Session 2: Der internationale Ansatz für die Stromnetze der Zukunft - IEA ENARD

Dependencies between the Smart Development of Transmission and Distribution Grids

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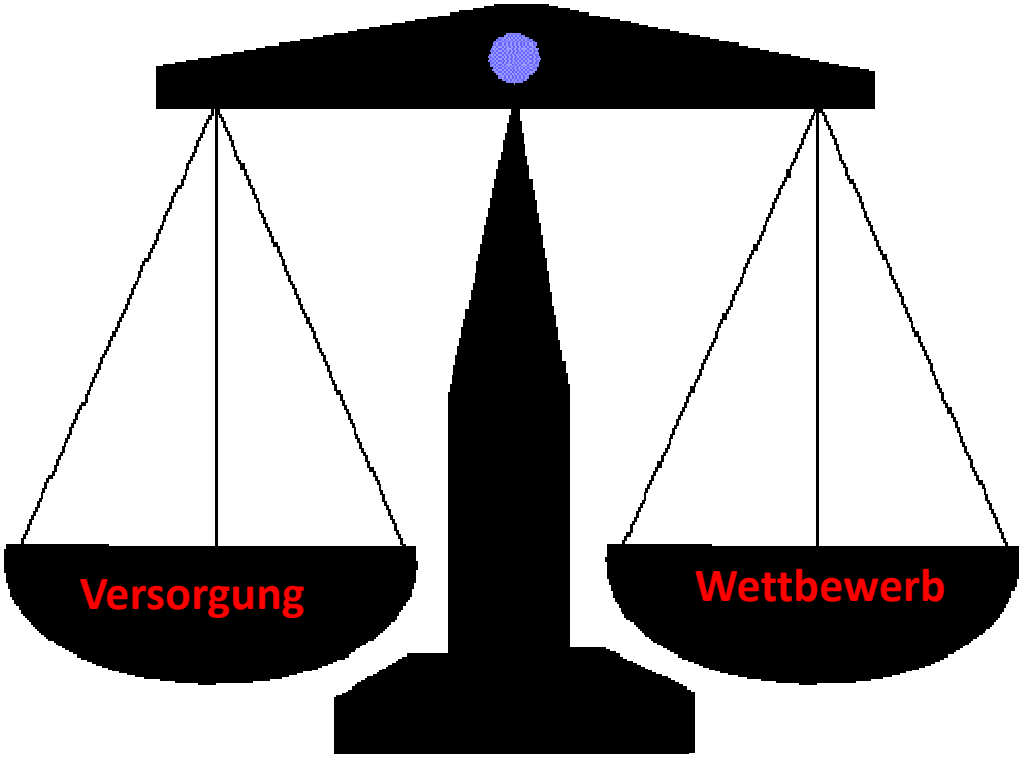
Gesetzliche Rahmenbedingungen Schweiz ab 1.1.2008: Das Stromversorgungsgesetz (StromVG)



Sichere und nachhaltige Versorgung der Endverbraucher mit Elektrizität in allen Landesteilen

Nationaler Wettbewerb und die Mitwirkung im internationalen Wettbewerb im Elektrizitätsbereich.

What does the new legal frameworks in Switzerland say? (1/2)

- Guarantee network connections
- Mandatory supply of electricity
- Tasks of network operators
- What to do when security of supply is endangered?
- Unbundling, network costing, information, billing
  - Regulated network costs
  - Network cost roll-over
  - Network tariffs
  - Cross-border network costs and payments
  - Cross-border network congestions

Cont. (2/2)

- Transmission network (operator)
  - Independence in terms of provision of security of supply
  - Tasks
- Regulator
  - Independence
  - Tasks
  - Administration costs
- In-Feed Tarif system for renewable generation

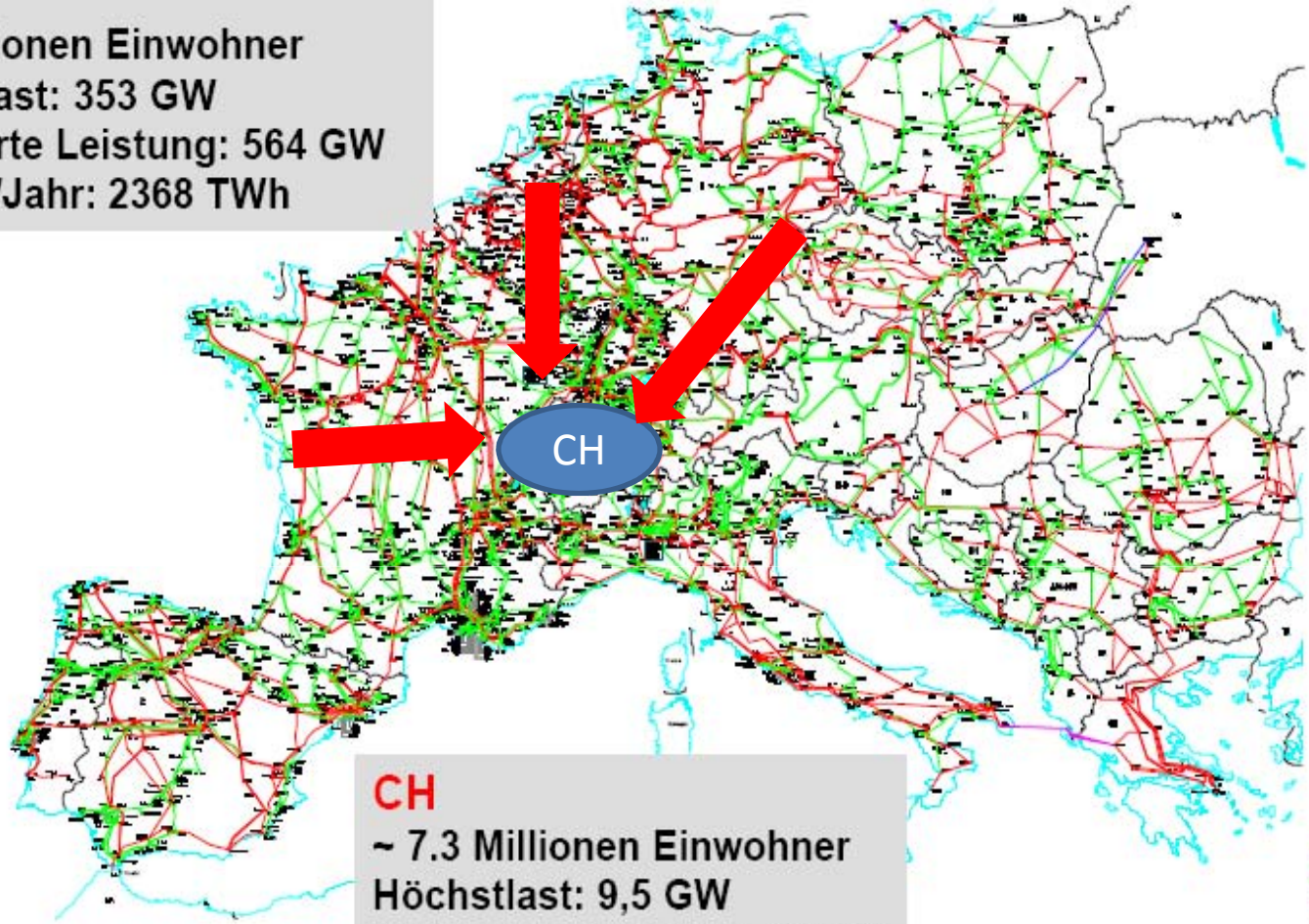
Dependencies transmission & distribution

