ON THE INFRASTRUCTURAL BACKGROUND OF THE EAST-WEST ENERGY INTERCONNECTION

By Tamás Fleischer

Introduction

In what follows, the term Central European region will be taken to mean the region as affected by various eastern and western initiatives over the last few years rather than a sharply contoured geographic area. Such initiatives include the Alps-Adria Cooperation Agreement, the Pentagonale, the Central European Cooperation, and naturally, other similar concepts as well. On the eastern side, the broader border-line will put all countries west of the former Soviet Union, perhaps even the Baltic Republics, in this region, while a narrower division would only classify the Visegrad countries and perhaps Slovenia as belonging here. From the west, a stricter division would take only the Northern Italian, East Austrian, and the South German provinces into account, and in a broad interpretation, the whole of these countries and even Switzerland could fit into our framework.

A common feature of these regions, whichever way we define them, is one single fact, namely that they all somehow carry in themselves the borderline of four decades of political opposition between east and west, the range of the iron-curtain. Now as we take a closer look at the infrastructural issues of the East-European region, we will, to a large extent, concentrate on this dividing line. More precisely: on the one hand we will investigate, whether networks of the region have preserved something of their togetherness of the times prior to the iron curtain, and on the other hand, with even more scrutiny, we are going to examine what duty it is today to connect networks that are either torn or had been developed separately already from the outset.

We would like to mention at this point that the iron curtain is by far not the first spatial split in the history of this region; on the contrary, it may be regarded typical over the two-thousand-year history of the region that it was constantly trying to position itself inside Europe, at the periphery of significant empires, right at their colliding surfaces. It should suffice at this point to allude to Rome, to Charlemagne's Empire, or Bizantium, the border of western and eastern Christianity, or later the expansion of Islam and the Turkish Empire, or even Russia, in order to understand that the Jalta border was only one in this series

Of course, when considering the formation of networks of transport and energy, we only have to look back on the last century and a half of this history, and primarily on its last decades.

Energy Management

Starting Point: A Unilateral Energy Dependence

In the period of the change of régime the energy sector could be described by a few common features in each State of Eastern Europe. Such features - problems in fact - included an outstanding level of specific energy consumption in comparison to the GDP, the high ratio of energy-intensive branches within the whole of the national economy, and significant energy import relying very one-sidedly on the former Soviet Union. As a result, energy policies in each country specified the resolution of these major problems as their targets. Besides these set targets, entirely unexpectedly, there came a considerable down-scaling of industrial production, which also greatly reduced energy consumption for a period of time, independently from any other interference.

The basic aim of Hungary's energy policy mostly affecting international relations was a *one-sided diversification of energy imports* amounting to 61% of our energy consumption in 1989. Of course this translated into different requirements in each sub-branch, depending partly on the particular type of fuel that was used there, and partly on the local conditions in the European environment.

Coal Base: Local Enclave Plants

Coal resources constitute 2/3 of the fossile energy stock of the earth. 5.4% of the coal resources are found in Eastern and Central Europe, and this region provides 8% of the entire global output. While the share of coal in the overall consumption of energy in the region is declining, it still reaches 48% of the total consumption. (In OECD countries the corresponding ratio is 22%; and it is similar to that in Hungary.) 2/3 of the coal used in this region is burned in electric power plants [6].

It seems that *environmental norms* will provide the basis for standardisation which is going to emerge as the criterion for international competitivity. This means that regional coal resources below the international competitivity are not going to be graded [6], and will be automatically excluded from export-import trade, and later, as emission standards become stricter, they will be naturally excluded from direct use even in the countries of origin.

