Review of Electricity Supply and Demand in Southeast Europe

Varadarajan Atur
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**FOREWORD**

A key development in the Southeast Europe energy sector is the agreement between Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Former Yugoslav Republic of Macedonia, Kosovo, Romania, Serbia and Montenegro, and Turkey to develop a regional electricity market. This initiative is co-sponsored by the European Commission and the Stability Pact. The intent is to ensure the integration of this regional electricity market into the EU’s Internal Electricity Market.

In a regional market there would be benefits from competition and coordination, bearing in mind the heterogeneous resource endowments of the countries involved, non-coincident peak demand, and possibilities for sharing capacity reserves. These benefits would show up in the form of lower end user prices for a given level of system security.

One key issue in the context of the electricity market is the regional electricity balance. The current study assesses the electricity balance in Southeast Europe for the past ten years, and attempts to provide a preliminary forecast balance for the next ten years. The forward looking part of the study draws on national data provided by utilities in the region and gives an idea of the magnitude of investment finance that will be required in a limited power trade scenario. The study goes on to assess the scope for reducing the level of investments to achieve desired levels of system security through energy efficiency improvements and increased trade. The study suggests that the evolving supply deficit in the region can be significantly reduced through improved energy efficiency and increased trade.

The study was carried out by the Electricity Coordinating Center (EKC), Belgrade, for the World Bank’s Infrastructure and Energy Department (ECSIE) in the Europe and Central Asia Region, under the guidance of Varadarajan Atur, ECSIE, World Bank. David Kennedy prepared this Working Paper version of the study. Ziad Alahdad (ECCRO, World Bank) and Dejan Ostojic (ECSIE, World Bank) acted as peer reviewers for the exercise. I would like to thank EKC and the Bank staff involved for their efforts.

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ABSTRACT

This paper reviews the power sector demand-supply balance in Southeastern Europe (SEE), covering Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Former Yugoslav Republic of Macedonia, Romania, and Serbia and Montenegro (including Kosovo). The paper first looks at the actual balance over the period 1991-2001. After that, the forecast balance to 2012 is reviewed. The analysis is based on aggregated country level demand and capacity data provided by the electric utilities and supplemented drawing on published sources.

The context for the paper is the agreement between the countries above, together with Greece and Turkey, to form a South Eastern Europe Regional Electricity Market (SEEREM). The objective is to identify the magnitude of generation investments to be made in the evolving market. The paper also proposes mechanisms to reduce investment requirements, namely energy efficiency improvements and increased trade, and provides a brief assessment of technical and institutional barriers to trade.

The preliminary conclusion of the paper is that additional generating capacity of around 4,500 MW will be required over the next ten years, together with substantial rehabilitation of existing plant. The associated financing requirement would be well in excess of $5 billion. However, these figures reflect a significant degree of national energy self sufficiency. It is likely that less investment would be required if countries were to coordinate investments, with economies resulting due to heterogeneous resources, non coincidental peak requirements, and sharing of reserves. A regional least cost expansion plan is currently being developed as a follow up to the present study; this new study is to be financed by the EC and co-managed by the World Bank. The institutional framework to support increased trade is being developed as part of the SEEREM.

1. Shortly to be renamed the Regional Energy Market, and to incorporate Italy as a member.
ABBREVIATIONS AND ACRONYMS

B&H Bosnia & Herzegovina
CIDA Canadian International Development Agency
EBRD European Bank for Reconstruction and Development
EC European Commission
EIB European Investment Bank
EKC Electricity Coordinating Center
EPS Electrical Power System
ETSO European Transmission System Operator
EU European Union
GW Gigawatt
GWh Gigawatt-hour
Kfw Kreditanstalt für Wiederaufbau
kV Kilo Volt
kWh Kilowatt-hour
IFI International Financial Institution
MW Megawatt
p.a. per annum
REM Regional Electricity Market
RS Republika Srpska
SECI Southeastern Europe Cooperation Initiative
SEE Southeastern Europe
SEEERF Southeastern Europe Electricity Regulation Forum
SEEREM South Eastern Europe Regional Electricity Market
toe Tonnes of oil equivalent
TWh Terrawatt-hour
GDP Gross Domestic Product
UCTE Union for Coordination and Transmission of Electricity
CHAPTER 1

INTRODUCTION AND EXECUTIVE SUMMARY

Background
In March 2002 the European Commission (EC) launched a major initiative to establish a South Eastern Europe Regional Electricity Market (SEEREM) covering Albania, Bulgaria, Romania, Bosnia and Herzegovina (B&H), Croatia, the Former Yugoslav Republic of Macedonia (hereafter referred to as “Macedonia”), Serbia and Montenegro (including Kosovo),2 Greece, and Turkey. Italy has applied for membership in March 2003. Under the Athens Memorandum signed between these countries, it is envisaged that the power market for nonhousehold consumers will be liberalized in 2005.

As part of the SEEREM initiative, the Bank has assumed responsibility for coordinating various donor and IFI programs. In addition, the Bank will manage, together with the EC, a Generation Investment Study aimed at developing a least cost expansion plan for the region. The current study may be seen as a first step in developing the regional expansion plan.

The current study was carried out by the Electricity Coordinating Center (EKC), Belgrade, for the World Bank’s Infrastructure & Energy Services Department (ECSIE) in the Europe and Central Asia Region. The main objective was to review electricity supply and demand in the Southeastern Europe (SEE) region over the last decade and to obtain an initial assessment of power sector investments required for the next ten years. The study goes on to explore scope for increased power trade as a means of reducing investment requirements.

For the purposes of this report, the SEE Region includes the SEEREM countries above. Discussion of Greece and Turkey is limited to the context of power trade as opposed to supply and demand balance/investment requirements.

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2. For the purposes of this study, Serbia and Montenegro includes the province of Kosovo, reflecting historic power sector integration. Kosovo is currently under the administration of the United Nations Interim Administration in Kosovo (UNMIK) according to the terms of UN Security Resolution 1244 of June 1999.
Methodology and Data Used

Country level data on demand, installed capacity, and planned capacity additions, were aggregated to give estimates of regional demand and supply. Data were obtained from utilities in the region and supplemented with data from other published sources and also from ongoing studies of the SEEREM as noted in the bibliography. Data collection was generally difficult, largely due to the reluctance of the utilities to share information readily. Some critical data such as availability factors for power plants and firm capacities for hydropower plants could not be obtained. Also, key information on whether planned generation expansion includes investments for rehabilitation of existing capacities and environmental compliance could not be confirmed. Efforts have been made to verify the data for consistency through expert reviews and consultations to the extent possible within the limitations of this study and resources allocated.

