S U S T E L N E T

Policy and Regulatory Roadmaps for the Integration of Distributed Generation and the Development of Sustainable Electricity Networks

REVIEW OF TECHNICAL OPTIONS AND CONSTRAINTS FOR INTEGRATION OF DISTRIBUTED GENERATION IN ELECTRICITY NETWORKS

Country overviews of the Czech Republic, Slovakia, Hungary and Poland

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Abstract

This report presents an overview of the technical options and constraints for the integration of distributed generation in electricity networks in four Newly Associated States (NAS), the Czech Republic, Poland, Slovakia and Hungary. It is published as part of Work Package 3 of the SUSTELNET project analysing these technical options and constraints in general. This additional report analyses possible differences between EU MS and NAS regarding these technical options and constraints.

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1. INTRODUCTION

This report presents an overview of the technical options and constraints for the integration of distributed generation in electricity networks in four Newly Associated States (NAS), the Czech Republic, Poland, Slovakia and Hungary. This additional report to the SUSTELNET project analyses possible differences between EU MS and NAS electricity networks regarding technical options and constraints for Distributed Generation. These technical options and constraints have already been studied in the report *'Review of Technical options and Constraints for Integration of Distributed Generation in Electricity Networks'*[1].

For each of the four countries a thorough analysis is made of the layout of the transmission and distribution grid. This is followed by an analysis of the share of DG currently in use and the future potential of Distributed Generation (DG - mainly small-scale combined heat and power and renewable energy sources). Then an analysis of the impact of the currently installed DG on the network and the technical barriers for integration of new DG is made. Finally, a short overview of policy and network regulation is provided.

The final chapter of the report includes a summarised overview of the findings and a final conclusion on the similarities and differences of the NAS and EU MS electricity grids.

[1] John Eli Nielsen (Eltra), December 2002, published on www.sustelnet.net.

2. THE CZECH REPUBLIC

The electricity system of the Czech Republic is based and operated on the same principles as the systems of others UCTE member countries. The national transmission system operator (TSO) ČEPS, a.s., (‘ČEPS’) is a regular member of the International Association of Electricity Transmission System Operators (ETSO)[2] and since 1st January 2003 ČEPS has become participant in the CBT mechanism[3].

2.1 Basic lay-out of the grid

The standardised voltage levels are divided into three categories as follows: low voltage level (‘LV’), high voltage level (‘HV’) and very high voltage level (‘VHV’):

- *Low voltage level* is defined as a voltage level with phase-to-phase voltage up to 1000 V (1000 V including). Common voltage level for power distribution and usage is 380/220 V.
- *High voltage level* is defined as a voltage level with phase-to-phase voltage higher than 1000 V up to 52 kV.
- *Very high voltage level* is defined as a voltage level with phase-to-phase voltage over 52 kV.

The CEPS transmission system is a part of the Czech power supply system, which links major entities operating within the power supply system and across which the majority of cross-border exchanges are carried out. The CEPS transmission system comprises 37 substations of 420 kV and 245 kV located at 30 transformer stations, along with 2,902 km of 400 kV lines and 1,441 km of 220 kV lines. Two 123 kV substations and 134 route kilometres of 110 kV lines are also part of the transmission system. Transmission lines equipped with composite fibre optic overhead ground wire (OPGW), owned by CEZ and operated in 1999 by CEPS, were transferred to joint CEPS-CEZ ownership in 2000, with the major share held by CEPS. CEPS is responsible for electricity transfer, transmission system operation, maintenance and development, and real-time dispatch in the Czech power supply system. It is also responsible for preparing and testing a Defence Plan (to prevent failure spreading) and a Restoration Plan (to restore the power supply after major system failures). It provides technical management of system services such as power-frequency control and voltage and reactive power control, and is responsible for the availability and efficient use of power reserves.

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2 On 29 June 2001 ETSO became an International Association with direct membership of 32 independent TSO companies from the 15 countries of the European Union plus Norway and Switzerland. At the end of 2001 ETSO membership has been enlarged to Slovenia and CENTREL countries as full and associate members respectively. The networks represented by ETSO supply more than 400 million people with electric energy. The consumption of electric energy amounts to approx. 3000 TWh per year.

3 The mechanism to compensate the use of national transmission systems by cross-border trade (CBT-mechanism).

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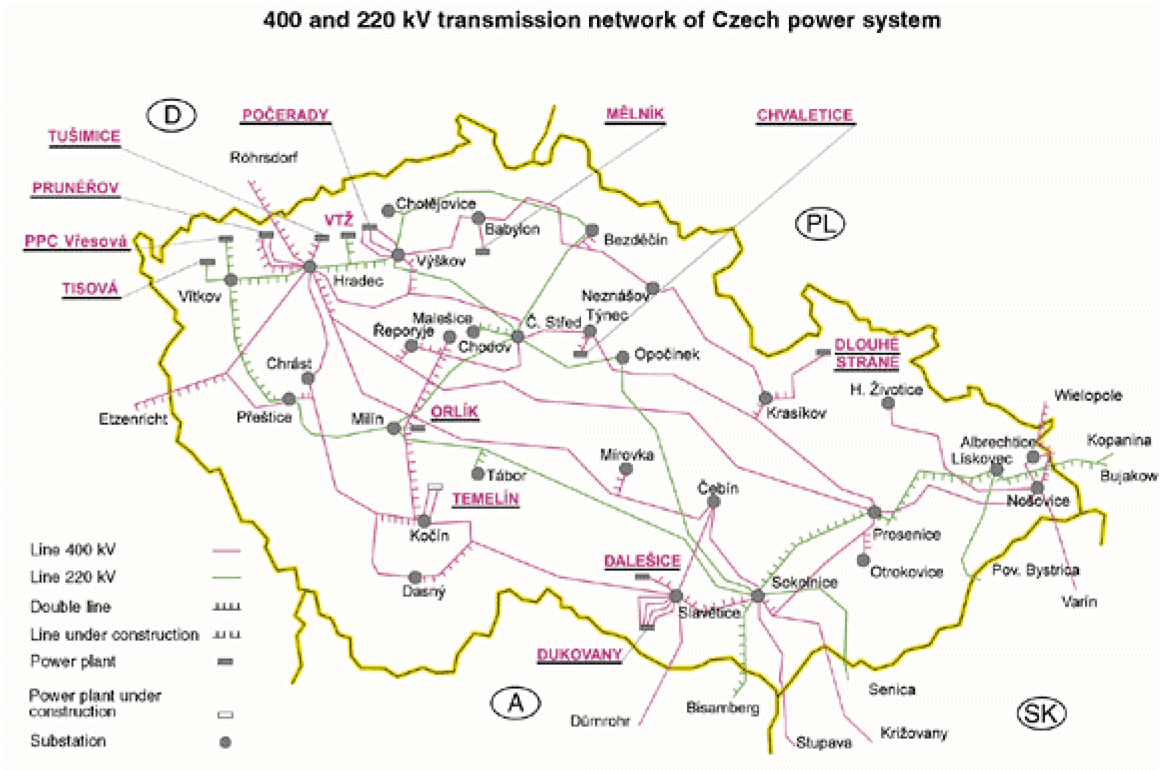

Figure 2.1 *Map of the Czech transmission system*
Source: CEPS, a.s.

2.1.1 Transmission system facilities

A list of transmission system facilities is given in Table 2.1. 2,928 route kilometres out of a total of 5,481 route kilometres of high voltage lines (110 kV to 400 kV) are equipped with optical fibres. Total transformation capacity amounts to 16,770 MVA and total compensation capacity is 1,426 MVAr.

Table 2.1 *Types of lines operated by CEPS, a.s.*

Line Voltage [kV]	Single	Double	Multiple	Total
	Route kilometres			
400	2389	511	2	2902
220	962	479		1441
110	50	54		134

Source: CEPS, a.s.

By virtue of its design, the Czech Republic's 400 kV and 220 kV network fully complies with the N-1 criterion. Stricter requirements apply to the connection of nuclear power stations. The full output of a nuclear power station has to be safely supplied to the network even in case of a simultaneous failure of two feeders from the power station's substation. Further development of the transmission system (TS) is planned in accordance with technical and strategic standards set in the rules for transmission system operation (the Grid Code).

Investment projects currently under preparation are aimed at covering a sharp increase in demand in certain regions or improving the reliability and quality of supply. The projects also respond to changes in transit flows and requests for the connection of new centres of consumption or generation to the system. The major aim of these projects is to improve transmission of electricity generation by current generating facilities to the demand sites. As there is currently a high overcapacity in the Czech power system, DG only plays a minimal role in meeting the demand of strengthening supply. Only in special cases, there is a role for DG in providing system services.

2.1.2 State of the network (weak networks, upgrades and extensions)

Transmission facilities

The electricity network system was built as an integral one on the whole territory of former Czechoslovakia and therefore the strongest interconnection is between the Czech Republic and Slovak Republic[4]. The weakest cross-border connection is with Austria - 1 single line 400 kV and double line 220 kV. Despite this fact the transmission facilities are strong enough for standard operation inside the Czech Republic, for cross-border flows and for appearance of extraordinary events (emergency situations) as well. The envisaged investment in transmission facilities responded to development of demand on electricity in particular areas. For further increase of reliability of transmission in case of extraordinary events, one of the existing lines will be strengthened - the line in the corridor between substations Bezděčín - Čechy Střed.

Distribution facilities

The influence on distribution facilities development is multiple. Since the beginning of nineties all regional distribution companies have made large investments into renovation and strengthening of their distribution facilities. Generally, distribution facilities are in satisfactory conditions. Future development is connected with the company policy regarding to assets development. The present Government decree concerning the quality of electricity supplies and services will be amended (after approval by Electricity Regulatory Office). The level of standards given by this decree represents secondary impact on the investment into distribution facilities.

Common development of the grid facilities is influenced by customer requirements but there is no rash increase of investment into distribution facilities expected. Among some distribution companies, even a slight decline of investments can be noted. Other distribution companies keep a significantly high level of such investment, which is aimed to increase reliability of the distribution facilities, in accordance with their policy. The average level (in the regional distribution companies with public accessible data) of total amortisation and depreciation of tangible fixed assets is below 45%. Huge damages caused by massive flood in August 2002 must be recovered by extra investment into both LV and HV distribution facilities. This recovery program represents without any doubt the preference number one for investment allocation now.

Other specifications

The distribution facility is the interconnected complex of grid and devices on the voltage level of 110 kV (excluding the particular lines and devices of 110 kV, which are part of the transmission system) and lower voltage levels[5]. These lines are designated for electricity distribution on the Czech Republics' territory (including the measurement, metering, protection, control, securing, information and telecommunication technology). Distribution facilities are established and operated in a public interest.

The transmission facility is the interconnected complex of grid and devices on the voltage level of 400 kV, 220 kV and particular lines and devices of 110 kV (described in the Annex to the Rules for Transmission Grid Operation - Grid Code). These lines are designated to electricity transmission on the whole territory of the Czech Republic and interconnection with neighbouring countries (including the measurement, metering, protection, control, securing, information and telecommunication technology). Transmission facilities are established and operated in a public interest.

[4] List of cross-border connections is enclosed in the Annex.
[5] Lines of 380/220 V, 3 kV, 6 kV, 10 kV, 22 kV and 35 kV.

2.2 Interconnection of the grid with neighbouring countries

2.2.1 Electricity exchange on very high voltage level

The regular import and export is done through the 220 kV and 400 kV level. Import (or export) through the voltage level of 110 kV is possible only through so called island operations, because the parallel operation of neighbouring electricity systems is technically allowed only on the level of transmission systems. The electricity demand for these 'islands' is covered from neighbouring countries. The limited demand for electricity in these particular island operations and the reliability criteria limit the cross-border exchange on the 110 kV voltage level.

2.2.2 Electricity exchange on both high and low voltage level

LV and HV lines are not used for the international commercial electricity exchange. Only in a few isolated cases the cross-border connection is used for the supply of some small villages or solitary houses where the delivery is ensured in an easier way from the neighbouring states (the mountain area can be mentioned as a typical example).[6]

The cross-border lines on the voltage of 110 kV to Poland and Slovakia are used for regular electricity import and export. Only one double line out of 10 lines has been newly constructed, the others were build in past. The new direct line connects Northern Moravia distribution area with Poland and is used partly for supply of an industrial steel company and partly for trading with electricity. No regional distribution company intents to construct new cross-border line now or in the near future. There are two main reasons for this decision:

- Rules for electricity system operation in the Czech Republic and other countries do not support international electricity exchanges on distribution level.
- The construction of new lines is complicated due to objections of the environmental protection movement and private ownership of land (i.e. acquisition of land in the whole corridor would take long time not only due to negotiation with owners, but also due to necessity to obtain construction permission which is subject to public review).

2.2.3 Yearly electricity exports/imports between the Czech Republic and neighbouring countries

Table 2.2 *Export and import of electricity in the year 2002 [TWh]*[7]

Export on level 400 and 220 kV	-20.9
Import on level 400 and 220 kV	8.4
Export on level 110 kV	-0.3
Import on level 110 kV	1.1
Balance	-11.4

Source: CEPS, a.s.

Table 2.3 *Share of cross-border profiles on the exchange of electricity in the year 2002 [TWh]*

Neighbouring country	Balance (import - export)[8]
Germany	-7.9
Poland	2.6
Slovakia	-1.1
Austria	-5.0

[6] In most cases such arrangement resulted in the Czech-Slovak border area after the split of Czechoslovakia.
[7] Export and import figures on the level 400 and 220 kV include transit.
[8] Preliminary figures, figures for levels 400 kV, 220 kV and 110 kV are given together.

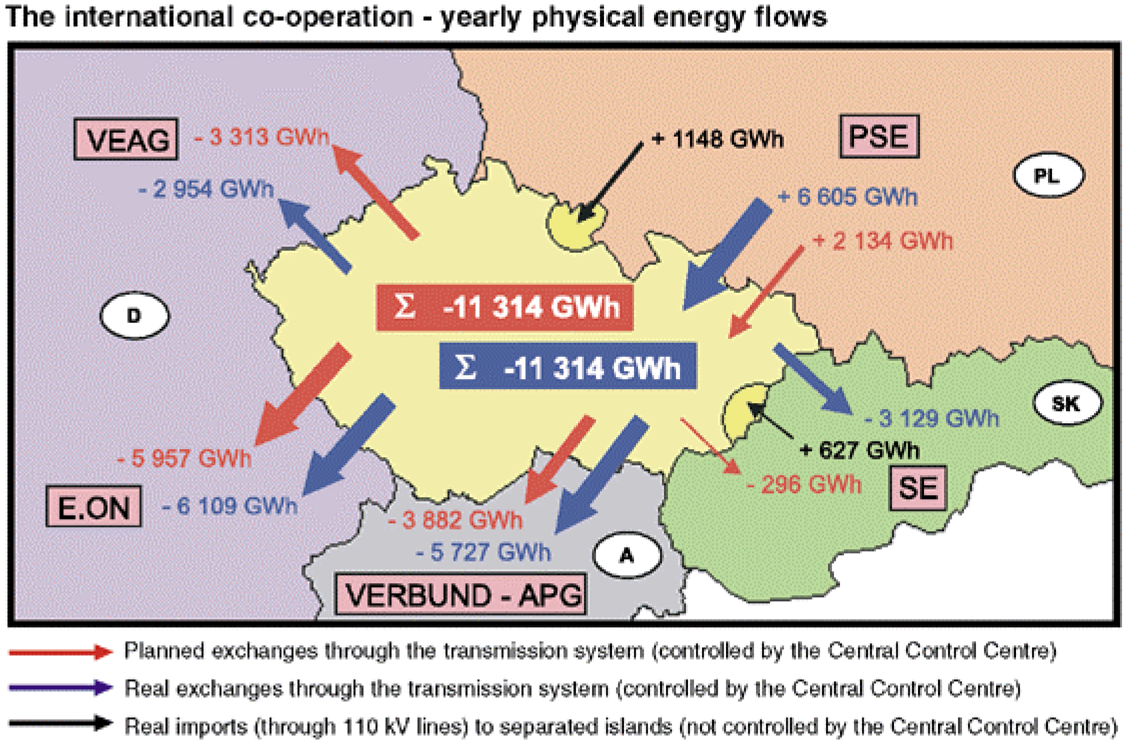

Figure 2.2 *Presentation of export and import of electricity in the year 2001 [TWh]*
+ Import to CR - Export from CR
Source: CEPS, a.s.

