Jahresbericht 2000

Über die Arbeiten gemäss Projekt-/Vertragsnummer: 39 628/79 405

Titel des Projekts: **Study on methodologies for establishing a system for cross-border tariffication in the internal electricity market**

Zusammenfassung:

Nach Darlegung der Projektziele werden die Schwerpunkte der Arbeiten und Ergebnisse aufgezeigt. Aufgrund des Umfelds und der bestehenden Konzepte wird der Bereich neuer Methodologien auf Verursachergerechtigkeit, Nicht-Diskriminierung und Abstützung auf physikalische Flüsse ausgerichtet. Entsprechende Pilotrechenprogramme wurden erstellt und anhand von Testdaten erprobt. Das Kernelement dabei ist ein Kostenmodell, das innerhalb der Arbeitsgruppe eingehende diskutiert wurde. Die Software wurde soweit vorbereitet, dass ein realer Satz von Messwerten aus dem europäischen Verbundnetz verarbeitet werden kann. Erste Simulationsrechnungen wurden bis Ende 2000 in Angriff genommen. In Zusammenarbeit mit Mitarbeiteren des Regulators in Belgien wurde ein repräsentatives Konzeptpapier erstellt bzw. ist in der Revisonsphase, das der EU-Kommission vorgelegt werden soll. Es gibt die Zielsetzungen und die prinzipielle Vorgehensweise in dieser Studie wieder.

Dauer des Projekts: 1. Oktober 2000 – 31. März 2001

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1. Projektziele 2000

Das Projekt zur Erarbeitung einer neuen Methodologie für die Verrechnung von Kosten für grenzüberschreitende Flüsse im europäischen Verbundnetz wurde durch Arbeiten und schliesslich durch eine Initiative des sogenannten Florenz-Forums angeregt, in dem Regulatoren, Netzoperateure, Vertreter von Ministerien und der EU-Kommission vertreten sind. Die Initiative ist vom Regulator Belgiens aufgegriffen bzw. übernommen und konkretisiert worden. Nach bilateralen Kontakten erfolgte eine gemeinsame Finanzierung des Projekts durch die Commission for the Regulation of Electricity and Gas in Brüssel CREG und durch das Bundesamt für Energie in Bern.

Aufgrund der ausgeschriebenen Terms of Reference wurde dem oben genannten Projektempfänger der Auftrag zur Durchführung erteilt. Vorarbeiten wurden bereits aufgrund der ersten inoffiziellen Kontakte im Juli 2000 begonnen. Es wurde das Umfeld, die bestehenden Ansätzen für verschiedene Verrechnungsmethoden und allgemeine Zielsetzungen erarbeitet. Letztere lassen sich im Vergleich zu den im Florenz-Forum diskutierten Methodologien so charakterisieren, dass Verursachergerechtigkeit, Nicht-Diskriminierung, Abstützung auf physikalische Leistungsflüsse und Handhabharkeit im Rahmen der europäischen Netzoperateure angestrebt wird. Mit anderen Worten, die Ausrichtung der zu entwickelnden Methodologien sollte im Gegensatz zu den Verfahren der ETSO (European Transmission System Operators) und der CEER (Council of European Electricity Regulators) stehen.

Die eigentlichen Arbeiten wurden in Besprechungen mit Vertretern des Regulators (CREG) und des Bundesamtes für Energie (BfE) aufgenommen. Die unmittelbaren Ziele waren die Erstellung eines Arbeitsplanes, die Ausarbeitung von Testprogrammen, die die Erprobung prinzipieller Verfahren für die Verrechnung erlaubten. Es wurden die Anforderungen an die Basis- und Eingangsdaten zusammengestellt, die eine Simulation der Verfahren entsprechend der neuen Methodologie erlauben sollten.

Der Arbeitsplan, der im Rahmen des Projektangebotes erstellt wurde, umfasste in einer ersten Phase, die sich bis Ende 2000 erstreckte, die Darlegung der grundsätzlichen Vorgangsweise, die Erstellung einer allgemein gültigen Systemsoftware in einer Testversion und eine grundlegende Diskussion der vorgelegten Konzepte innerhalb der Arbeitsgruppe.