Demand-Supply Balance: The Status and Outlook

The region has an installed power generation capacity of about 49.5 GW, comprising 35 percent hydro, 55 percent thermal and 10 percent nuclear. However, the available capacity has been much lower because the average age of plant is estimated to be over 30 years, with some plants being older than 40 years. The reliability of the generating plants is generally declining, and during poor hydrological years the region is unable to meet its energy needs.

After contraction during the 1990s, regional GDP has begun to grow in recent years. This is reflected in a regional electricity consumption annual growth rate of 1 percent from 1991-2001. Peak load growth over the same period was 2.2 percent per annum, reflecting GDP growth together with fuel substitution to electricity for heating.

The combination of declining available capacity together with demand growth meant that the region experienced increasing difficulties in meeting peak load demand. Whereas regional gross generation of about 167 TWh in 1991 was more than adequate to meet demand of 147 TWh, in 2001 there was a regional supply deficit. In this year, demand exceeded available capacity in Serbia, Montenegro, and Albania, resulting in each of these countries shedding load.

The regional utilities expect total electricity demand to grow at a rate of 2.3 percent p.a. during 2002-2012, or from 171 TWh to 214 TWh. Peak load is estimated to increase to 38.2 GW by 2012 (an increase of 6,800 MW from 2001 at 2.24 percent p.a.). The regional compilation of generation expansion plans shows that the region expects to add net new capacity of about 4,500 MW through 2012 in order to meet demand. The following key aspects emerge from an assessment of the countries’ power generation capacity plans:

- Romania’s plan shows that it will reduce its installed capacity by about 750 MW before 2012 (decommissioning 3,050 MW of old thermal capacity and adding 300 MW of hydro, 1,200 MW of conventional thermal and 800 MW of nuclear capacity). Bulgaria is under pressure from the EU to decommission up to 1,760 MW of its current nuclear capacity. The plans to add new thermal capacities (Bulgaria 2,100 MW; Croatia 800 MW; B&H 680 MW; Serbia 602 MW) could be affected by the EU’s strong commitment and efforts to reduce global emissions under the Kyoto Protocol.
- There have not been significant additions to capacity over the last 10-15 years, nor any significant investments in rehabilitation and modernization. Many of the investments in the current plans were in previous plans, but were not implemented due mainly to lack of financing. Now, however, the situation is becoming increasingly urgent. The financing requirement for the proposed aggregate plans to add 4,500 MW would be in the order of US$5 billion through 2012. Furthermore, it is likely that significant additional investments are needed for rehabilitation of aging production capacities throughout the region.
- The current investment climate is not favorable for attracting private sector investment in any substantial manner and the public sector does not have the ability to finance required investments over the coming decade. With the generating plants operating at capacity limits
(mostly de-rated due to aging), economic growth in the SEE countries might be jeopardized due to a lack of adequate supply of electricity. Load shedding can be expected to continue and even worsen in countries so far afflicted.

**Strategic Options and Priorities**

While the SEE countries should generally continue with efforts to implement their respective generation rehabilitation and expansion plans, there are two key priority areas which would help improve load management, namely energy efficiency and energy trade.

The average energy intensity for the region is 0.71 toe per $1000 of GDP compared to 0.19 for Europe. With the exception of Croatia, all other countries in the region show tremendous potential for improving overall energy efficiency in all sectors of the economy. A large part of energy inefficiency is likely to stem from the power sector. Energy efficiency improvements should therefore result in a reduced need for load shedding/new capacity in the power sector. Options for energy efficiency improvements include investments in new generating technologies, loss reduction, and demand side measures. Effective energy prices—tariffs and payments—would have to reflect costs in order that energy efficiency projects are financially viable and energy efficiency gains are realized. There is a need for effective price increases to cost recovery levels in all countries of the region.

Despite the many differences among the power systems of the countries in the region, the networks have basic interconnections and energy exchanges take place both for system stability and to meet national supply deficits. Bulgaria, Romania, and Bosnia and Herzegovina are the main exporters, while all others are net importers. In 2001 the region exchanged about 14.3 TWh, or about 8.7 percent of demand, for balancing purposes, and a further 8.2 TWh (5 percent of demand) with countries such as Greece and Turkey.

The sector investment plans of the SEE countries upon which this study is based assume self-reliance in energy. They generally do not recognize the potential benefits of regional coordination stemming from the mix of resources, noncoincidental peaks, and sharing of reserve capacity. A system based on optimization of these benefits likely would see significant increases in trade from the current levels, with ensuing cost reductions and improved system security.

A regional least cost expansion plan, based on a more thorough analysis of each of the countries’ demand forecasts and supply options, would encompass benefits of greater regional integration. Such a regional plan would likely indicate a smaller net new addition to capacity than the 4,500 MW suggested by the current compilation, depending upon the extent of readiness of the countries to coordinate and expand trading for peak load management and supply balance. As noted above, the Bank and the EC are managing a regional least cost expansion study as a follow-up to the current study.

Political agreement and institutional reform will be required if greater integration of national systems is to be achieved. The SEEREM recognizes this and requires participants to develop the institutional infrastructure required to support a regional market in which investments will be undertaken. Specific requirements include industry unbundling, the setting up of independent regulators, development of network access terms, conditions and prices, development of market mechanisms including commercial codes and financial settlement mechanisms, and opening markets for nonhousehold consumers.

In addition, investment is required to ease technical constraints to trade. Critical bottlenecks in the transmission interconnection network must be removed, and new lines—both within and between countries—must be added, if trade is to be increased.
Objective of the Study
The main objective of the study was to review the electricity supply and demand in the SEE region during the last decade and to obtain an initial assessment of the key challenges during the next ten years, based on projections made by the regional power utilities. An additional objective was to identify major opportunities for, and barriers to, expanding trade amongst the countries of the region and with other countries. As an input to the proposed SEE generation expansion follow on study, the current study is intended to show the broad directions of the electricity demand-supply balance situation during the coming decade.