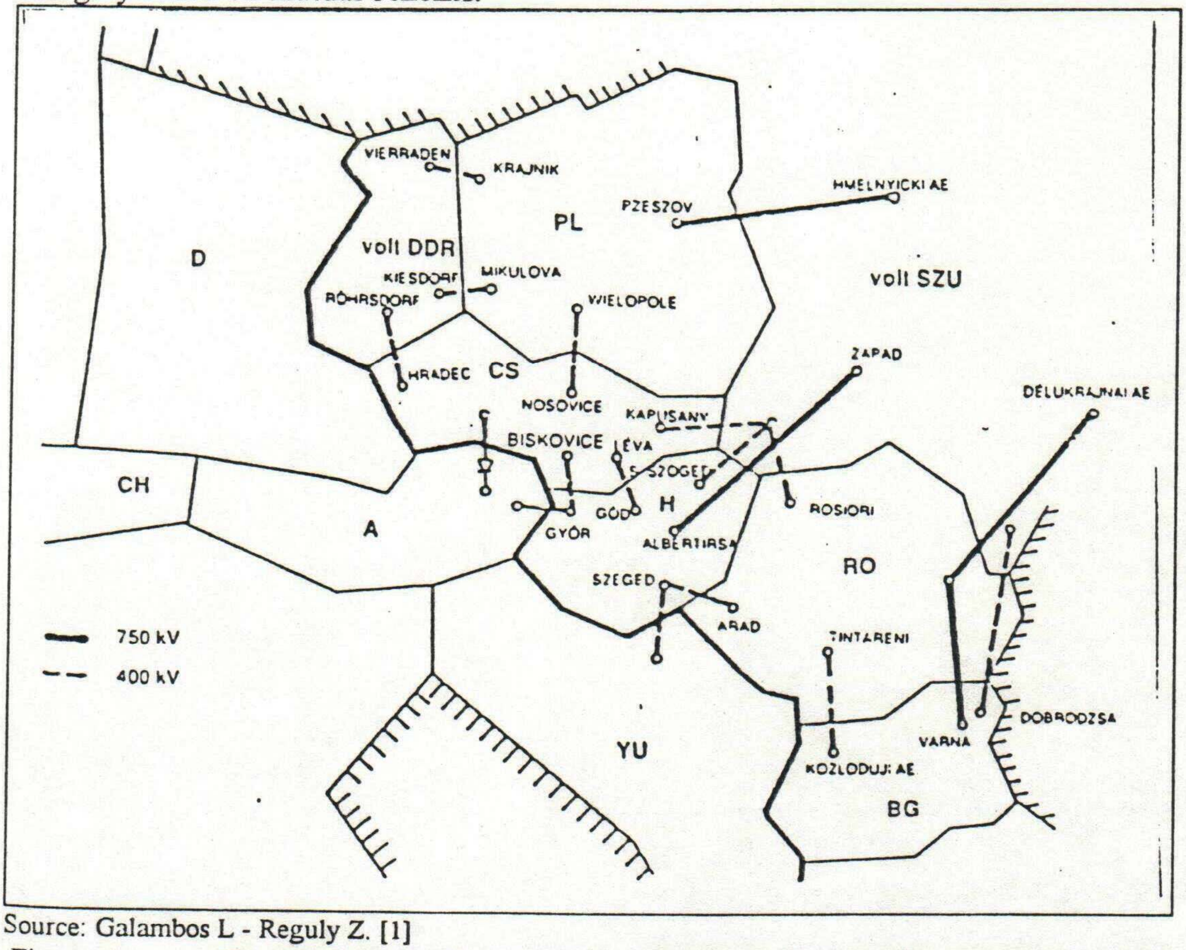
Hungarian coal mining is in a position of defense with regard to these tendencies. The current trend of development is diametrically opposite to making coal compatible with other fuels. And, in full harmony with the present Hungarian energy policy, the power-plant/target-mine mergers are meant to serve the purpose that a given quality of coal be burned in the one plant specifically adjusted to it from a technical point of view, thus mutually ensuring market and supply to each other on a longer term, independently from current world market price tendencies.

Electricity Industry: Visegrad Cooperation - Instead of Iron Curtain

Projecting on to the whole of Central and Eastern Europe, 34% of the total primary consumption of energy is used to generate electric energy.

The 1880s saw the construction of the first public power plants in towns (Temesvár, 1884, and, in today's Hungary, Mátészalka, 1888). Electric power supply first started in Budapest in 1893. Until the 1930s power plants operated characteristically on their own, supplying smaller regions with electric power independently from each other. The first long distance electric transmission line was built in 1929 between the two towns of Bánhida and Budapest with the aim of operating a train line on it. Supplying small settlements with electrical energy on the national grid, becoming gradually more and more uniform, reached completion in 1963 [7].