2. Geleistete Arbeiten und Ergebnisse im 2000

Das Hauptaugenmerk des Auftragnehmers konzentrierte sich in diesen Zeitabschnitt auf die Entwicklung von Konzepten und Verfahren, die den Anforderungen und Zielsetzungen, die im Projektangebot und im Arbeitsplan festgelegt wurden. In diesem Rahmen wurden mehrere Softwareversionen erstellt, mit denen aufgrund von Pilotdaten Simulationen durchgeführt werden konnten. Damit wurde die Funktionalität der Kostenmodelle erklärt und anhand von Sensitivitätsrechnungen erläutert. Die Ergebnisse wurden in Besprechungen mit Vertretern der Arbeitsgruppe dargelegt. Über diese Ergebnisse bestehen Arbeitsdokumente, Exceltabellen und Folien, die sich weniger für einen Jahresbericht eignen, jedoch bei Bedarf eingesehen werden können.

Die Arbeiten und Diskussionen im Sinne einer Bereinigung von Konzepten wurden so weit geführt, dass eine umfassende Simulation mit realen Daten geplant werden konnte. Die Vertreter des Regulators in Brüssel CREG haben vom belgischen Lastverteiler CPTE einen Satz von Daten von grenzüberschreitenden Leistungsflüssen des europäischen Verbundnetzes einschliesslich einiger Randgebiete erhalten und dem Auftragnehmer zur Verfügung gestellt. Damit konnte kurz vor Ende des Jahres nach Anpassung der Software an das umfassende Datenmaterial eine erste Simulation in Angriff genommen werden. Die Simulationen konnten 2000 nicht abgeschlossen werden, jedoch sind die bis dato erhaltenen Ergebnisse vielversprechend.

In Zusammenarbeit mit CREG wurde daneben ein Dokument erarbeitet, das der EU-Kommission vorgelegt werden soll und die Zielsetzung der Arbeiten der Gruppe (CREG, BfE, ETH-Zürich) darlegen soll. Das Dokument, das sich noch in Revision befindet, d.h. erst in einer vorläufigen Form vorliegt, ist diesem Jahresbericht beigelegt [1].

3. Zusammenarbeit und Kontakt mit nationalen und internationalen Institutionen

Das gesamte Projekt basiert auf internationaler Zusammenarbeit. Die Auftragnehmer sind in ständigen Kontakt mit den Vertretern von CREG in Brüssel. In der Arbeitsgruppe nehmen zudem Vertreter des BfE in Bern und des Bundeswirtschaftministeriums in Berlin (Beobachter) Einsitz.

4. Transfer von Ergebnissen in die Praxis

Das Projekt ist noch in einem frühen Stadium, so dass von einem Transfer von Ergebnissen in die Praxis noch nicht die Rede sein kann. Ein solcher wird erst möglich, wenn das oder die Verfahren von den europäischen Lastverteilern ETSO akzeptiert wird. Diese Akzeptanz ist eine der kritischen Punkte im Gesamtablauf der Verwirklichung einer neuen Methodologie für die Verrechnung von Kosten für grenzüberschreitende Leistungsflüsse, siehe unten unter 5.

5. Perspektiven für 2001

Wie oben ausgeführt konnte gegen Ende des Jahres 2000 eine erste Simulation mit realen Daten aus dem europäischen in Angriff genommen werden. Der Abschluss dieser Simulationsrechnungen ist ein erstes Ziel für das Jahr 2001. Die Auswertung der Ergebnisse, die in Besprechungen innerhalb der Arbeitsgruppe erfolgen wird, soll zeigen, inwieweit das Verfahren den praktischen Anforderungen und politischen Randbedingungen entspricht. Danach ist zu erwarten, dass Modifikationen des Verfahrens und der Software notwendig sein werden, um eventuelle Mängel des bestehenden Verfahrens zu beseitigen. Wenn damit befriedigende Ergebnisse erzielt werden können, ist eine Präsentation und eine breit angelegte Diskussion mit den europäischen Systemoperateuren erforderlich und auch vorgesehen, um einen ersten Schritt einer Umsetzung des Verfahrens zu bewerkstelligen. Diese Präsentation und Diskussion soll einmal bilateral mit Vertretern von ETSO und sodann in einem erweiterten Rahmen innerhalb des Florenz-Forums erfolgen. In diesem stufenförmigen Prozess sind Anregungen und Korrekturen am Verfahren und in der Vorgehensweise zu erwarten, die zu wiederholten Simulationsrechnungen Anlass geben könnten. Die unmitteltbare Zielsetzung ist jedoch die Vorlage von Ergebnisse im Rahmen des Florenz-Forums.

