OPERATIONAL IMPLEMENTATION OF THE TPA AGREEMENT II IN GERMANY

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The paper describes the tasks of the RWE Energie TSO in the interconnected network and the changes to the system operation due to the liberalized market and the additional operating requirements resulting from the TPA Agreement II in Germany.

Keywords: **Network, Market, TPA Agreement.**

1. SYSTEM MANAGEMENT AND SYSTEM OPERATION IN THE UCTE GRID

According to the Energy Industry Act, transmission grid operators are obliged to supply customers with electrical energy as reliably and cost-effectively as possible in sufficient amounts at any time while ensuring smooth grid operation.

The supply with electrical energy is characterized by some essential physical parameters requiring special efforts and precautions in order to maintain supply security. On the one hand, supplying customers with electricity requires an electrical system, i.e. transmission lines from the power plant to the consumer. On the other hand, electric power cannot be directly stored in large quantities, but has to be generated instantaneously when the customer needs it. Even small deviations from this equilibrium may jeopardize supply security and lead to supply disruption or to the collapse of the system, if the transmission grid operator does not take corrective action.

Operation of today's interconnected system in Germany is the result of historical evolution. More than a hundred years ago, the firs regional service areas developed in German cities and agglomerations. Individual generating units supplied consumers with electric power via power lines. Very often only one power plant unit fed electriciy into such a subsystem. Any failure of such power plant led to the immediate power blackout for all connected consumers. As more and more electricity was needed and improved supply security was demanded, all the electricity utilities operating in Germany gradually interconneced their extra-high-voltage subsystems forming today's "German interconnected system" in the course of decades (fig. 1). Interconnection led to significant improvements. Several power plants operating in parallel could back each other up im the event of power plant failures. The interconnection of the grids also enabled power plants to be used more efficiently. The parallel connection of the subsystems also improved security at several interconnection points in the extra-high-voltage system. Ring-shaped or meshed circuits were formed. In the event of a particular line failing the electricity can be transmitted across the remaining line(s) to the consumer.