2.2.4 Capacity of international interconnections vs. national production capacity

The available transmission capacity on the cross-border profile is decreased by the so-called loop flows among transmission systems of the Czech Republic and all neighbours. Free capacity for commercial exchange for the whole year is published by the respective auction offices (E.ON Netz for the Czech-E.ON Netz German profile, Vattenfall Europe Transmission for the Czech-Veag German profile, ČEPS for the Czech-Slovak and Czech-Polish profile, Austrian Power Grid for the Czech-Austrian profile) and the additional capacity for each month are given according to actual conditions for transmission system operation. The yearly capacities on the different profiles are shown in the Enclosure No. 1.

The maximum load in the electricity system of the Czech Republic was achieved in the year 2002 on 12th December, the load reached 11,193 MW. The balance of electricity export and import was in moment of maximal load -377 MW (surplus of export is marked as minus). Total installed capacity on the 31st December 2002 was 16,310.5 MW, total net production in the year 2002 was 70.4 TWh, total net consumption was 53.7 TWh and balance of electricity export and import was -11.4 TWh (surplus of export is marked as minus). Because of surplus of power balance in the Czech Republic within the whole year, producers are interested in export.

Main reasons for export of electricity are the following ones:

- The installed capacity of independent producers has increased significantly - their production increased by 9 TWh in the year 2000 in comparison with the year 1993.
- The domestic demand was predicted higher than real consumption in several previous years due to much deeper drop of the economic output than expected.
- A significant surplus has been exported since the year 1997, due to favourable prices of electricity from Czech power plants.

A similar tendency is expected in the near future as well.

2.3 Share of DG and RES now and in the future

2.3.1 Share of present electricity productions stems from different DG

Distributed generation in the Czech Republic includes the following types of generating facilities:

- Coal-fired CHP plants operated by IPPs (district heating companies, auto-producers) with installed capacity up to 55 MWe per unit.
- Combined cycle gas turbine and gas-fired CHP plants operated by district heating companies.
- Small and medium-sized hydro power plants operated by IPP and also by DSOs (plants < 10 MW).
- Wind and other RES-E sources.

The review of supply from DG facilities connected directly to the distribution system in 2002 is presented in the following table. The share of DG in total net electricity generation was 32%.

Table 2.4 *Electricity supply from DG facilities connected directly to the distribution system in 2002, in [GWh]*

Technology	IPP facilities	DSOs facilities	Total
Coal-fired CHP plants	20,155.0		20,155.0
Combined cycle gas turbine + gas-fired CHP plants	563.1		563.1
Hydro power plants	1,773.8	248.6	2,022.4
(share of Pump storage power plants)	(12.4)		(12.4)
Wind and other RES-E sources	1.6		1.6
Net generation total	22,493.5	248.6	22,742.1
Total electricity generation			70,393.2
Share of DG on total net electricity generation [%]			32.3

2.3.2 The typical level of grid connection for DG and RES technologies

The most important RES for electricity generation are small hydro generating facilities. As far as the numbers of RES concerns, the majority of them are connected to the LV, but more important are the facilities connected to the HV. Their installed and production capacity exceeds the capacity of significantly higher number of facilities connected to the LV. In the Czech Republic as a small hydro generating facility is supposed such a facility which electricity generation output is up to 10 MW.

The majority of DG facilities are combined heat and power production units. The most important ones are connected to VHV (110 kV) level. The Energy Regulatory Office (ERO) collects statistical data about the electricity generating facilities from independent power producers. On 31st December 2001 there were 24 legal bodies (excluding ČEZ, the biggest electricity producer) registered which were operating 35 generating facilities. ERO specifies 30 of them as "important sources". 12 facilities are connected to VHV (110 kV) and 18 facilities to HV. The other category are the so called auto-producers (i.e. generating facilities supplying mainly own legal entity and delivering less than 80% of yearly production to another market participant). There were 64 legal bodies operating 65 generating facilities (figures valid at the end of 2001). ERO specifies 35 of them as "important sources". The connection voltage level is VHV (110 kV) for 23 facilities and HV for 12 facilities.

2.3.3 Description of energy policy and implementation programmes for DG and RES

In the Czech Republic more indicative targets dealing with RES exist:

- The Energy Policy document of January 2000 presents the target of 3-6% of RES on Total Primary Energy Resources (TPER) in 2010.
- The Environmental Policy document of January 2001 presents a target of 4-6% RES in TPER in 2010.
- The National Programme for Promotion of Energy Efficiency and a Wider Use of RES and Waste Energy (National Programme) presents a target of 3.2% of RES in TPER in 2005; and presents a target of 5.1% RES in gross electricity consumption in 2005.

It is difficult to find reliable data on the current use of RES in the Czech Republic due to incomplete statistics.[9] Based on incomplete data from the Czech Statistical Office and some assessments, the current share of RES on TPER can be estimated as less than 2%. The most difficult task is the assessment of the consumption of non-market fuels, mainly biomass, for local heating. In case of RES electricity better statistical data are available, nevertheless, electricity generation from very small-sized hydro for own use may not be covered by statistics, as these sources do not need to apply for licenses. In the year 2002 the share of electricity from renewable energy sources (RES-E) on total gross electricity consumption was estimated as high as 4.1% but because during that year an extraordinary level of precipitation was recorded, the electricity generation was higher than a long-term average of 3.7%.

In the Czech Republic there were many papers published in which some assessments on RES potential were presented. The most comprehensive analysis was done within the National Energy Efficiency Study (NEES), which was carried out under supervision of the World Bank in 1999. The summary data on the RES potential from the NEES updated in 2002 are presented in Figure 2.3., including data for the year 2000. The available potential is a technical potential reduced by restrictions related to environment protection while the economic potential covers that part of the available potential which is economically viable (i.e. the payback period is not longer than the economic lifetime of the RES technologies).

The major RES potential is concentrated in biomass use, mostly for heat production- about 80% of available potential; the economic potential is triple of the current use.

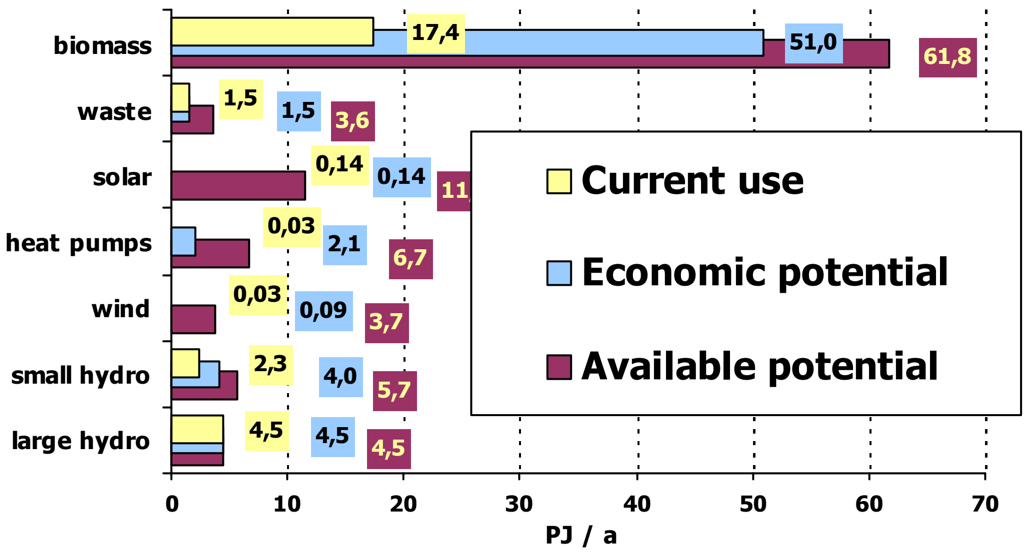

Figure 2.3 *Current RES use and potential in the Czech Republic for the year 2010 [PJ/a]*

[9] Due to that the European Commission approved a PHARE project on capacity building in RES statistics in the Czech Republic. The project will be carried out during the year 2003.

Only a limited part of RES potential is RES-E potential. Table 2.5 presents the recent calculation done by ENVIROS, s.r.o., carried out in the process of preparation of the Czech Energy Policy document.

Table 2.5 *Current RES-E generation and potential in the Czech Republic [GWh/a]*

RES-E source	2000	2005	2010
Wind energy	1	570	930
Small hydro	680	890	1120
Large hydro	1165	1165	1165
Biomass and biogas	200	360	1000
PV	0	0	15
Total	2046	2985	4230

Table 2.6 *Estimated investment costs for RES-E facilities [billion CZK]*

RES-E source	Till 2005	2006-2010	Total
Wind energy	17.2	5.3	22.5
Small hydro	9.2	4.9	14.1
Large hydro	0	0	0
Biomass and biogas	1.7	3.5	5.2
PV	0	1.5	1.5
Total	28.1	15.2	43.3

The share of RES-E on total domestic electricity consumption in 2005 is estimated at 4.7% and in 2010 at 6.2%. This estimation of the RES-E share is assumed to be optimistic and could be reached in case of:

- Installation of 400 MW in wind energy plants until 2005 and additional 150 MW until 2010.
- Utilisation of the full small hydro potential in 2010.
- Operation of the current large hydro potential and no additional capacity in large hydro.
- Prolongation of validity of the current level of advantageous feed-in tariffs of 2003 till 2010.
- Continuous growth of fossil fuel prices (slow in case of coal, faster in case of gas and oil).
- Investment grants to new RES installations (direct subsidies, soft loans, loan guaranties, low or not tax) which would cover up to 20% of investments, i.e. about 1 billion CZK per year.

Within the agreement on Accession of the Czech Republic to the EU, the Czech Republic agreed to a tentative target of 8% RES-E in 2010. This target has not yet been specified according to sources of RES but it is higher than the expected share for the year 2010 and will require additional efforts.

2.3.4 Technical barriers with regard to the planned development

The possible development of RES and DG must be checked from the point of view of technical feasibility (technical potential) and economic viability (economic potential).
Each particular kind of RES has different conditions for further development in future. Construction of a new huge hydropower generating facility could not be supposed as realistic due exhaustion of suitable locations, but also due to environmental protection considerations.

Wind generating facilities are not allowed to be built in national parks and other protected natural areas. Technical barriers for construction of new generating facilities are given by climatic conditions and by limited quantity of suitable locations (for example biomass production).

Table 2.7 *Possible negative local and regional environmental impacts of renewable energy installations*

Technology	Local impacts
Wind energy	Noise, visual intrusion, electromagnetic interference. Back-up generation or energy storage may be needed to overcome intermittent generation by wind turbine.
Hydro-power	Water usage, visual intrusion. New hydro development capital intensive.
Solar thermal and PV	Visual intrusion.
Biomass: agricultural and forestry wastes	Particulate / NO_x emissions. Visual intrusion. Fuel transportation.
Biomass: energy crops	Particulate / NO_x emissions. Fuel transportation. Visual intrusion. Small scale production - higher costs.
Geothermal energy	Water pollution, susceptible to pressure and temperature degradation.

These system integration constraints can occur in relation to integration with power generating and transmission utilities. The prominent supply of power is through a national and interconnected grid that is supplied by large power stations. Introduction of new, innovative schemes meets different attitudes according to regions. Specific barriers include:

- Lack of efficient energy storage technologies - without these technologies systems cannot provide continuous energy supply.
- Wind power generation is intermittent and may not meet the requirements for dispatching without backup generation such as gas turbines or other energy storage.
- Impact of asynchronous generators on the grid.

Nevertheless, some renewable energy sources (small hydro-power, small CHP) connected to a rural power distribution network can improve the reliability and quality of power supply. This is mainly the case of small hydro-power plants that can strengthen power supply in areas close to the national borders that are at the end of power distribution networks.

The total losses in both power transmission and distribution are 8.9% of which losses in power transmission are about 1/3.

2.4 Existing standardised rules for grid connection of DG

The rules for grid connection in the Czech Republic are standardised and publicly available. The basic rules are stipulated in the Energy Act, No 458/2000 Coll. and in the decree of the Ministry of Industry and Trade on conditions of interconnection and transport of electricity in electricity system, No. 18/2001 Coll.
The most detailed descriptions are given in:

- Rules for Transmission Systems Operation (Transmission Grid Code) - set by the independent Transmission System Operator (ČEPS, a.s.).
- Rules for Distribution Systems Operation (Distribution Grid Code) - set by Distribution System Operators.

Both the Transmission Grid Code and the Distribution Grid Code are approved by the Energy Regulatory Office.

The Distribution Grid Code is valid on the territory of all regional distribution companies in the Czech Republic. The Code describes besides other issues the obligatory technical specification of electricity generating facilities for parallel operation with distribution facility (see chapter 1a, iii), reactive power regulation, conditions for switching-on generators in public grid, possible influence on ripple control (widely used in ČR) etc.

The distribution system operator is entitled to set precise technical condition according to operating rules valid for particular part of distribution facility, these rules cannot be in contradiction with common Distribution Grid Code. The Distribution Grid code includes the following chapters:

- Terminology and definition.
- General condition for the use of the distribution system.
- Planning and connecting rules for the distribution system.
- Operational rules for the distribution system.
- Break-down planning and reserves
- Rules for exchange of documents, data and information and rules for registration of data about the distribution system.

2.4.1 Institution entitled to set the rules

The rules given in the Transmission Grid Code and Distribution Grid Code are issued and published by relevant operators upon the approval by ERO. The descriptions of particular conditions contained in codes are based on results of expertise and discussion, which is held by experts.

2.4.2 Standardised process for grid connections

Standardised process for grid connections has already existed. The Energy Act and the Act on Energy Management stipulate some conditions for construction of new power plants. Construction of electricity generating plants with capacities of 30 MW and higher shall be allowed only upon state approval ('authorisation'). The Ministry for Industry and Trade is entitled to grant the authorisation.

Decree No. 18/2001 Coll. (decree on conditions of interconnection and transport of electricity in electricity system) deals besides other with the share of the applicant (investor) on the costs caused by connecting of new facility to distribution grid. Technical details for grid connection are mentioned in the Transmission Grid Code and Distribution Grid Code.

2.5 Other relevant national circumstances

The Czech Republic is in the process of economic transition aiming to market liberalisation of all kinds of energy sources. The sale of certain energy products is still regulated. The price of heat for final consumes is fixed by a price formula to a regulated price. Benefit from the possible price increase is not necessary shared by all subjects in the whole supply chain. Due to the fact that between energy producer and consumer there are usually many intermediate bodies (traders, TSO, DSO) the producer usually has the lowest chance to profit on an increase of end-user prices. The number of intermediate bodies should be minimised to increase the remuneration of producers and thus DG can improve the situation in the future.

The present regulation system will expire in two years. It has not been clarified until now what kind of regulation including the incentives for RES and DG could be implemented. The most probable future scheme of support of RES and DG will be:

- Right for priority connection to the transmission and distribution system.
- Right for priority transmission or distribution of produced electricity trough transmission and distribution system.
- Regulated feed-in tariffs (market price of electricity with regulated premium - bonuses will be differentiated according to the type of RES and CHP.
- Guarantee for investors that future changes in the support scheme will not change the average economical results of the investment for next maximally 10 years.

- Regulated participation of distribution companies on costs connected with investment to the connection of RES and CHP to the existing system.
- No incentives for DG without CHP based on fossil fuels.