6. Publikationen 2000

keine

7. Dokumentation

[1] Arbeitsgruppe CREG, BfE, ETH-Zürich

A New Methodology for Establishing a System for Cross-Border Transmission Tariffication in the Internal Electricity Market

Dokument vorgesehen zur Vorlage bei der EU-Kommission

Revidierter Entwurf vom 3. Januar 2001

Commission for the Regulation of Electricity and Gas
Brüssels
Bundesamt für Energy, Bern
Prof. Dr. Hans Glavitsch
Prof. Dr. Göran Andersson

Date Jan. 09, 2000

A New Methodology for Establishing a System for Cross-Border Transmission Tariffication in the Internal Electricity Market

Revised draft: January 3, 2001 by CREG/Glavitsch

1. Background

1.1 General

The European transmission network has been installed under the guidance and supervision of UCPTE (now UCTE) for security (stability) considerations and for the exchange of electrical energy. The stable parallel operation of large power stations, around 1000 MW, required the connection to a powerful high voltage network. Furthermore, reliability considerations require the import of massive power in case of an outage of such a power station. This import is only possible through an interconnected high voltage network. Another original motivation was the exchange of hydro and thermal energy between the Alpine region and the highly industrial regions of neighboring countries of Germany and France. As the degree of interconnection grew other benefits became apparent, such as possible delays of installation of plants, readily available reserves, cheap surplus energy etc.. The exchange of energy has been organized on the basis of the load-frequency control system where all partners in the exchange participate on equal rights principles. This decentralized system allows to set net power outputs of a well defined area (by measured tie-lines) and as long as all participating areas adjust consistent set points the real outputs are in agreement with the desired net imports or exports. But the actual physical flows over the tie lines cannot be controlled by this system. The records show that energy exchanges over the last decades have increased continuously, i.e. in proportion to the overall electrical power consumption. The fact, however, is that no distinct fees on the usage of tie-lines other than transmission charges included in long-term energy contracts have been applied so far.

With the opening of the electricity market the need for exchanges of energy over borders still remains and will even increase. The interconnected network exists and lends itself to market operations. Within a country tariffication schemes have been established by which domestic loads and generators are charged for the usage of the transmission network and, of course, also for the distribution network. Since cross-border flows participate in the usage of the transmission network and cause losses it seems self-evident that the players causing the loading and the losses will have to share the corresponding costs.

A forum of regulators, system operators, representatives of governments and the European Commission met regularly in Florence (Florence Forum) to discuss tariffication schemes. The proposals discussed over the meeting periods included zero charges, charges due cross-border

flows, the requirement of non-transaction based tariffication, charges derived from losses and shares of cost attributable to reinforcements. The conclusions evolved to two concepts that have reached a certain degree of maturity, one being ready for implementation in the UCTE network. These will be commented in more detail in a subsequent chapter.

1.2 Problem

If the usage of transmission networks due to cross-border flows caused by transactions between neighboring utilities has to be adequately compensated then there is a new problem facing the partners in the UCTE system. Cross-border flows include import flows, export flows and transit flows, which are superimposed over the "domestic" flows of a country or control area. Import flows and export flows are beneficial to the local consumers and the generators respectively. However, transit flows will in general cause an additional loading of the network. The latter are of advantage to the external users, however, it is not quite obvious in what way this benefit can be evaluated or, otherwise, an adequate share of the costs can be determined. The problem lies in the fact that the detailed loading, usage of the network and consequently the compensation by third parties cannot be based on a detailed topological (load flow based) analysis. This applies to the superimposed usage as well as to losses. There has to be a simplified approach by aggregating the network and applying averaging techniques that in the end, however, have to be easy in handling, cost-reflective and fair. In one or the other way the tariffication scheme has to be compatible with the one for the domestic usage.