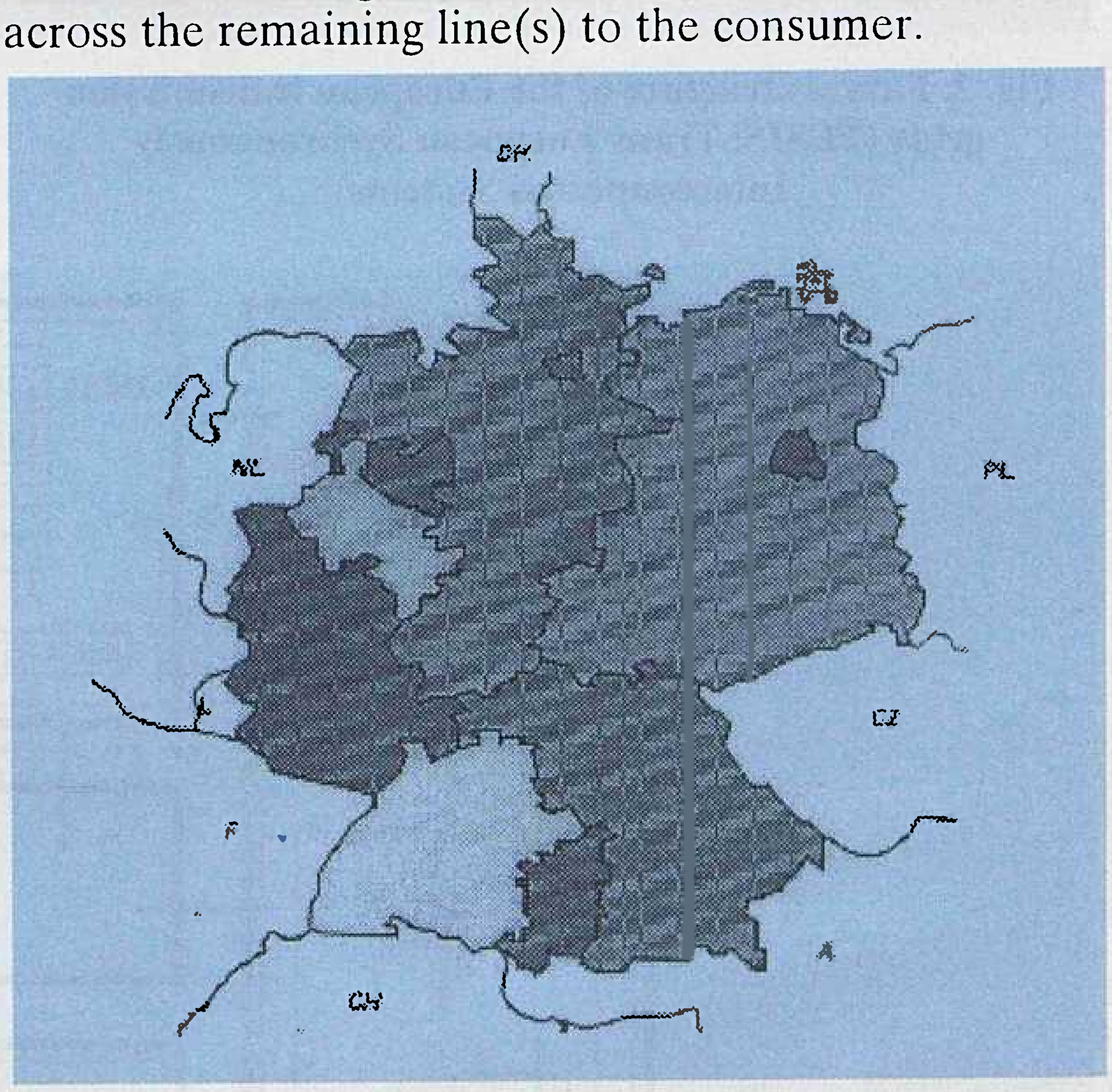

Fig. 1: Area of German Interconnected System

In Germany, there are currently [August 2000] eight transmission grid operators that have interconnected their 380 kV and 220 kV systems via national interconnect lines to form the German interconnected system. The 380 kV system and the 220 kV system are electrically connected with each other through transformers, so-called system interconnectors.

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However, the interconnected system does not end at the German border. International tie-lines from Germany to neighboring foreign countries as well as tie-lines between foreign partners link the subsystems to form a synchronous European extra-high-voltage system (fig. 2).

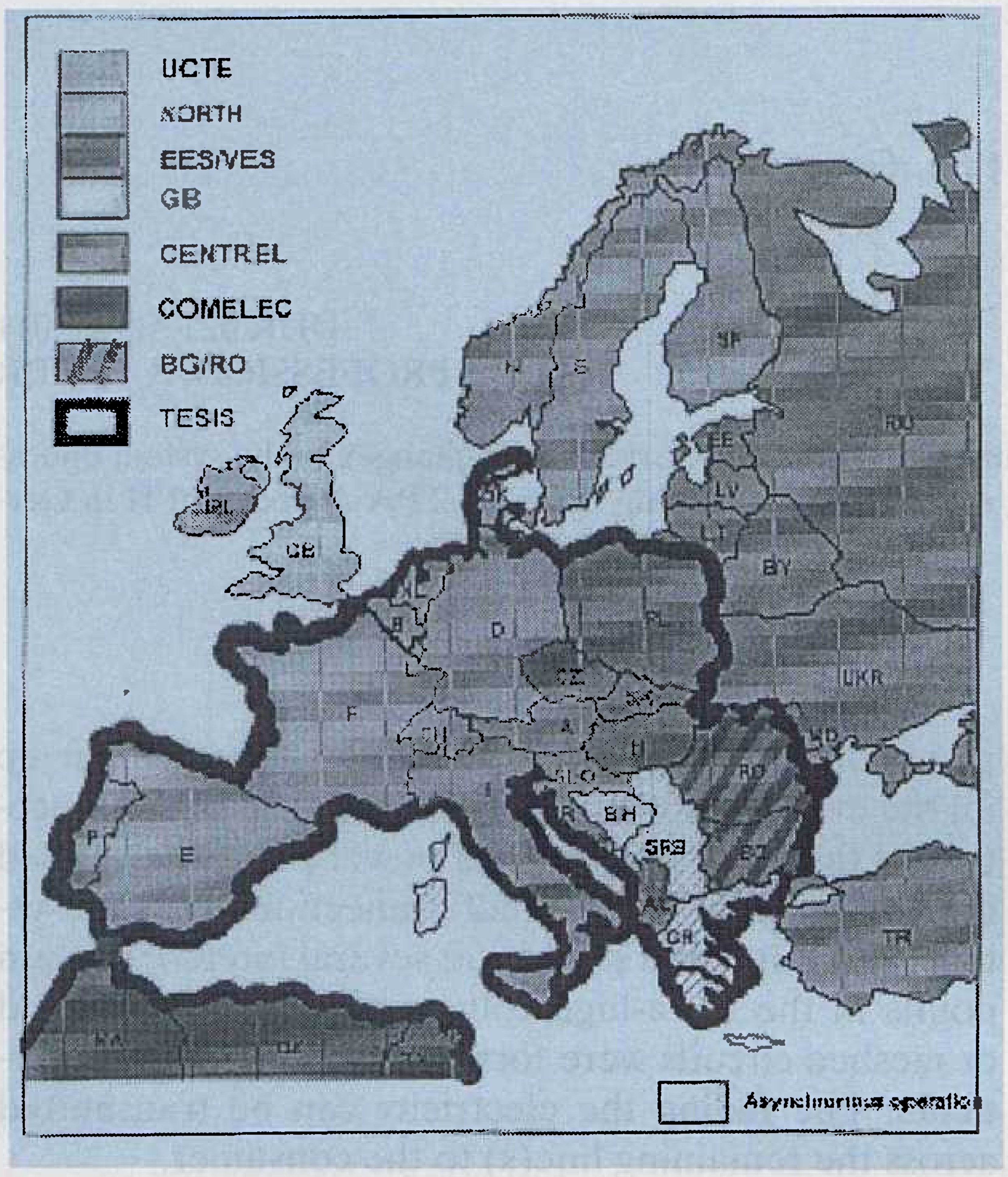

Fig. 2: Future structure of the European transmission grids (TESIS: Trans European Sychronnously Interconnected Systems)