The SEE Region
Definition
For the purposes of this report, the SEE countries include Albania, Bulgaria, Romania, Bosnia & Herzegovina, Croatia, the Former Yugoslav Republic of Macedonia and the current Federal Republic of Yugoslavia (Serbia and Montenegro). Bosnia & Herzegovina consists of two autonomous entities: the Federation of Bosnia and Herzegovina (FB&H) and the Republika Srpska (RS). Hereinafter, the Former Yugoslav Republic of Macedonia will be referred to as simply “Macedonia.” These countries cover a combined area of 613,000 square miles between the Adriatic and the Black Seas and have a combined population of 55 million.

The electricity supply and demand in Greece and Turkey are important from regional point of view, and are discussed in the context of regional trade, as opposed to supply and demand balance and investment requirement.

3. For the purposes of this study, Serbia and Montenegro includes the province of Kosovo, reflecting historic power sector integration. Kosovo is currently under the administration of the United Nations Interim Administration Mission in Kosovo (UNMIK) according to the terms of UN Security Resolution 1244 of June 1999.
Macroeconomic situation
The political and economic situation of the SEE countries has changed drastically in recent years. Prior to its dissolution, the former Yugoslavia had an energy infrastructure and general level of economic development comparable to that of other east-block states such as the former Czechoslovakia and Hungary. Within Yugoslavia there was considerable diversity, Slovenia being the most advanced part of the country. Prior to 1991 Albania was far less developed economically than any country in the region, and was the poorest country in Europe. The region underwent economic contraction during the 1990s as the structures of command and control economy crumbled and transition to market economy set-in. Troubles were compounded by war and related political instability. More recently the region has returned to positive growth. The average GDP per capita across the region is currently about US$1,800 (ranging from about US$985 for Montenegro/Serbia to about US$4,625 for Croatia); basic information (population, area, GDP/cap) is presented in Table 2.1 and Figure 2.1.

Regional power network
Many differences exist among the national power systems of the region in terms of size, production and load composition, etc. The former Yugoslavia had a single electricity grid and was a member of the Union for the Coordination of the Production and Transmission of Electricity (UCPTE, now renamed UCTE) network—in effect, it was part of the Western European power grid. The destruction of the transmission network in B&H and Croatia resulted in only Croatia, Slovenia and a part of B&H being connected to the UCTE. The electric power systems of Yugoslavia, Macedonia, part of B&H (Republika Srpska), Albania and Greece built the so-called “Second UCTE” zone, to which the power systems of Romania and Bulgaria were interconnected in 1994 and 1996 respectively.

At present, the power systems of Albania, Romania, Bulgaria, Macedonia, Greece, Republic Srpska (part of B&H) and Yugoslavia operate synchronously, in full accordance with the UCTE rules. Reconnection of this part of the UCTE network to the main UCTE interconnection is expected by the beginning of 2004. From February 1st 2002 until January 31st 2003, the power systems of Romania and Bulgaria were in inter-connective test with other UCTE members from SEE countries. The reconnection of the UCTE members in the Balkans and network extension towards Bulgaria and Romania would provide new opportunities for better utilization of existing interconnections and should improve the feasibility of common interest transmission interconnection projects.

The Study and Data Used
This is a desk study carried out by the Electricity Coordinating Center (EKC), Belgrade, for the World Bank’s Infrastructure and Energy Department (ECSIE) in the Europe and Central Asia Region. Most of the data used pertaining to demand, supply and generation expansion plans were

<table>
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<tr>
<th>Table 2.1: Basic Country Information</th>
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<tr>
<td>Population</td>
</tr>
<tr>
<td>Mil</td>
</tr>
<tr>
<td>Area</td>
</tr>
<tr>
<td>GDP</td>
</tr>
<tr>
<td>Total Electricity consumption</td>
</tr>
<tr>
<td>Gross Electricity consumption</td>
</tr>
<tr>
<td>Gross Electricity consumption</td>
</tr>
<tr>
<td>Gross Electricity consumption</td>
</tr>
</tbody>
</table>
obtained from the utilities in the respective countries as well as from some studies. It should be noted that critical evaluation of the data was not possible given the scope and budget for the study. EKC was established in 1993 to coordinate the work of electric power utilities in South Eastern European countries. EKC has been collecting and processing monthly data from these utilities and publish them every year. Since Romania and Bulgaria joined the parallel operation in 1994 and 1996 respectively, data for these countries before this period were not completely available.
Regional Electricity Demand over 1991-2001

The regional demand over the past decade, country-wise trend and snap shots of major sectoral consumption in 1991 and 2001 are shown in Figure 3.1 below.

Country level demand data is presented in Table 3.1 below. During the last ten years, gross electricity demand for the whole region varied between 145 TWh (1994) and 163 TWh (2001), with an annual average growth rate of about 1 percent between 1991 and 2001. The dip in consumption during the early part of the decade is attributed to economic downturns due to political instability and war. The decline in industrial demand from 55 percent of overall demand in 1991 to 47 percent in 2001 was largely offset by residential consumption growth, which increased from 32 percent of overall in 1991 to 39 percent in 2001. Rates of growth are different across the countries, with B&H leading at 12.31 percent followed by Albania at 6.94 percent and Montenegro at 5.6 percent. Bulgaria and Romania—the two largest countries—had negative demand growth during the period, but have since 2000 shown return to positive growth.

Most countries recorded peak load growth over the past decade. Regional peak load4 of about 25.5 GW in 1991 increased to 31.4 GW by 2001—an increase of 23 percent or 2.2 percent p.a. As with consumption, peak load growth also differed for each country. The highest increase in peak load was in Albania (from 580 MW to 1210 MW, or 109 percent), followed by Montenegro (from 278 MW to 714 MW, or 157 percent). Romania is the only country to have reduced its peak load (from 9723 MW to 9247 MW, or –0.5 percent).

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4. Peak load for the region was calculated as a sum of peak loads of all countries. It must be emphasized that peak loads of the countries do not appear at the same time and that the real regional peak load is therefore lower than the value presented. Since it is not possible to estimate the real values without sophisticated simulation, and since not all of these countries are in parallel operation, the arithmetic sum could be considered as a reasonable approximation.
**FIGURE 3.1: REGIONAL CONSUMPTION**

1991-2001 (GWh)

- **Gross consumption**: 146.9 TWh
- **kWh/capita**: 2172.0 kWh/cap.

- **Gross consumption**: 162.7 TWh
- **kWh/capita**: 2192.0 kWh/cap.

