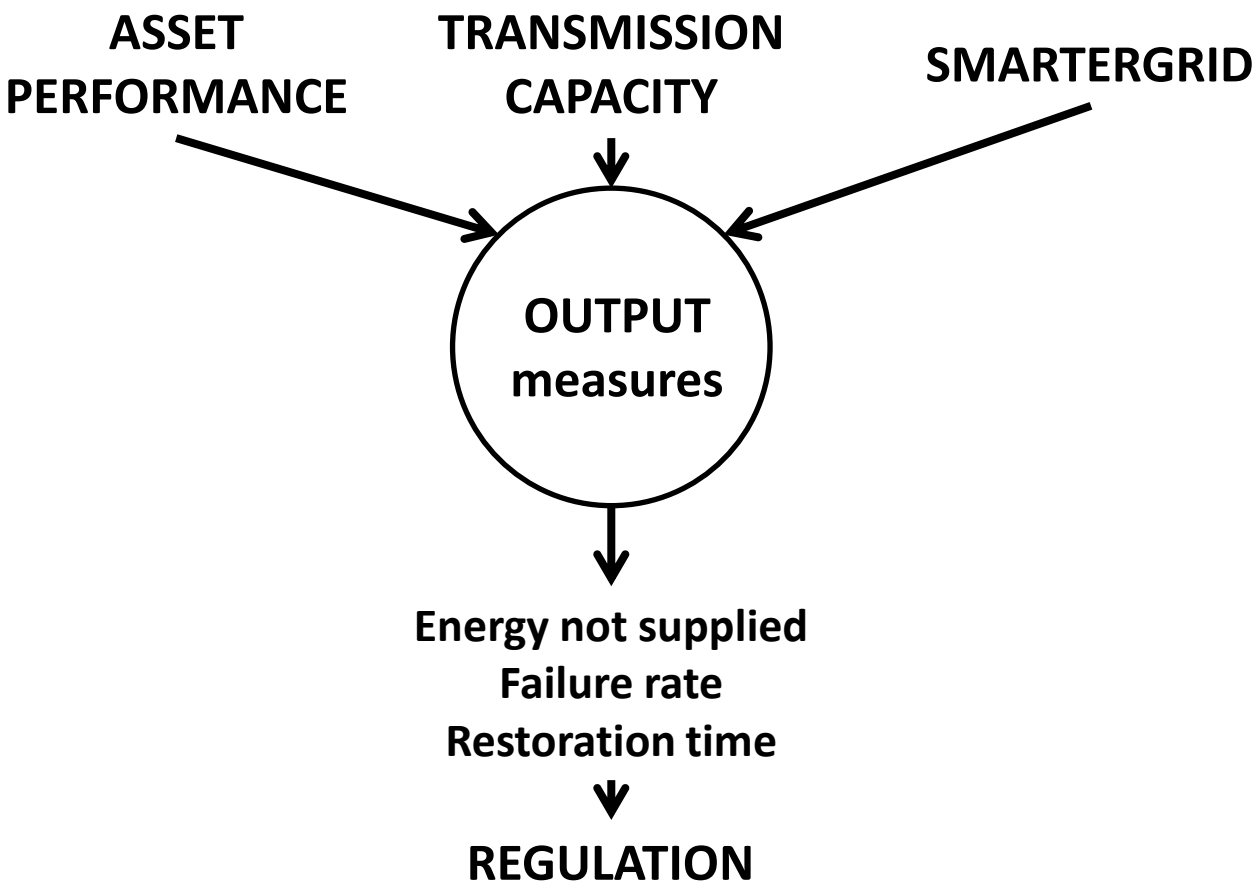
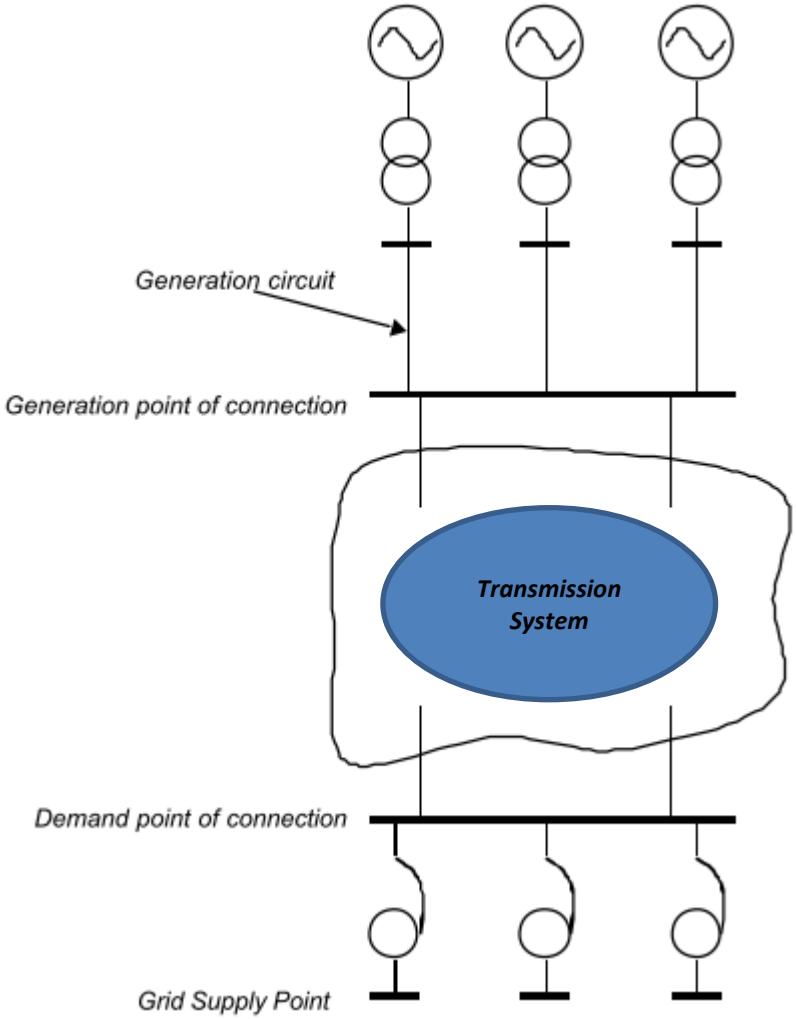
Asset Management Activity



Power System



Transmission Capacity

Adequacy

- Enough transmission and distribution assets
- Steady state

Security

- Ability of the system to cope with sudden disturbances (e.g. line faults, asset failure, load disconnection, disconnection of power plants, RES)

Security Criteria – International Review

- **Main Interconnected Transmission Network**
  - **Deterministic N-1 or N-2 criterion commonly used**
  - **No load loss, technical compliance**
  - **Cost/benefit to identify economic investment**
  - **Periodic check that provides correct economic solution**
- **Other parts of Transmission Network**
  - **Probabilistic criterion commonly used**
  - **Cost of unsupplied energy**
  - **Recovery time**
  - **Losses**
  - **Ancillary service costs**
  - **Congestion**
  - **CAPEX**
  - **Economic cost/benefit analysis**
- **Low probability but high impact events**
- **Peak and maintenance conditions**

Security Criteria – International Review

- **Generation Connection**
  - Frequency control policy (output measure)
  - Frequency response generation
  - Low frequency/voltage load disconnection
- **Demand Connection**
  - Customer service level (output measure)
  - Restoration time
  - Failure rate
  - Energy not supplied