Today's extra-high-voltage system is heavily meshed. Electricity flows in the system based on the laws of physics described by Kirchhoff's or Ohm's Law. The current circuit arrangement in the system, also referred to as topology (lines switched on or off, transformer tap positions etc.), the local power output to subordinate distribution grids, delivery to large industrial customers as well as the current deployment of power plants determine how much electricity flows across individual lines. The transmission grid operator therefore only has limited control over physical load flows by changing the power plant deployment and by rearranging circuits in the system. This is why it is extremely important to monitor the flow of electricity as well as the loads on all the equipment in order to identify overloads and bottlenecks in the network soon enough and to be able to take corrective action. The systems of each energy utility were designed in such a way that demand in any utiliy's own control sphere can be met from its own power plant capacity without any bottlenecks arising in the system.

2. TECHNICAL/OPERATIONAL COOPERATION THE UCTE INTERCONNECTED SYSTEM

A major goal of interconnected operation in the electricity industry consists in exchanging electrical energy between the interconnected partners while maintaining security. If more energy flows across national or international interconnect lines into a control zone than flows out of it, this difference constitutes the import of electrical energy. Conversely, if more energy flows out of the control zone than into it, electrical energy is exported.

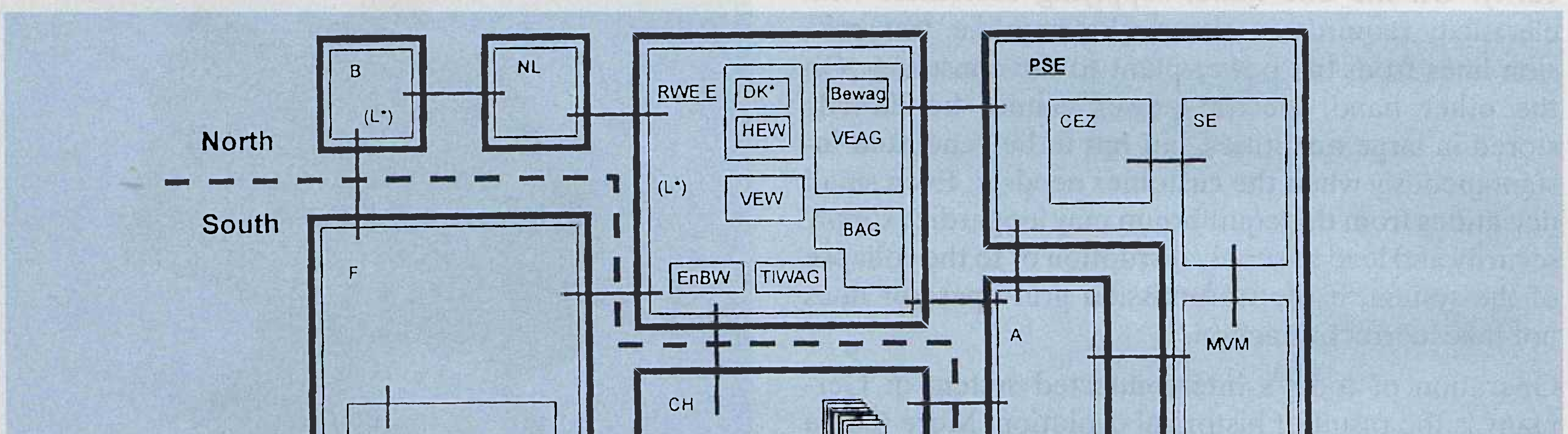

Fig. 3: Control blocs/control zones in the UCTE area

Each control zone is lined up to the program value (fig. 3) by means of load frequency control in order to be able to specifically influence and control export/import even in a highly meshed system. In its interaction with the primary-controlled power plants, load frequency control also maintains the network frequency (typically 50 Hz).

The systems of the eight German interconnected companies with parts of Denmark, Luxembourg and Austria together form the German control bloc. The load frequency controller for the German control unit is located in Brauweiler (RWE Energie, Transmission System Operation). It controls the exchange of electrical energy for all DVG partners vis-à-vis the UCTE system, including the CENTREL system (Poland, Slovakia, Czech Republic, Hungary). Within the German control bloc, each DVG partner controls the import/export with the neighboring systems for his own control zone.

3. CENTRAL SYSTEM MANAGEMENT FUNCTIONS IN INTERCONNECTED OPERATION

The central system management functions in interconnected operation can be broken down as follows in terms of their timing (fig. 4).

- "today for tomorrow" is up to system planning
- "today for today" is up to system use and deployment
- "today for yesterday" is up to system balancing (billing).