Further, the simple usage of the network by third parties is to be treated on a more complex level. There are two items or phenomena that makes this necessary. One is the appearance of loop flows in heavily meshed networks, which lead to additional loadings and costs. The other is the occurrence of congested lines and tie-lines. Although it seems that congestion management cannot be treated in this approach to cross-border tariffication it should be kept in mind that in the long run the basic scheme and elements of the methodology set up now have to be compatible with a later congestion management scheme.

When implementing a new methodology it is to be emphasized that energy trades in the European transmission system should be promoted and a TSO should not be given any handle to influence the European trade mechanism.

2. Objective of the new methodology

In view of various principles of tariffication discussed by other institutions, working groups, etc. [1,2] a fundamental principle is set out and this is that cross-border flows using transmission capacity in neighboring networks are charged in a compatible way to domestic flows and the agent responsible for the costs has to pay for it. Thereby it is emphasized that costs have to be related to physical flows and not to transactions. Correspondingly, these costs are charged to consumers and/or generators, again oriented towards their physical loads and output respectively.

As a detailed topological analysis of flows and a derivation of costs are not possible in this approach the methodology has to be based on measured cross-border flows entering and leaving a country or control area. Together with the local (domestic) generation and load a model of the internal usage of network by imports, exports and transits will be developed which reflects the costs of the external users. A costing model on an integrated basis with the

domestic usage of the network will be derived. This integrated approach seems necessary as the fixed and variable costs of the network of the country can only be determined in a first step irrespective of the individual usage. Knowing cross-border flows and internal loadings a separation of charges based on modeling assumptions seems possible and will be fundamental for determining the tariffication scheme.

Hence, a key point in the new methodology is the costing model of the network. Fixed and variable costs have to be included whereby certain features will be taken from already known approaches.

The transmission system operator (TSO) is the responsible agent for determining costs as well as for allocating charges to neighboring TSO's, domestic consumers and generators. Hence, the agents involved in the tariffication process are hereby mentioned:

- the domestic TSO
- neighboring TSO's
- domestic consumers
- domestic generators

The methodology is aimed at a restricted communication between TSO's of adjacent countries or control areas. This will allow a decentralized tariffication process whereby each TSO is a partner with equal rights and responsibilities.

The consequence of such a concept is that a TSO forwards charges to a neighboring TSO, i.e. charges are relayed from one TSO to the other TSO's related to the physical flows. Thus, the physical network also reflects the flow of charges.

3. Comments on existing methods

3.1 Evolution of methods within the Florence forum

Within the framework and the activities of the Florence Forum several concepts, stages and methods have been discussed and are still under consideration. The stages which were under consideration over the series of Florence meetings are not mentioned here. However, two methods have reached a certain maturity, one is being scheduled for implementation on a limited time basis. It is the ETSO concept worked out by the European Transmission System Operators and is foreseen to be implemented on January 1, 2001 within the UCTE network. The other concept is being discussed within a working group of CEER (Council of European Electricity Regulators). The two concepts are both based on aggregated nodes for the various countries but exhibit major differences, which will be commented below.

3.2 The ETSO concept

The ETSO concept has gone through various stages of development itself and some features are actually still under discussion. Here, a stage accepted in the Florence Forum in March 2000 will be described. The concept consists of two major steps or processes. One is the collection of revenues, the other is the allocation of income to TSO's via an allocation key. The method is well documented in [1].

Revenues are collected on the basis of hourly declared exports of a control area (country) over geographical borders which are multiplied by a unique tariff of 2 € per MWh. These revenues are collected in a central account. On the other hand transits over control areas are determined by taking the sum of the minimum of historical net imports and exports over a control area over a sufficiently long period (one year). The proportion of the transits with the respect to the overall usage of the control area (generation, load, transit) determines the share of the network cost due to transits (again worked out for one year). The share of these transit cost with respect to the total of all transits of the UCTE countries determines an allocation key (a percentage) that is used to allocate the income out of the accumulated account to the various countries.