The present system will be in place until the electricity market will be fully opened, planned for January 1st, 2007. Before that time, probably around 2005/2006 the impact of the existing incentives should be analysed and changed if necessary or adapted to the unified EU system of support.

3. SLOVAKIA

3.1 The Slovak Electricity System

The electricity system of the Slovak Republic is operated as an independent regulatory zone[10] in co-ordination with the interconnected electricity systems of the regional group CENTREL, being operated in parallel with the UCTE unifying the European interconnected electricity systems. For this reason, the Slovak electricity system is subject to the UCTE characteristics and rules (e.g. a need for constant frequency ranging between 50 Hz ± 0.02 Hz).

Table 3.1 *Basic electricity sector data (2001)*

Surface area of the territory supplied with electricity		48,500 km^2
Population		±5,400,000
Number of consumers	Large consumption	12,000
	Small consumption	2,200,000
Installed capacity of generating stations		8,325.5 MW
Total generation		32.0 TWh
Total consumption		28.3 TWh

3.1.1 Basic Layout of the Grid

The electricity system of former Czechoslovakia had been developing in parallel with co-operation with the systems of neighbouring countries, while gradually accommodating to the needs given by the growing electricity demand. In the 1970`s higher demand for electricity import from the Soviet Union to the countries of RVHP (The Council for Economic Co-operation among socialist countries) lead to the construction of a strong interconnection with the Soviet Union. On the territory of Slovakia 400 kV transmission lines were constructed, at first, connecting the system with that in the Soviet Union, and later on, with Hungary. As a result of political and economic changes the main dispatching centre of the RVHP countries ceased its existence. Since the year 1990 the national electricity system has been working with the UCPTE system (Western European countries). The electricity system of the Slovak Republic was at first operated in a synchronous interconnection with the CENTREL system, later on, after completing a two-year trial period of a parallel operation, Slovakia has become a full member of the UCTE.

Transmission of electricity from generating stations to distribution networks and several large-size consumers connected to an extra high voltage level, i.e. 400 kV and 220 kV, is provided by Slovenská prenosová elektrizacná sústava, a.s. (The Slovak Transmission System company - SEPS) that is also responsible for the import, export and transit of electricity. The transmission system also includes the 110 kV lines with a total length of more than 100 km (mostly double lines). There are 24 substations at all voltage levels in the transmission system. Electricity distribution to final consumers is carried out through extra high (110 kV), high (22kV) and low (presently mostly 0.42 kV) voltage levels.

A total length of low voltage networks being 48,842 km (predominantly outdoor lines) is divided as follows:

[10] A regulatory zone is defined as the electricity system physically confined by the points of metering the balance for the secondary regulator of active power among individual regulatory zones of the interconnected system. That is in fact the whole electricity system of the Slovak Republic.

Table 3.2 *Length of transmission and distribution lines in Slovakia [km]*

kV			SEPS, a.s.	ZSE, a.s.	SSE, a.s.	VSE, a.s.	Total
400	EHV		1,752,6				1,752,6
		Double lines	243,0				
220	EHV		962,2				962,2
		Double lines	174,0				
110	EHV		101,2	2,704	2,624	1,255	6,684,2
22	HV			12,455	9,729	7,855	30,039
Mostly 0.42	LV			19,116	19,269	10,457	48,842

Since no major investments have been made into the electrical systems over the past years, as claimed by relevant stakeholders, extensive upgrading needs to be undertaken, particularly in the case of distribution networks (a large number of planned activities have been incorporated into development plans of individual regions). In its initial price decisions applicable for the year 2003 the regulatory authority therefore allowed distribution companies to include into their justified costs a significant amount of funds to be used merely for the purpose of the reconstruction and the construction of new lines.

Development Plans (the Concept on Territorial Development of Energy Systems in the Slovak Republic) also include the construction of several local interconnections at all voltage levels. It is planned to construct:

- double and single 400 kV lines,
- double 110 kV lines,
- 400 kV substations,
- 400/110 kV transformer stations.

The Slovak Transmission System Company is currently leading discussions concerning any possibilities of strengthening the inter-state transmission lines by doubling some of the 400 kV lines. There is obviously an intention to phase out the 220 kV lines, as presently stated by the staff of the Transmission System Company and as presented in development plans.

3.1.2 International Interconnections

As shown on the map of the transmission system, Slovakia is interconnected with all its neighbouring countries, except for Austria (there has been no interest from the Austrian side, so far). Interconnection at the level of the 400 kV transmission system:

- One double line interconnection with Poland, the other interconnections are made with single lines: there are three interconnections with the Czech Republic, two interconnections with Hungary and one interconnection with the Ukraine.
- There are two interconnections with the Czech Republic at a level of the 220 kV transmission system.
- An interconnection of distribution systems (extra high voltage level of 110 kV) exists with the Czech Republic and the Ukraine.

Trading between Slovakia and its neighbours is carried out mainly in a North-South direction, hence it is necessary to strengthen mainly the profile to *Hungary* that is presently insufficient. An interconnection of Rimavská Sobota (or Moldava) - Sajóivánka is under preparation at the moment.

Table 3.3 *Electricity exchanges (in TWh) through individual profiles with neighbouring countries*

Import from:	1999	2000	2001	Export to	1999	2000	2001
Czech Republic	2.85	4.26	3.71	Czech Republic	1.53	1.27	1.21
Poland	1.28	1.70	2.02	Poland	0.00	0.00	0.00
Ukraine	0.91	0.39	0.33	Ukraine	0.04	0.20	0.22
Hungary	0.01	0.00	0.00	Hungary	3.52	7.55	8.31
Total	5.05	6.35	6.06	Total	5.09	9.02	9.74
Balance	+0.04	+2.67	+3.68				
Total Production	27.89	30.89	32.00				

It is clear from the data above that more than 85 per cent of electricity was exported (including transit) to Hungary in 2001, however, due to capacity constraints it cannot be higher. The balance with the Czech Republic is negative in the long run. Exchanges are carried out through the HV transmission and distribution systems (distribution utilities import electricity from the Czech Republic to the so-called 'islands' that are not part of the Slovak transmission system). As regards Poland, there is no electricity export, only import from Poland to Slovakia. Electricity exchanges with the Ukraine are less significant.

The losses of the Slovak electricity system are summarised in the table below, showing that more than 80% of losses are occurring in the distribution network.

Table 3.4 *Electricity losses of the EHV, HV and LV networks*

[GWh]	2000	2001	2002
Losses of regional distribution utilities	1600	2119	1765
Losses in the transmission system	223	220	240
Total gross losses	1823	2339	2005

From the technical standpoint, the current level of electricity generation may be increased (some additional capacity is provided by generating stations as well as 'excess' installed capacity), however, the electricity price and business opportunities with respect to electricity sales make such an investment in new generation capacity questionable.

Through the analysis of the installed capacity it has been concluded that current excess capacity of Slovakia reaches around 700 MW (9.6% of the installed capacity of the Slovak Republic). After the year 2006 and 2008 several generating stations are to be decommissioned (two units of the nuclear power station as a result of a political decision, four thermal power station for environmental reasons). Their overall capacity exceeds 1,300 MW, i.e. roughly 16 per cent of the existing installed capacity). After the year 2008 the situation will be rather opposite, Slovakia will be in shortage of installed capacity (about 1,200 MW will be missing provided that at least the low scenario is followed), unless new generating stations are constructed.

Figure 3.1 *The Transmission System of the Slovak Republic*

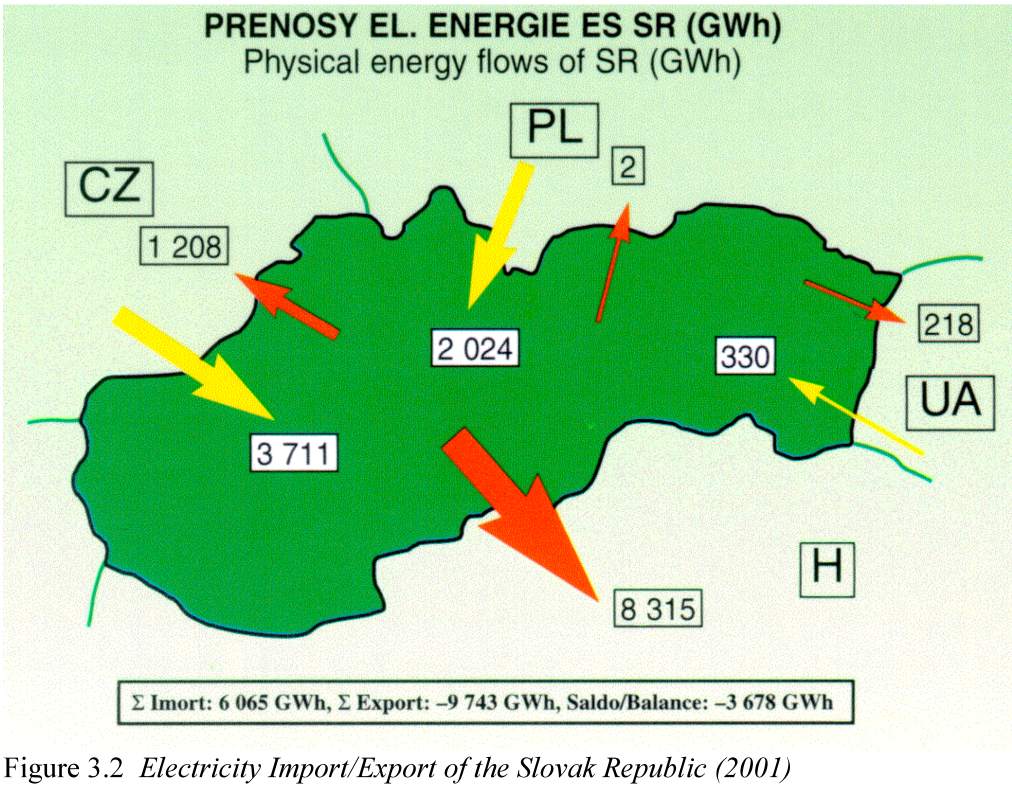

Figure 3.2 *Electricity Import/Export of the Slovak Republic (2001)*

3.2 Present and Future Potential of DG and Renewable Energy

3.2.1 Generating Assets and Proportion of Electricity Generation

The structure of generating assets had been gradually evolving in the conditions and for the needs of a substantially larger power system of the former Czechoslovakia. The second decisive factor with an impact on the structure of generating stations was the fuel basis (local coal, fuel import, etc.).

In the past the existing generating assets of the public energy systems - *balancing power stations* were substantially influenced by the planned development of nuclear power stations. Following the separation of the electricity system of the Slovak Republic it was essential to improve environmental performance of the operational power stations through the implementation of upgrading projects, covering nuclear power stations (2,640 MW), thermal power stations (almost 2,000 MW) and a few hydro power stations.

3.2.2 Distributed Generation

Public combined heat and power plants (CHP plants) represent the plants of a higher unit output, while the boiler park is usually accommodated to any increase in heat demand. There are eight such generating stations with a total installed electrical output of 323 MW. Their share in the total electricity generation in 2001 accounted for roughly 3 per cent, i.e. 958 GWh. The upgrading activities recently completed in the CHP plants were focused on the switching to refined fuels and improvement in energy conversion efficiency. All CHP plants deliver electricity to the distribution network (110 kV).

Industrial power stations cover about 10 per cent, i.e. 800 MW, of the overall installed capacity of the Slovak Republic. This group includes mainly CHP plants of a smaller unit output with a preferable heat supply for technological purposes. Their use or any further construction depends on the needs of a specific enterprise and the economic situation and perspective development of individual owners. Electricity generated by an industrial power station is usually used within the premises of such enterprise. Any excess electricity exceeding the company needs is contractually sold to public distribution systems, or, any missing electricity is purchased from a respective distribution company. The overall production of such generating stations achieved 2,917 GWh, i.e. more than 9 percent of the total electricity generation.

Small-size cogeneration plants - There are approximately 130 small-size cogeneration units installed on about 60 sites, with a capacity ranging from 20 kW_e to 1,200 kW_e, a total installed capacity exceeding 16 MW_e and an annual electricity generation roughly 90 GWh.

Besides small cogeneration units there are five cogeneration plants in Slovakia (with a capacity ranging from 5 to 14 MW) with an installed capacity of 50 MW_e. Recently this number was extended with a new generating station with a capacity of 4.5 MW_e, (operational data is not available yet).The largest CHP plant in Slovakia, the combined cycle plant Bratislava with an installed electric output of 218 MW, is generating almost 1,166 GWh in 2001. The plant is partly used for the purpose of regulation; therefore, it cannot be included in the category of DG plants. There are no other CHP plants used for the purpose of balancing/regulation. Hydro power stations and large-size thermal power plants are balancing plants, however, these do not belong to DG under this project.

Natural gas represents the basic fuel used in Slovakia. With relation to this, the existing gas supply system supports an extensive use of cogeneration technologies, as well.

3.2.3 Renewable Energy Sources

According to the National Energy Policy the technically exploitable potential of RES for the purpose of electricity generation is as follows:

Table 3.5 *Overview of current and future RES potential*

RES source	Technically exploitable potential [GWh/year]	Current potential [GWh/year]
Hydro power	6607	5000
Biomass	1270	85
Geothermal energy	60	0.35
Solar energy	1537	0.004
Wind energy	605	3.6

- The main renewable energy in Slovakia is *hydropower*. The currently used hydro potential achieves about 2,500 MW (about 30% of the total installed capacity in Slovakia and more than 75% of technically exploitable hydro potential). Almost 5 TWh of electricity is generated by hydro power stations, which is about 15 percent in total generation. Some of such hydro power stations are used for the balancing of the electricity system. Installed capacity of small-size hydropower stations is about 57 MW, generating 36.6 GWh in 2001.
- Within the Development Programme of Hydro Power Stations 250 locations have been identified on several river flows in Slovakia that are suitable for the purpose of the construction of hydro power stations (< 10 MW).
- Of all renewables, *biomass* has the largest proportion of technically exploitable potential, however, mostly for the purpose of heat production (as a fuel). Large amount of biomass originates from the wood processing industry. Since such enterprises are large energy consumers, it would be appropriate to build the generating stations firing wood waste. Production of agricultural biomass will depend on the agricultural policy with respect to use of energy potential. Potential for electricity generation accounts for 1.27 TWh, though presently only about 85 GWh is in use.
- *Geothermal energy* is used only in two small-scale cogeneration units (about 44 kW). Further use is considered only in demonstration projects. There is one project with a larger potential (5 MW), however, it has not been implemented yet due to the extremely high costs for geological exploration.
- *Solar energy* is used in a small extent due to high specific capital costs. The only active systems are solar collectors. Since the territory is almost fully covered by distribution networks (98%) and the awareness of the public with regard to benefits of such systems is rather low, the current use of this type of renewable is about 4 MWh.
- Regarding *wind power*, one project of the construction of a wind power plant with a capacity of 4 x 600 kW has been initiated in the western part of the country. Four turbines have been installed with some support provided by the PHARE programme. The annual production is expected to be 3,600 MWh. Nevertheless, Slovakia does not have suitable climatic conditions for more extensive use of wind power (surge wind, turbulent streams), besides national parks that are not suitable for ecological reasons.

The construction of any renewable energy-based power plants is generally dependent on sufficient investment capital and compliance with environmental requirements.

3.2.4 Network Connections

Any connections of most of the generating stations are agreed on a case-to-case basis. In general, the generating stations with an installed capacity up to 100 kW are connected to a LV system, the generating stations with an installed capacity over 100 kW are connected to LV, HV and EHV systems. The connection conditions of the Distribution Code represent the fundamental document that may be extended with specific requirements of a distribution network operator (defined for example by Internal Regulations of a specific DNO). Requirements such as specific synchronisation and sizing of generating units, specific type and location of metering devices, switchboards, protection devices, specific information transmission methods, compensations, back effects on the system etc. However, it is not possible to provide more detailed information on this matter, since such requirements are determined on a case-to-case basis. The generating stations such as small-scale cogeneration plants (combined heat and power plants), small hydro power stations and wind power stations are connected to HV and LV systems.