3.1. "Today for tomorrow" (system planning)

System management is a permanent target/perfomance comparison. The load frequency control of all interconnected partners consists for each of them of a central controller and assigned control power plants. A measuring system measures the network frequency which is approx. 50 Hz all over the UCTE area. For the German control bloc, all tie-lines to the foreign neighbors are measured, with the data being transmitted via control links to the system management of RWE Energie at Brauweiler where they are added up in the load frequency controller using the correct algebraic signs in terms of export and import. This balance constitutes the **actual value** of the power exchange between Germany and foreign countries. The **target value** results from adding up the desired energy exchanges (transactions, participations, etc.) which all DVG partners or traders, and hence the entire German control unit, have agreed with foreign interconnected partners. These exchange programs are agreed day by day among the interconnected partners hour by hour (today for tomorrow) and are set in the controller. The sum of all exchange programs must equal zero because otherwise the surplus energy produced would increase the frequency or an energy shortage would lead to a drop in frequency below its target value. Finally, the UCTE-wide coordination and validation of the exchange programs is done every day by the system management of ETRANS in Laufenburg and RWE Energie Brauweiler.

3.2. "Today for today" (system use and deployment)

During the day, target value and actual value are compared by the load frequency controller in the current hour (today for today). Any imbalance between generated and consumed power is identified by the controller by the difference between target and actual value and the measured network frequency. If e.g. the net-

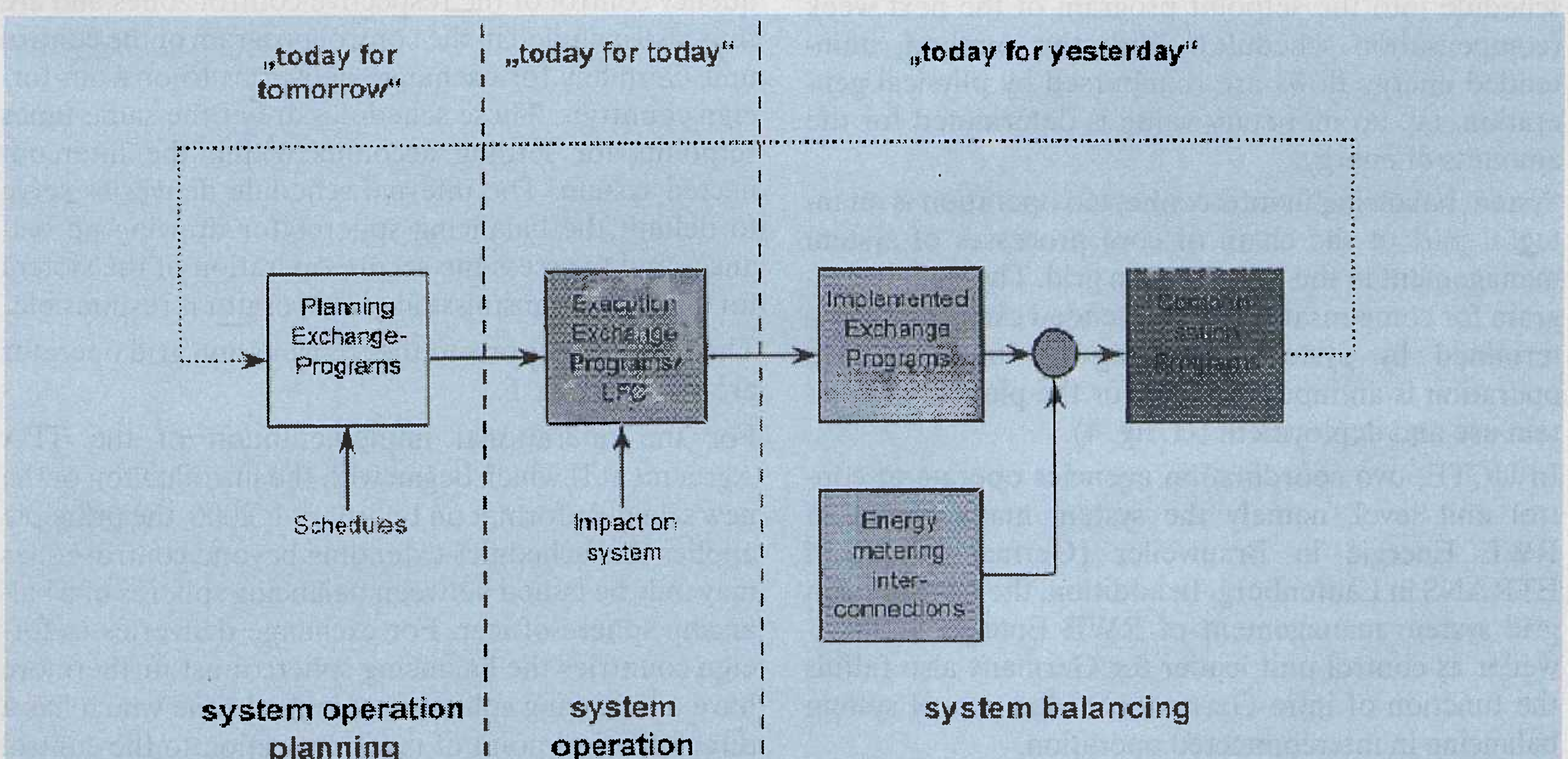

Fig. 4: Time sequence of system management

work frequency is too low and the import of the control zone is too high compared with the agreed program value, a lack of power exsist in this network. In such case, the load frequency controller issues a control command to the control power plants to generate more power in order to restore the balance between generation and consuption in the respective control zone. If, however, more power flows out of control zone A at too low a netwoork frequency, there is a power deficit in another control zone B. The control power plants in zone A now receive no instruction to generate more power, but the power plants in zone B are activated. This ensures that control zone B compensates for the power deficit based on the principle of causation. The load frequency controller thus identifies the power deviation based on the control equation

$$\Delta R = \Delta P + K \cdot \Delta f,$$

identifies the causing control zone and, if appropriate, takes remedial action by adjusting the power by way of the control power plants.