<table>
<thead>
<tr>
<th>Year</th>
<th>Albania</th>
<th>BiH</th>
<th>Bulgaria</th>
<th>Macedonia</th>
<th>Montenegro</th>
<th>Serbia</th>
<th>Romania</th>
<th>Croatia</th>
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</thead>
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<tr>
<td>1991</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **1991**
  - Households: 13%
  - Industry: 32%
  - Other: 55%

- **2001**
  - Households: 14%
  - Industry: 47%
  - Other: 39%
### Table 3.1: Consumption by Country

#### Year 2001

<table>
<thead>
<tr>
<th>YEAR 2001 / Country</th>
<th>Albania</th>
<th>B&amp;H</th>
<th>Bulgaria</th>
<th>Croatia</th>
<th>Macedonia</th>
<th>Montenegro</th>
<th>Romania</th>
<th>Serbia</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP (mil USD)</td>
<td>4320</td>
<td>5384</td>
<td>10577</td>
<td>5961</td>
<td>2564</td>
<td>846</td>
<td>44600</td>
<td>12435</td>
<td>86688</td>
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<tr>
<td>Total Consumption (GWh)</td>
<td>4093</td>
<td>7243</td>
<td>25418</td>
<td>11900</td>
<td>4014</td>
<td>1727</td>
<td>41459</td>
<td>26330</td>
<td>122184</td>
</tr>
<tr>
<td>KWh/capita</td>
<td>1215</td>
<td>1724</td>
<td>3081</td>
<td>2559</td>
<td>2007</td>
<td>2594</td>
<td>1851</td>
<td>2629</td>
<td>2200</td>
</tr>
<tr>
<td>Average Growth Rate 1991-2001 (%)</td>
<td>6.32</td>
<td>9.59</td>
<td>1.28</td>
<td>0.69</td>
<td>1.98</td>
<td>4.60</td>
<td>1.34</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>Growth Rate 2000/2001 (%)</td>
<td>-4.87</td>
<td>7.46</td>
<td>-0.27</td>
<td>0.64</td>
<td>-9.32</td>
<td>4.90</td>
<td>2.57</td>
<td>-0.82</td>
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<tr>
<td>Gross Electricity Demand (GWh)</td>
<td>5432</td>
<td>9804</td>
<td>36210</td>
<td>14455</td>
<td>6293</td>
<td>4116</td>
<td>52577</td>
<td>33797</td>
<td>162684</td>
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<tr>
<td>Households Electricity Demand (GWh)</td>
<td>1258</td>
<td>n.a.</td>
<td>10931</td>
<td>5560</td>
<td>2599</td>
<td>1098</td>
<td>8269</td>
<td>15167</td>
<td>44882</td>
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<tr>
<td>Trans. Losses and aux. Cons. (GWh)</td>
<td>675</td>
<td>293</td>
<td>10792</td>
<td>721</td>
<td>1081</td>
<td>153</td>
<td>6666</td>
<td>1390</td>
<td>21771</td>
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<tr>
<td>Average Growth Rate 1991-2001 (%)</td>
<td>6.94</td>
<td>12.31*</td>
<td>0.57</td>
<td>0.08</td>
<td>2.00</td>
<td>5.60</td>
<td>-1.01</td>
<td>1.97</td>
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<tr>
<td>Growth Rate 2000/2001 (%)</td>
<td>-4.87</td>
<td>5.07</td>
<td>-0.27</td>
<td>4.47</td>
<td>-2.30</td>
<td>7.30</td>
<td>2.58</td>
<td>3.78</td>
<td></td>
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<tr>
<td>Peak load (MW)</td>
<td>1210</td>
<td>1965</td>
<td>7400</td>
<td>2796</td>
<td>1261</td>
<td>714</td>
<td>9247</td>
<td>6812</td>
<td>31405</td>
</tr>
<tr>
<td>Peak Load Growth Rate 2000-2001 (%)</td>
<td>0.83</td>
<td>4.74</td>
<td>0.27</td>
<td>5.07</td>
<td>2.27</td>
<td>7.53</td>
<td>-10.8</td>
<td>3.32</td>
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</tbody>
</table>

*Electricity demand in B&H is not included for period 1991-1993.
Regional Electricity Supply during 1991-2001

The regional supply over the past decade country-wise trends are shown in Figure 3.2 and Table 3.2 below.

The total regional generation of about 167 TWh in 1991 comfortably met the demand of 147 TWh, whereas the production at 165 TWh in 2001 was inadequate to meet the demand of 163 TWh—this due to exports outside the region by some countries—necessitating imports and load shedding in Albania, Serbia and Montenegro.

The region as a whole provided hydroelectric power for about 25 to 34 percent of requirements depending upon hydrology, but Albania and Montenegro—whose capacities are predominantly hydro (over 75 percent)—suffered shortages when thermal production could not make up for the hydro shortfalls, especially in the 1999-2000 dry period. This is evident in the negative rate for production growth over 2000-01 for Albania and Montenegro. The largest part of electricity was produced from thermal power plants (coal/lignite, oil/gas)—about 45 percent in 1991 which increased to 55 percent by 2001. At the same time, the share of oil/gas based production decreased sharply from 20 percent in 1991 to a mere 2 percent in 2001, which is attributed to lack of gas supplies to the region, notably Romania which has been experiencing a gradual decline in gas production, but an increasing need for other than power production. During the decade, there were capacity additions in Romania (Cernavoda nuclear, 700 MW) and in Bulgaria (Chaira pumped storage, about 800 MW. The changing composition of capacity for the region between 1991 and 2001 is illustrated in Figure 3.3.

Electricity Exchange in 2001

As with any interconnected system, utilities in the Region have also been exchanging power for systemic reasons, but also increasingly to meet specific shortfalls in the recent years. The annual physical energy exchange between (among) the utilities of the region during 2001 is shown in

![Figure 3.2: Regional Electricity Generation 1991-2001 (GWh)](image)

* Electricity production in B&H is not included in the period 1991-1993
### Table 3.2: Production Trends by Country  
1991-2001

<table>
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<tr>
<th></th>
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<th></th>
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<td>0</td>
<td>1.1</td>
<td>-8.1</td>
<td>1581</td>
<td>1147</td>
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<td>53888</td>
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<td>62</td>
<td>10</td>
<td>0.4</td>
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<td>2059</td>
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<td>0.3</td>
<td>3.5</td>
<td>6588</td>
<td>4472</td>
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*1994-2001
Table 3.3 below. In 2001, the total exchanges was about 14.2 TWh within the region, and 22.5 TWh including Greece and other (mainly Turkey). Bulgaria, Romania and B&H (mainly Republic of Srpska) were the main exporters, while all others were net importers, mostly to meet their own needs and to transit power to other countries. Trade between Serbian and Montenegro relates to an exchange of peak for base power. Large capacity deficits in Albania, Macedonia and Montenegro in poor hydrological years means that imports are required to satisfy demand.
### Table 3.3: Annual Energy Exchange between Utilities of SEE and Others in 2001 (GWh)