- Security of supply
  - Generation
  - Demand
  - Grid
    - Transmission
    - Distribution
- Economical aspects
  - Costs
    - Networks
    - Subsidies for renewable generation
  - Markets for electricity

Where do we need special Intelligent Developments ?

Security of Supply

UCTE
450 Millionen Einwohner
Höchstlast: 353 GW
Installierte Leistung: 564 GW
Energie/Jahr: 2368 TWh

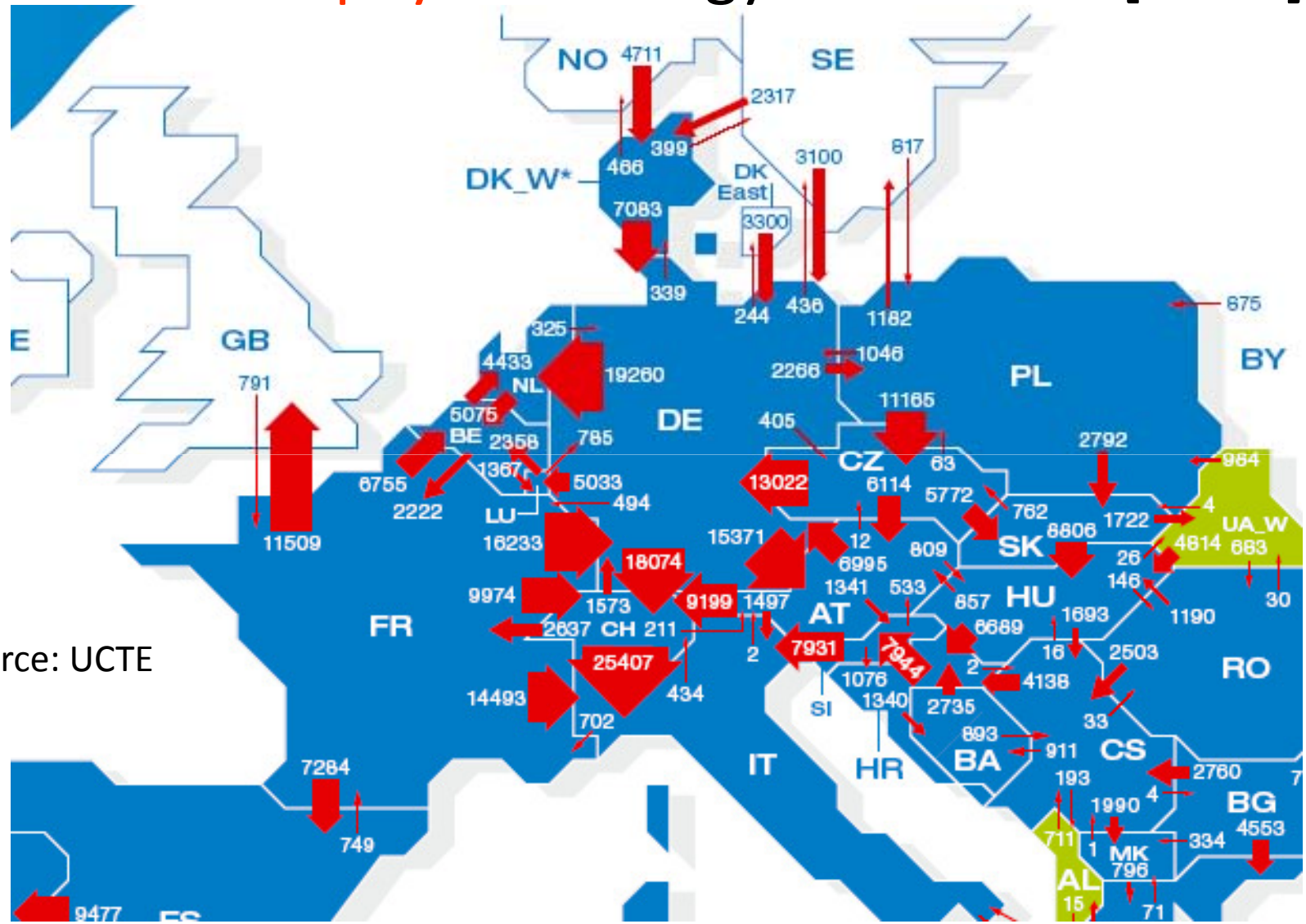


CH
~ 7.3 Millionen Einwohner
Höchstlast: 9,5 GW
Installierte Leistung: 17 GW
Energie/Jahr : 59 TWh

220 kV
380 kV

Source: swissgrid

Traditional physical Energy Flows 2005 [GWh]



Source: UCTE

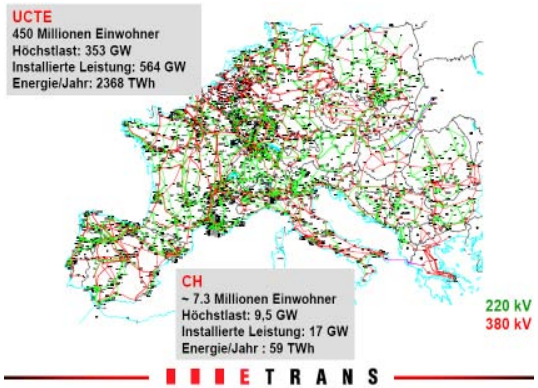
Traditional fundamentals of Transmission Grids