3.3. "Today for yesterday" (system balancing)

In the meshed interconnected system, technically induced differences between target value and actual value, i.e. between agreed supply and physical power flow, are unavoidable especially following disruptions (e.g. power plant failures). The difference of the two values is called "unintended deviations", while the determination of the unintended deviation is referred to as system balancing (today for yesterday). This power deviation is determined subsequently every hour by the interconnected partners. Mean power values, broken down by tariff periods, are calculated from the hourly energy values of any given week and are entered as schedule into the setpoint program of the next week (compensation schedule). With this method, unintended energy flows are reimbursed by physical generation, i.e. no monetary value is determined for the amounts of energy.

System balancing in interconnected operation is an integral part of the chain of core processes of system management in the transmission grid. The weekly program for compensation of unintended exchange as determined by system balancing in interconnected operation is an input variable for the planning of system use and deployment (cf. fig. 4).

In UCTE, two coordination agencies operate at control unit level, namely the system management of RWE Energie in Brauweiler (Germany) and of ETRANS in Laufenburg. In addition, the transmission grid system management of RWE Energie in Brauweiler as control unit leader for Germany also fulfills the function of intra-German coordination of system balancing in interconnected operation.

1 ΔR control deviation, ΔP power deviation, Δf frequency deviation, K performance figure

4. ADDITIONAL OPERATIONAL REQUIREMENTS RESULTING FROM THE TPA AGREEMENT II

The aforementioned tasks have long since been performed by the transmission grid operators (of DVG) for "their" respective control zone and on top of this by RWE Energie for the control unit Germany.

With the introduction of the new TPA Agreement II in Germany [5] and the publication of the new DVG GridCode [3], which is applicable since June 2000 (http://www.dvg-heidelberg.de), another element, the "balancing sphere" has been established. A balancing sphere is a virtual entity created for the purpose of combining defined feeding and tapping points within a control zone. The "balancing sphere officer" is responsible for balancing. The balancing sphere officer compiles a balanced procurement and delivery portfolio for his balancing sphere. For procurement he can draw also on imported capacity aparat from the capacity of contracted generators, while for deliveries he can use, apart from his own load, also export capacity. Apart from the exclusive supply of all consumers within a given balancing sphere, a customer may also purchase additonal schedule deliveries from other balancing spheres (sub-balancing sphere) apart from his so-called "open supply contract" to meet any procurement fluctuations.

The balancing sphere officer communicates all import and export schedules of his balancing sphere to the transmissional grid operator being responsible for "his" control zone. In this respect, a differentiation has to be made between internal (within the control zone) and external (across control zones) schedules. The external schedules are again input variables for the load frequency control of the respective control zones and are thus also included in the control program of the control unit Germany for exchange deliveries to or from foreign countries. These schedules are at the same times setpoints for settling accounts within the interconnected system. The internal schedule deliveries serve to delimit the balancing spheres for drawing up balances and to assess the secure operation of the system for which the transmission grid operator is responsible.

The schedule reports to the transmission grid operator are shown in fig. 6.

For the operational implementation of the TPA Agreement II which began with the introduciton of the new schedule format on February 1, 2000, the principle applies that schedules extending beyond control zones may only be issued between balancing spheres of a balancing sphere officer. For exchange deliveries to foreign countries the balancing sphere must furthermore have a balancing sphere in a control zone which has a direct physical point of interconnection to the control unit concerned. This approach which at first glance may give the impression of being rather an obstruction has clear benefits in operational implementation, espe-