Upgrading the network to enable connection to the international grid started in 1952 with the view of creating the possibility of import through connecting the Hungarian and the Czechoslovakian networks. This was followed by the connection to Yugoslavia in 1958, and by the handover in 1962 of the first Soviet-Hungarian pipeline. In 1963 the Hungarian electric energy system also became member of the unified CDU system formed among COMECON member States. Apart from that, since 1968, there has been regular exchange of electric power between Austria and Hungary based on mutual benefits.



Source: Galambos L - Reguly Z. [1]

Figure 1. The CDU network and the most important international connections in 1991

The opposition between east and west, and the mere existence of the *iron curtain* was most tangible in the CDU and the UCPTE electric power systems among all technical networks (*Figure 1*). Within that, in the late 80s the Hungarian electric power system featured three main problems [1]:

- strong and direct network-related cooperation with the CDU system, but only feeble relations outside the system.

- large amounts of direct imported electric power and a mono-lateral import-dependence from the Soviet Union

- the quality (network frequency) of the supply did not reach up to European standards

A tentative inquiry got around in the late 80s, followed, in the summer of 1990, by the formal preliminary announcement to UCPTE of Hungary's intention to join. Since the regulations require the neighbouring countries to assess the request, the actual conditions of joining had to be agreed on with the competent persons in Yugoslavia and Austria. The agreement provides the following:

- the equilibrium of the balance and output of energy of the Hungarian electric power system shall be ensured on a long term

- adjustment of output frequency in accordance with UCPTE guidelines shall be applied, and

- a long-distance relation system of the required transmission capacity shall be constructed in order to make synchronised cooperation with UCPTE possible

The feasibility study finished by the middle of 1992 stated that the Hungarian network may be modified to become possible to connect. From among the problems, the setback of the economy, and the exploitation of the existing domestic facilities of power generation made it possible to reduce import 1800 MW down to 500 MW, which itself is split between the Ukraine and Poland, which in fact means that one-sided export-dependence has virtually come to an end. Our mid-term power plant construction programme is scheduled to build capacities in excess of the drop-out due to scrapping. The construction is designed to gradually connect blocks of up-to-date technology that may be flexibly and quickly erected. As concerns safe transmission capacity, the new 400 kW long-distance line extended to Austria due to the electric power repayment relating to Nagymaros is meant to satisfy this condition.

In order to comply with UCPTE standards of output-frequency, the plants will have to be equipped with automatic primary (seconds-based) adjustment. On the capacity side the primary reserves are sufficient. In system-level secondary (minutes-based) adjustment there is need for modernisation, and even the increase of output reserves might become necessary. This does not necessarily mean construction work may be required; it should be considered whether a competitive solution is available through operating uneconomical plants, overloading currently operating ones, or through purchasing secondary reserves.

Representatives of the neighbouring Czech, Slovak and Polish electric power systems has also announced their intention to join the UCPTE. In conformance with

UCPTE's earlier practice it ordered the preparation of the feasibility study and that of the above procedure *by country*. Beginning with 1992, however, UCPTE has changed its rationale and is now managing the joining of all the four countries. So in that respect the Visegrad cooperation actually came live in the framework of CENTREL, the cooperation of the Hungarian, Slovakian, Czech, and Polish electric power systems. The four systems will have to form a four-sided autonomous operation splitting off the Ukrainian system. The main objective is to prove their independent operating and controlling capabilities. On the one hand, this is a constraint in the sense that Russia, which formerly did the adjustment across the whole CDU network declines to continue doing so; and it is sensible on the other hand, as UCTPE does not undertake this obligation either, since it sets the proof of the independent working abilities as a condition to joining. (By the way, satisfying this condition is *easier* than the condition whereby the four countries have to prove their ability to work independently from each other.) The systems test has already been started in 1993. (29-30th of September)

Besides joining the UCPTE, the Hungarian electric power system wishes to keep Russian and Ukrainian import and export links as well as the freedom to transit. This requires the formation of a direct current cartridge equivalent to the necessary output. This cartridge is planned to be installed well inside the country, to the arrival point of the 750 kV line in Albertirsa.

Nuclear Power Plants: Empires of Market and Technology

Even if not as conspicuously as in the case of networks, but even in nuclear power plants there is a *wall*. In this case, however, the wall is based on technology. Soviet power plants have been erected virtually in all parts of Central Europe (plus one in Finland). And they constituted a chain through their recourse to the Soviet Union for supply and reprocessing. One of the new problems is that this kind of *used fuel collecting network* service has been ended.