Security Criteria – International Review

Network Contingencies

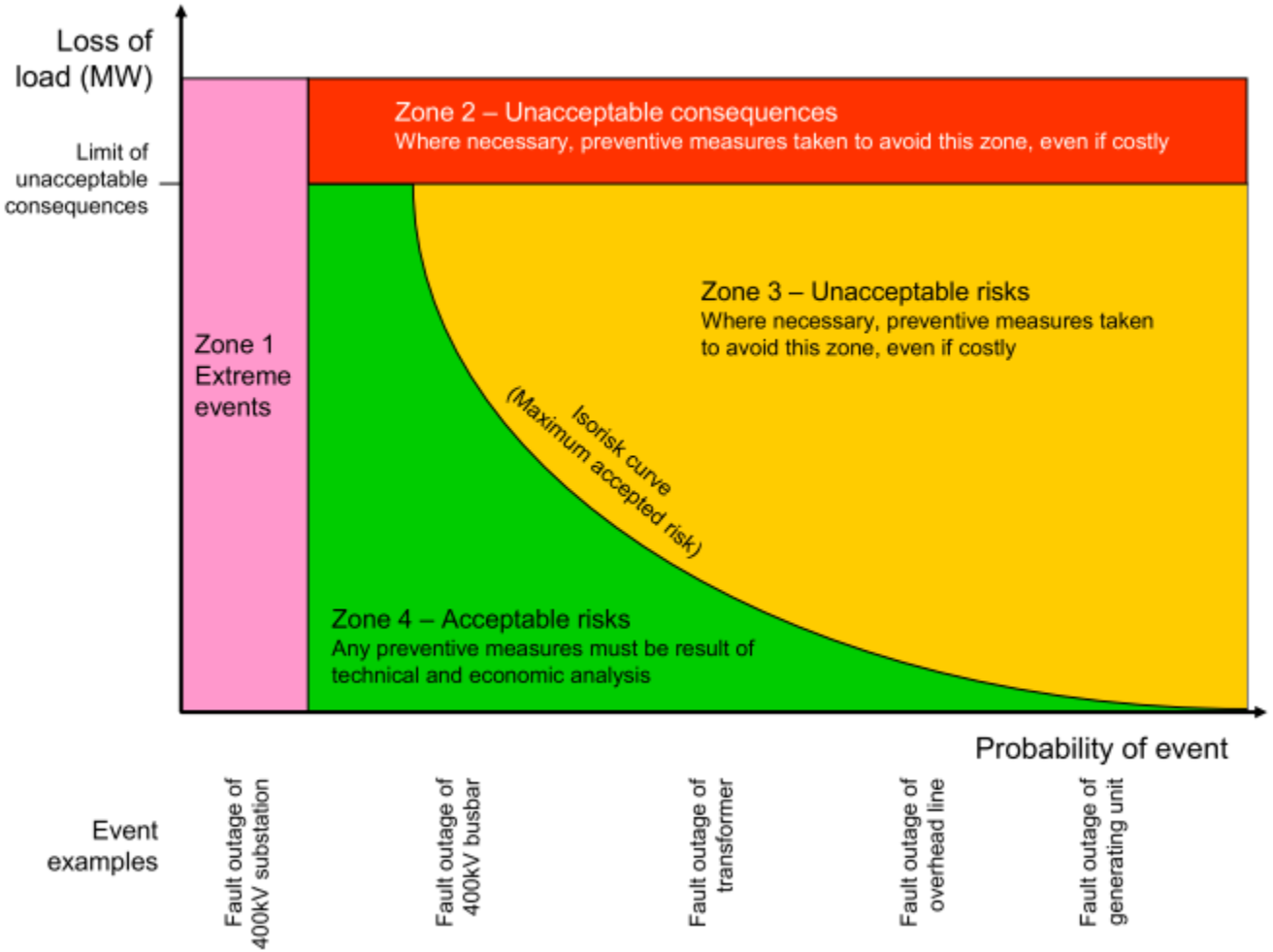
- Any asset in main transmission network
- Any generation connection asset
- Any demand connection asset
- Asset reliability – international benchmark (ITOMS)

Security Criteria – Combined Deterministic-Probabilistic Approach

- **Satisfies deterministic criteria but quantifies risk**
- **Network required to meet a**
  - **- deterministic criterion and**
  - **- probabilistic risk criterion**
- **Risk assessment process commonly used in industry**
- **Provide an output measure for main interconnected transmission network**

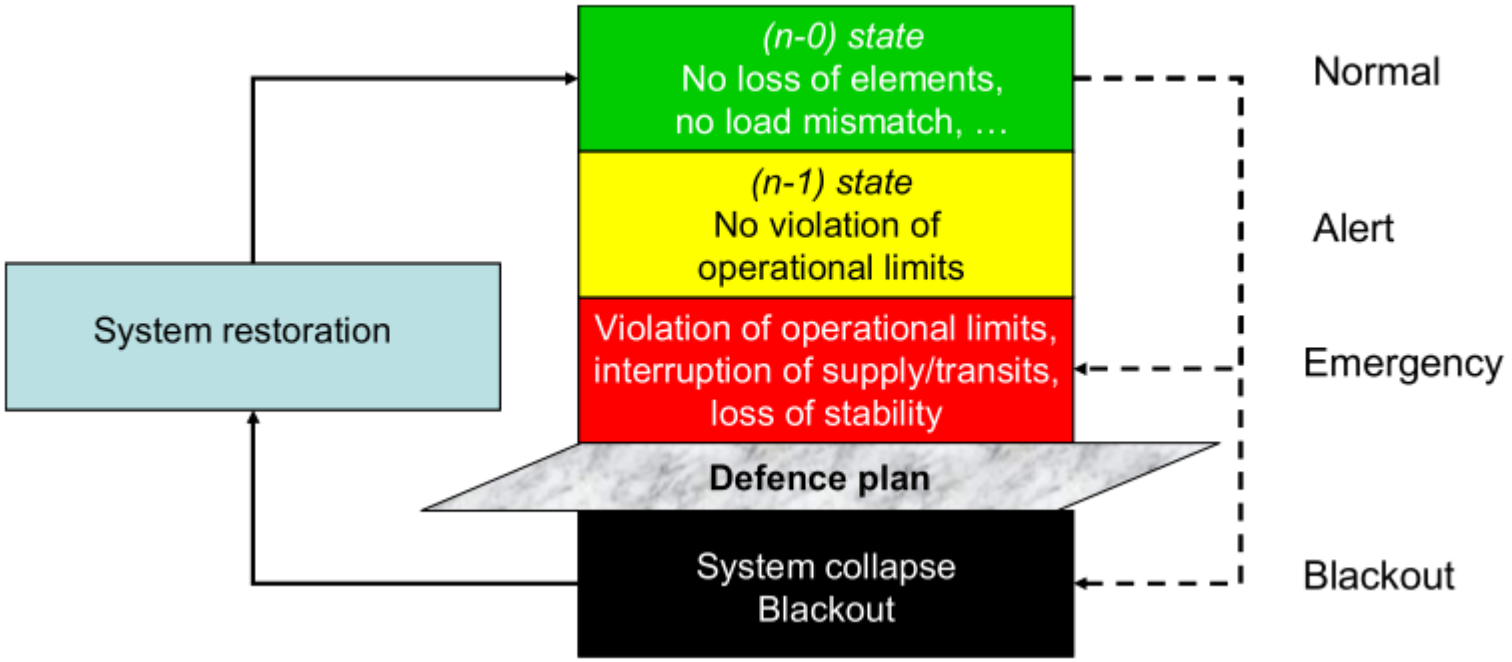
Reference: A Joint Deterministic-Probabilistic Approach to Bulk System Reliability Assessment. Roy Billinton et al

Transmission Capacity - Risk Assessment



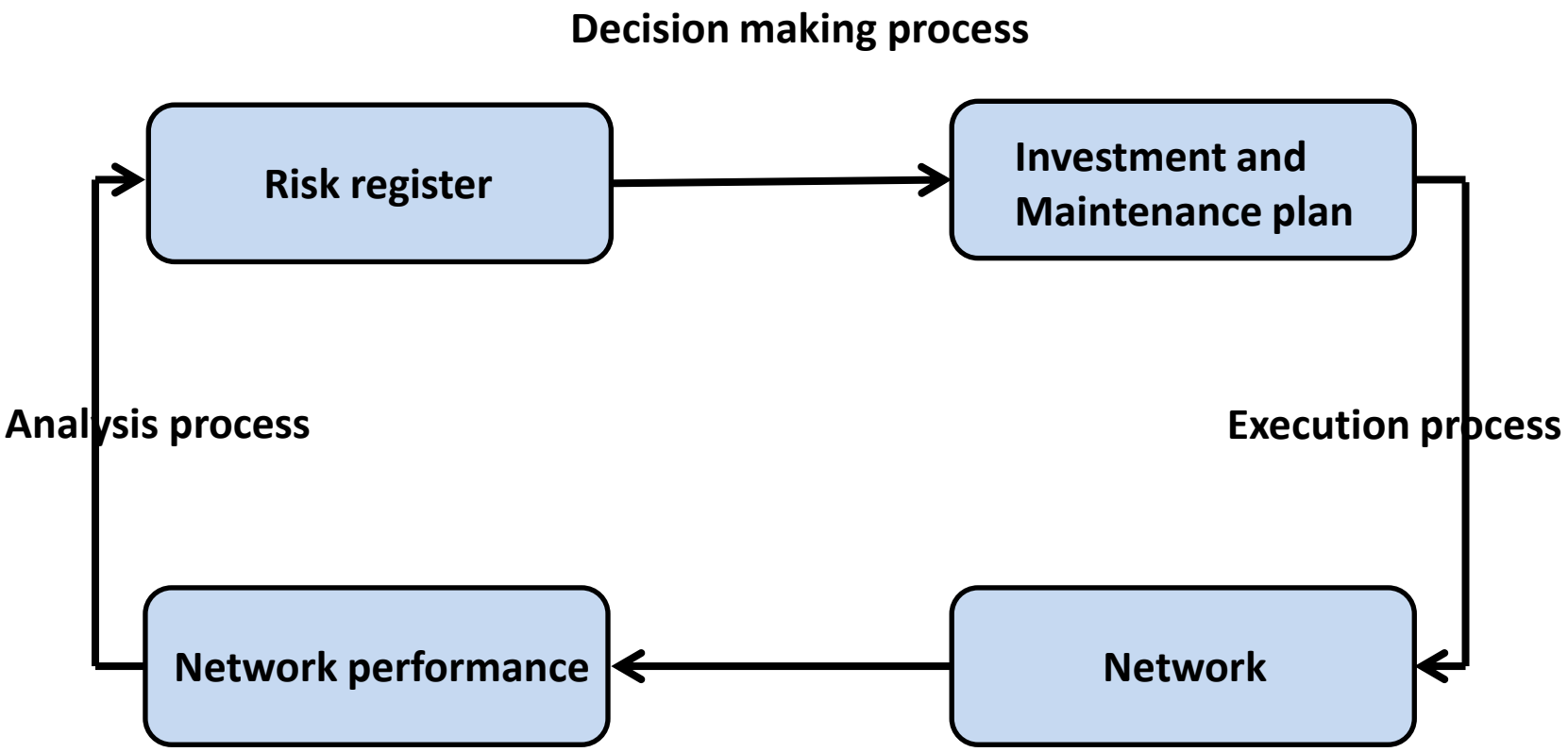
Source: CIGRE WG C1.17 Planning to Manage Power Interruption Events