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<thead>
<tr>
<th>Bulgaria</th>
<th>Romania</th>
<th>Serbia</th>
<th>Albania</th>
<th>B&amp;H</th>
<th>Croatia</th>
<th>Maced.</th>
<th>Mont.</th>
<th>Region</th>
<th>Greece</th>
<th>Other</th>
<th>Total</th>
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<tr>
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<td>598</td>
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<td>1762</td>
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<td>19</td>
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<td>10</td>
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<td>65</td>
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<td>3435</td>
<td>236</td>
<td>3671</td>
<td></td>
<td></td>
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<td>721</td>
<td>98</td>
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<td>1138</td>
<td>1146</td>
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<tr>
<td>Region Total</td>
<td>1088</td>
<td>673</td>
<td>5311</td>
<td>823</td>
<td>696</td>
<td>0</td>
<td>1527</td>
<td>4131</td>
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<td>3600</td>
<td>4600</td>
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<td>55</td>
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<td></td>
<td></td>
<td>1051</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

| Other    | 76      | 1278   | 1610    | 3780 |       |       |       | 6744   |        |       |       |

| Total Import | 1091 | 749 | 6589 | 1816 | 2306 | 3780 | 1582 | 4131 | 22044 |        |       |
| Net Export | 6928 | 1310 | -2117 | -1751 | 1365 | -3192 | -436 | -1702 | 405   |        |       |
| Demand    | 36210 | 52577 | 33797 | 5432 | 9804 | 14455 | 6293 | 4116 | 162684 |        |       |
| Prodn.    | 43870 | 53888 | 32736 | 3682 | 11356 | 11262 | 5816 | 2398 | 165008 |        |       |
| Def/Sur   | 7660 | 1311 | -1061 | -1750 | 1552 | -3193 | -477 | -1718 | 2324 |        |       |
| Net Export | 6928 | 1310 | -2117 | -1751 | 1365 | -3192 | -436 | -1702 | 405   |        |       |
| Transit   | 732  | 1     | 1056  | 1     | 187  | -1     | -41  | -16  | 1919  |        |       |
Forecast Load Balance Summary
All forecasts of electricity demand and generation extension plans were based on the respective
plans of the electric power utilities in the region, and in some studies information was either
incomplete or unavailable. As noted earlier, no particular in-depth analysis was possible to evaluate
whether the construction plans of new generation units are realistic.

Aggregate electricity demand and peak load forecasts for all SEE countries for years 2001,
2002 (estimate) and 2012 (forecast) are presented in Table 4.1.

The analysis is based on a moderate scenario for all countries. The data for 2001 are actual,
whereas those for future years are target values as per consolidated plan.

Regional gross consumption is expected to start at 171.2 TWh in 2002 (a very slight increase
over 2001) and projected to grow to 214.3 TWh in 2012, which represents an average growth rate
of about 2.30 percent. Taking into account the growth rate in the period 1994-2001 (1.82 per-
cent), the growth rate in 2000/2001 (2.13 percent), and that the forecasts do not factor in much of
the potential energy efficiency improvement and implementation of realistic tariffs in the region, it
could be argued that the growth rate during 2002-2012 could be slightly lower than 2.30 percent.
On the other hand, this growth rate can be considered plausible, having in mind the low specific
electricity consumption (varying from 1200 kWh/capita to 3000 kWh/capita comparing to about
8000 kWh/capita in the EU countries), and the expected growth in the economy and industrial
development.

Corresponding to the demand/consumption forecasts, regional peak load estimates are 30.6 GW
in 2002 and 38.2 GW in 2012. Comparing these to the realized value in 2001 (31.4 GW), the fore-
casted peak load implies an increase of 25 percent during the coming decade at an annual growth
rate of 2.24 percent. Forecast consumption and peak load growth is illustrated in Figure 4.1.

Planned capacity additions are shown in Table 4.2. The region aims to add a net capacity of
about 4,500 MW through 2012, including 1400 MW of thermal, 2300 MW of hydro and 800 MW
of nuclear capacity. Large thermal capacity impacts are in Bulgaria, Romania, Serbia, Croatia and
B&H. Bulgaria aims at adding 2000 MW of thermal, while Romania aims at decommissioning
<table>
<thead>
<tr>
<th>Country</th>
<th>GDP ($/ capita)</th>
<th>Gross Electricity Consumption (GWh)</th>
<th>Peak Load (MW)</th>
<th>Production (GWh)</th>
<th>Installed Capacity (MW)</th>
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<td>2067</td>
<td>5432</td>
<td>6205</td>
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<td>B&amp;H</td>
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<td>171255</td>
<td>214391</td>
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</table>
about 4000 MW of old thermal capacity. The other net additions are B&H with 600MW, Croatia with 800 MW and Serbia with 500 MW. Proposed additions are mainly coal fired plants, and also include some oil and modest gas units. As for hydro, Montenegro and B&H plan to add significant capacities with 1100 MW and 900 MW respectively. Romania’s second nuclear unit is expected be commissioned during the decade with 800 MW capacity. Overall, the proportion of thermal, hydro and nuclear capacities are expected to remain essentially constant during the decade under this generation expansion plan, shown in Figure 4.2 below.

If the above generation expansion plan is realized, the target capacity mix by 2012 in the individual SEE countries would be as summarized in Table 4.3 below.