According to electricity supply to the distribution network small energy generating stations (up to 10 MW) are divided into the following categories:

- *'Pure' DG plants.* At least 90% of their installed capacity or 90% of their production must be supplied to the distribution network.
- *Excess generating stations* Only excess electricity generated by such plants is supplied to the respective distribution network; their main role is to cover the electricity needs of their operators.
- *Special general stations.* Such plants generate electricity as in the before-mentioned categories, however, based on the agreement with the DNO electricity is supplied only in specific time zones and the parameters agreed.
- *'Off-network' generating stations.* Such plants are operated in the area supplied by the DNO; however, they are not directly connected with the distribution system, but run separately outside the system.

3.2.5 Specific DG and RES technologies in Slovakia

In Slovakia larger DG plants (installed capacity P_i > 2 - 5 MW) are predominantly combined heat and power production plants generating steam for the district heating systems. Only small proportion of such generating stations generates electricity in the condensing cycle. Most of the plants are mainly industrial and municipal CHP plants that are older than 20 - 30 years, burning coal, fuel oil, gas or wood waste.

Over the past 3 to 5 years new DG plans were constructed, using the advanced technologies of gas turbines that are installed either in a simple or combined cycle. All generating stations with combustion turbine have been designed to supply heat for the technological purposes or for the purpose of space heating in residential and tertiary sectors and industrial premises. The generating stations burn gas or oil as a fuel. Cogeneration plants of a smaller output (P_i < 2 - 3 MW) employ to a larger extent reciprocating engines burning natural gas.

CHP plants and majority of the industrial power plants are operated with the preference given to heat production, while electricity is generated in a forced operation. From the year 2006 on coal-fired units have to be either decommissioned for the environmental reasons (emission non-compliance), or equipped with desulphurisation equipment.

Biomass may be used for the purpose of biogas production, which is then burned in small-scale cogeneration units, or in the conventional steam cycle. Several run-of-river hydro power plants have been constructed on weirs, water reservoirs, derivative canals and pressure feeders in Slovakia. Large hydro power stations (over 10 MW) mostly use conventional Kaplan turbines and Kaplan direct flow turbines for power generation. Small hydro power stations use several types of water turbines (depending on water head), such as Kaplan, Francisci, Pelton and Banki turbines.

3.3 Energy Policy Objectives

3.3.1 Renewable energy

The National Energy Policy adopted in January 2000 claims that none of such energy sources is presently used in a sufficient manner (renewables cover around 4% of the total consumption of primary energy sources). The Ministry of Economy is therefore drafting the *Renewable Energy Strategy*, the objective of which is to identify main areas and possibilities of using renewable energy, to specify any benefits and to outline relevant proposals for the increased utilisation and further development of renewables in Slovakia.

Development of renewable energy is supported at *a national level* by means of legislative and national strategic documents prepared by the relevant ministries. The above-mentioned Renewable Energy Strategy is based on the following background policies:

- Programme Declaration of the Slovak Government (incentivisation rules for the use of indigenous primary energy sources, including the use of renewables).
- National Strategy of Permanently Sustainable Development of the Slovak Republic (gradual substitution of non-renewable energy sources with renewables).
- Agricultural Policy (the increased use of non-traditional and renewable energy sources with the programme of reconstruction and modernisation of manufacturing and technical facilities of the agricultural and food complex, Rural Development Plan).
- Forest Policy (supporting the programmes aimed at complex wood utilisation, especially for energy purposes).
- Water Supply Policy (the increased use of hydro for the purpose of electricity generation).
- Energy Policy of the Slovak Republic (potential opportunities of further use of renewables until the year 2010 - increase in energy production from renewables by 63% or 133%, while taking intensive systematic measures, compared to the year 1997).

The Action Plan for Renewable Energy for the period of 2002 - 2012, developed at the end of the year 2002, claims that it is necessary to remove a series of obstacles that hinder the more extensive use of renewable energy sources (for example, insufficient strategic framework for the renewable energy policy, insufficient legal and institutional frameworks, lack of or inaccessibility to funding, weak incentivisation, low awareness and information available). As regards to direct support programmes, there are demonstration projects with a high level of information dissemination, including the Energy Efficiency Fund and the Revolving Fund for renewable energy) and prioritising actions with respect to financing, the Fund for Biomass-based Central Heat Supply. To improve the information dissemination, it has been suggested that renewable energy committees are founded, thus, providing support to state authorities with the implementation of the Renewable Energy Strategy, improving the work of regional and local energy agencies and incorporating undertakings into the European network of renewables-based energy trading. The efficient tools for improvement of public awareness include advisory services and information campaigns, including the thorough monitoring and the recording of results. Research and development projects should be carried out within the EU funded programmes, such as the 5th and 6th Framework Programmes.

At the same time, Slovakia has adopted several *international commitments* arising from the international conventions on climatic changes and permanently sustainable developments: White Book, Green Book, Action Plan for Renewables, Kyoto Protocol, UN. DP - Agenda 21, commitments prescribed by OECD and IEA, UN - UN Framework Convention on Climatic Change, COP-8 Deli, Johannesburg Declaration, Directive 2001/77/EC, Community Programme ALTENER II, etc. The EU funded programmes include ALTERNER, SAVE, Energy for Intelligent Europe, ISPA, SAPARD. Slovakia will have access to structural funds following its accession to the EU.

The Slovak Republic was requested to commence the process of technical adaptation of objectives arising from the Directive 2001/77/EC concerning the support of electricity generated from renewable energy sources, implementation of which is expected to be completed by October 2003. As a result of negotiations with the European Commission the indicative target for the Slovak Republic has been determined at a level of 31 percent, which is rather high. Presumably, such target will be achieved through the development of hydro power stations.

To accomplish a long-term objective with respect to achieving the use of renewable energy comparable to that in EU countries, it is necessary to introduce realistic fuel and energy prices, create appropriate legislative, economic and financial background and encourage business environment. The country is required to use a co-ordinated approach in several branches of economy and take respective system measures in practice (such as pricing and tax policy, legislation, ecology, etc.) in order to fulfil the conditions arising from the Directive on Renewables.

3.3.2 Cogeneration

As already described in the WP 2 country report[11], cogeneration has relatively good foundations (a proportion of electricity generating in cogeneration is above the EU average) in the Slovak Republic. The main barrier for its further deployment is a distorted gas price. Cogeneration contributes to achieving the main goals of the National Energy Policy that outlines the general framework for the future development of such form of energy production. From legislative standpoint there are two Acts explicitly supporting cogeneration. These are Energy Act No. 70/1998 and Act No. 286/92 on Income Tax.

State support is aimed mainly on medium and small-sized capacities. Even though several projects have been implemented over the past few years (the largest project- the combined cycle plant Bratislava, plus a number of smaller-sized), a proportion of capacity installed in cogeneration is rather low, compared to an estimated technical potential until the year 2010. Based on the National Energy Policy the potential estimated until the year 2010 accounts for 320 MW in the residential and tertiary sector and 480 MW in the industry. When setting specific objectives with respect to cogeneration technologies, it is more realistic to take into consideration the economic potential rather than the technical one.

Even though there is no specific national policy with respect to cogeneration, two relevant projects dealing with this issue have been accomplished recently. First this is the EU SAVE II project 'Analysis of Obstacles and Barriers to CHP in the Czech and Slovak Republics', the main output of which was the CHP Action Plan. The final document was to be used as the background material for the policy makers at the Ministry of Economy of the SR, providing the essential information on potential, targets, budget and recommended policy instruments. Another significant project worth mentioning is the National Energy Efficiency Study of the Slovak Republic, the objective of which was to define technical, economic and market potentials for implementation of various energy efficiency measures, with a specific attention given to cogeneration.

As regards to incentives with respect to an increased use of cogeneration plants, it is useful to mention the National Programme for Energy Savings and Increased Use of Alternative Energy Sources launched by the Ministry of Economy in the year 2000. Such scheme is financially supported from the state budget, annually receiving about 30 mln SKK. The support may be awarded in the following forms:

[11] See: "A brief review of four New Accession States regulatory systems and their impact on the deployment of Distributed Generation", downloadable from www.sustelnet.net.

- subsidies for interest of a commercial loan, up to 70% or 3 mln SKK as a maximum,
- recoverable financial support (an interest-free loan) with a payback period up to 3 years, maximally up to 3 mln SKK.

3.3.3 Technical Barriers

Unless the development plans aimed at the upgrading and reinforcement of distribution networks are implemented, the existing status of distribution network may cause technical barriers. An important issue is the transmitting capacity of distribution networks with a high proportion of *LV* networks (effect of long lines on short circuit power) in Slovakia. As a result of this, it would be problematic to dispatch such generating stations.

For new DG plants (particularly small cogeneration plants) severe (often unjustified) requirements raised by DNOs with respect to the plants' connection are becoming rather financial than technical problems. Such conditions require the following:

- Providing reliable and safe supply under appropriate conditions.
- Eliminating any back negative effects in the network.

The conditions need to take into account the status of the existing network, applicable technical standards and relevant regulations, plus technical parameters of a specific generating station. According to the views of some investors and plants` operators the required conditions often go beyond the standard connection conditions. These include for example oversized conductors for supply to the network, the construction of a new transformer station or communications with the dispatching centre. All this incurs additional costs to the plants' operator, because, usually, there are standard in-built protections in cogeneration units.

With regard to the planned deployment of renewables and cogeneration, the problems now seem to be rather legislative than technical. For example, nowadays, it is impossible to implement any of the projects prepared, since they require state support. The governmental document (Action Plan on Renewables) is in the process of finalisation. The barriers with respect to the use of renewables are currently being analysed in order to outline a strategy and to set a proportion of national funds for the Slovak businesses to be able to participate in European support programmes.

3.3.4 Technical Status of DG Connection

At the end of the year 2002 the regulatory authority approved the following basic technical rules:

- Transmission System Code
- Distribution Code
- Updated Dispatching Order.

Transmission System Code

The connection conditions applied for new generating stations depend on technical characteristics of the transmission system and are also given by the rules for an international co-operation of the synchronously interconnected system within the UCTE. A connection of any transmission system users at the existing points of connection with the transmission system have to comply with the standards specified in the Transmission System Code. A connection of new generating stations and any modifications in the existing capacity is governed by the conditions defined by the Transmission System Code and Ordinances of the Ministry of Economy of the Slovak Republic. The Transmission System Code sets forth the requirements with respect to capabilities units, their automatics and protective devices.

Distribution Code
The Distribution Code is a follow-up to the Transmission System Code, thus ensuring the fundamental rules for the development and reliable operation of the whole power system of the Slovak Republic and electricity supplies with the quantity and quality required. The purpose of such rules is also to ensure that both the DNO and network users are fairly involved in the maintenance of a given network and apply appropriate operating conditions in order to guarantee the stable operation of such distribution system.

The planning connection regulations with respect to the distribution systems are applicable for the existing and future generators, including the consumers with auxiliary electricity generation that own the equipment operating in parallel with the distribution network or is able to do so. There are three basic categories of generators, depending on the plant connected:
- with a capacity up to 1 MW (at a HV level or lower),
- with a capacity ranging from 1 MW to 50 MW (at a HV level or higher),
- with a capacity higher than 50 MW.

The Distribution Code provides the details not only on the requirements related to the connection of generating stations (basic data on plants and provision of information, technical requirements - plants' operating parameters, co-ordination with the existing protective devices, island operation, plant start-up, etc.), but also operational regulations, the rules regarding collection and delivery of information, requirements for generating stations, telecommunication requirements with regard to system dispatch, etc.

Apart from the above-mentioned Codes, the relations between DNOs and distribution system users are governed by the Guidelines of the Slovak Electricity Dispatching Centre (SED), the scope of which is specified by the Dispatching Order of the Power System of the Slovak Republic, and operational instructions of a respective DNO. However, distribution system users have to respect relevant legal regulations, too (laws, ordinances and other relevant regulations), technical standards and provisions relating to electricity supply.

Dispatching Order
The operation of the Slovak Power System and related energy facilities connected to it is governed by the Slovak Power Dispatching Centre in the scope defined by respective provisions of the Act No. 70/1998 on the Energy Industry as amended by latter provisions.

The Dispatching Order covers basic rules concerning the power system dispatch, defines powers and obligations at respective degrees of dispatching (national level, regional level and local level) and specifies the basic functional strategy of dispatching. It is binding for all holders of the licence for production, purchase, transit and distribution of electricity and any owners or operators of energy facilities connected to the power system of the Slovak Republic.

The unified power system dispatching is secured at three levels of hierarchy (I. the Slovak Power Dispatching Centre, II. dispatching centres of regional distribution utilities and hydro power plants and III. local dispatching centres). The allocation of powers and responsibilities is determined by the Transmission System Code and relevant operational instructions that are developed for all degrees of dispatching. So far, DG and RES are dispatched only on the basis of contractual terms and conditions.

Internal Regulations of Distribution Utilities
With regard to the development of new electricity production technologies, there is an increasing interest in constructing small energy generating stations with a total installed capacity up to 10 MW that are connected to the HV and LV system and are operated on the territory supplied by the distribution networks of a respective DNO (by law each holder of the electricity distribution licence has the so-called defined territory). Under the valid Energy Act the electricity pur-

chaser is obliged to purchase all electricity from such generating stations provided that it is justified and technical and economic conditions allow such purchase. For this reason, distribution companies apply internal regulations (internal regulations only for plants up to 10 MW, other plants are subject to the Distribution Code), defining technical and connection conditions of such generating stations and determine feed-in tariffs. For the construction or extension of small generating stations, it is necessary to have the project approval from a respective distribution utility, a valid electricity generation licence (issued by the regulatory authority) and to sign the Power Purchase Agreement. Any costs incurred from a connection of a small generating station are covered by the plants' owner, unless otherwise agreed by the distribution licence holder (under the Energy Act).

Connection conditions are determined with consideration to technical parameters of equipment, synchronisation conditions, a type and location of metering devices, location of switching device and controlling mode, protection requirements, requirements relating to information transmission or remote control, compensation, assessment of any back-effects (voltage fluctuations, while starting-up, operating and decommissioning anz plant, flickering, level of harmonic, etc.). Furthermore, it is necessary to demonstrate the short circuit resistance of the entire equipment and to define an appropriate point of connection, while taking into account the network conditions.

Following the development of an implementation project and before bringing a small-size generating station into operation, the investor or future operator needs to elaborate, in co-operation with a respective dispatching centre, the *local and operational regulations* for a specific generating station. These are regulations and instructions required for the purpose of safe operation of a small-size generating station. Such regulations have to also include the procedure on how to deal with any failures, while ensuring the consistent control between the plants' operator and the DNO.

The connection conditions specified in the Transmission and Distribution Codes may be regarded as the standardised rules. As regards to RES and DG support, new legislation is currently under preparation.

Institutional Framework with respect to Technical Rules

- Transmission System Code is developed by the transmission system operator and approved by *the regulatory authority*.
- Distribution Code is developed by the distribution system operator and approved by *the regulatory authority*.
- Dispatching Order is developed by the Slovak Power Dispatching Centre and approved by *the regulatory authority*.

Apart from the Codes and Dispatching Order, producers are bound to adhere to the Ordinances to the primary energy legislation that are proposed and issued by *the Ministry of Economy* and relevant technical standards (STN - Slovak Technical Standards) issued by the *Office for Standardisation, Metrology and Testing*.

Generating stations of smaller capacity are governed by Internal Regulations of *the distribution system operator.*

Standardisation

As previously described, there are standard rules governing the connection of generating stations to the networks (the Codes approved and the Dispatching Order updated in the year 2002).