At present, there is a total of 61 Soviet designed power plants in Eastern Europe [8].

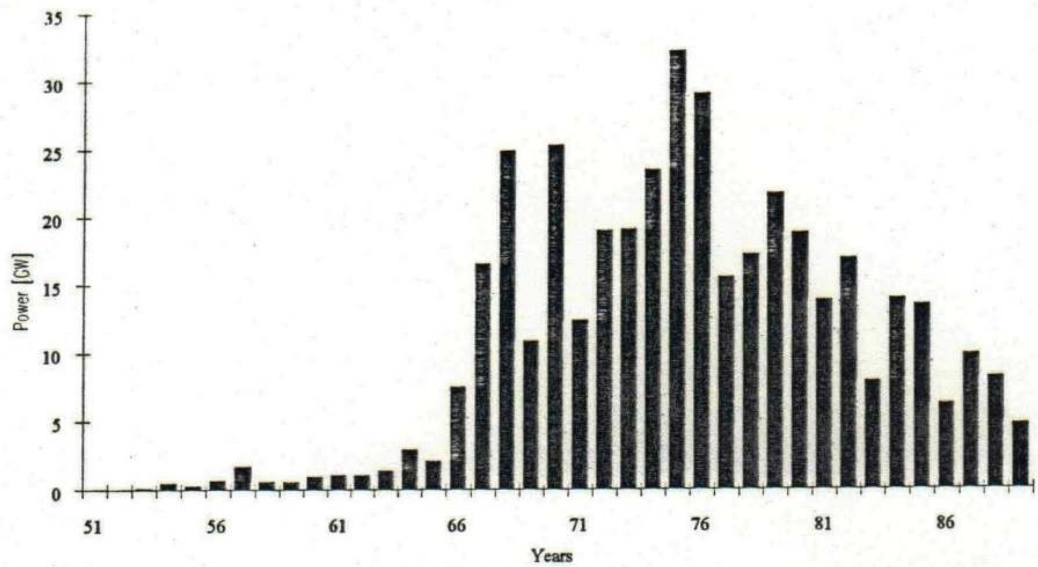
The 2 serviceable Ukrainian blocks in Tshernobil, the 11 blocks in the European part of Russia and the 2 blocks of 1500MW each in Lithuania are Tshernobil-type (RBMK) plants.

The similarly questionably safe VVER-440-230 type is represented by 2 blocks in Russia, 4 blocks in Bulgaria, and 2 blocks in Slovakia. (The four similar blocks in the former East Germany were shut down at the unification, and two blocks in Bulgaria have likewise been put out of operation.)

4 blocks of the VVER-440-213 type - considered safer - are still at work in the Czech Republic, 4 in Hungary, 2 in Slovakia, 4 in Russia and 2 in the Ukraine. The even newer VVER-1000 type is represented by ten blocks in the Ukraine and seven in Russia. Various other types have five blocks in Russia.

There are 25 blocks under construction in the former Soviet Union, 2 in the Czech Republic, 4 in Slovakia, 2 in Bulgaria and 5 in Romania.

The share of electricity generated from nuclear power in the various countries: Hungary 47%, Slovakia 35%, the Czech Republic 21%, the Ukraine 25%, Russia 12%, Poland 0%.



Source: Char, N.L, - Csik, B.J. [9] and IAEA data.

Figure 2. Orders for nuclear plants

If we put the construction of nuclear power plants into a broader global perspective, *Figure 2* obviously witnesses a steady fall of new orders placed over the last decade and a half. The whole cycle recalls a decline of a technology previously swinging upward. The huge pressure between 1989-91 whereby the western countries wildly competing with each other tried to lay their hands on the Hungarian market. By now the pressure *here* has eased up a little, since probably the centre of the potentially aquirable markets have shifted further eastward.

Natural Gas: Distributive and Magistral Networks Gradually Growing Together

Gas production for public purposes came before the spreading of electricity in Hungary. Coal based town gas factories were established one after the other to service street lighting. 1856 saw the establishment of such a factory in Budapest, and two further ones were founded in 1864 in Szeged and Debrecen to be followed by others in a total of ten cities until the end of the century.