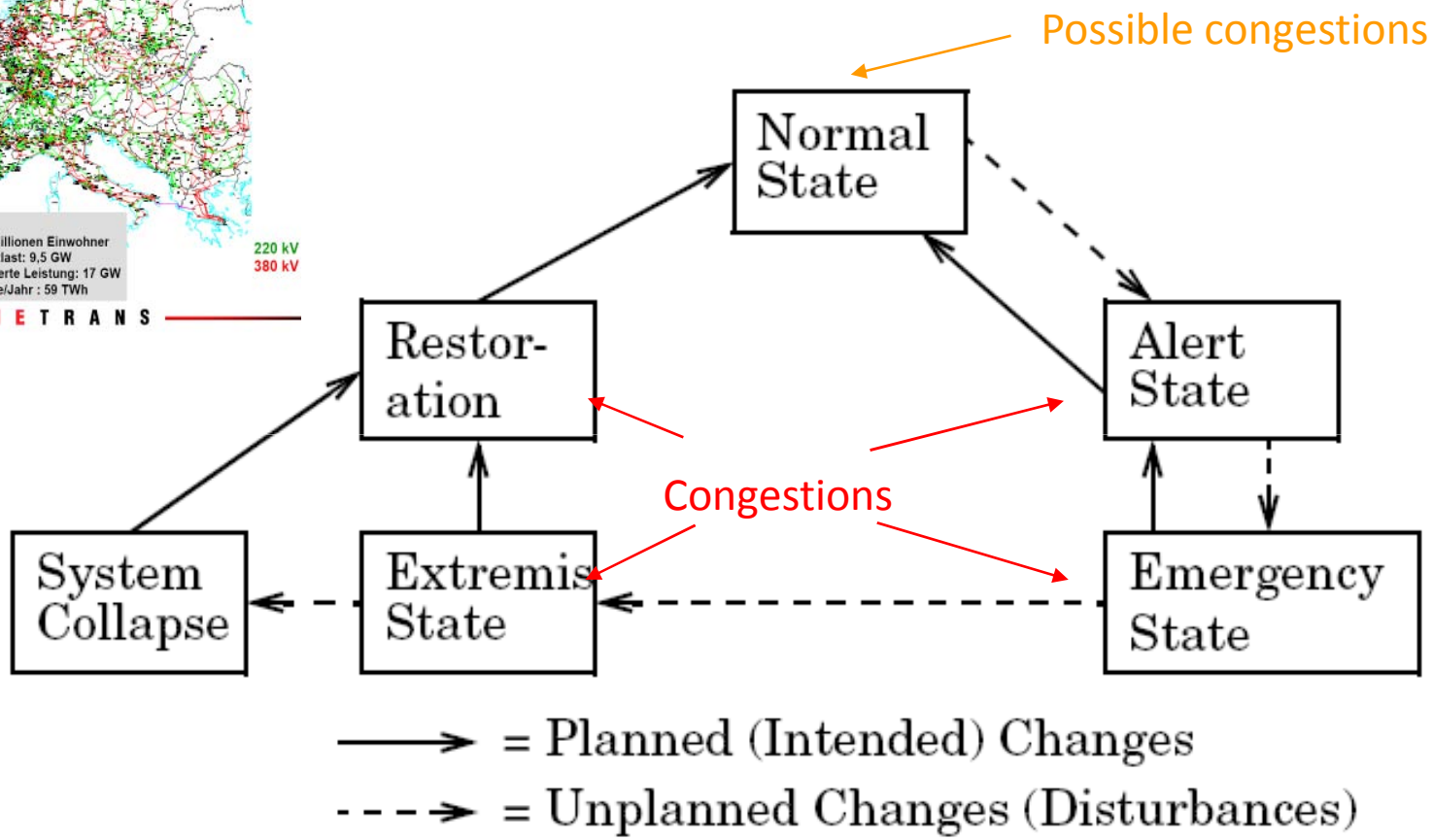
- For connections of
  - Large generations .. Wheeling masses
  - Large loads
  - Large regional transmission networks
- For transport of large amounts of electricity over longer distances
- For system properties
  - For security of supply
    - Meshed network structure
    - Double lines
  - For high voltage and dynamic stability
  - For cross-border interconnections for the sake of outage support

Traditional fundamentals of Distribution Grids

- For connections of
  - Small generations .. No large wheeling masses
  - Smaller loads
  - Any other distribution networks
- For distribution of smaller amounts of electricity over short distances
- Radial structure: For robust system properties
  - High independence from parallel networks
  - Controlled short-circuit currents
  - Controlled network capacities and costs

Electricity system states





The different operating states of a power system.