Assessment of Region’s Generation Expansion Plan
As previously noted, more sophisticated modeling and analyses would be required for a thorough assessment of each of the countries’ expansion plans and hence of the combined system in a regional context. However, considering that this study is aimed at presenting an overview, some important assessments can be made, especially as regards the realism of the specific plans and hence the expected consequences for the supply balance. These are noted below:

- Forecast electricity production growth rates are lower than those for electricity consumption. Taking into consideration the deficit already experienced in recent years, problems in covering electricity balances of some countries can be expected even under a very low growth rate scenario. Considering the already old equipment of inefficient technologies, delaying the planned investments in generation would cause serious problems in electricity balance for Albania, Croatia, Macedonia, Montenegro, and Serbia. Industrial and service sector demand are expected to increase in line with economic growth. Inadequate supplies could hurt growth and curtail the gradual turnaround of the region.
- The expansion plans of B&H, Montenegro, and Bulgaria are very ambitious, as also of Serbia to some extent. Most of these investments were in plans in previous years, but were phased to outer years due to lack of financing. During the last decade the only capacity additions were in Romania (Cernavoda nuclear, 800 MW) and Bulgaria (Chaira pumped storage, about 800 MW). Also, some rehabilitation works were undertaken in Romania (thermal) and to a limited extent in other SEE countries. Considering the current climate for attracting financing, and considering that it could take several years before any serious investors consider investments in these countries, it is again
## Table 4.2: Planned Capacity Additions

<table>
<thead>
<tr>
<th>Generation Capacities (MW)</th>
<th>Thermal</th>
<th></th>
<th>Hydro</th>
<th></th>
<th>Nuclear</th>
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<td>New</td>
<td>Installed</td>
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<td>2363</td>
<td>5216</td>
<td>691</td>
<td>53994</td>
<td>4444</td>
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doubtful whether these countries can realize their expansion plans. There could also be difficulties in adding coal and lignite based capacities (especially in Bulgaria) because of the seriousness of the EU in fulfilling Kyoto Protocol targets for global emission reductions.

Notwithstanding the difficulties in net additions to capacity as noted above, since no significant investments have been made during the past 10-15 years to rehabilitate and/or modernize existing capacity, the further aging of the equipment will lower the availability and reliability of plants unless urgent rehabilitation and modernization are undertaken to restore the capacity availability to a reasonable level. This should be the top priority for all countries since large capacities in Bulgaria (nuclear) and Romania (thermal) would be decommissioned (in part owing to pressure from the EU). It is estimated that about 2500 MW of capacity will need rehabilitation and modernization to improve plant reliability and availability in addition to the 4500 MW of net new capacity through 2012.

Even if rehabilitation and modernization successfully restore capacity availability, the region would have to aim at improving energy efficiency and better utilization of their combined capacity for peak load management and for meeting energy deficits to avoid load shedding.

<table>
<thead>
<tr>
<th>Country</th>
<th>Albania</th>
<th>B&amp;H</th>
<th>Bulgaria</th>
<th>Croatia</th>
<th>Macedonia</th>
<th>Montenegro</th>
<th>Romania</th>
<th>Serbia</th>
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<td>12900.0</td>
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<td>2150.0</td>
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<td>15950.0</td>
<td>9109.0</td>
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<td>20.16</td>
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<td>65.80</td>
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<td>54.26</td>
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<td>47.45</td>
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<td>0.00</td>
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<td>Electricity Production 2012 (GWh)</td>
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<td>57.63</td>
<td>51.04</td>
<td>82.66</td>
<td>48.50</td>
<td>57.21</td>
<td>68.33</td>
</tr>
<tr>
<td>Nuclear (%)</td>
<td>0.00</td>
<td>0.00</td>
<td>38.86</td>
<td>11.68</td>
<td>0.00</td>
<td>0.00</td>
<td>16.21</td>
<td>0.00</td>
</tr>
<tr>
<td>Average Production Growth Rate 2002-2012 (%)</td>
<td>5.94</td>
<td>2.41</td>
<td>1.34</td>
<td>2.87</td>
<td>1.91</td>
<td>5.78</td>
<td>1.77</td>
<td>1.76</td>
</tr>
</tbody>
</table>
Energy Efficiency Measures

The region’s per capita consumption of electricity is about 2,500 kWh compared to 8,100 kWh for Europe, whereas the consumption of all forms of energy is 0.71 toe per $1000 of GDP compared to 0.19 toe for Europe. Except for Croatia, whose consumption of 0.34 toe per $1000 of GDP is close to the world average of 0.30 toe, all other countries in the region show tremendous potential for improving overall energy efficiency in all sectors of the economy. Although there may not be a direct correlation between overall energy intensity and electricity usage and, in fact, increased growth may well result in increased electricity usage, improving energy efficiency in Albania (0.53 toe per $1000 of GDP), Serbia (0.50 toe per $1000 of GDP), and Montenegro (1.04 toe per $1000 of GDP) should help in reducing or at least dampening the demand and/or peak load and thus help minimize load shedding. These measures could include investments in new technologies to reduce energy intensities and demand-side management to shift and reduce peak loads.

Even B&H, Romania, and Bulgaria, which are electricity exporting countries (with respectively 0.72, 1.11 and 1.53 toe per $1000 of GDP) would benefit significantly from energy efficiency measures. Although the current levels of electricity prices and the practice of nonpayment (mostly by state owned enterprises and state agencies) do not provide the right incentives for undertaking investments in energy efficiency, the reforms already underway in most of the countries and the continuing fiscal pressures should bring about the needed changes. Energy savings will pay for the investments in energy efficiency, but most investments will require medium-long term financing. Further studies to identify the potential and priority areas for improving energy efficiency should be undertaken, based on which the IFI’s and GEF could provide the financing needed to jump start energy efficiency investments in these countries.

Expanding Regional Trade

As much as countries desire self sufficiency in energy, the old paradigm of building a completely self-reliant system to assure energy security is neither feasible nor required if trading across interconnected networks is pursued as an objective. For the SEE countries, trading (or power exchange) has been a necessity and there is potential for significantly expanding to for the mutual benefit of all countries involved. Indeed, all SEE countries, plus Turkey, have committed themselves to expanding electricity trade under the SEEREM Athens Memorandum of November 2002.

The sector investment plans of the SEE countries are based on self-reliance in energy, which neither takes advantage of, nor considers, the collaboration opportunities that exist in the region, with the exception of periodic and on the spot power exchanges. The differences in peak load timing between countries and regions offers opportunities for optimizing generation capacity and mix on a region-wide basis. A regional least cost expansion plan, based on a more thorough analysis of each of the countries’ demand forecasts and supply options, would encompass these benefits. Such a regional plan would likely indicate a smaller net new capacity addition to maintain balance than the 4,500 MW suggested by the current compilation, depending upon the extent of readiness of the countries to coordinate and expand trading for peak load management and supply balance.