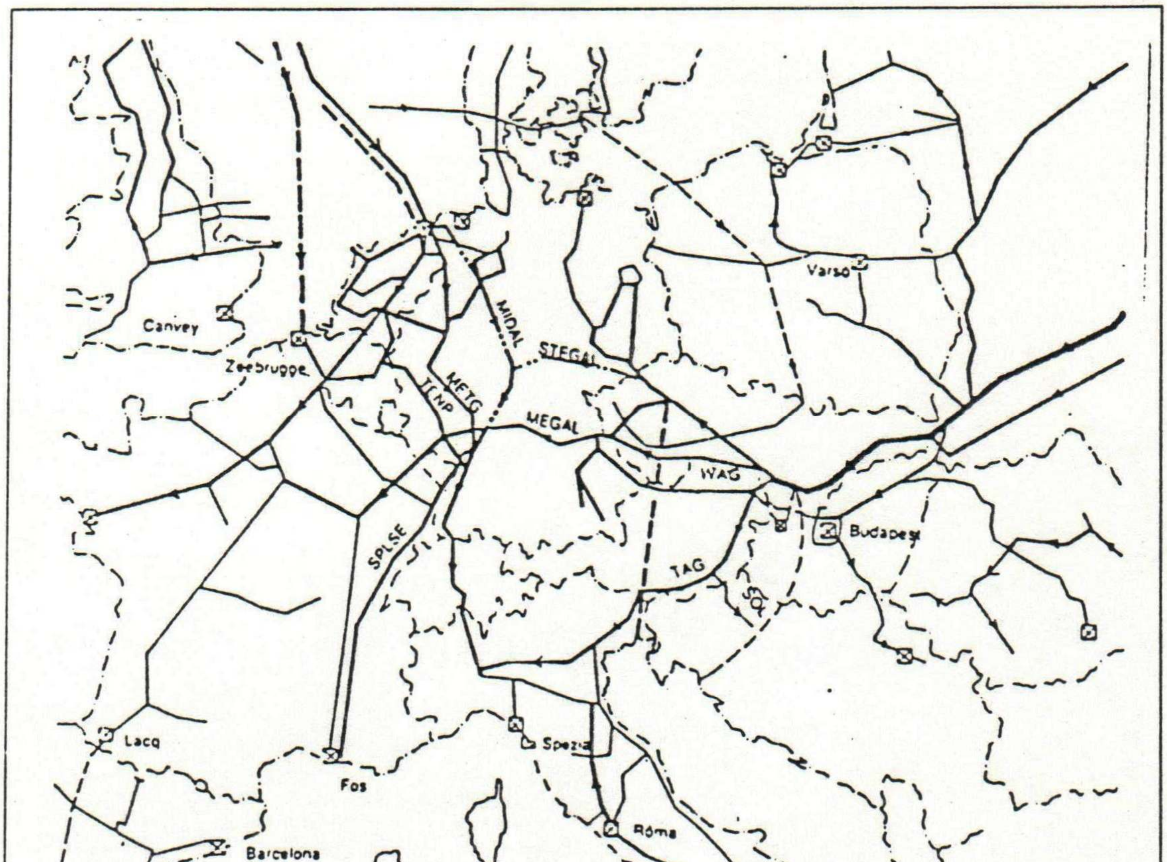
Producing and using natural gas did not start before 1937, and the periods of its growth are a faithful reflection of the history of the last century and a half. The first peak was triggered by German needs during the war, the following upward trend meant the commencement of the operation of a Soviet-Hungarian joint venture in the 50s, while the two other periods of increased production - in the 60s and the 70s - were meant to supply a 'manually controlled' industrialisation following the Soviet pattern. Consequently, the pipeline network was mainly built between the sources and the industrial districts, and reached the length of 2000 km-s by 1970.

In the early 60s, there was also an international link among the lines first constructed, supplying Romanian natural gas to the Tiszapalkonya chemical plant.

Even internationally, trade of natural gas only started at that time: it first meant the pipe connection between the Groningen natural gas fields in Holland and the neighbouring countries, and an Algerian natural gas liquidizer constructed in 1964 using American technology together with the installation of the European receiving station. Soviet natural gas entered the European market in the next decade from a pipeline built up to Germany. The major lines in Europe were constructed in these three 'climatic' directions i.e. sources of the Atlantic, sources of the Mediterranean and Soviet sources (*Figure 3*). This, at the same time meant the formation of two different types of gas supplying systems.