The event on 04 November 2006

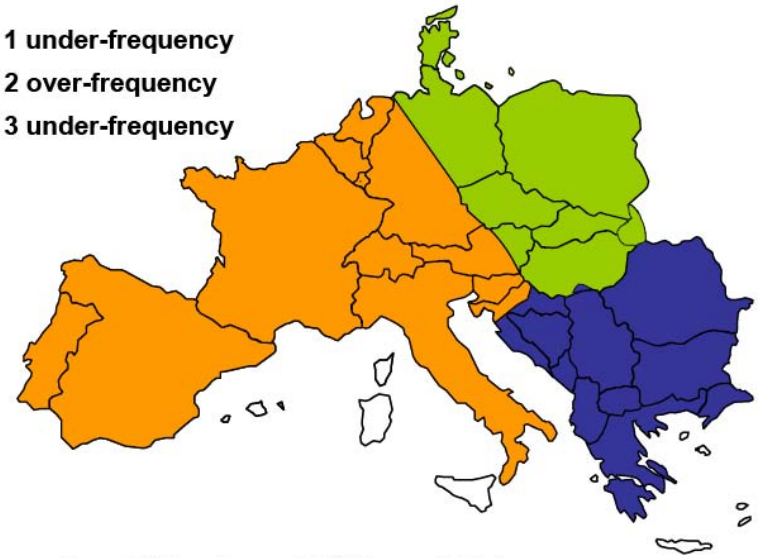
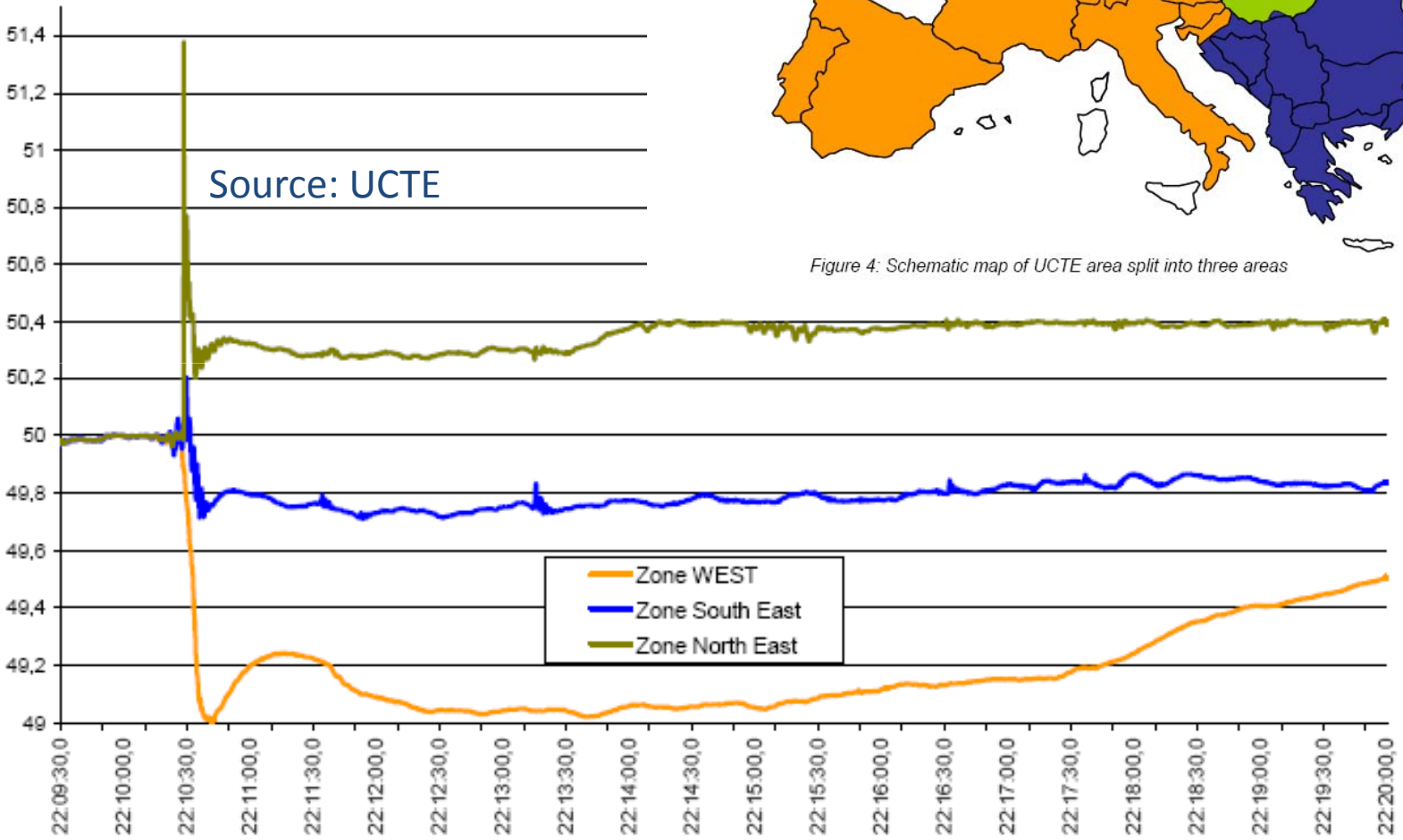
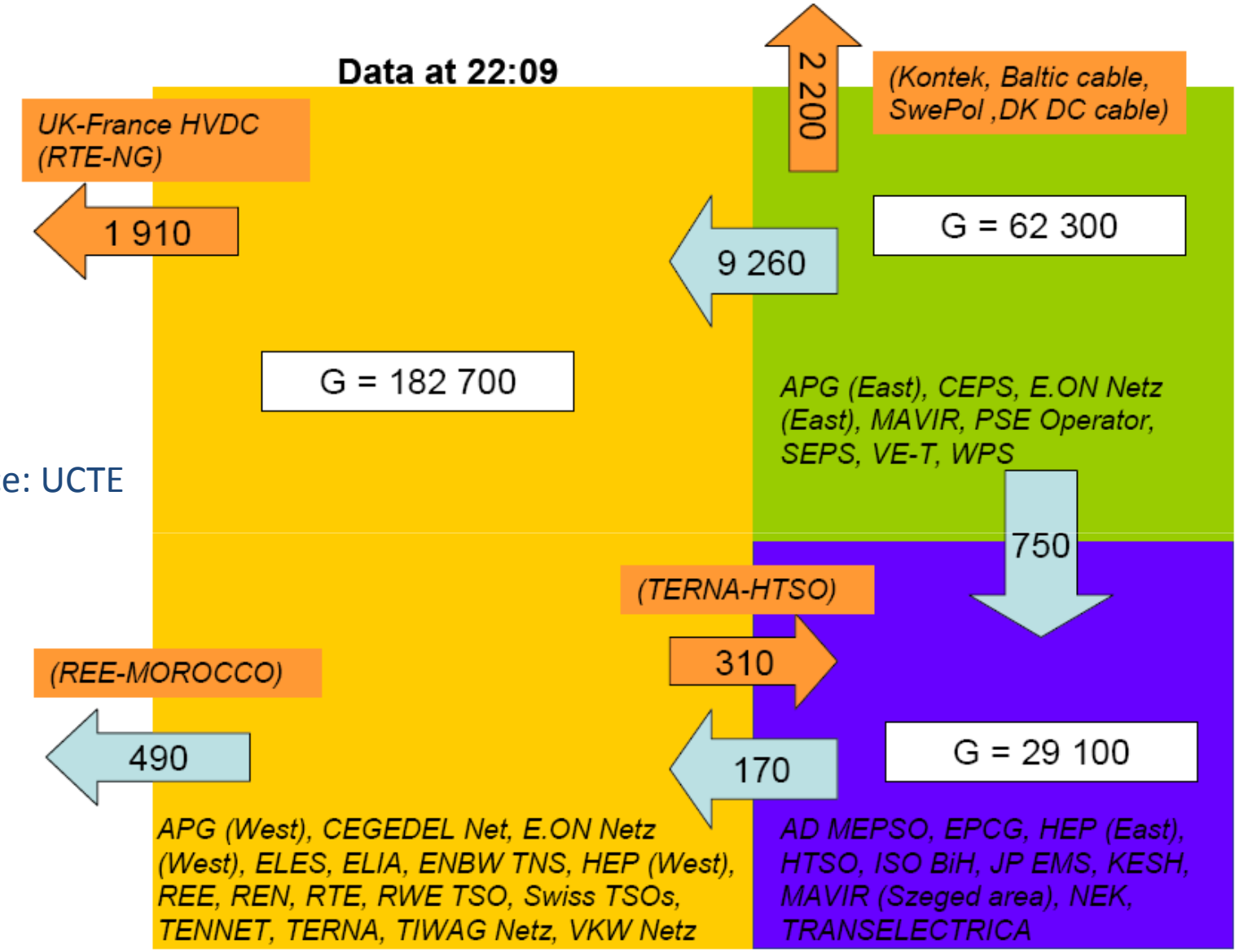