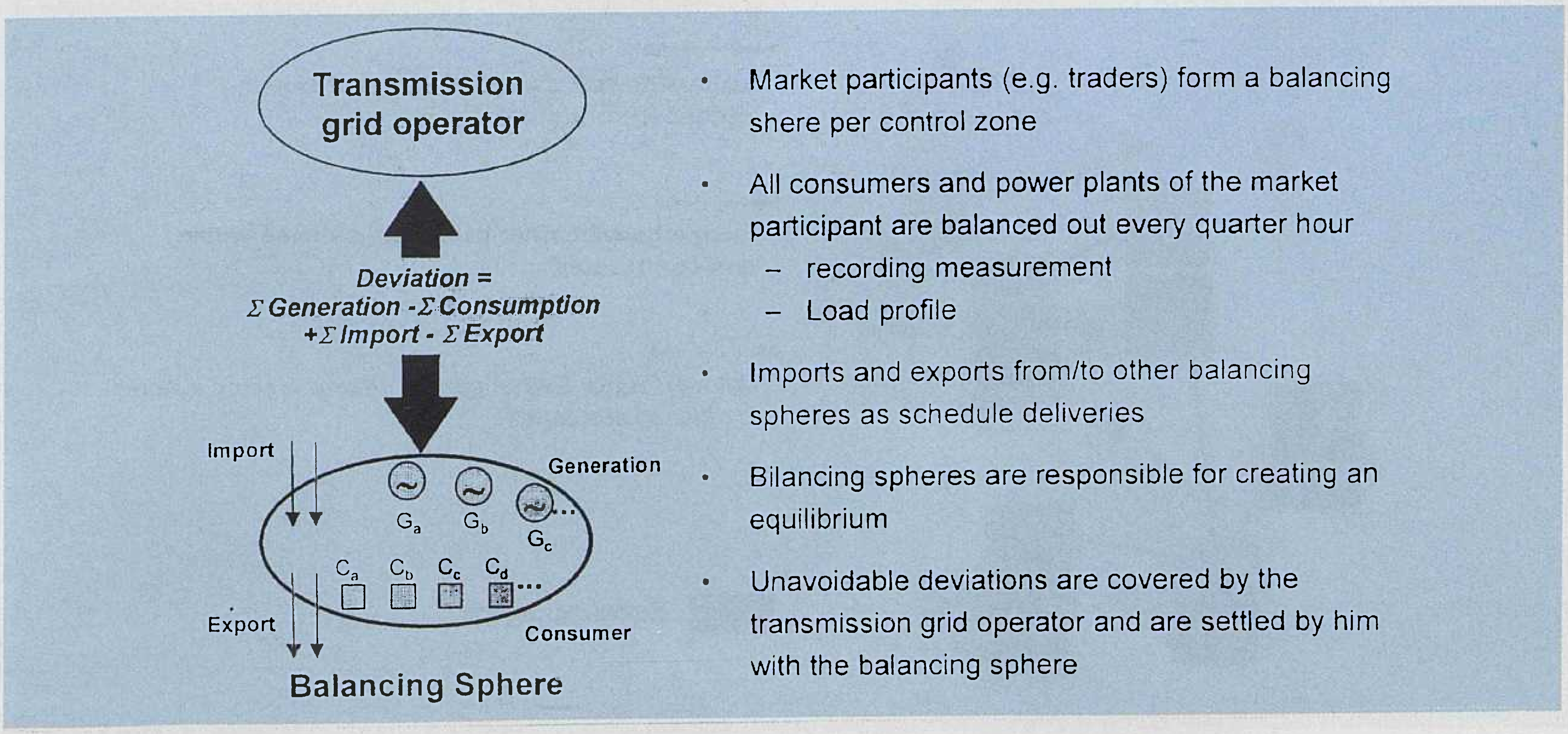

Fig. 5: Cooperation between balancing sphere and transmission grid operator

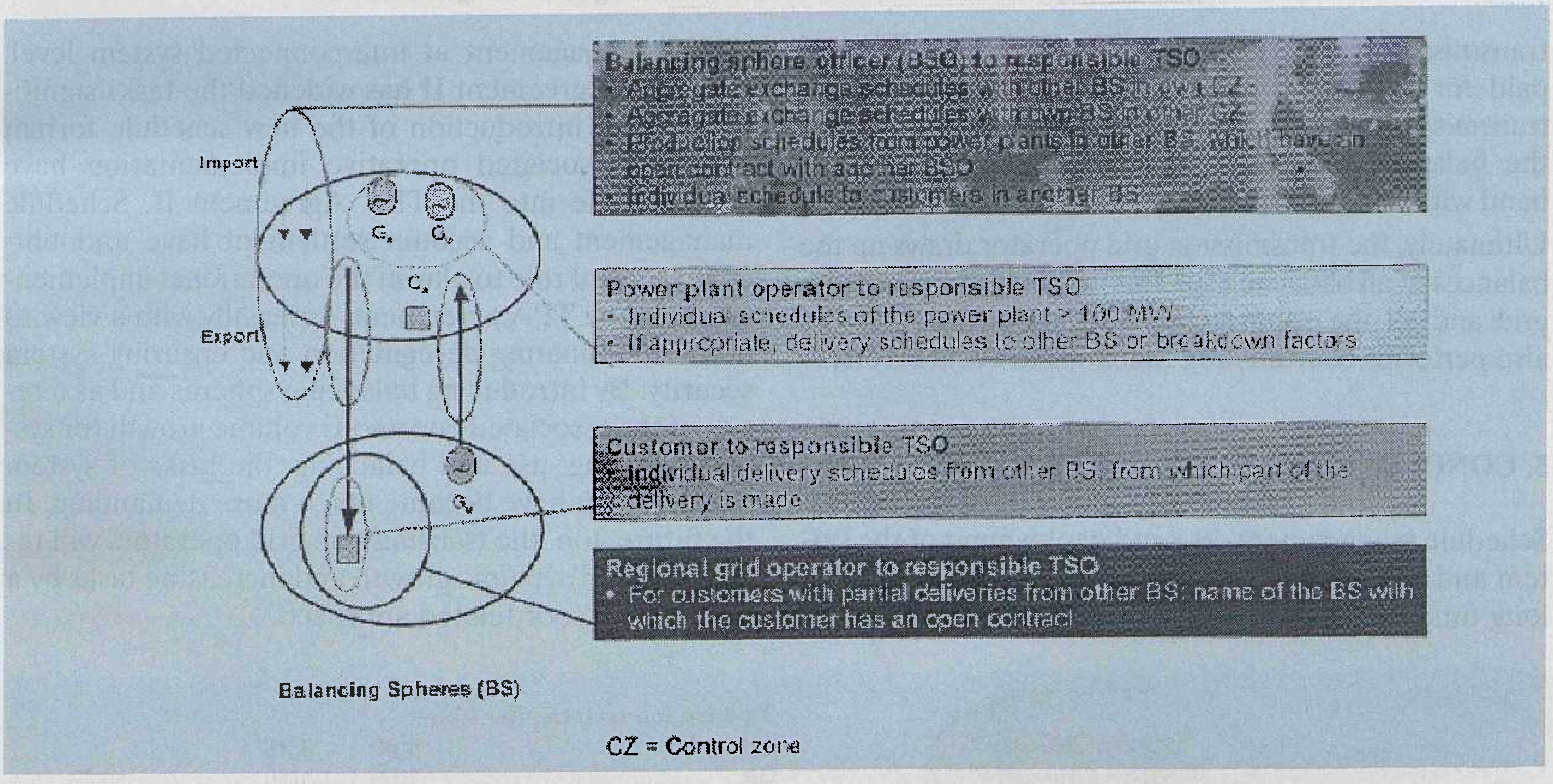

Fig. 6: Schedule report according to TPA Agreement II and DVG grid code 2000 to the transmission grid operator

cially with a view to simplifying the forms used for schedule notification and in respect of avoiding, detecting and eliminating errors.

All partners are extremely satisfied with how the new schedule system works after an extremely short development and preparation time. The current format and detailed descriptions can be downloaded from the Internet homepages of the DVG companies. For RWE Energie, the address is:

http://www.rweenergie.de

The introduciton of the TPA Agreement II has also led to new, extensive tasks for account settlement. Account settlement for system usage and of balancing spheres is now required on top of the aforementioned tasks of account settlement for interconnected system operation. Balances have now to be drawn up also within the individual control zones of the transmission grid operators as the new TPA agreement has been implemented. For drawing up the balances of the balancing spheres the balance deviation between feeding and tapping is determined per unit of time (1/4 h). The balance deviations are netted out in an account separately for two nationwide standard tariff peridos. By analogy with the volume balancing for interconnected operation, the account balance is determined and evaluated per tariff period after the end of the balancing period (Monday 00.00 hours - Sunday 24.00 hours). Up to a predefined ceiling (typically 5%) it is planned to offset the account balance in kind within the next balancing period. Energy volumes exceeding the ceiling are charged by the