In order to expand trade, the following aspects would need to be addressed:

SEE Power System Interconnection and Operation

Network interconnection and operation require very strict technical conformance and performance standards that are governed by regional and continental protocols such as the ETSO, UCTE, CENTREL, etc. As noted before, all countries in the region are preparing to operate under the UCTE norms (with Bulgaria and Romania joining soon), which should help expansion of power exchange and wheeling across the network. ETSO standards would also help to support exchange power between the region and other countries, such as Greece and other European countries.

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5. The data on consumption and energy intensity are taken from IEA Statistics for 2000.
The existing interconnections are not only inadequate, several critical parts have been destroyed due to war and several others need upgrading to conform to UCTE standards and to allow increase in power flows. These include transmission lines, substations and associated equipment. Interconnections require considerable coordination among countries, especially between those that are connecting to ensure that investments are undertaken in a synchronized manner on their respective terminal points in the networks. Based on load flow analyses, the minimum necessary high voltage lines to assure system interconnection of Bulgaria and Romania to UCTE/CENTREL and the simultaneous restoration of interconnected operation in SEE as foreseen by 2004, are the following:

- 400 kV Arad (Romania)-Sandorfalva (Hungary) and Subotica (Yugoslavia)-Sandorfalva (Hungary),
- 400 kV Rosiori (Romania)-Mukachevo (Ukraine)
- 400 kV Mladost (Yugoslavia)-Ernestinovo (Croatia),
- 400 kV Mostar (Bosnia & Herzegovina)-Konjsko (Croatia).

**Existing Transmission Lines**

Under the SECI Transmission project (SECI Project Group 2001), in order to define the most promising interconnection projects from regional point of view, a preliminary technical analysis has been completed and further study is underway. For this purpose, an Interconnection Study Task Group (ISTG) was formed of experts from Bosnian ZEKC, Bulgarian NEK, Croatian Energy Institute “Hrvoje Pozar” and EKC. The study includes regional steady state load flow analysis. Every country in the region has nominated some projects (interconnection line) of regional interest according to its own short- and medium-term plans. A list of candidate interconnections that has been reviewed and revised as the most probable projects for consideration are shown in Annex 4.

Those projects which are most likely to be in operation in 2005 are listed and shown above. Other projects are expected to be considered as post-2005 options in ongoing studies. Most of the projects are of regional interest and are expected to contribute to the development of appropriate infra-structure for parallel and synchronous operation of power systems in SEE countries as per UCTE standards. These projects would also facilitate and improve the effectiveness of electricity transactions between these countries. The SECI studies indicate that about 1000 MW of additional transmission capacity would result from these interconnections.

**SEE Regional Energy Market**

Under the original draft Athens Memorandum establishing the SEEREM, all SEE countries have agreed to develop a regional energy market. Multilateral efforts to assist these countries are underway with the lead initiative from the EC/Stability Pact and supported by the World Bank, EBRD, EIB, USAID, KfW, CIDA, etc. Several studies have been launched to examine the priorities and prepare action plans for the countries and the region as a whole.

The original draft Athens Memorandum sets 2005 as a provisional date for opening of non-household power markets. If liberalization is to be successful, a number of critical reforms must first be implemented. These include tariff reform, the setting up of independent regulators, the development of secondary legislation (tariff methodologies), and industry unbundling, and development of market infrastructure (a market operator, trading rules, financial settlement mechanisms, etc.).

Following liberalization prices will tend to cost recovery levels, at least in competitive parts of the market. Where there are currently cross subsidies from industrial to residential consumers, this would require price rebalancing. Current cross subsidies are illustrated in Table 4.4 below. It is key that price rebalancing is allowed to occur if distribution companies are to remain financially viable. Further it is key that affordability consequences of residential tariff reform are mitigated. The Athens Memorandum recognizes the importance of tariff reform. As part of the SEEREM development, consultants are working with the governments involved to identify potential affordability consequences of liberalization, and ways to strengthen social safety nets as necessary.
One key means for implementing tariff reform is through design of the regulatory framework. The current status of power sector regulation in SEE is summarized in Table 4.5 below. Most countries in SEE have legislation (or draft legislation) for setting up of an independent regulator. This is typically a body separate from any ministry, headed by a commission appointed on a fixed term basis, and accountable to the government/parliament. Only in a small number of countries does the regulator have full tariff setting power, with government approval of tariff required in a number of cases. As regards secondary legislation, there is work to do in all countries developing network and end user tariff methodologies to promote efficient performance and provide incentives for potential investors. A regional regulators association formed as part of the SEEREM is focusing on these and other issues, including cross border

<table>
<thead>
<tr>
<th>Country</th>
<th>Prices $/kWh</th>
<th>Industrial</th>
<th>Commercial</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albania</td>
<td>0.042</td>
<td>0.071</td>
<td>0.034</td>
<td></td>
</tr>
<tr>
<td>Bosnia (EPBiH)</td>
<td>0.027</td>
<td>0.061</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bosnia (EP HZ BiH)</td>
<td>0.027</td>
<td>0.061</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bosnia (EP HZ BiH)</td>
<td>0.051</td>
<td>0.103</td>
<td>0.053</td>
<td></td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0.033</td>
<td>0.033</td>
<td>0.031</td>
<td></td>
</tr>
<tr>
<td>Croatia</td>
<td>0.088</td>
<td>0.075</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Macedonia</td>
<td>0.025</td>
<td>0.051</td>
<td>0.035</td>
<td></td>
</tr>
<tr>
<td>Montenegro</td>
<td>0.019</td>
<td>0.026</td>
<td>0.017</td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td>0.039</td>
<td>0.039</td>
<td>0.049</td>
<td></td>
</tr>
<tr>
<td>Serbia</td>
<td>0.014</td>
<td>0.014</td>
<td>0.021</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4: Power Tariffs in SEE Countries (2001)

Table 4.5: Status of Power Sector Regulation in the SEE Countries (2001)