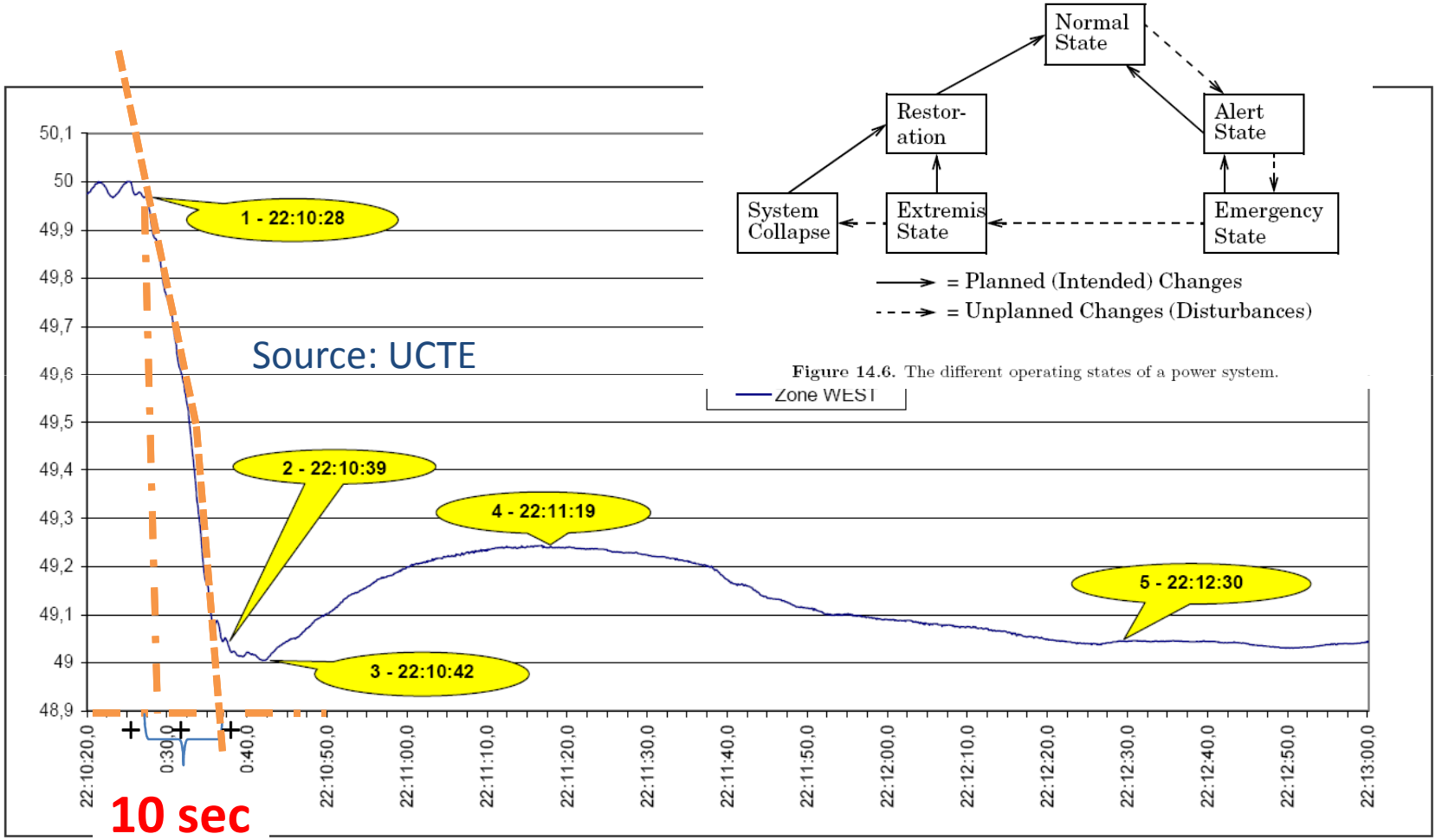
Figure 4: Schematic map of UCTE area split into three areas




Data at 22:09
2 200
(Kontek, Baltic cable, SwePol ,DK DC cable)
UK-France HVDC (RTE-NG)
1 910
9 260
G = 62 300
G = 182 700
APG (East), CEPS, E.ON Netz (East), MAVIR, PSE Operator, SEPS, VE-T, WPS
750
(TERNA-HTSO)
310
(REE-MOROCCO)
490
170
G = 29 100
APG (West), CEGEDEL Net, E.ON Netz (West), ELES, ELIA, ENBW TNS, HEP (West), REE, REN, RTE, RWE TSO, Swiss TSOs, TENNET, TERNA, TIWAG Netz, VKW Netz
AD MEPSO, EPCG, HEP (East), HTSO, ISO BiH, JP EMS, KESH, MAVIR (Szeged area), NEK, TRANSELECTRICA

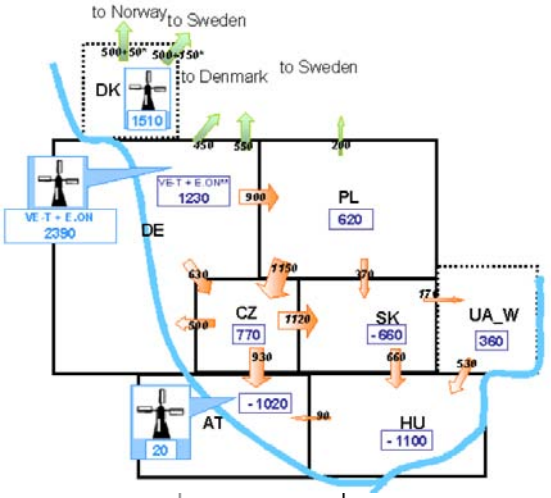
Source: UCTE

1 Hz change in 10 seconds (WE-area)



Power Output of Windmills (NE-area)