4. HUNGARY

4.1 The Hungarian Electricity Grid

The basic technical standards for grid operation in Hungary are those of the UCTE.

4.1.1 Transmission grid

The transmission grid consists of the following voltage level wires: 750 kV (connecting Ukraine only), 400 kV, 220 kV, 120 kV overhead, some negligible 120 kV cable transmission. From the following table it can be seen that 400 kV and 220 kV voltage level transmission is prevailing.

Table 4.1 *Transmission grid wires broken down to voltage levels*

	Length [km]		
Voltage level (kV)	*1999*	*2000*	*2001*
750	268	268	268
400	1733	1705	1735
220	1194	1188	1188
120	107	127	131
Total	3302	3318	3322

The following picture shows the Hungarian power grid including the interconnections with neighbouring countries.

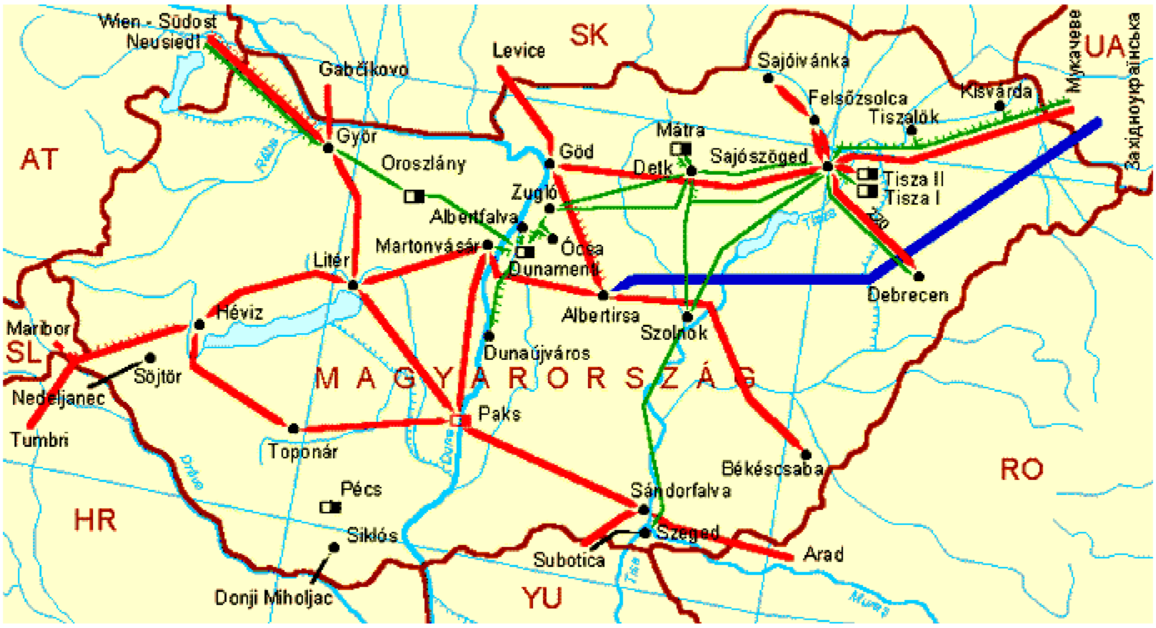

Figure 4.1 *Hungarian power grid*

4.1.2 Distribution network

The Distribution network consists of high, medium and low voltage level wires. High voltage is 120 kV, overwhelmingly overhead. Medium voltage comprises overhead as well as underground cable wires. The medium voltage overhead network consists of mainly 20 kV wires, but there are some 35 kV (cc. 4%), and 30 kV (cc. 1%) wires, too. The underground cable wires are mainly of 10 kV voltage level, and there are some very minor 6 kV cables as well. The low voltage level is by definition below 1 kV - actually 420 V and 230 V - and this is the level that directly connects to most of the non-industrial consumers (e.g. households, offices etc.). The following table shows the distribution network wire length in different voltage level categories.

Table 4.2 *Distribution network wire lengths (km) broken down to voltage levels (2001)*

Supplier company:	DÉDÁSZ	DÉMÁSZ	ELMŰ	ÉDÁSZ	ÉMÁSZ	TITÁSZ	Total
High voltage 120 kV[1]	1,005	1,018	774	1,425	1,445	1,018	6,655
Medium voltage	10,495	11,510	8,671	11,769	9,325	11,394	63,164
- Overhead wires[2]	9,195	10,900	4,000	8,969	8,820	10,294	52,178
- Cable[3]	1,300	610	4,671	2,800	605	1,100	10,986
Low voltage (below 1 kV)[4]	12,501	17,519	14,000	15,392	10,951	12,002	82,365
- Overhead wires	3,468	2,645	6,415	4,619	2,226	2,441	21,814
- Cable	9,033	14,874	7,585	10,773	8,725	9,561	60,551

[1] mainly overhead (and some tens of km cable).
[2] (20 kV, 35 kV and 30 kV).
[3] (10 kV and 6 kV).
[4] (420 V or 230 V).

4.1.3 The state of the network (weaknesses, upgrades)

There is no particular knowledge on network weakness or insufficient distribution capacities. However, for commercial reasons a transmission line is planned between a nuclear power plant and the city of Pécs. This would cause commercial difficulties for the regional distributor and a power plant near the city that is just about to shift from coal to gas and biomass. According to the network expert of the Hungarian Energy Office (HEO), networks could incorporate more DG than they currently do without any significant network upgrading. Naturally, the judgement of the case is different if system operation and reliability are also considered in the context of intermittency.

In 2002 the network loss at DNOs was between 8.9 and 12.6% (it varies across the 6 DNOs). The average is about 11-12%. The system level transportation loss (transmission plus distribution) is similar, as you can see in Table 4.3 after net production and import are added. It is partly due to the fact (but the full picture is much more complex) that the wires are made of aluminium, which has a much bigger resistance than copper (which is used in most EU countries). From 2001 to 2002 there was some progress, since in 2001 there were DNOs even with 13 and 14% loss.

The Hungarian grid is interconnected with neighbouring countries for almost 100% through high voltage level (220 kV 400 kV, 750 kV). The table below shows the yearly electricity exports/imports (in GWh) between Hungary and neighbouring countries.

Table 4.3 *Volume of electricity production and foreign trade [GWh, 2001]*

Year	Net electricity production[12]	Import	Export	Net import	Overall network loss
2000	32,444	6,197	2,757	3,440	4,733
2001	33,701	6,946	3,775	3,171	4,676

Source: Electricity Statistical Yearbook 2001

The following table also shows physical turnover, which also includes non-co-ordinated transit.

Table 4.4 *Electricity turnover including co-ordinated and non-co-ordinated transit [GWh, 2001]*

	Physical turnover	Commercial turnover
Import	10,403	7,004
Export	7,232	3,833
Net import	3,171	3,171

Source: Electricity Statistical Yearbook 2001.

Table 4.5 shows the capacity of international interconnections (in MW) vs. national production capacity (i.e. the importance of import/export of electricity for Hungary).

Table 4.5 *Cross border capacities versus generation capacities [MW, 2001]*

Neighbour country	Export / Import	Capacity [MW]
Slovakia	Import	1300
Austria	Import	300
Croatia	Export	1000
Ukraine	Import	600
Serbia and Romania	Export	350
	Total export	1350
	Total import	2200
Production capacity		
Installed		8365
Peak power station actually used		4566

Source: MAVIR Rt (the system operator).

Although net import amounts to some 10% of total electricity consumption in Hungary, currently there is excess of generation capacity. Import - apart from some peak demands and emergencies - usually take place because on average import is much cheaper than domestic production.

It can be argued that because MVM, the state owned wholesaler and TSO, had the exclusive right to import until the beginning of the partial liberalisation (i.e. January 1, 2003) the actual export/import volumes of electricity annually traded show a smaller amount than capacity would allow. Domestic power plants and MVM making long term PPA contracts with them have this way been protected. Thus, it is expected that after widening the market opening (increasing the number of authorised consumers as well as lifting their 50% import limit) the share of import will rise. This expectation is supported by the fact that during the first cross border capacity auction new entrant traders had already purchased a significant magnitude of import capacities, especially for import from Slovakia. Export mainly goes to Croatia, where the fluctuating hydro capacities often result in good prices for transit or even for expensive Hungarian electricity (see also Figure 4.2). For the possibility of comparison, domestic generation capacities are detailed in Table 4.6.

[12] Electricity production minus own consumption of power plants.

Table 4.6 *Characteristic data on Capacities of the Hungarian Electricity System [MW, annual average weekday peak, 2001]*

[MW]	1990	1995	1998	1999	2000	2001
Installed capacity	7,177	7,288	7,602	7,845	7,855	8,365
Available capacity	7,065	6,982	7,424	7,667	7,601	8,059
Usable capacity	5,376	5,610	6,313	6,603	6,725	7,138
Actually usable capacity	5,286	5,468	6,033	6,236	6,349	6,663
Peak-power station load	3,635	4,383	4,614	4,640	4,425	4,566
Import-export balance	1,751	415	144	188	465	476
Peak load (annual weekday)	5,386	4,798	4,758	4,828	4,890	5,042
Maximum peak load	6,534	5,731	5,817	5,801	5,742	5,965

Source: Electricity Statistical Yearbook 2001.

Figure 4.2 shows the imports and exports of electricity in Hungary for the year 2001[13]. It clearly shows that Hungary is dependent on electricity imports, but at the same time also exporting electricity.

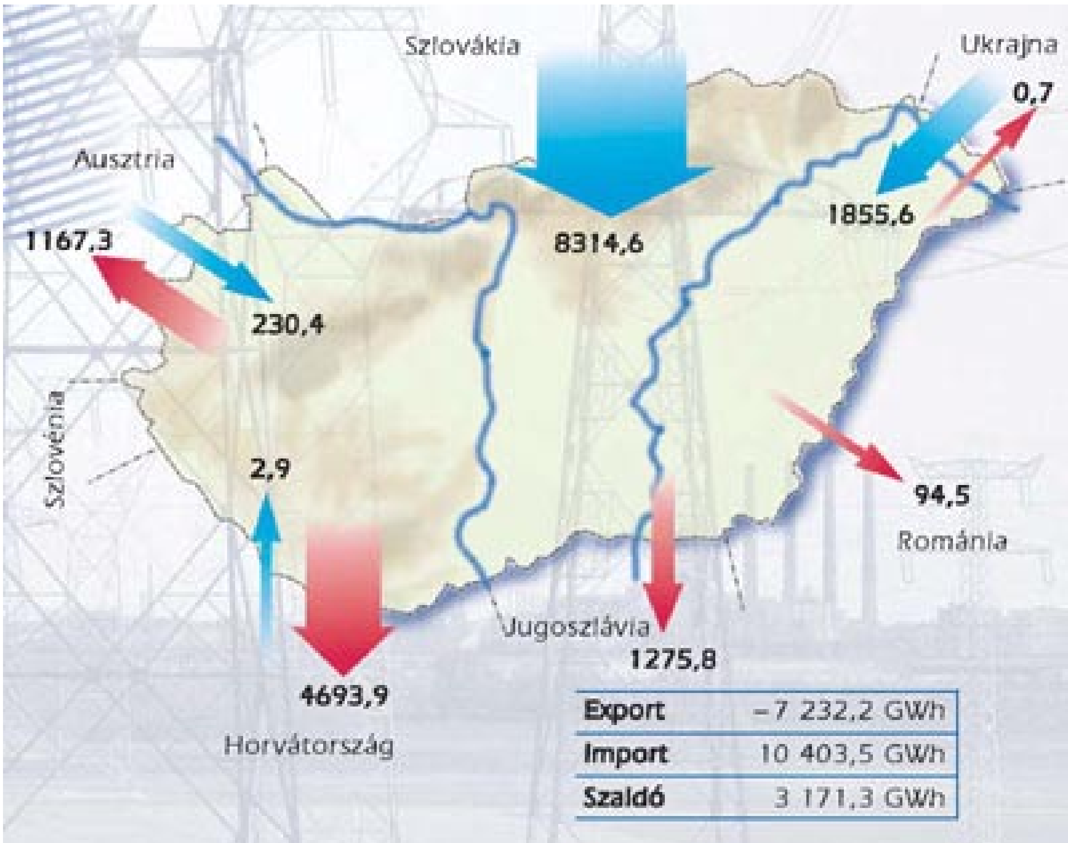

Figure 4.2 *Electricity imports/exports in Hungary in 2001*

[13] Note that this picture includes not co-ordinated transit.

4.2 Share of DG and RES now and in the future

The following tables give and overview of the share of DG and RES in the Hungarian energy sector. In Table 4.7 the DG capacity is given.

Table 4.7 *Capacities of generators that can be regarded as DG (2001)*

Type	Number of plants	Built in capacity [MW]
Gas engines	173	174
Wind turbines	2	0.85
Hydro plants	9	50.2
Other small power plant[14]	28	270

Installation of further gas engines are expected; wind capacities are likely (relatively) to boom to tens of MW; 80-100 MW installation of other small power plants - mainly gas turbines - are expected in the next 2 years. As to production volumes and potential only data on RES and RES-E could be collected (see Table 4.8).

Table 4.8 *Renewable energy sources in Hungary [PJ/annum]*

	Geothermal	Solar	Biomass	Wind	Hydro
Potential	50	4	58	7.2	5
Currently utilised	3.2	0.01	28	0.008	0.7

Table 4.9 *RES-E capacities and generation in 2001*

Type of RES	Built in capacity [MW]	Generation [GWh]	RES-E share in total generation [%]
Generated from hydropower plant[15]	37.5	186	0.51
Generated from biogas	1.8	7.63	0.021
Wind generation	0.85	0.92	0.0025
Waste incineration	24	112.48	0.31
Plant waste	4.7	1.3	0.004
Photovoltaic	0.03	0.06	0.0002
Total RES-E	68.9	308.4	0.85
Total domestic generation	8365	36418	-

Source: Ministry of Economic Affairs.

Table 4.10 *Structure of RES-E potential as envisaged by 2010 so as to achieve the 3.6% RES-E target*

Type of RES	Capacity [MW]	Generation [GWh]
Biomass (mainly wood and wood waste)	130-150	1050
Incineration of (selected) waste	50-60	400
Wind	18-50	20-52
Hydro	7-9	56
Biogas	12-16	50
PV	2	2-3
Total	219-287	cc. 1600

Source: Ministry of Economic Affairs.

The typical level of grid connection for DG and RES-E is 20 kV or sometimes in urban environment 10 kV cable.

[14] Definition of small power plant: power plant with a capacity below 20 MW. There is no other DG definition that could be used against the statistics.

[15] The most of it does not qualify as renewable, at least not for support, as the two major hydro power plants are above the 5 MW threshold stipulated in domestic legislation.

4.3 Description of energy policy programmes for DG and RES

There is no explicit DG policy in Hungary. However, specific RES objectives exist. To achieve them, CHP and RES-E receive a preferential treatment in the form of feed in tariffs. Gas based CHP might be hindered by expected increase of the gas price after gas market liberalisation. Also, the share of natural gas in primary energy use is very high (reduced diversification; two pipelines, one from Russia) as well as gas reserve storage capacities are not sufficient; these facts make policy makers oppose further increase of the share of natural gas (see Table 4.11).

Table 4.11 *Structure of Primary Energy Consumption (2000) in [%]*

	Renewable and other	Coal	Oil	Natural gas	Nuclear
IEA countries	6	20	41	22	11
Hungary	4	16	27	38	15

The renewable energy support system is quite complex and scattered in Hungary. It should be designed as a system of instruments so as to achieve the share targets laid down in government policies. However, the instruments and targets have not really been brought in line, the subsidy schemes and sums of money distributed seem to have been planned in a quite ad hoc manner apparently separately from the targets. The current system and level of support seem insufficient to fulfil even the goals currently set.