The advantage of the concept lies in its simplicity. It covers costs as they are defined by the determination of costs due to transits. Disadvantages are due to the fact that exports and physical cross-border flows that actually determine the loading of the network are not related. The cost of the usage of the network by a flow between two adjacent countries without the presence of a transit does not appear in the process. The net exporter pays his share, but the importing country does not have a corresponding income. Hence, the so-called cost-reflectiveness is missing. Further, the actual physical cross-border flows do not enter the process.

3.2 The CEER concept

The CEER concept is also based on aggregated nodes (super nodes) for the various countries. The tariffication scheme itself relies on two steps. One is the determination of network costs per node in terms of losses. A share of losses is calculated for cross-border flows (sum of imports and exports) and evaluated for given energy costs. Various possibilities for this share are being discussed, e.g. as increments, by superposition etc., which is termed average losses. Average losses are to be multiplied by the factor of two and by the energy costs that lead to the individual costs of cross-border flows (costs per TSO).

The second step is the allocation of shares of the network costs to the other TSO's. For this purpose a tracing of flows is used employing sensitivity coefficients that are collected in a matrix of dimension *n times n* where *n* is the number of countries. The process of generating these coefficients is quite complex and not transparent. Also a peculiarity of the concept is that imports, export, loads and generation are included by adding the absolute values of these quantities. Hence, loads and generation receive charges and the net income of a TSO is the result of a positive difference between these charges.

In this method, the network costs are based on losses only. Even by an increase of the cost of losses by a factor of two these costs are not representative of network costs caused by cross-border flows, which must be considered a severe disadvantage of the concept. A further drawback lies in the complex determination of sensitivity coefficients and in the handling of a large matrix.

4. Principles of the new methodology

4.1 Generally postulated principles

The methodology adheres to principles which are generally accepted and which are outlined here to complete the overall requirements. Further, they emphasize the general validity of the methodology. The methodology will be

- cost-reflective
- non-discriminatory
- non-transaction based

These properties are given is some more detail, namely:

Cost-reflectiveness means that the proposed method has to reflect as closely as possible the true cost caused by the usage of the network by the various agents in order to deliver efficient economic signals to the market players. This must be true for external users, domestic users, domestic generators, etc.. In particular, the usage by a transit, for example, must be adequately modeled in relation to the domestic usage. Transit flows use the network in a similar way as domestic flows and, therefore, should pay their share of the usage at a comparable specific level. Cross-subsidiarization between domestic and foreign users should be avoided.

Non-discriminatory means that all users of a transmission network should support the same costs and domestic flows, import, export and transit flows should bear the same charges.

These principles lead to the consequence that a transit carries charges to the adjacent neighboring country or control area.

A non-transaction based tariffication means that costs, charges and revenues are strictly derived from physical cross-border flows.

4.2 Principles related to the methodology

Beyond the general principles as mentioned above there are some properties that characterize the methodology to be developed and applied more specifically. These are listed below and commented:

A. The network of each country is aggregated into a compact node (super node). Cross-border lines and flows are thereby automatically defined.

B. Hourly cross-border flows and domestic loads (or generation) are measured and processed.

C. The costing model integrates the domestic and external usage of the aggregated node and determines/allocates the shares of the network cost.

D. Neighboring nodes are treated as if they were loads or generators connected to the transmission network of an individual node.

E. The model and the method are flexible as costs can be allocated to generators and/or loads in a predetermined proportion (charging directions).

F. Collection of revenues and allocation of income to the TSO is on a local basis such that no centralized mechanism is required. The methodology is oriented towards a decentralized application.

G. Network costs include capital costs (fixed costs) and variable costs (cost of losses). They are converted to a specific fee (postage stamp), which is applied to the flows of local and external users (according to the structure of the costing model). The determination of the appropriate shares is a matter of a specific treatment as, for example, the cost of losses due to cross-border

flows is not easily separated from the cost of losses due to domestic usage. This process, however, seems independent of the tariffication mechanism.

The list of principles could be further extended, however, it seems that with the items above a fair characterization is made.