Source: UCTE



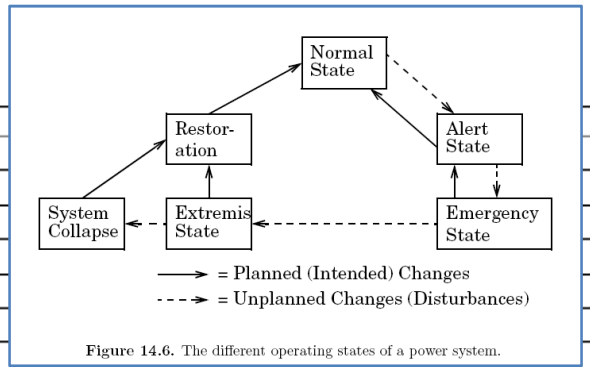
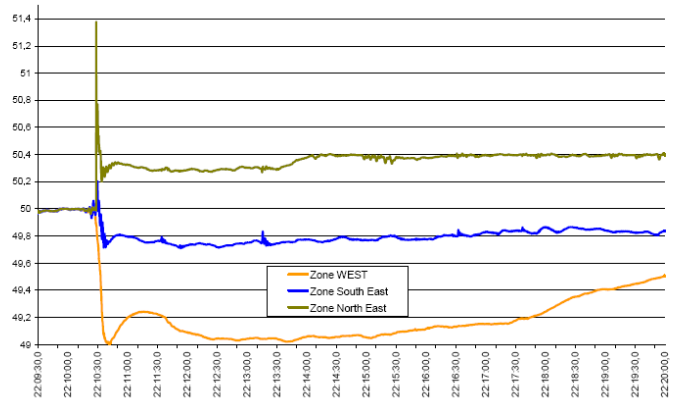
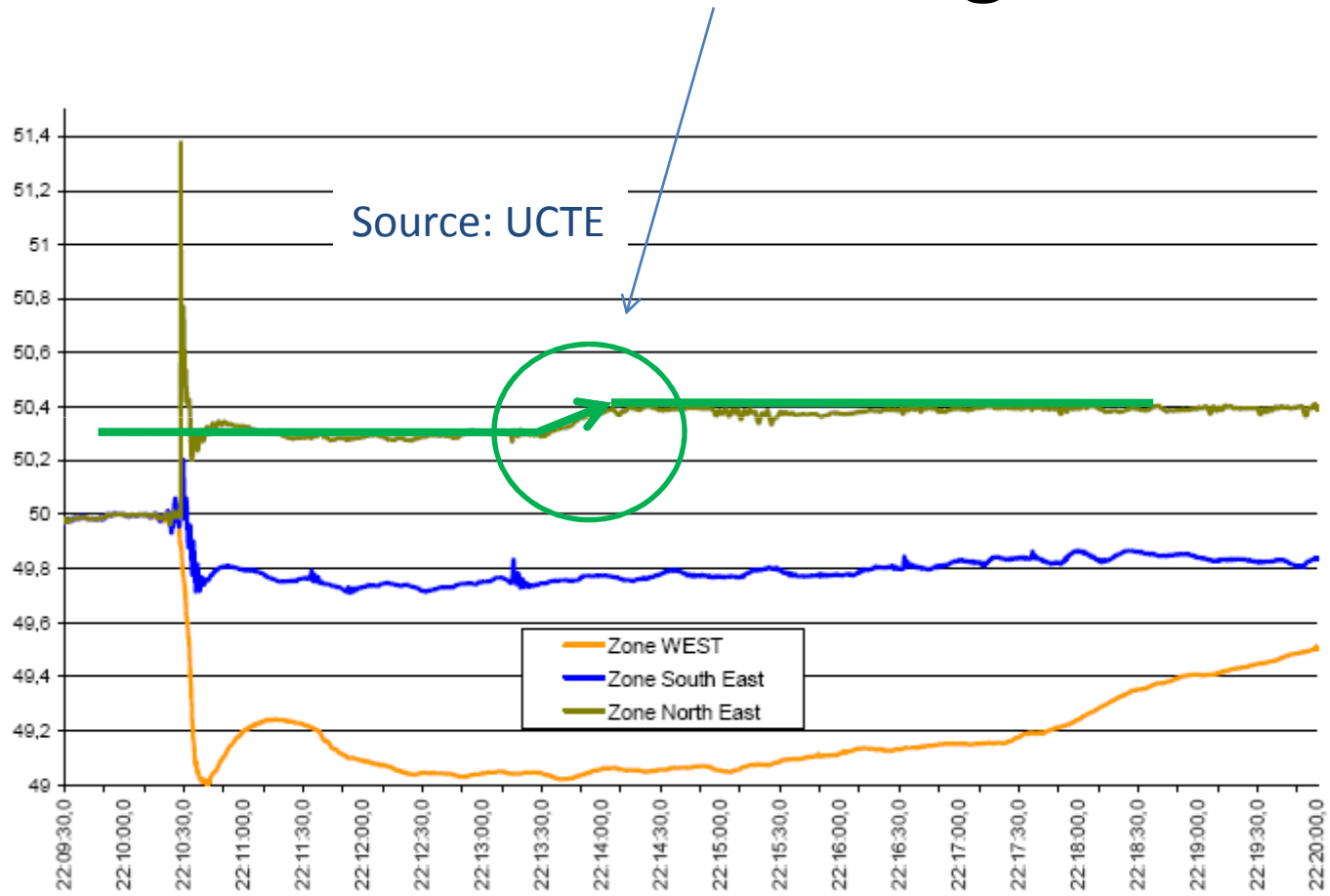


Figure 14.6. The different operating states of a power system.