These goals are:

- to increase the amount of renewable energy to at least 50 PJ/annum by 2010 (from less than 30 PJ/annum; it relates to total primary energy consumption of approximately 1000 PJ/ annum,),
- to increase the share of renewable energy in primary sources from 3.5% to 6% by 2010,
- to increase the share of electricity generated by renewable energy from the current 0.7% to 3.6% by 2010 (a recently set goal due to agreement with the EU Commission with respect to the implementation of the RES-E directive).

To fulfil the goals more efficient and effective instruments are needed for the promotion of renewables. This is even more apparent when comparing Hungarian RES-E production of 0.8% with the Community target of 22% contained in the 2001/77/EC Directive for 2010, or even with the negotiated Hungarian target of 3.6%.

For promoting electricity generated from renewables (RES-E) there is a non-differentiating feed in system in place. The Ministry of Economic Affairs ascertains the purchase price irrespective of the renewable energy type (with take over obligation for electricity distributors) for peak and off peak periods. These prices until 2003 also applied for small-scale co-generated electricity (CHP). The past feed in system 'crowded out' RES-E in favour of CHP (with the uniform tariff and artificially low gas prices cogeneration was overwhelming). As of January 2003, RES-E is still not differentiated by energy type, but receives a higher tariff than CHP. Also, CHP feed in tariffs are differentiated according to capacity and whether it serves district heating or not. Apart from small-scale (if capacity is below 6 MW) generation, CHP with district heating utilisation receives a higher feed in tariff than with other heat uses. Above 50 MW CHP only receives a feed in tariff if its heat goes for district heating - and even then only a reduced rate.

The new tariff system is planned to last - with annual adjustment according to the price formulas given in the decree - until 2010, unless the introduction of the Tradable Green Certificate (TGC) system replaces it (for RES-E; see below). The chance of such replacement creates a regulatory risk.

In the longer term the government may consider introducing the tradable green certificate system as a paragraph in the new Electricity Act (2001 December) authorises it. It is yet far from being finalised what sort of support scheme will dominate RES-E production, but it is an important interest to find an economically efficient solution. However, the chances of introducing a Hungarian TGC system before the EU assessment of experiences in 2005 of RES-E support schemes are minimal.

Another key feature of the current support system is that it mostly consists of centrally distributed state subsidies: investment grants and preferential loans provided from an energy agency and the central environmental fund. However, the decisions on applications are not systematic, not cost effective and budgets are not matched with policy goals. The energy agency also manages some foreign programs and revolving funds established from UNDP, German and Phare contributions.

4.3.1 Technical barriers with regard to the planned development (in the short and mid-term future up to 2010)

Some fear that the intermittent character will degrade reliability of supply. Also, it even already now occurs that there is occasionally an overproduction at night from generation supported by feed in tariff; this case the ‘cheap’ nuclear production is down adjusted which is opposed by many. There are plans to prevent such cases, one solution could be to reduce off peak feed in tariff, another to provide wider possibilities for the regulated consumers to consume cheaper at night (and/or more expensively in peak periods).

In the long term it would be helpful, if regional dispatchers could not only real time follow the generation situation at small plants (even the possibility for real time following is often lacking), but also could send signals for generation adjustment, too. Along with technological development incentives for balancing may create such a system.

4.3.2 Technical status of DG connection:

The main rules are set by a decree on connection issued by the Ministry of Economic Affairs. The details of connection are laid down in the (common) Distribution Code and the General Terms of Business of DNOs. The decree is not unambiguous and expected to be changed.

The General Terms of Business are prepared by the DNOs individually, but they also co-operate to some extent in doing this. The General Terms of Business are also to be approved by the HEO. The new Distribution Code came into force in January 2003, the new General Terms of Business are to be prepared by October, 2003.

4.3.3 Standardisation process for grid connections

DNOs are obliged to connect generators or consumers at regulated prices (for low and mid voltage level connection, below 120 kV[16]) which depend on the voltage level of connection and on whether connection takes place directly to the DNO wires or to a transformer before that. DNOs dictate the technical conditions, however law requires that they reach an agreement. Basically, this means that DNOs are obliged to connect DG operators in any case.

In case of unresolved debates, the parties can turn to the Energy Office and eventually to court. The regulated connection fees listed in the new ordinance[17] (Dec 29, 2002.), on intent and generally, do not even cover the shallow costs of necessary wires and equipment incurred by the DNO. However, the DNO must provide in exchange of the connection fee the necessary in-

[16] For 120 kV and above, connection charge is a matter of bilateral agreement.

[17] Previously connection fees were not set, it was a bilateral settlement on the basis of due costs of necessary investments made by the DNO.

vestments within given distances (between the tapping point (branch-off point) and the connection point). For connection points at a distance larger from the network than stipulated in the ordinance the extra lines should be financed by the DG investor. The distances in meters are set in the ordinance, but these are different values according to particular circumstances.

The assets built will be the property of the DNO, and thus are also rewarded via the UoS charges paid by consumers[18]. However, there are some provisions in the ordinance that are interpreted differently by energy office and DNO representatives: especially whether costs beyond the tapping point (or some DNOs say wherever if costs are substantially larger than connection fees cover) can or cannot be retrieved. The energy office claims their purpose was "no", however the wording of the decree is not unambiguous, and DNOs interpret it in the opposite way (in essence as deep charging). Because of the ambiguities the decree is expected to be amended this year, as was already the case with several other new ordinances that came out prior the market opening at the end of 2002.

The generator can also choose to negotiate the connection fees; in this case in a bilateral agreement he will incur the costs of necessary investments carried out by the DNO (but the DNO will own the infrastructure), or can also choose to build its own connection, in this case he incurs all the costs up to the tapping point, will be the owner of the built infrastructure, and he need not pay connection fees (similar to shallow charging, but in this case O and M costs will also be borne by the generator!).

For the DG investor it is worth negotiating or building connection on his own if he deems it is cheaper than the regulated connection charge (which is rarely the case, as was mentioned above; however sometimes it is possible because the connection charge is uniform for a given set of characteristics).

In the event of 'larger distances' there might be conflicting views between the DG investor and the DNO on the costs of the extra lines, so negotiating or self-connection may be worth.

[18] See UoS charges section of WP2

5. POLAND

5.1 Basic lay-out of the Polish power system

The Polish electrical power sector is the largest in Central and Eastern Europe. In the Polish energy system, there are 17 large public power plants and 19 public combined heat and power stations (CHP). The total output of the power system in 2001 amounts to 34,642 MW, including 29,735 MW in thermal power stations, 2,160 MW in hydro power stations and 2,662 MW in CHP. The majority of power is located in the South of Poland, in the proximity of large deposits of hard coal and lignite. Peak demand for power in Poland reaches no more than 23,000 MW, which gives approximately 40 per cent in power reserves (in practical terms, however, this reserve is calculated at 20-30%). However, a large volume of the power is actually generated by highly outdated and inefficient hard coal-fired power stations.

Table 5.1 *Data of the Polish energy sector*

	1990	1995	2000	2001
Installed capacity [MW]	31,952	33,142	34,542	34,642
Including:				
Thermal power stations [MW]	26,828	27,952	29,397	29,735
Industrial power stations [MW] (CHP)	3,166	3,107	2,647	2,662
Hydro power stations	2,005	2,008	2,116	2,160
New installed capacity [MW], including:	-47	75	382	85
Power stations [MW]	-	65	371	3
Capacity decommissioned, corrections [MW]	-47	-66	-53	15
Peak demand [MW]	23,392	23,056	22,289	22,868
Electrical energy production [GWh]	136,311	139,005	145,183	145,616

The system of power grid control in Poland consists of three levels with different tasks:

- *Level 1* of Transmission System Operator (TSO), which operates transmission systems at the voltages of 400 kV and 220 kV, transformers of 400/220 kV, transformers 400/110 kV and 220/110 kV, co-operates with centralised power stations supplying energy at 220 kV and 400 kV and those at 110 kV.
- *Level 2* of Distribution Network Operations (DNOs), which operate distributing networks of 110 kV and 15 kV, transformers 110/15 kV, co-operate with local power stations and CHP units supplying energy at 110 kV, 31 kV and 15 kV.
- *Level 3* of operators of generation, distribution and dispatch systems working with single power points or local distributing networks.

In 2001, the transmission system consisted of a very high voltage system (220 kV, 400 kV, 750 kV) and a high voltage system (110 kV,) that comprised 45,270 km of lines. This including 32,380 km of 110 kV, 8,116 km of 220 kV lines, 4,660 km of 400 kV lines, and 114 km of 750 kV extra high voltage lines, one 750 kV substation, twenty eight 400 kV substations and sixty two 220 kV substations. The 750 kV line, connecting the Polish grid to Ukraine, is currently not used.

The distribution subsystem consists of 670,338 kilometres of mid- and low-voltage lines. The installed capacity of the transmission grid transformers is 32,152 MVA and the total installed capacity of all transformers installed in the grid of all voltages 120,120 MVA.

Table 5.2 *Basic data of the Polish power grid*

	1990	1995	2000	2001
Electric grid length [km]	657,357	687,701	713,412	715,608
High voltage together [km], including:	42,846	44,702	45,222	45,270
750 kV	114	114	114	114
400 kV	3,998	4,552	4,660	4,660
220 kV	8,212	8,174	8,116	8,116
110 kV	30,522	31,862	32,332	32,380
Mid voltage together [km]	259,311	270,247	278,319	278,901
Low voltage together [km]	352,200	372,752	398,871	391,437
Capacity of grid transformers [MVA]	97,662	109,690	118,772	120,120

At present, there are 29 distribution companies, serving approximately 15.4 million customers. End users buy electrical energy from:

- High voltage network, this applies to 240 customers and accounts for 23% of the whole electricity market.
- Middle voltage network, this applies to 240 customers and accounts for 31% of the whole electricity market.
- Low voltage network, this applies to 15,338,000 customers and accounts for 46% of the whole electricity market, household-27% (13,893,000 customers), small business and services-19% (1,445,000 customers).

The government has decided to merge the distribution companies into groups prior to their privatisation (STOEN and GZE are already privatised). As a result of mergers, ultimately there will be seven entities functioning in Poland with market shares shown in Table 5.3.

Table 5.3 *Existing and planned grouping of distributing companies in Poland*

Group	Sales volume [TWh]	Market share [%]	Number of consumers [millions]	Consumers share [%]	Area covered [km^2]	Area share [%]
G-8	15.81	16.11	2.61	16.97	74,627	23.86
P-5	14.16	14.43	2.20	14.31	58,192	18.60
W-5	10.84	11.05	1.61	10.44	27,428	8.77
L-6	18.64	19.00	3.73	24.21	105,842	33.84
K-7	23.20	23.65	3.35	21.79	42,146	13.47
STOEN	5.41	5.52	0.78	5.05	486	0.16
GZE	10.07	10.26	1.11	7.24	4,062	1.30
TOTAL	98.13	100	15.39	100	312,783	100

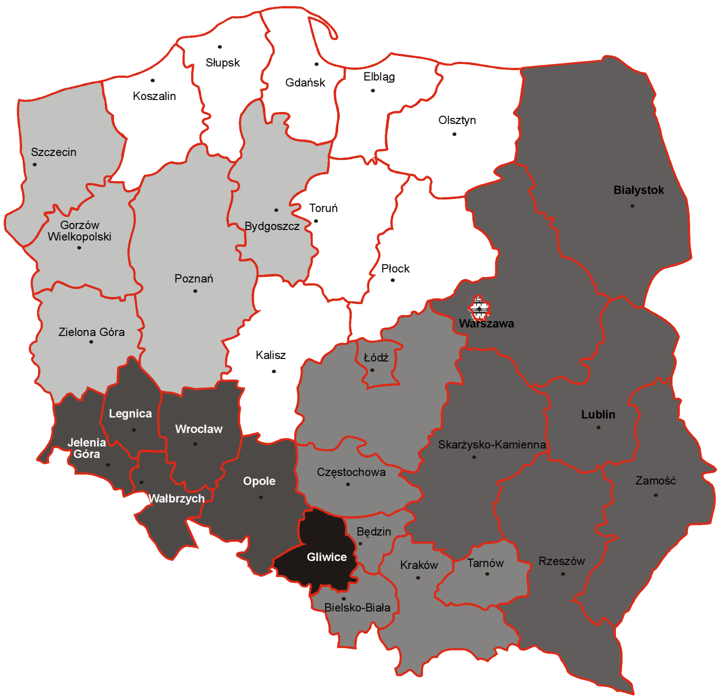

Figure 5.1 *Distribution companies in consolidation groups*

Table 5.4 *Length of grid net in distributing companies*

Year	Length [km]	Different voltage levels HV	MV	LV
1990	537,820	42,820	216,113	278,887
1995	547,417	44,657	221,391	281,369
1998	690,834	31,961	269,895	388,978
1998/1990	1.28	0.75	1.25	1.39

The sector is currently undergoing significant changes on the way to de-monopolisation, market liberalisation and privatisation.

The figure below shows the Polish power grid, including important power stations.

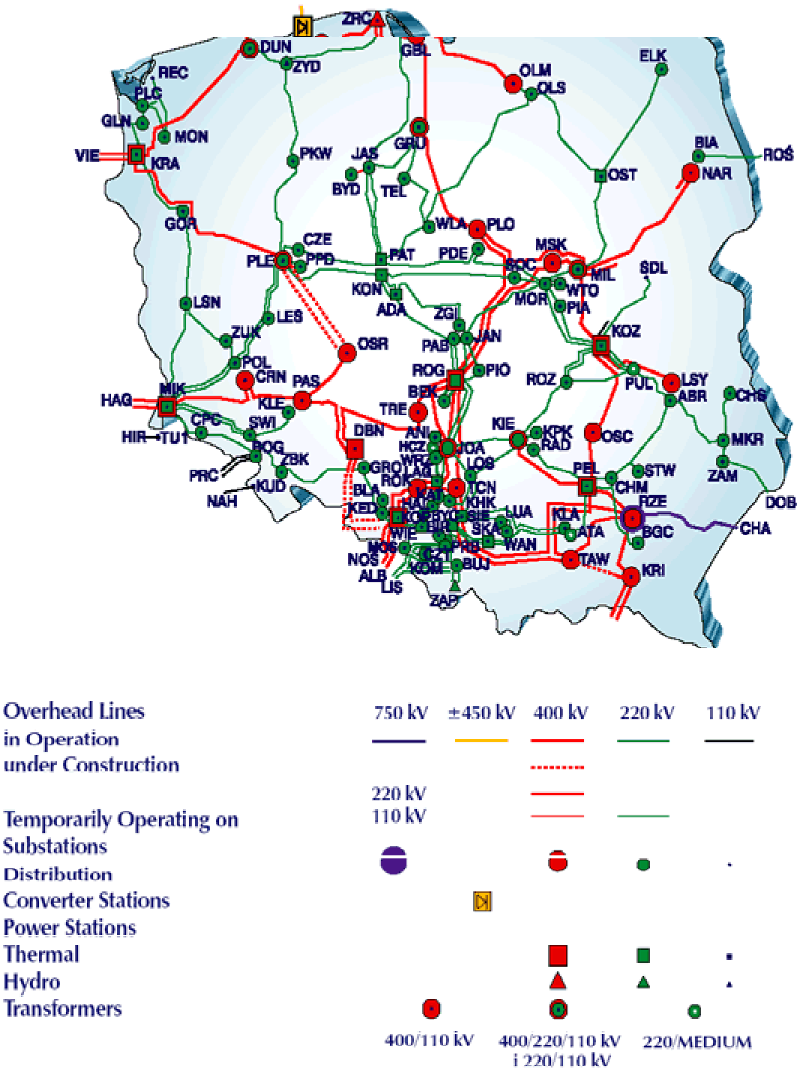

Figure 5.2 *Outline of the Polish power grid*

5.1.1 Interconnections with neighbouring countries

In 1993, the Polish power system was disconnected from the UPS/IPS (CIS + Baltic countries) system due to its instability. In 1992, the CENTREL system was established connecting the grids of the Czech Republic, Slovakia, Hungary and Poland. In 1995, CENTREL started synchronous operation with the Western European system, UCTE. Since 17 May 2001, Poland has been a fully authorised member of UCTE, and since 30 November 2001 - an associated member of ETSO.