The Atlantic *distribution* system is an organic development of local networks relying on local sources, where - with some reminiscence of the operation of electricity networks - exports could be accounted for in the form of equivalent amounts through chain-transactions between neighbouring areas.

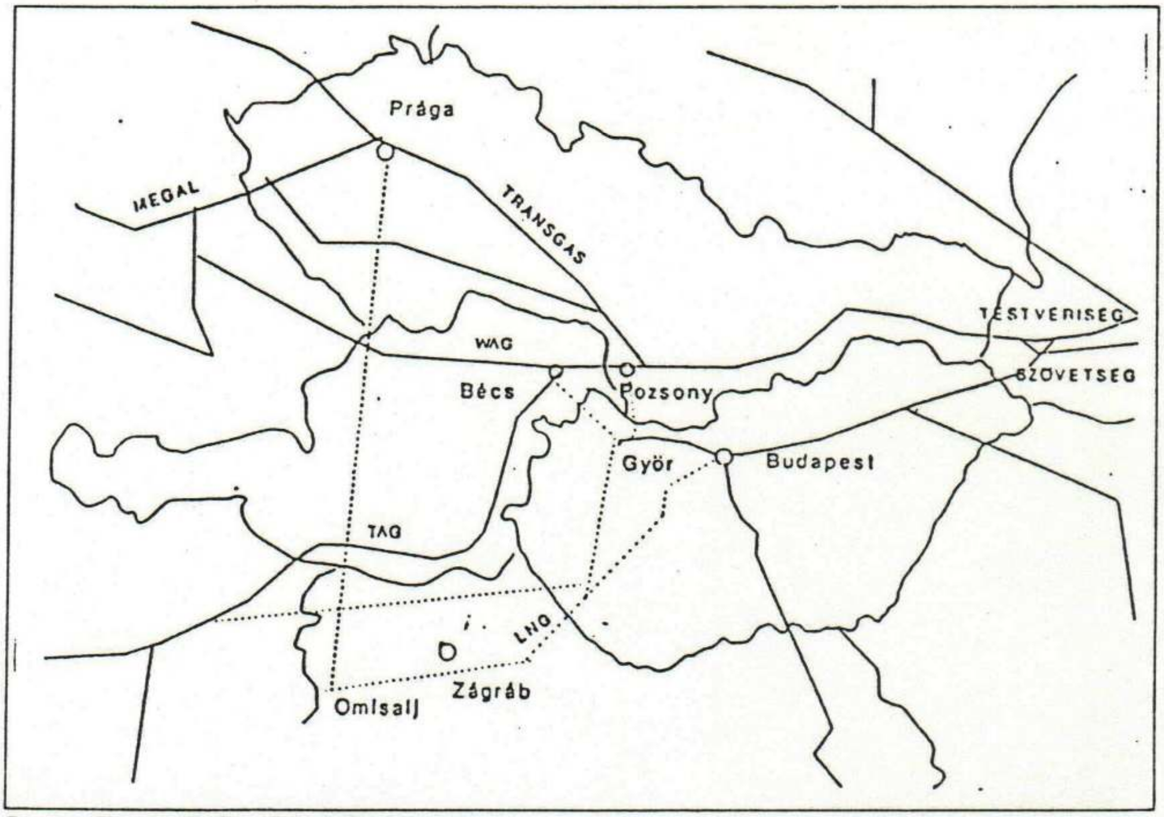
Unlike the above, the main feature of the *magistral* system is the construction of long, independent, large-diameter export target lines. It is built in cases where the source country cannot itself finance the production, and its supply network is also deficient. The user of the gas will then provide funds in order that the gas should reach him/her after overcoming the local difficulties. While technically this is up-to-date and it represents a high level of development, in the source country it results in an enclave-like formation to produce and transport exclusively raw material greatly independently from the local economy. This was characteristic of export departing from both *Algerian* and former *Soviet* territories.