Figure 13: Output of windmills (VE-T, E.ON Ne



Increasing frequency due to reconnected distributed generation

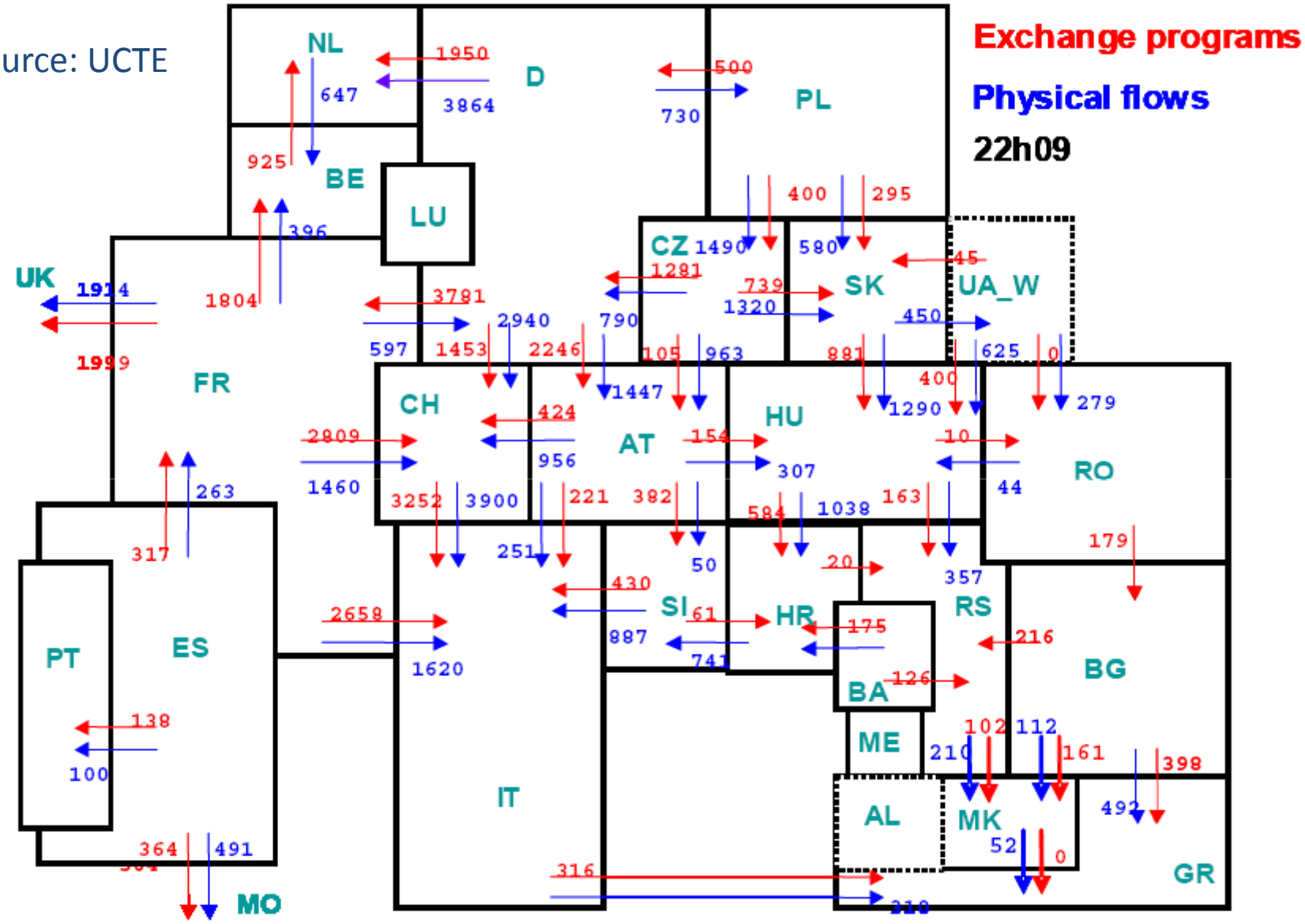


Deficiencies of the system

- System operators: Insufficient information available from generation units connected to the transmission grid
  - Unknown generation programs (including intra-day changes) and unknown online data.
  - Unknown amount and location of power injection

We do not know enough about the distribution system

Source: UCTE

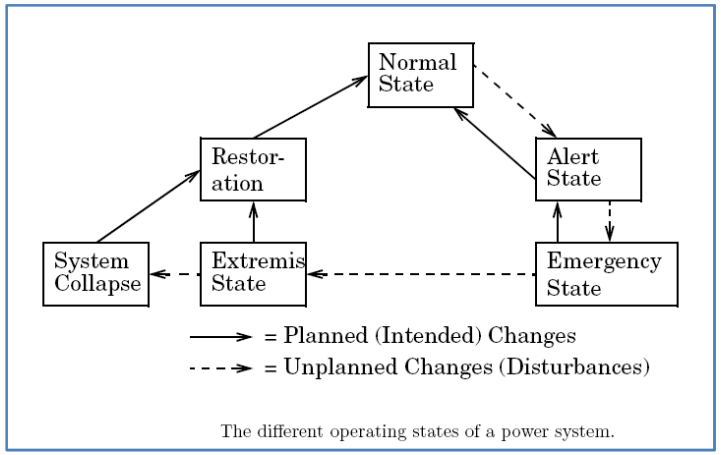


Also the distribution system plays a role

Key Problem:
Management of emergency situations.

- We need measures prepared in advance for
  - Control of remaining safety margin in the grid,
  - Control of cross-border exchange schedules and generation pattern changes and
  - the time needed for the system operators to implement these different measures

This must include the distribution system



The different operating states of a power system.

Dependency
Transmission & Distribution

- Conditions in the adjacent systems: Interdependent system security analyses.
  - Simulation of contingencies (tripping of power system elements) located outside the own control area.
  - Mandatory and regular online contingency analysis (N-1 simulations)
  - Preparation and regular checks of the efficiency of remedial actions through numerical simulations.

This could go down into the distribution system

Dependency
Transmission & Distribution

- Interdependent defense plans and load shedding philosophy
  - Today: significant amounts of distributed generation trips during disturbances with large frequency deviations
  - The restoration and re-energization process has to be explicitly coordinated by system operators
    - Today: DSO actions and the related responsibilities and duties of involved parties are not clear

Dependency
Transmission & Distribution

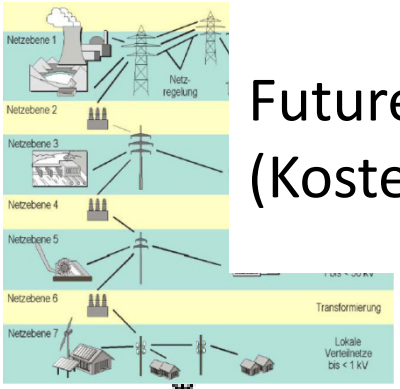
- Shared information platform
  - allowing system operators to observe in real time the actual state of the whole UCTE system including sensitive distribution areas
    - in order to quickly react during and after large disturbances.
    - … WAM … WAC

Information about the distribution system is a must.

Dependency
Transmission & Distribution

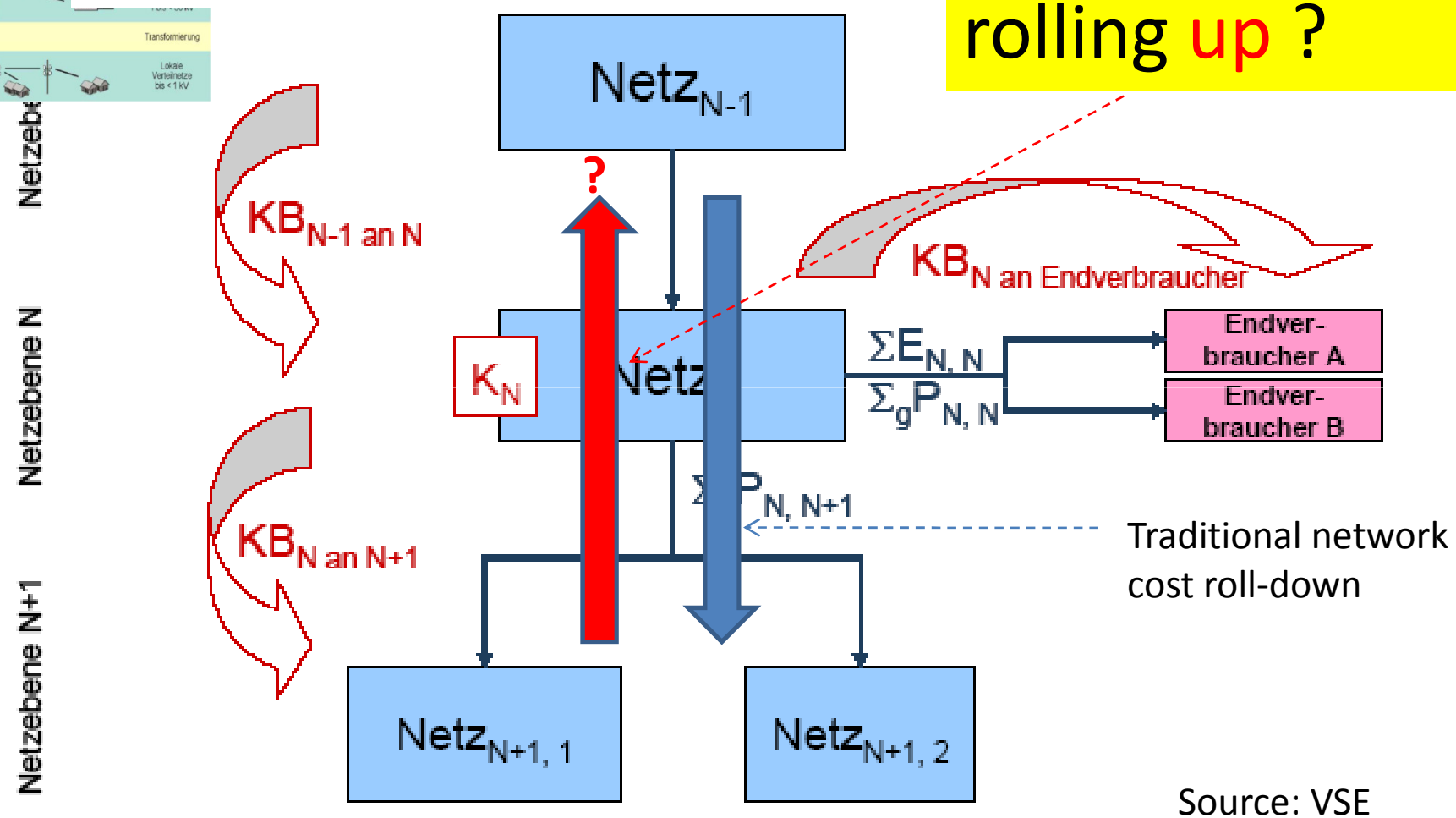
- Adapt the regulatory **or** legal framework
  - System operators: Have emergency control over generation output
    - **Generation units connected to the distribution grid**
      - Clear rules for behavior during frequency and voltage variations
      - The question: Different or not from **generation units connected to the transmission network**.
  - Generation units (or aggregations of them with local position)
    - obliged to inform the system operator about their generation schedules and **intra-day changes of programs** prior to their implementation.
  - System operators should receive **on-line** DSO generation data