System States



Source: CIGRE Report WG C1.17 Planning to Manage Power Interruption Events

Risk Management Cycle



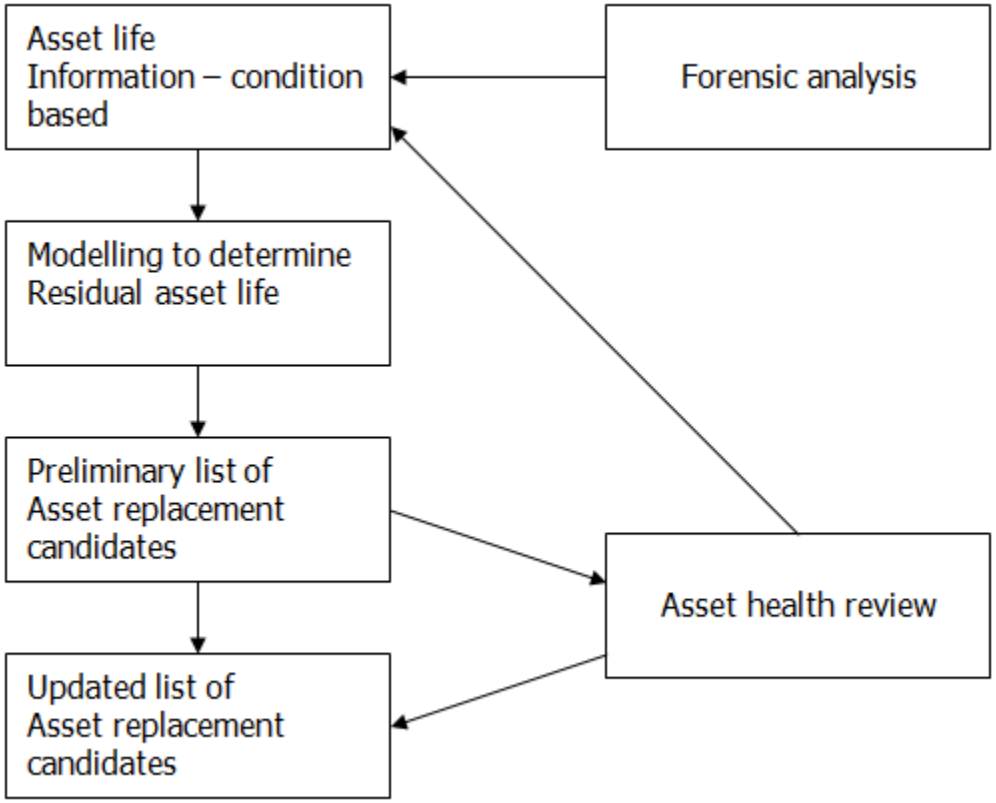
Source: CIGRE WG C1.16 Transmission Asset Risk Management

Asset Management

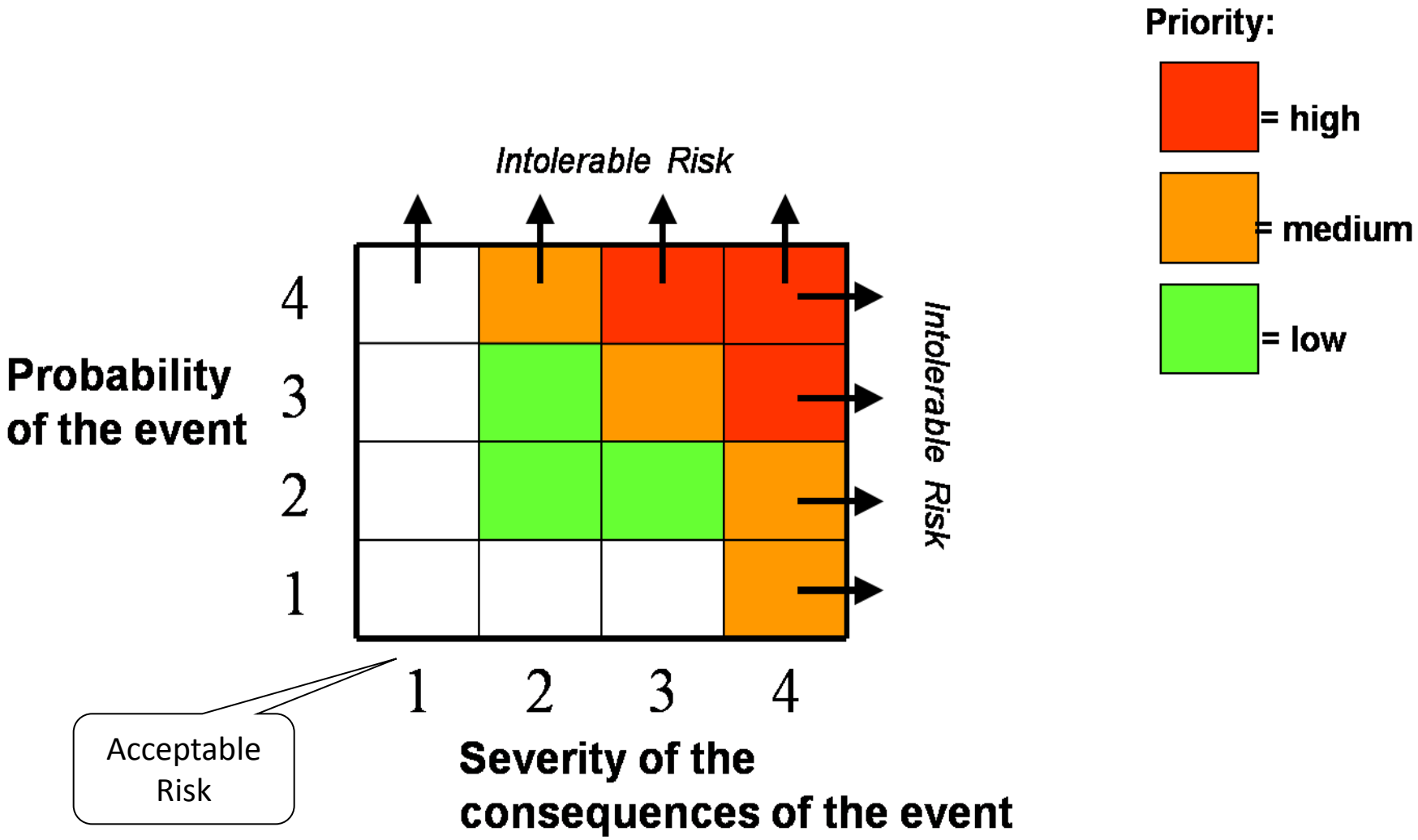
Level	Time frame	Focus by relevant manager
Strategic	Long-term	Link company key performance indicators with asset management policies and facilitate the approval of tolerable risk levels/criteria at the corporate level
Tactical	Medium-term	Optimising and justifying investment decisions and coordinating short- and long-term asset management plans and budgets
Operation	Short-term	Optimising the allocation of budget in the short-term and coordinating funding with service providers to maximise efficiency and benefit