Source: Mramurácz L.. [4]

Figure 3. Possibilities of diversification in the European natural gas pipeline system

Figure 3 provides a good distinction of the three predominant destinations. Norwegian gas from the North sea together with the Dutch gas is fed into the system from the Atlantic. (In 1989 gas exports of these two countries totalled 60 billion m^3). From the south, besides liquid gas supplies already mentioned (this is how just about yearly 16 billion m^3 of natural gas arrives in Europe from Algeria), TRANSMED, the 3000 km Algeria-Tunisia-Italy magistral pipeline was completed in the 80s. In 1989, it conducted 11 billion m^3 of gas into Italy. Ukrainian-Russian gas comes from the south through Slovakia and branches off in the Bratislava region to travel on towards the Czech Republic, Germany, Austria, and Northern Italy. In 1989, a total of 100 billion m^3 of Soviet gas exports was shared on a 50-50 basis by Western and Eastern Europe. (Hungarian imports of the latter amounted to 6 billion m^3.)



Source: Energy Policy. July 1992 [3]

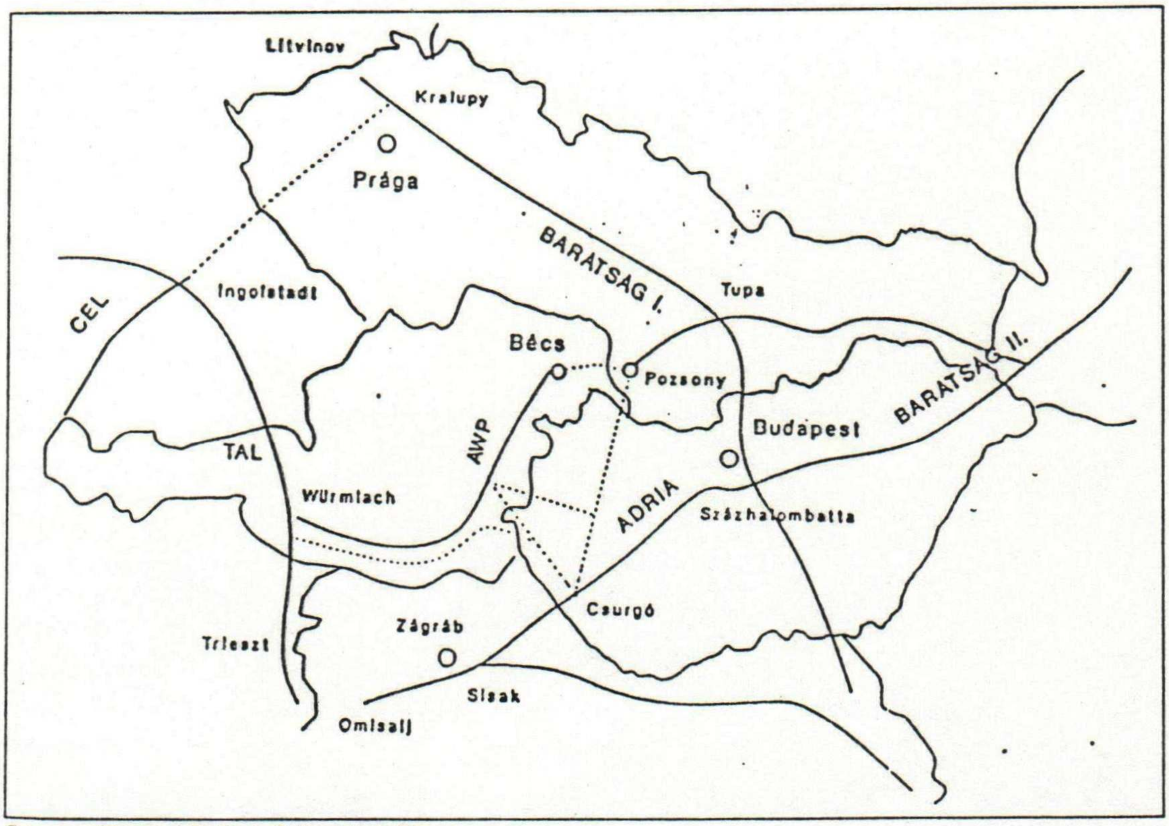
Figure 4. Interconnection possibilities for the Hungarian natural gas pipeline system.

Natural gas supply systems reaching into Europe from various directions apparently merge in German and Northern Italian soil. It was primarily the interest of these two countries to secure the nearly 50 billion m^3 German and just below 30 billion m^3 Italian gas imports from several sides. Linkages to the pipe networks, however, make it possible even for other countries to lift the one-sidedness of that import possibility now that the distributive use of magistral axes may take place on a continental scale.