5. Description of the new methodology

5.1 The super node concept

As it has been stated in several places above a topological approach to the analysis of flows and deriving costs accordingly is not possible. In a realistic approach to a workable tariffication scheme it is necessary to aggregate the network of a country or control area in a compact node, which will be designated "super node". Presently the UCTE network without the CENTREL system would require nine super nodes. Super nodes are connected by equivalent tie-lines comprising all circuits crossing geographical borders between countries, e.g. one equivalent line connects the super node of France with the super node of Germany. Such a line carries the total cross-border flow between the respective countries. A schematic view of super node connected to neighboring ones is given in Fig. 5.1

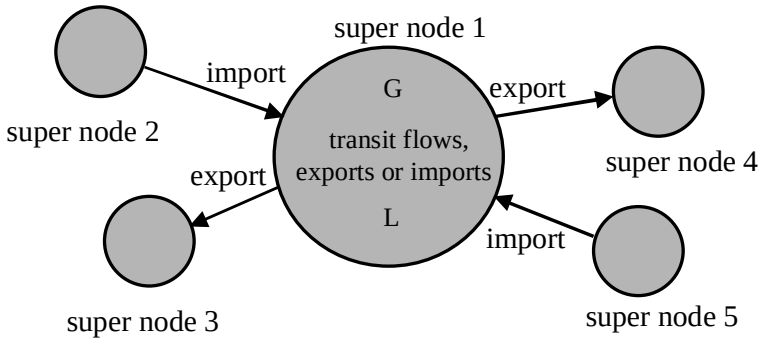

Fig. 5.1 Schematic view of super nodes
G generation, L load

The geographical dimension of a country does not enter in the formation of the super node which means that one super node represents France and one super node represents Netherlands. Considerations can be given to transits of equal power over a small and over a large country that may not generate the same costs. For the moment a distinction relative to the size of the supernode will not be made.

Cross-border flows entering and leaving super nodes are hourly active flows in MW or in MWh. Super nodes are characterized by the domestic (internal) generation and/or load. As long as losses are not introduced in the active power balance a specification of either generation or load is sufficient as cross-border flows, generation and load balance automatically. By specifying these items the complete internodal flow of the UCTE network is given. Thus, this set of data is also the set of measurements required for the tariffication process.

By handling these items transits, imports and exports can be calculated. By transit the share of the total import/export flow leaving/entering the super node as export/import flow is meant. Total imports and total exports can also be determined.

This balancing process is a prerequisite for any further tariffication scheme.

5.1 Cost elements in the tariffication process

The integration of costing for domestic and external usage requires that all the cost elements of a network represented by a super node and its operation have to be included. The basic concept consists in the collection of annual costs and in the determination of a specific fee, i.e. a postage stamp that can apply to individual flows. This procedure is not new and applies also to tariffication schemes for the local power distribution and generation. The cost elements can be separated into two categories, namely fixed costs and variable costs related to load, generation, imports and exports. The two categories comprise

A. Fixed costs (annual costs)

   amortization of the investment
   interest
   taxes
   maintenance
   administration
   control
   profit

B. Variable costs

   cost of losses
   cost of ancillary services

It is assumed that all costs under A are accumulated into one single amount per year valid for the particular super node. This is the overall network cost per year. For the calculation of the postage stamp for domestic use only this figure would have to be divided by the annual load of the super node (assuming that charges are based on energy only and are collected from the domestic load) as it is the accepted procedure in many countries.

For an appropriate share of the overall network costs to be allocated to cross-border flows a proportional share (linear model) is assumed. This seems justified by the further modeling assumption that cross-border flows affect the network as if they would be loads or generated inputs. What is not so obvious is to what extent cross-border flows are to be included. In the proposed methodology use is made of the power balance between generation and imports on one side and consumption and exports on the other side. Hence, a modified postage stamp is worked out by dividing the overall networks costs by the sum of consumption and export (or by the sum of generation and imports).

Thereby a remarkable benefit for domestic users appears. If, for example, the generation of a super node supplies the domestic load and the export assuming the absence of any imports then the modified postage stamp is lower than the one without an export. The local consumer pays lower network costs. On the other hand, a super node that is not able to supply its own consumption leads to a postage stamp, which is determined by the local load. These are features that are included in the costing model of the super node.