Source: CIGRE WG C1.16 Transmission Asset Risk Management

Asset Condition Monitoring



Risk Assessment Matrix



Source: CIGRE WG C1.16 Transmission Asset Risk Management

Asset Management

- Decisions at the strategic, tactical, operational level
- Can be quantified – risk assessment
- Linked to company key performance indicators
- Risk management standard ISO 31000
- Asset management standard PAS 55

PAS 55:2008

- ***"Specification for the optimized management of physical infrastructure assets"***

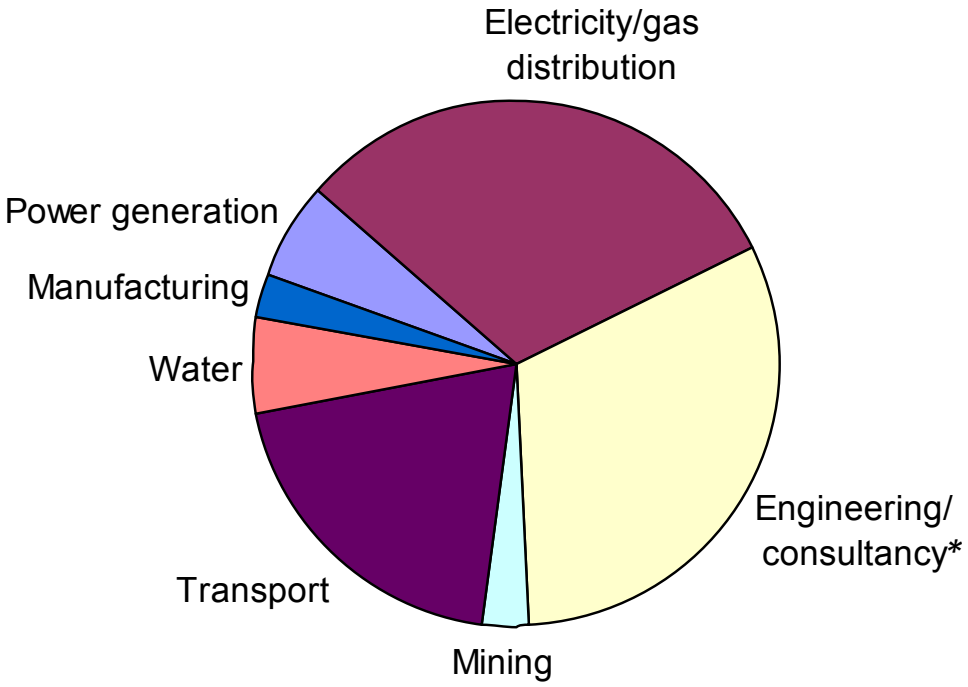
- **For the purposes of PAS 55:2008, asset management is defined as:**

  systematic and coordinated activities and practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their life cycles for the purpose of achieving its organizational strategic plan

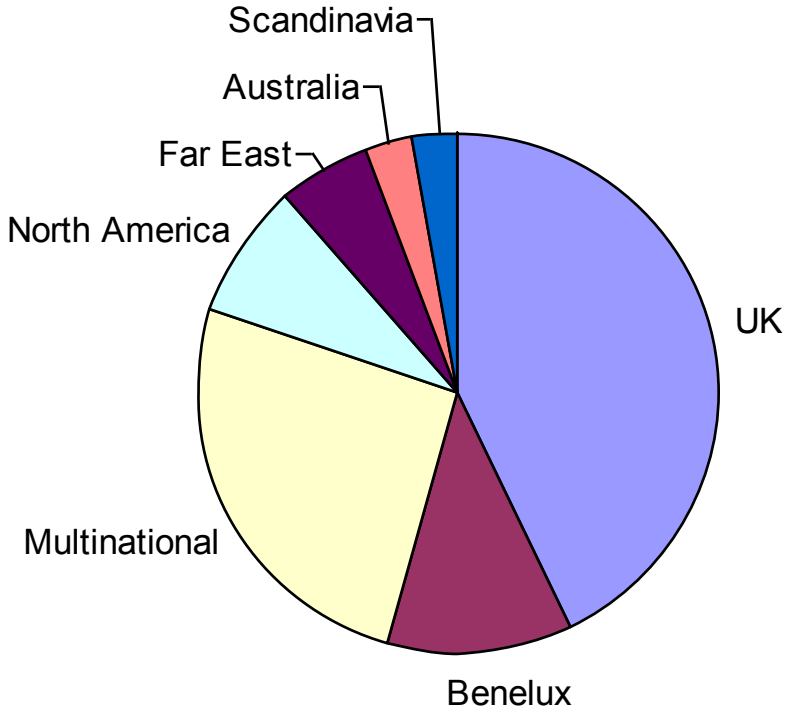
Review Panel for PAS 55:2008

49 organisations from 15 industries in 10 countries

Industry Sectors

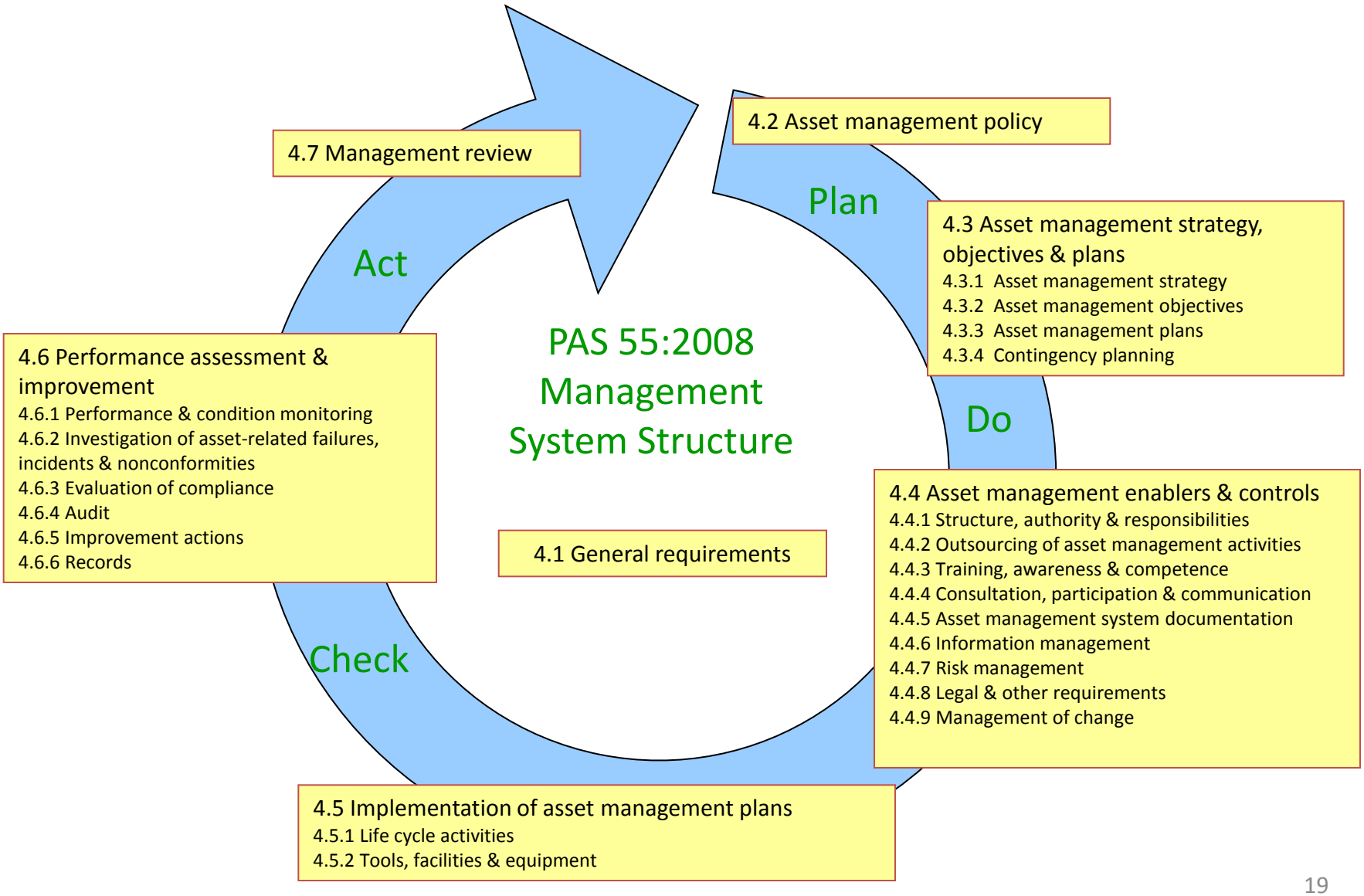


Geographical footprint



** Included construction & maintenance service providers to multi-industries*

Structure of PAS 55:2008



Development of international standard for asset management

- **September 2010**
  - ISO TMB confirms recommendation to form ISO/PC251 and develop proposed standard for asset management
- **PAS 55:2008 to used as 'base document' for drafting new standard**
- **New standard to be in 3 parts:**
  - ISO 55000: *Asset management - Overview, principles and terminology*
  - ISO 55001: *Asset management - Management systems - Requirements*
  - ISO 55002: *Asset management - Management systems - Guidelines for the application of ISO 55001*