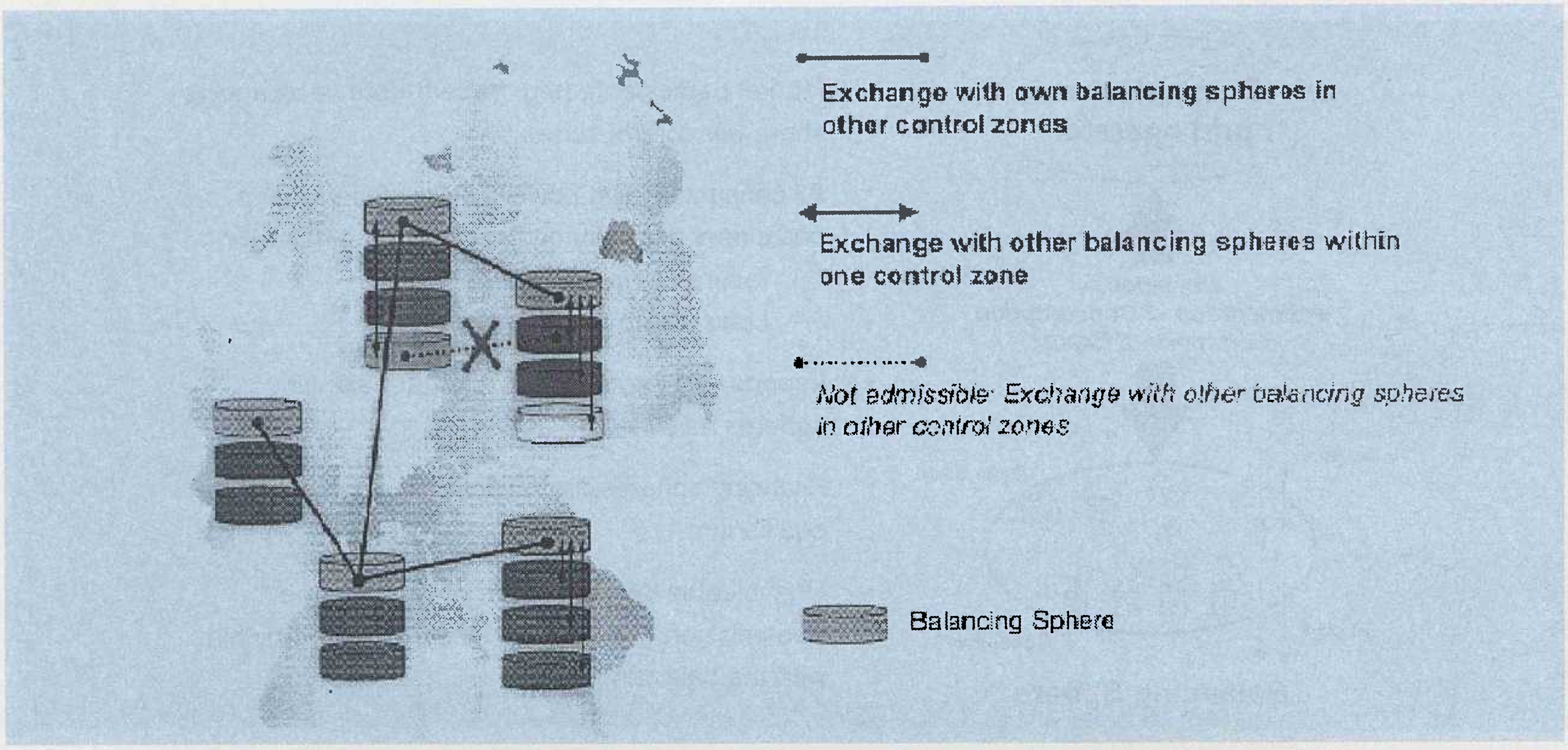

Fig. 7: Principle of schedule notification according to TPA Agreement II

transmission grid operator in the event of deficits or paid for in the event of surpluses. In addition, the transmission grid operator charges for control power if the balance deviation exceeds an agreed tolerance band within a unit of time.

Ultimately, the transmission grid operator draws up the balances of all balancing spheres within his transmission grid and all the subordinate distribution systems. He also performs coordinating funcitons to avoid errors.

5. CONCLUSION

Schedule management, use and deployment of the system and volume balancing have been performed for a long time by the interconnected companies as part of system management at interconnected system level. The TPA Agreement II has widened the tasks significantly. The introduction of the new schedule format and the associated operative implementation have breathed life into the TPA Agreement II. Schedule management and account settlement have undoubtedly a central role to play in the operational implementation of the TPA agreement, especially with a view to non-discriminating deregulation and ensuring system security. By introducing balancing spheres and as a result of the associated enormous volume growth for system planning, use and balancing, the tasks of system management have become much more demanding. In the future, too, the transmission grid operators will respond to the dynamic growth and increasing tasks by a flexible and coordinated approach.

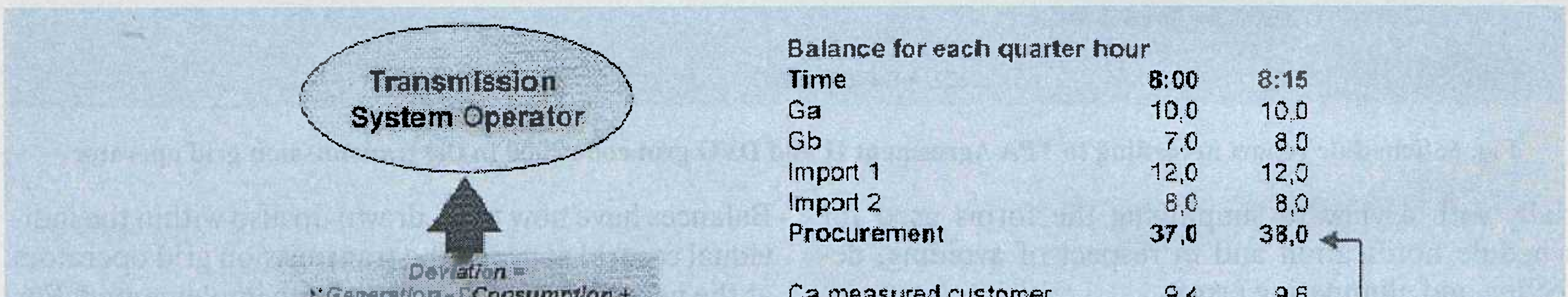

Fig. 8: Drawing up balances for balancing spheres based on TPA Agreement II

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PRIMJENA "TPA II" UGOVORA U NJEMAČKOJ

Rad opisuje zadatke RWE Energie TSO u prijenosnoj mreži kao i promjene rada sustava nastale zbog liberalizacije tržišta i dodatnih zahtjeva na rad koji slijede iz "TPA II Ugovora" ("Sporazum o pristupu treće strane") u Njemačkoj.

OPERATIVE DURCHFÜHRUNG DES II DEUTSCHEN ABKOMMENS ÜBER DIE BETEILIGUNG DRITTER PERSONEN

Beschrieben werden die im Verbundnetz vorkommenden Aufgaben der Leitung des Übertragungssystems des Konzernes RWE Energie, im Bezug auf den freien Markt und zusätzliche Ansprüche auf diese Leitung, welche aus dem II deutschen abkommen über die hervorgehen.

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