Coming back to variable costs it has to be realized that a linear separation of costs between domestic usage and external usage is not possible for physical reasons. The superposition of cross-border flows over domestic flows causes additional losses in a nonlinear fashion. Further, the superposition depends on the direction of flows in the individual circuits. Hence, additional losses and the corresponding costs vary from hour to hour. Since any topological analysis has been excluded for practical reasons any detailed analysis of the losses is impossible. Thus, it has to be resorted to an appropriate approximation.

The starting point for a reasonable determination of the share of losses is the determination of overall losses of the network of a super node. The utilities are in command of fairly reasonable procedures for determining losses on an annual basis, at least in form of estimates. Including historical data (including historical cross-border flows) allows the estimation of losses due to the combined usage of the network. The critical point is the separation of losses. If cross-border flows and domestic flows would be strictly unidirectional the superimposed losses would follow a quadratic law. However, in the practical case of a general network this is not the case. Realistic results would have to be obtained by a series of load flows derived from representative scenarios. The realization of such an analysis cannot be generally assumed. Hence, what remains is a linear separation similar to the separation of fixed costs. Since, the relative size of costs of losses compared to the fixed cost is small the error introduced by such an assumption is tolerable.

The conclusion is that a combined modified postage stamp is to be determined for the tariffication process.

5.2 Generation and allocation of the costs

Before going into details with these topics the terms “generation of costs” and “allocation of costs” are explained more closely. By generation of costs a process is meant by which active flows through a circuit model produce costs in proportion to the flows. The process is similar to the generation of ohmic losses in an electrical circuit. In the costing model inside the super node appropriate circuits are set up which create costs that are reflective to the usage of the network. In the proposed methodology transits, imports, exports and domestic loads as well as domestic generation can generate costs.

The costs generated in such a way are related to the individual users which can be consumers, generators, imports and/or exports.

The costing model of the super node being the core of the methodology consists of two separate processes that generate costs. One is oriented toward transits, the other to the remaining part of the cross-border flows that can be either import flows or export flows supplying the domestic load or resulting from surplus generation respectively.

The application of the costing model requires the identification of the transit share of the cross-border flow that compares with the ETSO concept. This transit share generates costs by applying the modified postage stamp, see above, which are forwarded to the neighboring super node in the direction of the flow. Thereby an allocation of costs already takes place. This allocation can be in the direction of loads or in the direction of generation.

The remaining part of the incoming or outgoing flow is combined with the domestic flow that also generates costs. If it is an import and the charging direction is towards loads then the

generated costs are allocated to the domestic consumer. If there is a surplus generation it is added to the transit flow thereby also combining the costs derived from the transit and the costs generated by the domestic flow. Thus, the export flow carries charges from the transit and the local generation.

If the charging direction is towards generation the allocation process is opposite to the direction of flows.

What has to be added now is the consequence that import flows carry charges that have been allocated to their respective export flows. They have to be superimposed on the costs generated locally. The same is true for export flows if the charging direction is opposite.

Hence, the methodology is a flow-based process where costs are generated in a similar way as for a domestic tariffication methodology. The allocation of costs is justified by the cause-effect relationship between the agent originating the flow and the resulting effect within the super node.

5.3 Decentralized tariffication and communications

The costing model is set up is such a way that all ingredients for performing the tariffication process are easily available to the individual super node. Thereby the basic assumption is that charges are forwarded from the neighboring super nodes together with the flows, i.e. in a handshaking process. Compensations are confined to adjacent super nodes only.

With the existence of communication systems such as the internet, such a handshaking process could be implemented without any difficulty. Then the tariffication process could be handled by each TSO individually, i.e. in a decentralized way. A centralized agent is not necessary and by experience is not in the interest of the European TSO's. Reference is made to a recent article in the IEEE Power Engineering Review [3] where the CEO of PJM Interconnection gives visions of the influence of knowledge-based information systems on the utility industry. It is found that the tariffication system outlined above lies well within the framework of future combined information and power systems.

6. References

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[2] Guidelines for a Cross-border Transmission Tariff System
CEER WGCBT Discussion paper, Draft, version 5, November 2000

[3] Phillip G. Harris; Impacts of Deregulation on the Electric Power Industry
IEEE Power Engineering Review, October 2000