Countries involved in ISO/PC251 as Participants or Observers

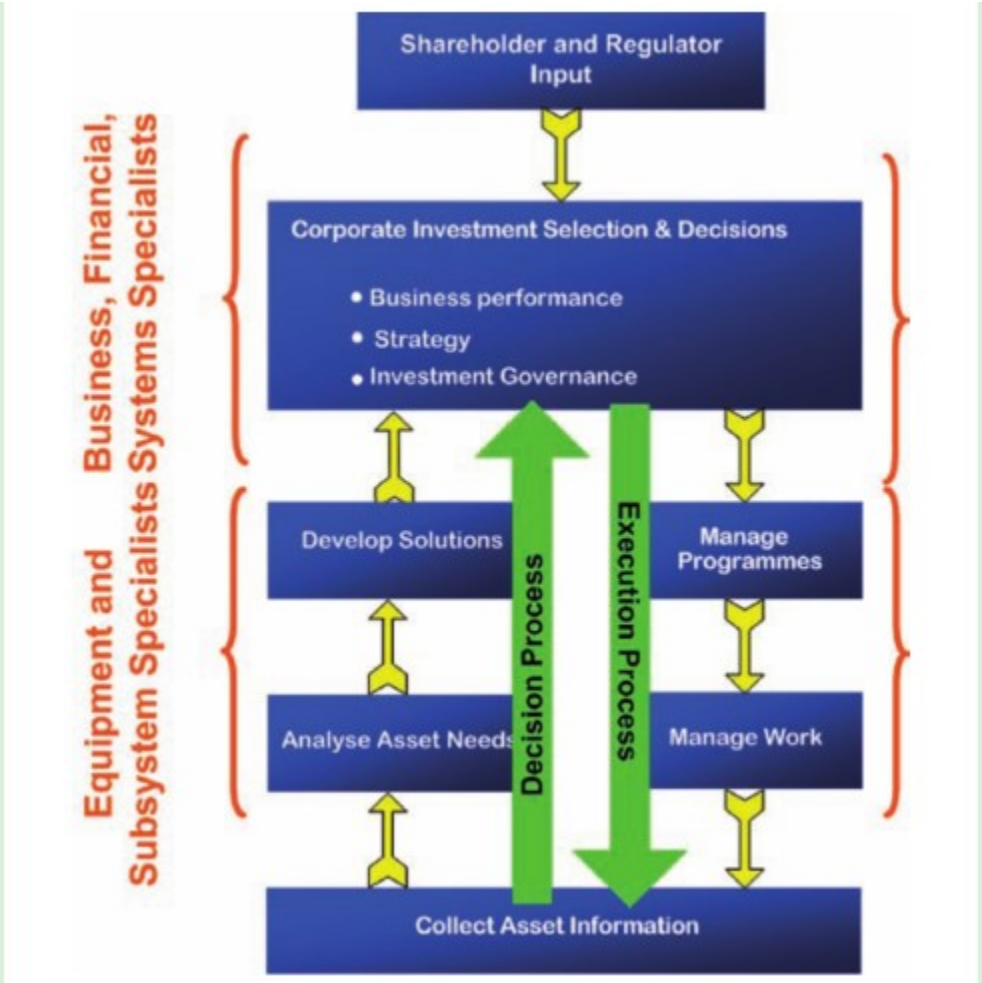
ISO/PC251 Participating Members

1. Argentina
2. Australia
3. Canada
4. Czech Republic
5. Denmark
6. Finland
7. Germany
8. India
9. Ireland
10. Italy
11. Republic of Korea
12. Netherlands
13. Mexico
14. Peru
15. Portugal
16. South Africa
17. Spain
18. Sweden
19. United Kingdom
20. United States of America
21. United Arab Emirates
22. Japan
23. France
24. Switzerland

ISO/PC251 Observer Members

1. Armenia
2. Austria
3. Belgium
4. Hong Kong
5. Iraq
6. Israel
7. Malaysia
8. Morocco
9. New Zealand
10. Norway
11. Slovakia
12. Switzerland
13. Thailand

Asset Management Business Process Model



Source: CIGRE WG C1.

What is a smart (or smarter) grid ?

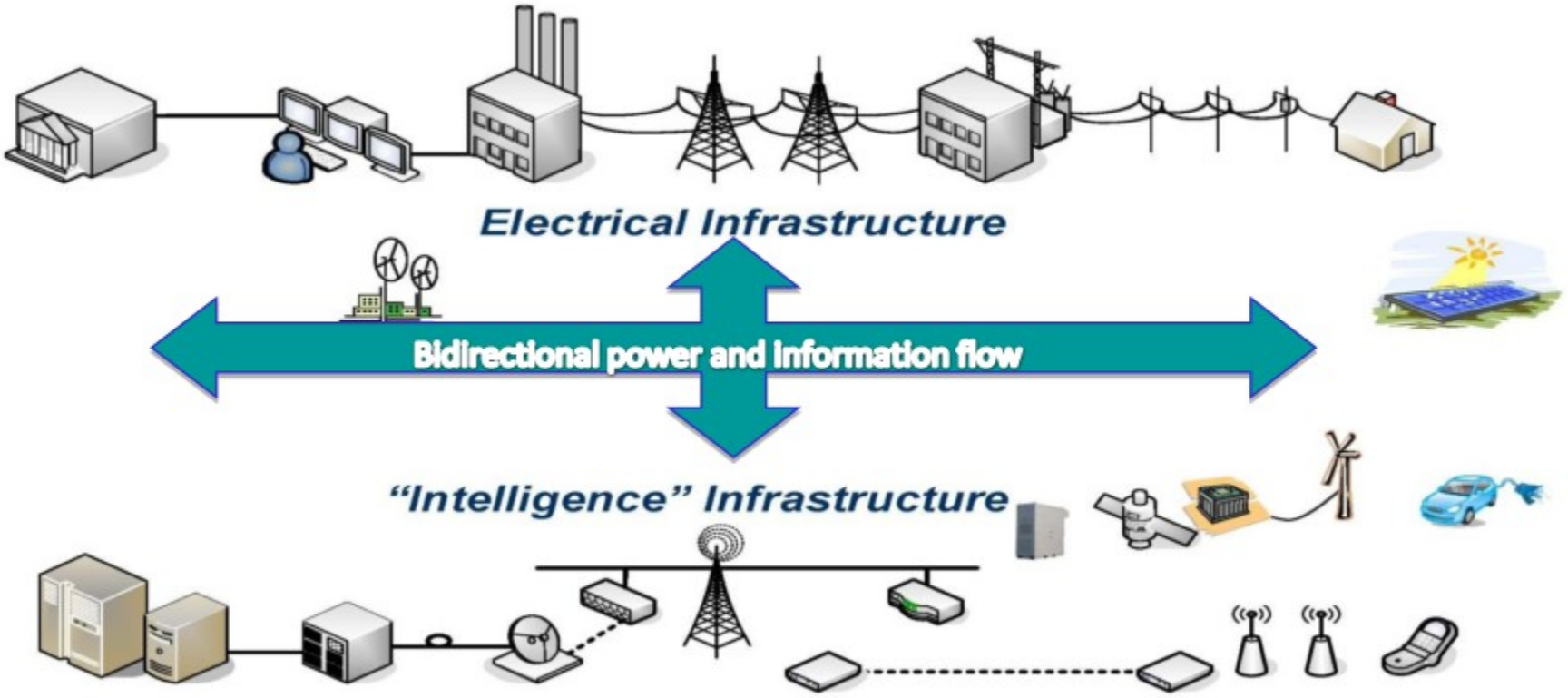
- **Definition is not easy**
  - **Wide scope**
  - **Stakeholders own vision/perspective**