Existing interconnections at voltages 220-750 kV enable international power trade (import - export) amounting up to 1.8 GW in peaks. Poland's export markets include Austria, Germany, Switzerland, Hungary, the Czech Republic, Ukraine and Slovakia and import markets include Germany, Belarus, and Ukraine (see also Table 5.5).

Table 5.5 *Poland's export and import of electric energy in the years 1990-2001*

	1990	1995	2000	2001
Import [GWh]	10,437	4,356	3,290	40,306
Germany	4,128	3,901	2,005	1,316
Ukraine	6,295	336	629	490
Belarus	-	0	163	637
Export [GWh]	11,477	7,157	9,663	11,035
Germany	3,529	2,357	688	1,193
Czech Republic, Austria, Switzerland, Slovakia, Ukraine	7,871	4,800	8,910	9,842

Export of electric energy in 2001 reached nearly 11,035 GWh. In terms of production sold in the sector, the value of electricity export in PLN was about 2%. Import of energy was significantly lower than export and was recorded at the level of about 20 million USD, with a drop by approx. 44% from 1999. Taking into account the production overcapacity in the Polish energy sector and dynamic development of renewable energy capacity, Poland is not interested in imports of electricity.

Since 2000, Poland has been connected with Sweden (and the NORDEL system) through an underwater 450 kV and 600 MVA DC cable. In the year 2002 the 110 kV line Wolka Dobryńska (PL) - Brześć (BY) has been commissioned, linking distribution network of LUBZEL S.A. (city of Lublin) with a power station in Belarus.

5.2 Share of DG and RES technologies

Table 5.6 *Polish classification of DG*

Criteria of classification	Power range	Examples of applied technologies
Installed capacity	Micro → 1 W - 5 kW Small → 5 kW.- 5 MW Mid → 5 MW - 50 MW Large → 50 MW - 150 MW	Gas turbines, Stirling engines, Diesel engines, Fuel cells,
Technology	RES → 1 W...5 MW...10 MW	Small hydro, Wind, PV, Geothermal Biomass, Landfill gases,
	Modular CHP	Gas turbines, Engines, Fossil fuel units

The 'Development Strategy of the Renewable Energy Sector' (1999) assumes that until the year 2010 the existing RES capacity (in 1999) has to be increased in order to fulfil the obligation to produce 7.5% electricity from RES in 2010. The strategy predicts that the required capacity could be shared in the following way:

- 600 MW in wind power,
- 200 MW in small hydro power,
- 590 MW in biogas CHP units,
- 1200 MW in biomass CHP units,
- 2 MW in photovoltaic power.

The data can be considered only as reference data and cannot be considered as a governmental target although the strategy was approved by the government.

- Biomass is the most promising renewable source of energy, so far mainly utilised for heat production. The share of biomass in the balance of renewable energy in Poland is growing. Biomass may be utilised in direct combustion processes in a solid (wood, straw) and gaseous form (biogas) as well as processed into liquid fuels (oil, alcohol) A considerable volume of waste wood is a by-product from the wood processing industry. Wood for heating purposes has been traditionally used in Poland for many years. The current number of wood-fired installations is estimated at 100,000 units, varying in heat capacity from 0.1 to 40 MW. The use of biomass for electricity production has been limited so far; as of 2002 the installed electrical capacity of biomass and biogas installations amounted up to 24 MW.

- Among the various ways of energy generation, hydropower has the longest tradition in Poland. Polish hydropower resource is relatively small due to the limited and unfavourably distributed precipitation, high soil permeability and relative flatness of the country. Nevertheless, good possibilities exist for the further development of (small-scale) hydropower in Poland, including facilities with installed capacity below 5 MW. Although the potential is small-scale, hydropower engineering in Poland has a chance of further development. The existing technical potential can be mainly found at existing hydro-electric power stations where power output can be increased by 20-30% through the modernisation of their generators. Thanks to this relatively dynamic development of small hydro-electric power stations (23 stations placed in service in 1996; 19 in 1997, 29 in 1998), a number of plant manufacturers, in particular of turbines and their components, operate on the market.
- Wind power only began to develop in Poland at the beginning of the 1990s, and that was mainly on the Baltic seaside. The most privileged areas in terms of availability of wind power resource are the Baltic coast, Suwałki area and Mazovian lowland plain. Nowadays some new projects of wind farms are being considered. According to reports from the Polish Power Grid (PSE) as much as 9,000 MW of capacity in wind farms have already applied for submitting the grid connections conditions. If only a part of these plans will be accomplished it would bring about substantial increase in RES electricity production and change of operational conditions of the whole power grid. Among these projects the following projects are at relatively matured stage: 122 MW wind farm in Białogóra, 28 MW in Sejny, 60 MW in Karnice gmina, 30 MW in Skoszewo, 18 MW in Cisowo.
- The potential for solar energy remains limited in Poland. Poland has a very uneven distribution of solar radiation throughout the year, mainly in spring and summer. The distribution of density of a solar radiation flux and its structure show that opportunities of its utilisation are somewhat limited, especially in winter. To date, around 1000 solar installations for the heating of usable water have been installed in Poland with a total surface area of the collectors exceeding 10,000 m^2. Photovoltaic cells in which solar energy is directly converted to electricity are virtually not used in Poland.

Some data on RES obtained from distributing companies for 2000 published by the Energy Regulatory Authority is shown in Table 5.7. It is to note that the data cover only energy purchased by distributing companies and do not represent the whole RES energy market.

Table 5.7 *Data on RES obtained from distributing companies for 2000*

Energy source	Installed capacity [MW]	Energy production [MWh]	Average energy prices [PLN/MWh]
Biogas	10.272	31 612.50	249.32
Biomass	0.580	55.00	132.42
All large hydro	476.825	1 316 318.98	67.80
Large hydro[19]	316.625	523 588.98	138.86
Small hydro	198.751	569 470.29	141.35
Wind	4.252	5 304.33	235.89

Accordingly to the data of Energy Regulatory Authority the share of renewable electricity in its total annual sale to final users was 2.32% (2239 GWh) in 2001. Renewable installed power at the end of October 2002 is presented in Table 5.8.

[19] Large hydropower stations without the largest station Włocławek with a capacity of 160 MW.

Table 5.8 *Installed power in RES in October 2002*

Renewable energy source	Installed power [MW_{el}]
Hydroenergy	528.5
Wind energy	28
Biogas	22.6
Biomass	1.1
Total	580.2

The main DG source in Poland with a high technical and economic potential is Combined Heat and Power (CHP). Concerning climate, technology and market conditions it is assumed that CHP sources of the power from several kW to 100 - 50 MW are economically justified. It is estimated by a rather rough calculation that at present the demand for such distributed sources is of 3000 MW, and then in the next couple of years it may be an additional demand of 5000 MW.

The Polish law creates for RES a specific share of the market with a clear administratively set increase till 2010. In that year the share of RES is expected to be 7.5% of the total electrical energy purchase to the final consumers, which amounts to approximately 8 TWh per year. Since at present app. 2.5 TWh is produced from RES, an increase of 5.5 TWh is expected till 2010. It is considered that small hydro will cover 0.5 - 1.0 TWh, biomass similar 0.5 - 1.0 TWh and the missing share i.e. 3 - 4 TWh is to be produced from wind parks. Assuming the average operation time for a wind turbine in Poland 1500 - 2000 h/year it is estimated that 2000 - 2500 MW in wind power is required. The cost of this investment is more that 500 mln Euro. Development of wind farms requires substantial investments in the existing power grid as well as operational control abilities of the national grid.

5.2.1 Grid connection of DG and RES

Entities connected to the network are divided into the following connection groups:

- group I - entities connected directly to the transmission network,
- group II - entities connected directly to the distribution network, of rated voltage 110 kV, and the entities connected to the distribution network which require delivery of electric energy of parameters other than standard, or the entities that own generating units coordinated with the network,
- group III - entities connected directly to the distribution network, of rated voltage greater than 1 kV but lower that 110 kV,
- group IV - entities connected directly to the distribution network, of rated voltage not exceeding 1 kV and connecting power greater than 40 kW or the 'before-the-meter' protection rated current in the current circuit greater than 63 A,
- group V - entities connected directly to the distribution network, of rated voltage not exceeding 1 kV, and connecting power not greater than 40 kW and the up-the-meter protection rated current in the current circuit not greater than 63 A,
- group VI - entities connected to the network through a temporary connection which, according to the contract, will be replaced with a target connection, or entities connected to the network for a specified time period not longer than 1 year.

Energy network enterprises that deal with the transmission and distribution of electric energy and heat are obliged to conclude contracts for connection to the grid, for sale of energy or for transmission services with customers or entities requesting the connection to the grid, on an equal treatment basis. This obligation holds if it is technically and economically feasible to supply energy or fuels, and an applicant meets the requirements for being connected to the grid and receiving the supply. If an energy network enterprise refuses to conclude such contract, it should immediately notify an interested entity in writing, giving reasons for refusal. Enterprises are

obliged to meet technical conditions of supply of energy upon terms specified in the separate provisions of law and in a licence.
An entity being connected to the grid is obliged to enable the network operator to build and develop the grid in the area of the entity's property within the scope necessary to make a connection, and to provide premises or sites for the installation of metering facilities.

Disputes concerning services mentioned, refusal to connect to the grid, refusal to conclude an electric energy or heat sale contract and unjustified discontinuity of their supplies are decided by the President of the Energy Regulatory Authority upon the request of one of the parties.

Very large end users such as steel factories, coalmines or chemical factories are supplied directly from the 110 kV or 220 kV power lines then transformed into lower voltages. The large single loads are connected to the grid at 6 kV or 10 kV, rarely at 15 kV.

In Poland the upper limit of generation capacity connected to the highest distribution voltage i.e. 110 kV is confined to 150-200 MW. This means that practically all DG is connected to grids lower than 110 kV. There are no special rules for DG connection. They are treated as the rest of generators according to their power, voltage and other specific data of the sources.

5.2.2 Standardised rules for DG connection

Introduction of DG in power grid can open new areas of considerations that can substantially enhance the necessary technical issues to be taken into account when increasing penetration of DG occurs. This has been summarised in Table 5.9.

Table 5.9 *Technical issues to be considered with DG development*

Technical issue	Description
System reliability	Due to the ratio of DG, technologies applied, reliability of DG units, power overcapacity in the system its reliability may increase or decrease
Frequency control	Need of additional local equipment for frequency control may occur
System control	With DG conflicts with upper hierarchical control systems may occur
System modelling	Possibly new means of modelling system may be needed not to overlook influence of DG
Development planning	Possibly new means of power system development planning may be needed e.g. at regional level
Load prognosis	Applied methods should enable to take into account particularities of DG
Maintenance planning, load dispatch	Existing methods should be checked and verified to take into account presence of DG in the system
System safety	Methods and tools for system safety assessment should be verified
Energy quality	Non-linear loads e.g. variable speed drives, power electronic devices due to DG should be taken into account
Automatic protection system	Presence of DG in distributing networks may results in more complicated design procedures and co-ordination of automatic protection

5.2.3 DNO duties regarding dispatching DG

DNOs show little interest in DG since they do not see any rapid interest in promoting DG. This is partly due to the fact that DNOs are currently occupied with ongoing process of consolidation and restructuring. Only some leading DNOs have shown interest into new forms of services, aimed at customers or introduction of new technologies e.g. DG development, others concentrate their activities on classical services with dominating position of distribution and electricity trade. There are a lot of doubts about cost allocation due to development of DG in local distributing networks. If a DNO can make profit, it would be active, provided the legislation is in place and it has the required knowledge on its sustainable electricity public obligations.

Concerning technical issues on dispatching DG generally it can be said that due to the lack of financing new investments in the network are very limited to those necessary and bringing return on capital in considerably short time. As long as the new capacity in DG is small in comparison with the whole power installed in DNO network technical problems are not of prime importance. In the future the installation of large wind parks with a capacity of several hundred MW could threaten the stability of the grid.

5.2.4 Transition tariffs for DG

There are no special tariffs for DG. They are set according to the same rules as for other generators.

Table 5.10 *Competence of regulation the electrical energy market in Poland*

Access to the network	Decision on network access conditions	Regulator Network operators(TNO or DNO)
	Dispute settlement	Regulator
	Possibility of appellations	Antimonopoly Court
Unbundling		Minister
Tariffs	Approval of tariffs	Regulator
	Possibility of appellations	Antimonopoly Court
Intersystem connections	Setting rules of access and tariffs	Regulator TNO
	Possibility of appellations	No decided
Wholesale market	Functioning	Market rules
	Dispute settlement	Regulator Court
Retail market	Rules of functioning	Minister Regulator
Concession in whole sale and retail markets		Regulator

5.2.5 Administrative priorities for grid connection of DG

The existing power grid has been designed to serve the purposes of centralised energy generation. This means that the grid density and its infrastructure have been developed in a natural way close to the energy resources areas. The grids of mid and low voltages are underdeveloped and in many cases unsuitable for direct connections of DG sources. On the other hand it creates conditions for improving the local supply by introduction of new DG sources. Real problems may occur when the introduction of new sources becomes massive i.e. new DG capacity will be of comparable size as the capacity of old centralised sources.

Due to large capacity of some DG e.g. wind farms the investors seek connection to very high voltage grid i.e. 220 kV or 400 kV or directly to distributing networks. In the latter case DNOs must have approval of TNO. There are no rules for choosing the most suitable technologies, location or criteria for accepting or refusing connection conditions. In practice some essential conditions of connection are not agreed during the phase of granting the right to connect to the grid but later on when both sides come to detailed terms of the connection agreement e.g. when the DNO reveals the required cost of connections. This uncertainty opens arena for disputes and is considered as a substantial hinder to the process of investments in DG.

In the case of RES article 7 of Directive 2001/77/EC shall be considered:

> *"1. Without prejudice to the maintenance of the reliability and safety of the grid, Member States shall take the necessary measures to ensure that transmission system operators and distribution system operators in their territory guarantee the transmission and distribution of electricity produced from renewable energy sources. They may also provide for priority access to the grid system of electricity produced from renewable energy sources. When dispatching generating installations, transmission system operators shall give priority to generating installations using renewable energy sources insofar as the operation of the national electricity system permits."*

In Poland rules that guarantee access to the transmission and distribution systems are in place and enable non-restricted trade of RES energy. Some restrictions may occur due to the safety requirements of stable system operation in the case of large wind farms with highly unpredictable production. These can be made more acceptable by new regulations and control systems of wind farms or assuring back power of adequate capacity.

The second provision of the art. 7 states that *providing priority access to the grid system of electricity produced from renewable energy sources is obligatory*. In Polish circumstances, according to the present Energy Law, all the entities must be treated equal regarding access to the grid. Therefore, granting any priorities for RES would require change in the Energy Law. To accomplish that a provision must be added to the Energy Law on 'special energy sources' e.g. RES or CHP for which special regulations are applied.

5.3 Conclusions

There are a variety of technical, business practice, and regulatory barriers to interconnection in the Polish domestic electrical energy market. These barriers discourage and sometimes prevent distributed generation projects from being developed. The barriers exist for all distributed-generation technologies and in all parts of the country. The impact of lengthy approval procedures and high standard fees are particularly severe for smaller distributed generation projects. Many barriers being encountered in today's marketplace appear to derive from or are more significant because of the fact that utilities have not previously dealt with many small-scale project or customer-generator interconnection requests. Many barriers also derive from or are more significant because there is not yet a national consensus on technical standards for connecting equipment, necessary insurance, reasonable charges for activities related to connection, or agreement on appropriate charges or payments for distributed generation. Utilities often have the flexibility to remove or lessen barriers. Distributed generation project proponents faced with technical requirements, fees, or other barriers that they found too burdensome are often able to get those barriers removed or lessened by informally protesting to the utility, to the utility's regulatory agency, or to other public agencies. But, this usually requires considerable additional time, effort, and resources. Official judicial or regulatory appeals, however, were often seen as too costly for relatively small-scale distributed generation projects.