Economical aspects



Future network cost roll-over (Kostenwälzung Netze) principle ?

Is the future network cost rolling up ?



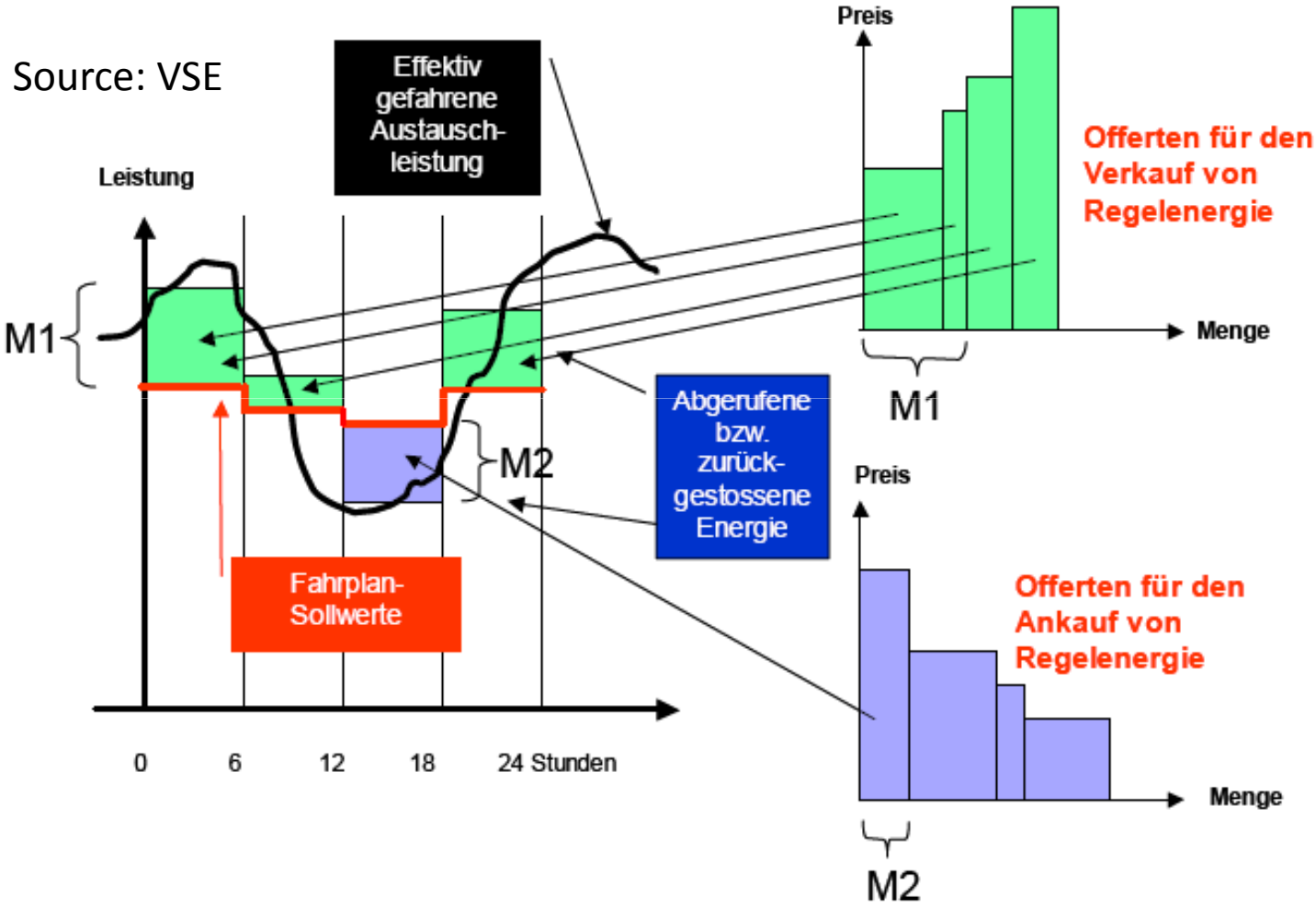
Traditional network cost roll-down

Source: VSE

Source: VSE

Dependency Transmission & Distribution
The new balance groups and markets for regulating power coming from distribution systems

Source: VSE



Regulating power coming from the distribution system (reduce generation and load)

Summary

- Technical system dependencies via frequency and voltage require smart system solutions
  - Manage dependencies where necessary
  - Force independence where necessary
- Cost dependencies in the regulated network
  - Rethink the roles of the distribution network
- What do we need?
  - Technical – Need for new system based security measures (system includes distribution)
  - Economical – Need for new distribution grid based
    - generation markets including storage
    - network costing and pricing principles
  - Legal
    - Need for new distribution grid frameworks with hard technical rules for distribution network users
    - Right incentives for the investments into distribution grids