- **Smart Grids European Technology Platform definition:**

"A smart grid is an electricity network that can intelligently integrate the behaviour and actions of all users connected to it (generators, consumers and those that do both) in order to efficiently deliver sustainable, economic and secure electricity supplies. A smart grid employs innovative products and services together with intelligent monitoring, control, communication and self-healing technologies…"

- **Convergence of the three sectors:**
  - **energy, communication infrastructures and information technology…**
  - **To achieve sustainability and efficiency**

Smarter Grid



Source: CIGRE Symposium The Electric Power System of the Future

Smarter Grid Characteristics

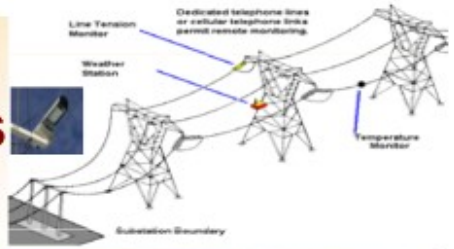
- Advanced metering infrastructure (AMI)
- Substation automation (SA)
- Distributed generation (DG)
- Accommodates wide variety of supply and demand
- Demand response (DR)
- Greater use of transmission capacity
- Self-healing
- Resilient to physical and cyber attacks
- Delivers power quality for 21st century users
- Improve energy efficiency
- Enables and supported by competitive markets

Source: CIGRE Symposium The Electric Power System of the Future

Smarter Grid – Some Approaches

Management of Power Delivery Flow and Dynamics

Dynamic Thermal Circuit Ratings

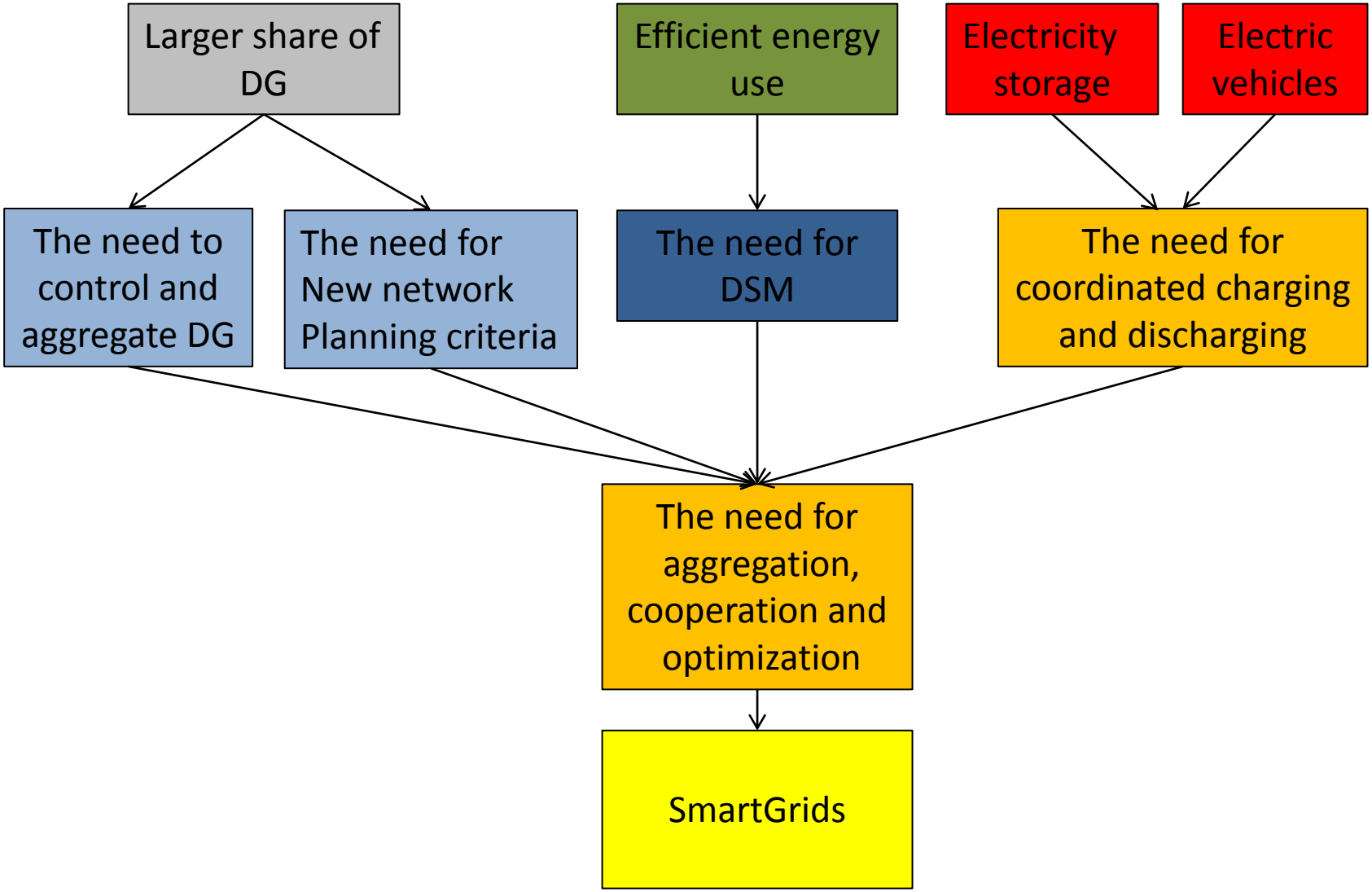


Dealing with the Root Cause not the Effects Approach

Power Electronics-based Controllers, e.g. HVDC & FACTS Technologies?? w/wo Energy Storage

Source: CIGRE Symposium The Electric Power System of the Future

The Active Distribution Network



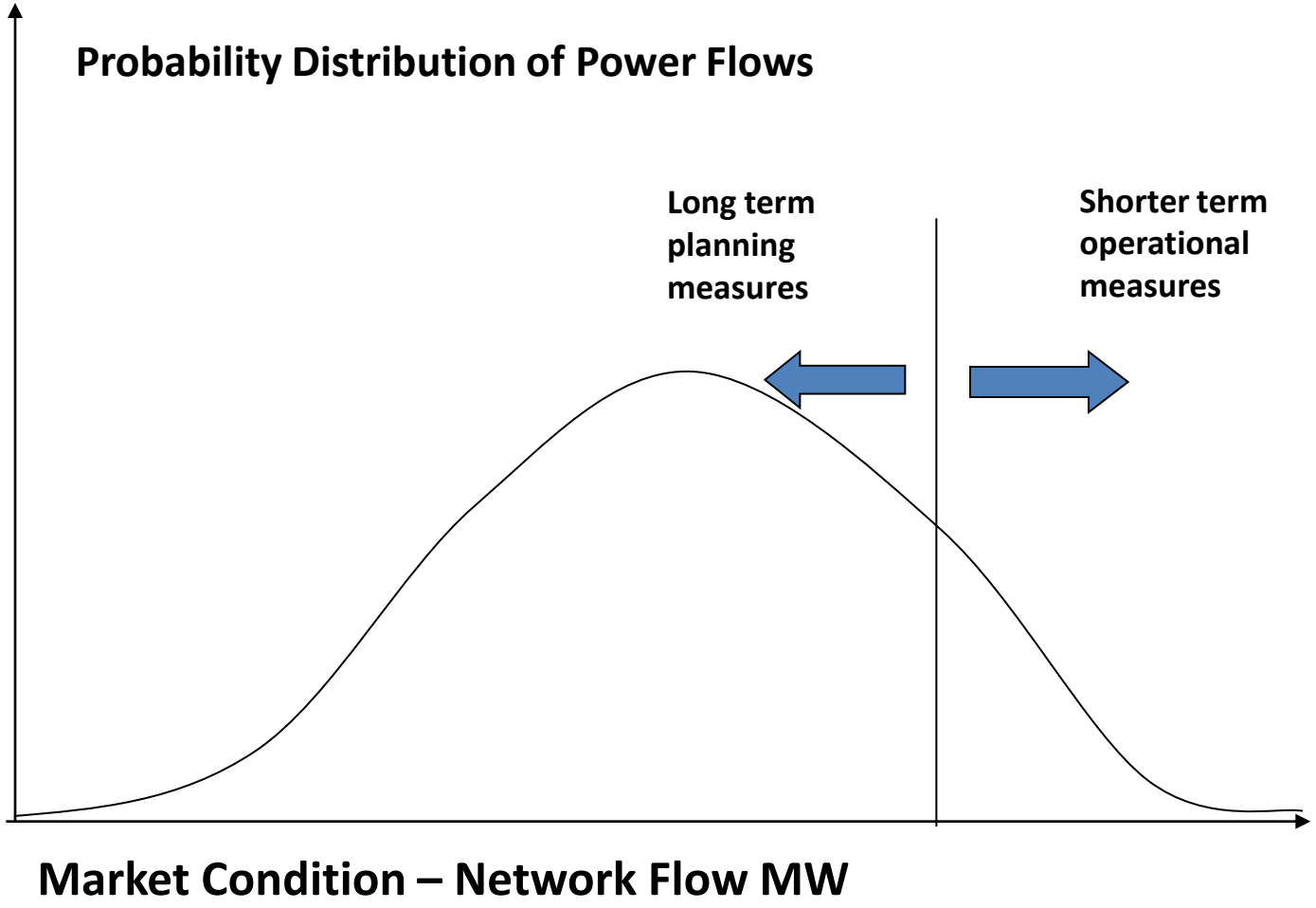
Source: CIGRE Symposium The Electric Power System of the Future