To develop a real competitive market for DG technologies among other the following should be undertaken:

- Reduce technical barriers:
  - Adopt uniform technical standards for interconnecting distributed power to the grid.
  - Adopt testing and certification procedures for interconnection equipment.
  - Accelerate development of distributed power control technology and systems.
- Reduce business practice barriers:
  - Adopt standard commercial practices for any required utility review of interconnection.
  - Establish standard business terms for interconnection agreements.
  - Develop tools for utilities to assess the value and impact of distributed power at any point on the grid.

- Reduce regulatory barriers:
  - Develop new regulatory principles compatible with distributed power choices in both competitive and utility markets.
  - Adopt regulatory tariffs and utility incentives to fit the new distributed power model.
  - Establish expedited dispute resolution processes for distributed generation project proposals.
  - Define the conditions necessary for a right to interconnect.

6. EXECUTIVE SUMMARY AND FINAL CONCLUSIONS

This report presents an overview of the technical options and constraints for the integration of distributed generation in electricity networks in four Newly Associated States (NAS), the Czech Republic, Poland, Slovakia and Hungary. This additional report to the SUSTELNET report *'Review of Technical options and Constraints for Integration of Distributed Generation in Electricity Networks'* (John Eli Nielsen, 2002) analyses possible differences between EU MS and NAS electricity systems in their ability to integrate DG capacity.

The four NAS have aimed at full integration of their electricity systems with the Western European UCTE system since the beginning of the 1990s. For this purpose, the CENTREL system was established in 1992, connecting the power grids of the Czech Republic, Slovakia, Hungary and Poland. The objective of CENTREL was to improve those countries' power systems to reach the much stricter UCTE requirements (e.g. constant frequency of 50 Hz ± 0.02 Hz). Since 2001, all four NAS are full members of UCTE. As a result, the integration with the UCTE system led to stronger interconnections with Western European countries and to disconnection of the UPS/IPS (CIS + Baltic countries) system.

The basic layout of the national power grids consists of a transmission system, operated by a TSO (transmission system operator) and mainly 220 to 400 kV lines (up to 750 kV in Hungary and Poland). The distribution system (110 or 120 kV lines and lower) belongs to several regionally operating DNOs (8 in the Czech Republic, 3 in Slovakia, 6 in Hungary and 29 in Poland).

As a result of higher electricity demand in the past, in all NAS, overcapacity of power stations exist. Hungary is so far the only country relatively depending on imports. However, imports are higher than technically necessary because the imported electricity is on average cheaper than domestic production. The situation in Slovakia is as follows, current overcapacity enables the country to export electricity but the need to close some older power stations (including two units of a nuclear power plant) around 2008 will change this situation. It is expected that new production capacity will be needed in Slovakia or import capacity will have to be increased. Only the Czech Republic and Poland have sufficient capacity to cover domestic demand now and in the short-term future and at the same time export a significant amount of electricity.

Electricity production in the four NAS is largely based on three main sources, hard coal and lignite, nuclear power and hydropower. The Polish power sector is almost completely dependent on hard coal and lignite (90%), in the Czech Republic nuclear power forms an important source of electricity next to lignite and Slovakia has significant nuclear and hydropower production. The Hungarian power production is mainly based on hard coal and nuclear power, with some small share of oil and gas fuelled power plants. The electricity production by RES is relatively limited, with the exception of Slovakia, where (large) hydropower presents about 15% of national power production.

Table 6.1 *Currently exploited potential of RES in the NAS*

RES Source	Currently exploited potential [GWh/year]			
	CR	SK	HU	PL
Large hydro power	1165	5000	186	1316
Small hydro power	680			569
Biomass	200	85	7.6	32
Geothermal energy		0.35		
Solar energy	0	0.004	0.06	
Wind energy	1	3.6		5
Waste			112	

Nevertheless, all four countries have agreed to reach a certain share of RES electricity by the year 2010 according to the EU RES-E directive (indicative targets). The targets are given in Table 6.2. When comparing the existing RES-E share to the target for 2010, it has to be concluded that new RES capacity will be necessary, almost all in the form of DG.

Table 6.2 *Indicative RES-E targets for the NAS compared to present RES share [%]*

Country	EU RES-E target	Present RES-E share
Czech Republic	8.0	3.7
Slovak Republic	31.0	15.0
Hungary	3.6	0.8
Poland	7.5	2.5

When looking at the share of Distributed Generation in total, it shows that in all four countries CHP covers a significant amount of electricity production (between 10 and 20%). Most CHP plants are connected to industries and/or district heating systems. The technical conditions of these plants differs from site to site. Some municipal and industrial CHP plants are older than 20-30 years. Over the past 5 years new DG plants were constructed using advanced technologies such as the combined cycle.

When looking at the future potential of DG, we see that in all four countries a potential for growth exists for (small-scale) CHP. Other sources with relatively high potential are biomass (in combination with CHP), small-scale (< 10MW) hydropower and wind power (mainly on the Baltic Coast, Poland). Biomass can be an interesting source for DG given the high availability of wood and wood waste in all countries. So far, biomass is used for heating purposes only (e.g. in district heating systems), but the abundance of cheap fuel provides a potential for future use in power production.

The electricity systems in all countries are capable of delivering electricity in a relatively reliable way. Network losses differ among countries and regions, but are in general between 7 and 14%. In the Czech Republic the quality of the grid is viewed as being satisfactory, due to major investments in grid upgrade during the 1990s. An exception is the region affected by floods in the year 2002 where large investments will be necessary in the short-term future. In Slovakia and Hungary upgrades in the near future will be necessary as investments in the networks have been postponed in the past years, this also includes new and upgrade of existing cross-border lines.

DG is mainly connected to the distribution network, owned by DNOs, at voltages lower than 120/110 kV, actual connection level depending on the DG size. So far intermittent DG has a low share in power production (below 1%) and is therefore not influencing network quality. The problem of intermittency is recognised and in the future new investments into the network may be needed. Especially in Poland, a large number of wind power projects are planned to be realised in the coming decade. Some DNOs fear that this will negatively influence the quality of the grid. The benefits of some DG sources (CHP, small hydro) are not yet fully recognised but could be significant in some areas with weak networks. So far, DG has no major role in balancing the network. This is mainly done by large hydro power stations and large CHP installations (e.g. 200 MW CHP plant in Slovakia).

Grid connection regulation differs among the four NAS although all countries have Transmission and Distribution Codes in place and also an Energy Regulatory Authority is established. Transmission and Distribution Codes/Regulations are in most cases approved by the regulatory authority. The Czech Republic has fully standardised Transmission and Distribution Codes that include grid access for third parties. In Slovakia, DNOs have the possibility to demand additional requirements when connecting DG. This system is not very transparent, because it is difficult to assess if the requirements that are set are really needed to guarantee the quality of the grid or that it is a barrier raised by DNOs to limit grid access by independent power producers. In Hungary standardised rules exist, DG operators also have the choice to negotiate connection charges with the DNO under special circumstances. In Poland, standardised grid connection regulation is still under development although access to the network for DG is guaranteed.

Generally, no specific technical constraints to DG have been found in the NAS, main difference is that TSO/DNO and generators are not yet prepared to integrate large amounts of intermittent DG. The existing DG sources in all four NAS are mainly (small-scale) hydropower and CHP plants that are mainly controllable loads. Intermittent DG has no significant role in the NAS power systems so far. This situation could change for Poland in the near future, given the high potential for wind power, and will require major changes in the networks. Although network upgrades will be necessary in the other NAS also, the problem with intermittent DG is less relevant here.

The influence of DG production on the operation of the electricity supply system has so far been limited and only occurs in particular cases when of DG production increased strongly due to massive DG support. The current system of guaranteed feed-in tariffs in Hungary favours DG (mainly CHP) and overproduction of DG out of peak hours leads to necessary downscaling of centralised production. However, this has had no major implications on power quality and network reliability yet.

To prevent such cases, there are plans to reduce off-peak feed-in tariff, another to provide wider possibilities for the regulated consumers to consume cheaper at night (and/or more expensively in peak periods). In the long term it would be helpful, if regional dispatchers could not only real time follow the generation situation at small plants, but also could send signals for generation adjustment, too. Along with technological development incentives for balancing may assist in creating such a system.

APPENDIX A CROSS-BORDER CONNECTIONS

A.1 Czech Republic

Table A.1 *List of cross-border lines 400 kV, 220 kV*

Neighbouring country	Voltage [kV]	Substations	Yearly auction capacities 2003 [MW]	
			Import into the ČR	Export from the ČR
Germany (E.ON Netz)	400	Hradec - Etzenricht	400	750
		Přeštice - Etzenricht		
Germany (VEAG)	400	Hradec - Röhrsdorf (double line)	300	800[20]
Poland	400	Albrechtice - Wielopole		
		Nošovice - Wielopole	300	800
	220	Lískovec - Kopanina		
		Lískovec - Bujakov		
Slovakia	400	Nošovice - Varín		
		Sokolnice - Stupava		
		Sokolnice - Senica	700	500
	220	Lískovec - Považská Bystrica		
		Sokolnice - Senica		
Austria	400	Slavětice - Dürnohr		
			400	300
	220	Sokolnice - Bisamberg (double line)		

Import and export available capacities include also the capacities for transit.

Table A.2 *Cross-border lines 110 kV*

Neighbouring country	Number of lines
Poland	5
Slovakia	5

A.2 Slovakia

Table A.3 *Interconnection capacities between Slovakia and neighbouring countries*

SEPS - ČEPS (Czech Republic)	1,200 MW (Agreement on Organisation of Joint Auction)
SEPS - MAVAIR (Hungary)	950 MW
SEPS - PSE (Poland)	500 MW
SEPS - WPS UA (Ukraine)	300 MW (the profile does not meet criterion n-1)

As regards to other *international interconnections*, the construction of the following 400 kV line interconnections is expected for the upcoming years:

- Poland Varín - Bytczina
- Ukraine Lemešany - V. Kapušany - Mukačevo
- Czech Republic Varín - Nošovice
- Austria Stupava - Vienna (*depending on the interest of the Austrian side*)

[20] Co-ordinated common auction = total auctioned capacity of VEAG profile is shared by CR and Poland together.

A.3 Poland

Table A.4 *Existing trans - border interconnections*

Countries	Interconnector	Rated voltage [kV]	Capacity at 35 ºC [MVA]	Capacity limits [MVA]	Year of commissioning
PL- D	Mikulowa- Hagenwerder	400	2 x 1427	1385 (transformer)	1999
PL-D	Krajnik- Vierraden	220	2 x 196		1987
PL-CZ	Albrechtice- Wielopole	400	1212		1978
PL-CZ	Nosovice - Wielopole	400	1212		1978
PL-CZ	Liskovec- Bujaków	400	400		1976
PL-CZ	Liskovec- Kopanina	400	400		1960
PL- BY	Białystok- Roś	220	154		1962
PL-S	Słupsk- Karlshamn	450	600		2000
PL- SK	Krosno- Lemesany	400	2 x 1434	1385 (transformer)	1998
PL-UA	Rzeszów- Chmielnicka	750	4000	1300 (control device)	1985
PL-UA	Zamość - Dobrotwór	220	168		1967

All these elements justify participation of the TENs financing within the scope of reinforcement of interconnections between Polish and German systems, as well as projects securing access of the Baltic States and Russia to the European power market. New interconnections stemming from the above considerations will create also the necessity of national grid development and modernisation. Decisions on such investments cannot be subject solely to economic viability criteria and therefore it is justified that this scope of the Polish transmission grid development should be included jointly in the TENs projects and given a high priority.

Table A.5 *Planned trans - border interconnections*

Countries	Interconnector	Capacity [MW]	Length of line [km]	Estimated cost [mln €]	Feasibility study	Comments
PL - D	Mikulowa - Hagenwerder		n/a	15	2001	Installation of phase shifting transformers
PL - D	Krajnik - Neuenhagen-Vierraden				2001	Voltage level switch over from 220 kV to 400 kV
PL - LT	Ełk - Alytus	600	154	410	2002	New 400 kV line with BTB station
PL - D	Trzecia linia AC 400 kV		200	141	2001	New 400 kV line
PL - UA	Rzeszów - Chmielnicka	600/1200	n/a		2001	Restart of operation of existing 750 kV line with BTB station
PL - SK	Byczyna - Varin		135	98	2001	New 400 kV line
PL - BY	Narew - Roś /Belozerska	600	90	43		New 400 kV line with BY units in radial operation
RU - PL	Elbląg -Kaliningrad	600	100			New 400 kV line with BTB station

Discussions concerning possibility and conditions of constructing an interconnection between the power grids of Poland and Lithuania are being continued on the governmental and companies (PSE SA, and Lietuvos Energija) levels. The most convenient technical solution for this interconnection has shown to be a double-circuit, 400 kV AC line with power capacity of 1000 MW with back-to-back station situated in Alytus, Lithuania. The investment cost of the overall project is estimated at 434 million euro. The lifetime period of the interconnector is assumed at 40 years. Cost of the interconnector itself and back-to-back station estimated at 167 million euro financed by Poland and Lithuania from own sources and credit in relation 20/80.

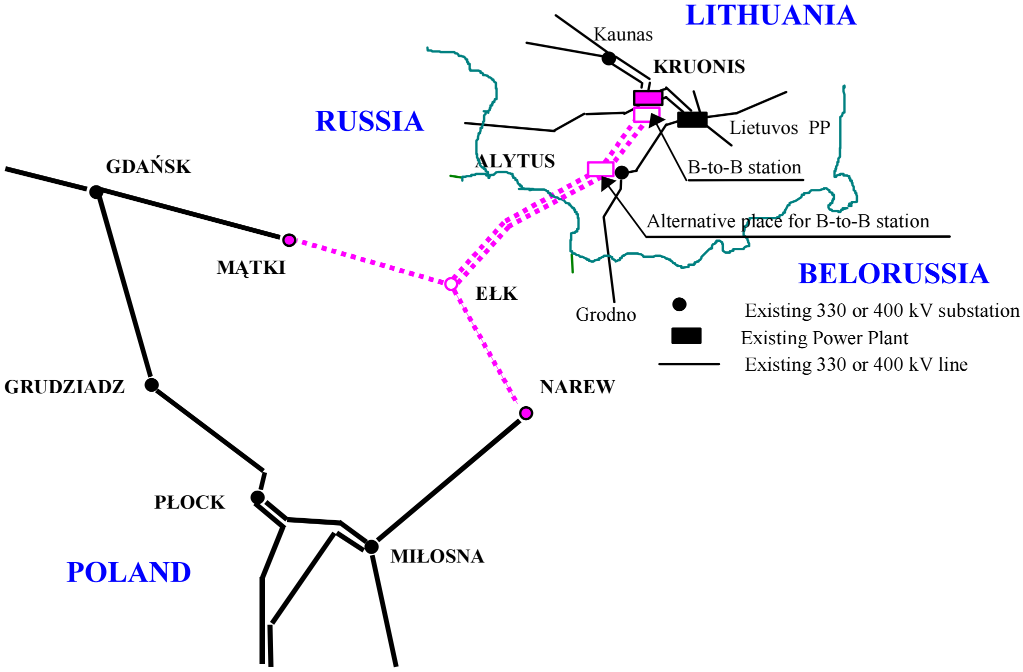

Figure A.1 *Planned interconnector between Poland and Lithuania*