Eliminating some of the one-sided exposure for Hungary would primarily require that direct connection into the pipeline become *technically* possible even westward, towards Italy and Austria. This purpose will be served by the 118 km pipeline planned between Gyôr and Baumgarten (Vienna), able to conduct 4 billion m^3 natural gas annually. *Figure 4* indicates that our energy concept counts on two further connections: the Slovakian line would also be accessible via Ivánka (Bratislava); a higher level of diversification - but also a one size larger investment - would be necessary to build a link between the Adriatic coast and the Northern Italian region.

In building this last link there would be Italian interest as well, provided that a deal even more attractive for it should not override this interest, which in fact could be at the same time the typical incarnation of one form of cooperation offered to it in a Central European division of labour. To be more precise, for Italy the real advantage would be to have the natural gas coming from the Ukraine burned in Hungary and routed to Italy already as electricity. The environmental load resulting from the production would stay with Russia, the emission resulting from energy generation would stay with Hungary, with the possible energy surplus, with its positive and negative sides - while Italy would have the electric power. It should be noted here that from the point of view of the diversity of Hungarian electric energy the deal would definitely have its attractive sides for our energy management. (The Austrian construction industry sold its surplus capacity in a basically similar construct, when it *helped out* Hungarian water management in the erection of the Nagymaros hydroelectric dam.)

Oil Industry: Early Diversification



Source: Energy Policy. July 1992 [3]

Figure 5. Interconnection possibilities for the Hungarian oil pipeline system.

Oil had been the only type of fuel in the case of which Hungary had two-way relations as early as the 80s even though the Adria pipeline was virtually out of operation and the country relied on Soviet import. Ever since it became important, however, using the pipeline has been impossible (since September 1991) because of the civil war in former Yugoslavia.

Figure 5 demonstrates the pipeline systems crossing Hungary or touching the region. The linkages already completed ensure a connection towards Slovakia, the Ukraine, Serbia, and Croatia, while there is actually no connection with the network outside the 'bloc'. Plans include this as well, but we should add that in the case of crude oil, the line is going to be a target line, which, as pointed out above, work on the *magistral principle.* The capacity of the existing lines is mostly exploited, and together with the construction of the connecting pipe lines, capacity has to be ensured up to a harbour.

Another pillar supporting us in reducing our dependence is ensuring adequate reserves in the particular countries. In 1992, strategic oil reserves in Hungary did not exceed possible demand for 30 days, and storage capacity did not exceed 40 days. Our energy policy intends to expand oil reserves to the West European standards of 90 days within the framework of a 5 year programme. This expansion has priority: there is no specific programme accepted at this stage for diversifying through constructing pipelines.

Summary

The paper analyses the development of the Central European infrastructure networks to see if the present changes can promote a kind of closing up to "Europe". Even if the contact with the western networks have a first priority in every Eastern conception, the different branches of the energy have very different real chances to close up.

Those aspirations that - from both sides - try to create urgently the high-capacity magistral links between East and West, generally do not care about the question of the modernisation of the inner structure of the Eastern networks, in order to develop them for an adaptive, flexible network capable for a self-development, instead of getting into contact with the Western systems as a subordinated annex.

A characteristic exception is the electric power system, where the previous verification of the existence of an internal balance is *an explicit condition of the connection*, that is a verification of the readiness of the Visegrad countries for cooperation. Here the target is an interconnection and cooperation on system level, and here the western partners' aim is *not* to create a market for electricity, just the contrary, they want to avoid, that such a situation should occur lastingly. (The interests of the developed countries rather relates to the exportation of electric power generation equipments.)

The more asymmetrical are the interests relating the network, the bigger ground are gained by those magistral elements of the network, that are not imbedded into the local circumstances. We have to underline, that the magistral elements form an important part of the network development, so it is not only a sign of underdevelopment. But it leads to a conservation of the underdevelopment, if the magistral connection has been formed preceding the basic level net, or preceding a well balanced operation of the basic level net. In this case the interconnection is developing with not the network but with separated enclaves (or even not with that in the case of exclusively transit transports).

These kind of dangers are to be overthinked when determining priorities in network development, first of all in the case of transports. As for the oil and natural gas pipe-line system the European network is just keep on developing to create a real network.

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