Network Planning – International Practice

Main Points

- **Markets give rise to uncertainty in future power flows**
- **Market survey essential to identify transmission capacity needed**
- **Managing power flows through combination of investment in assets and operational measures – risk analysis**
- **Long term studies undertaken linked to Government energy policy**
- **Probabilistic analysis used to gain picture of future**

Transmission Options – Risk Management



Regulation

Source: CIGRE Symposium The Electric Power System of the Future

Performance-based regulation of outputs

- A key principle of good regulation is to concentrate on outputs of the regulated entity and effects of a given activity
- Regulation of outputs can be done by:
  - direct regulation, i.e. minimum requirements for certain parameters
  - performance-based incentive regulation providing monetary rewards and penalties related to some parameters
  - benchmarking and comparative publication of performance results
- It requires:
  - **sound definitions of performance targets and indicators**, which must be available to observe, quantify and verify the regulated performance indicators, by clear and transparent measurement rules
  - performance targets strictly related to the pursued objectives and therefore **cleansed of external effects** outside the operators' control
  - **National evaluation of the best indicators** to be implemented

Source: CIGRE Symposium The Electric Power System of the Future

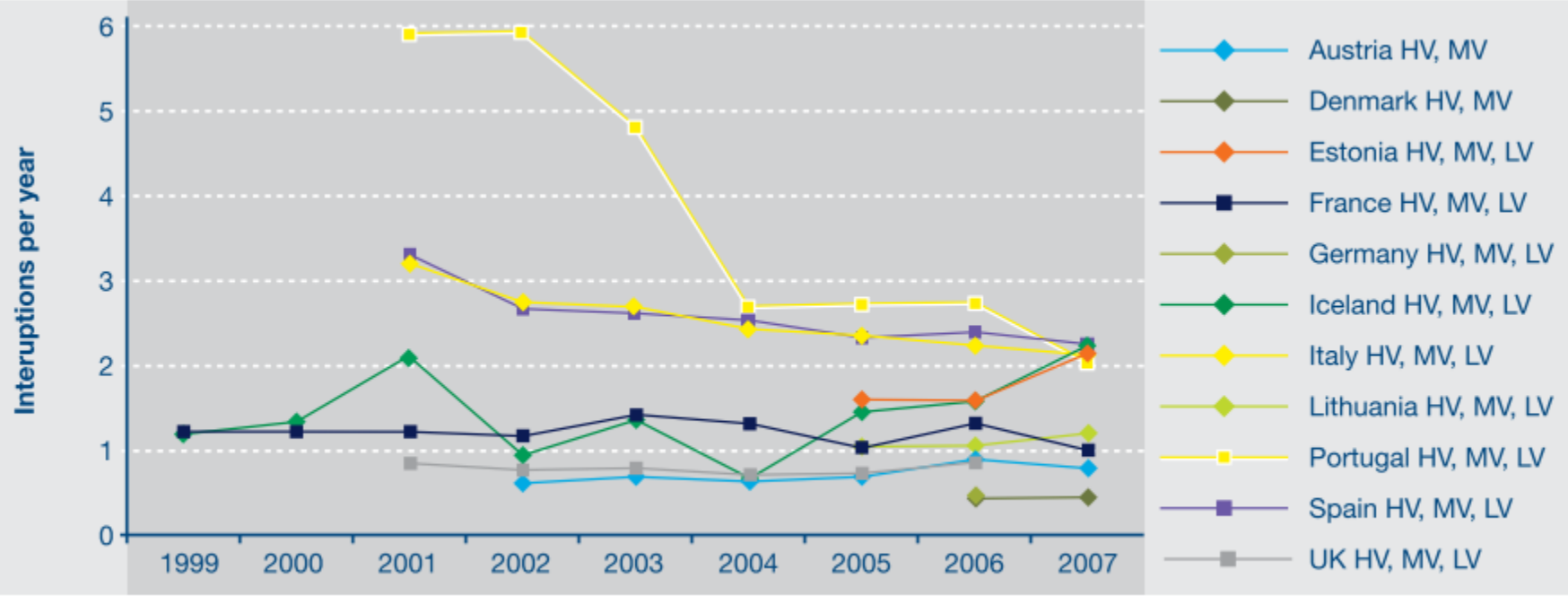
Potential performance indicators of transmission

- Quantified reductions of carbon emissions
- Environmental impact of electricity grid infrastructure
- Hosting capacity for distributed energy resources
- Energy not withdrawn from renewable sources due to congestion
- Duration and frequency of interruptions (originated in transmission networks)
- Voltage quality performance of transmission grids

- Level of losses in transmission networks
- Actual availability of network capacity
- Ratio between interconnection capacity of one country and its demand
- Exploitation of interconnection capacity
- Societal benefit/cost ratio of a proposed infrastructure investment;
- Time for licensing / authorisation of a new transmission infrastructure

Source: CIGRE Symposium The Electric Power System of the Future

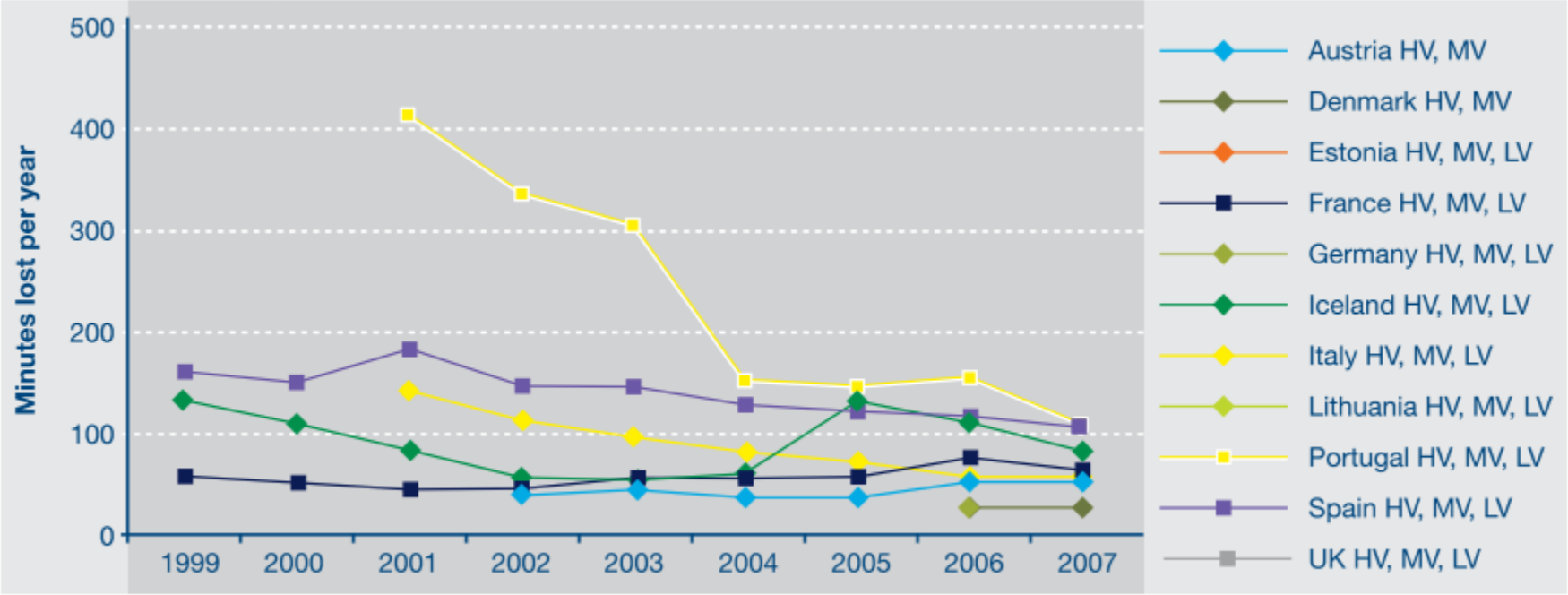
Unplanned interruptions excluding exceptional events; number of interruptions per year 1999-2007



The voltage level (LV, MV, HV) is related to where the incidents occur.

Reference: CEER report December 2008 – 4th Benchmarking Report on Quality of Electricity Supply 2008

Unplanned interruptions excluding exceptional events; minutes lost per year 1999-2007



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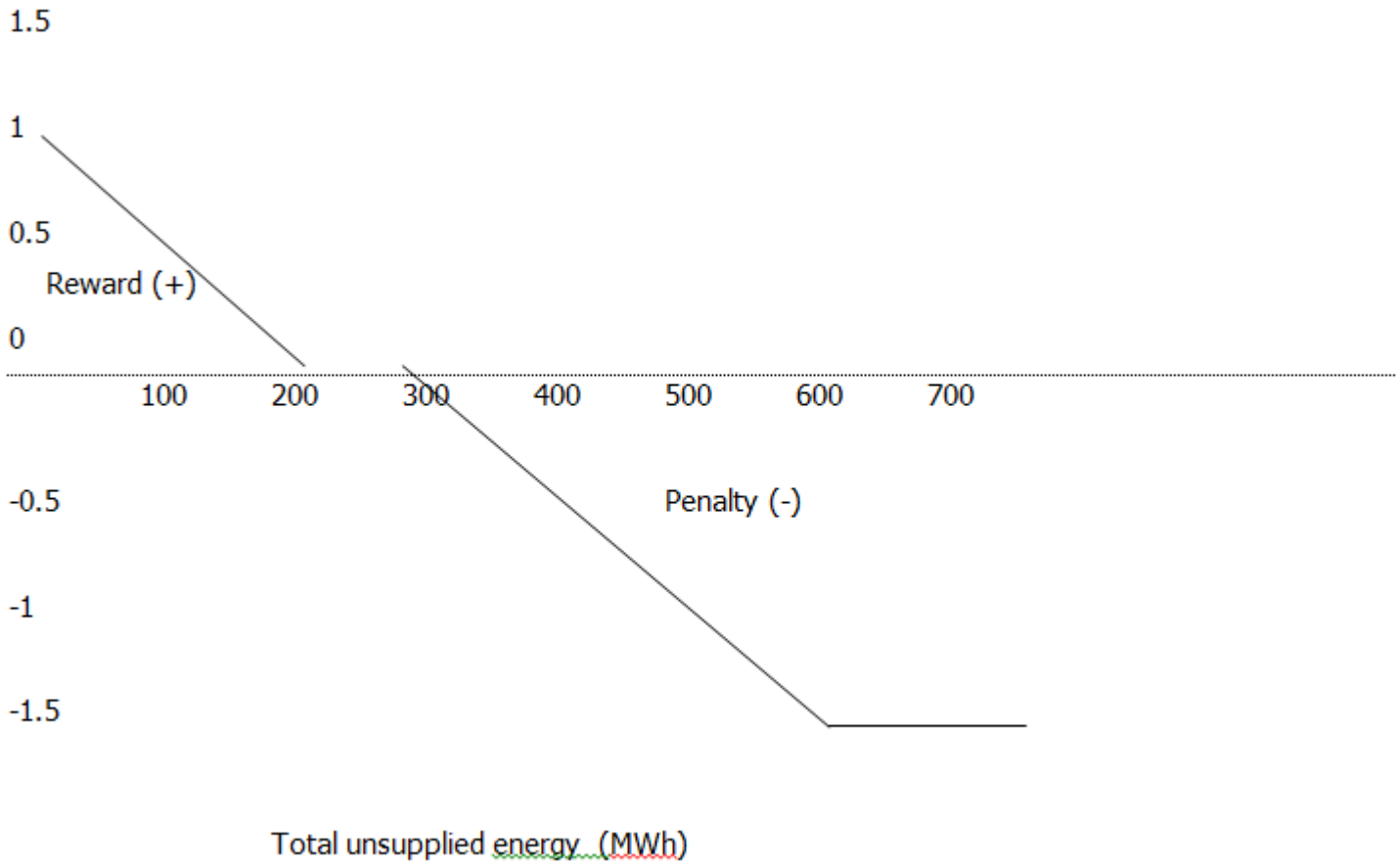
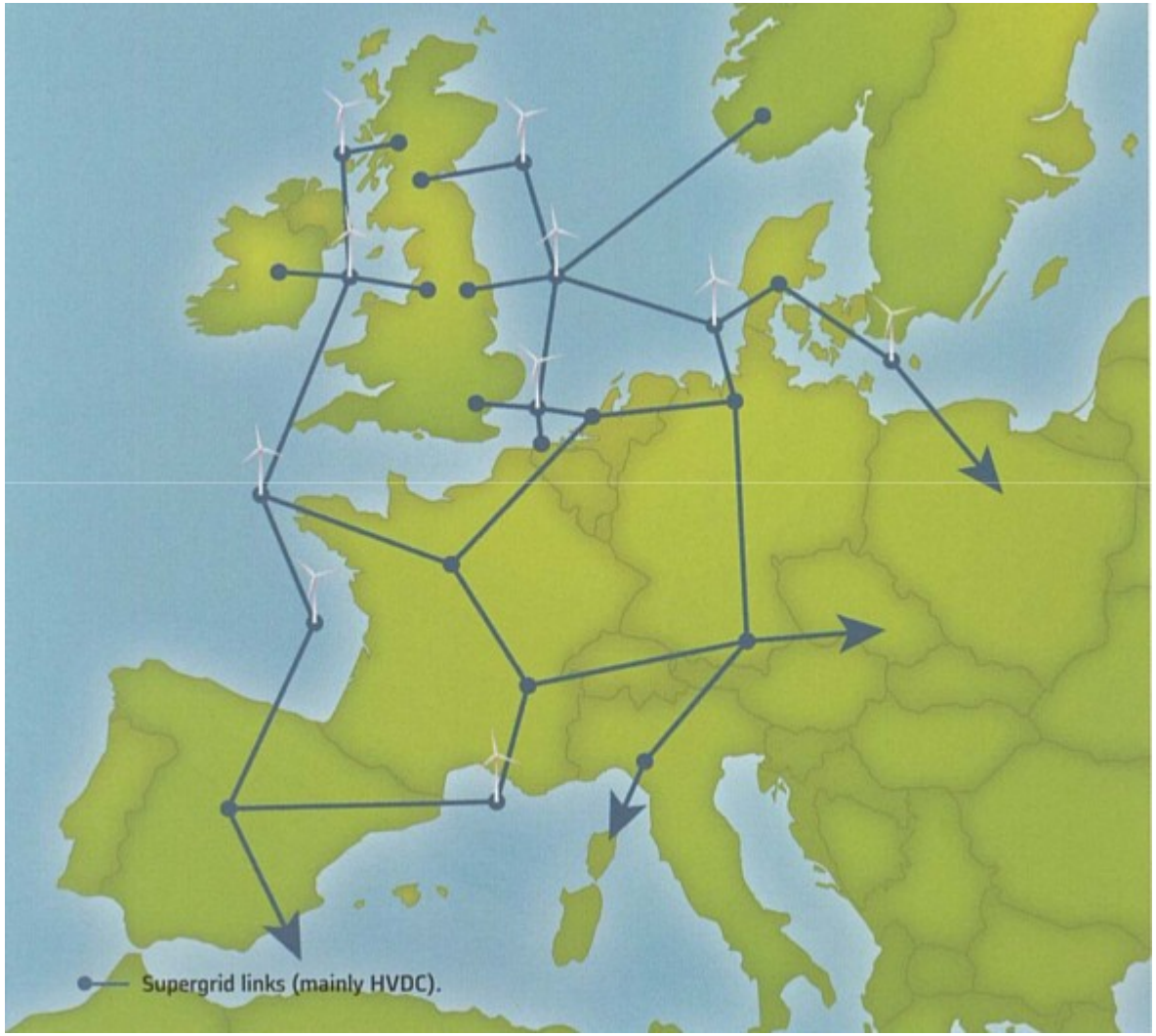
Financial Incentive Structure



The Future European Supergrid



Source: CIGRE-UK Conference: Connection of Remote Offshore Windfarms

Thank You