<table>
<thead>
<tr>
<th>Present unbundling status</th>
<th>Regulatory Agency</th>
<th>Body in charge of tariff approval</th>
<th>Dispute Resolution</th>
<th>Regulatory oversight body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albania</td>
<td>Organizational</td>
<td>ERA</td>
<td>Regulator (ERA)</td>
<td>KESH and ERA</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>Unbundled SERC</td>
<td>Government</td>
<td>Ministry</td>
<td>Parliament (planned)</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Unbundled organization and accounts</td>
<td>SERC</td>
<td>Regulator (SERC)</td>
<td>SERC</td>
</tr>
<tr>
<td>Croatia</td>
<td>Legal, but still not full organizational</td>
<td>CERC</td>
<td>Ministry and regulator (CERC)</td>
<td>CERC</td>
</tr>
<tr>
<td>Macedonia</td>
<td>Planned</td>
<td>–</td>
<td>Ministry of economy</td>
<td>Ministry (Regulator in future)</td>
</tr>
<tr>
<td>Romania</td>
<td>Legal, organizational, accounting</td>
<td>ANRE</td>
<td>Regulator (ANRE)</td>
<td>ANRE</td>
</tr>
<tr>
<td>Montenegro</td>
<td>Not started, no separation of accounts</td>
<td>–</td>
<td>Ministry of economy</td>
<td>–</td>
</tr>
<tr>
<td>Serbia</td>
<td>Not started, no separation of accounts</td>
<td>–</td>
<td>Proposed by the EPS and approved by the Ministry (Regulator in future)</td>
<td>Regulator</td>
</tr>
</tbody>
</table>
pricing and management of transmission congestion. The challenge going forward will be to
develop and implement such methodologies.

On industry restructuring, the requirement under the Athens Memorandum is that separate
transmission and distribution companies be set up. These may be stand alone entities, or subsidiaries
in a holding company structure (other subsidiaries might include power generation companies).
Some countries have moved to a new industry structure (for example, Bulgaria and Romania),
though in all countries there is further scope for industry commercialization. On market design, the
proposal is that this will feature bilateral contracts together with a balancing market. Details of mar-
ket design are the subject of an extensive consultancy project in the SEEREM context.
A summary of the conclusions from the study and further proposals for consideration are as follows:

- The study has provided indicative numbers for power supply-demand evolution in the region over the coming decade, including broad estimates of capacity additions and rehabilitation requirements. Despite the limitations on the completeness of data and unavailability of certain key data/information, estimates and inferences made seem to be in the range of high confidence limits for general acceptance. The study is a first step to a more thorough study on regional power generation expansion managed by the World Bank and the EC.

- The available capacity for electricity generation in the region is far less than the nominal installed capacity of 49.5 GW; this is one of the major causes for the shortage of power in some countries of the region. The generating equipment is old with an average age of over 30 years (some plants near 40 years), which sustains low reliability and hence lower availability. For example, in Romania alone, the available capacity was reported to be around 11,000 MW compared to nominal installed capacity of 18,500 MW, which is only 60 percent of installed. More than about 4,000 MW of installed capacity in Romania is deemed uneconomic for rehabilitation and is planned to be retired. Furthermore, the figures for installed capacities are not consistent among the different sources of information from the same country. Hence, installed capacity figures are not reliable bases for assessing supply-demand balance.

- The regional utilities expect total electricity demand to grow at a rate of 2.3 percent p.a. during 2002-2012, or from 171 TWh to 214 TWh, and the peak load is estimated to increase to 38.2 GW by 2012 (an increase of 6,800 MW from 2001 at 2.24 percent p.a.). The regional compilation of generation expansion plans shows that the region expects to add net new capacity of about 4,500 MW through 2012 in order to meet demand. Romania’s plan...
shows that it will reduce its installed capacity by about 750 MW by 2012 (decommissioning 3050 MW of old thermal capacity and adding 300 MW of hydro, 1200 MW of conventional thermal and 800 MW of nuclear capacity). Bulgaria is under pressure from the EU to decommission up to 1760 MW of its current nuclear capacity. The plans to add new thermal capacities (Bulgaria 2,100 MW; Croatia 800 MW; B&H 680 MW; Serbia 602 MW) would be affected by the EU’s strong commitment and efforts to reduce global emissions under the Kyoto Protocol.

There have not been significant additions to capacity over the last 10-15 years, nor any significant investments in rehabilitation and modernization. Many of the investments in the current plans were in previous plans, but were not implemented due mainly to lack of financing. Now, however, the situation is becoming increasingly urgent. The financing requirement for the proposed aggregate plans to add 4500 MW would be in the order of US$ 5 billion through 2012. Furthermore, significant additional investments are needed for rehabilitation of aging production capacities throughout the region.

The current investment climate is not favorable for attracting substantial amounts of private sector investment, and governments in SEE do not have the ability to finance all required investments over the coming decade. With generating plants operating at capacity limits (mostly de-rated due to aging), economic growth in the SEE countries might be jeopardized due to a lack of adequate supply of electricity. Load shedding can be expected to continue and even worsen in countries which have been experiencing it so far.

Expanding power exchange and trading should reduce regional investment requirements. The EU’s SEEREM initiative is timely in this regard. Infrastructure constraints are planned to be removed through new transmission interconnections and sector reforms are being pursued in all the countries (policy, legal, regulatory, and tariff reforms) to support the REM. The REM will deepen gradually, as will the willingness of the countries to shift focus to regional instead of local optimization in generation expansion plans.

The available interconnections enable some exchange of power, but in dry years the situation worsens, forcing load-shedding in some countries (Albania, Serbia, and Montenegro). Critical bottlenecks in the transmission interconnection network—both within and between countries—will need to be removed if trade is to flourish.

Greece is expected to remain a net importer from the region, whilst Turkey could emerge as a potential exporter, given forecast excess capacity. A number of technical constraints would have to be overcome for Turkey to capitalize on this potential. Regarding other countries, potential trade patterns will become clear as part of the Bank’s Generation Investment Study.

In addition to overcoming the countries’ reluctance to seek regional instead of local optimization of expansion plans, further expansion of trade will involve reform challenges. Trade will require access to transmission and distribution networks, creditworthiness of parties, financial clearing for trade without delay and reliable contract enforcement/disputes settlement mechanisms. Tariff reforms are required to remove distortions and to support energy conservation and efficiency measures. The financial and advisory support of donors will be needed to achieve these reforms and build the infrastructure.

Energy efficiency measures would help to improve load management, though may not fully offset demand growth and related demand for new capacity. All countries (except perhaps Croatia) show tremendous potential for reducing energy intensity and hence also improve competitiveness of their economies. KfW and USAID have shown interest to lead the efforts in promoting energy efficiency. Further studies to identify the potential and priority areas for encouraging energy efficiency as well as financing mechanisms are required.
Electricity security of supply for the SEE countries is best achieved through expanded power trade and exchange at costs that represent the lowest for the region as a whole, as well as through promotion of energy conservation and efficiency measures. If the reliability of the regional power system is not improved and actually available capacity is not assured, then there is a real risk of major power shortages from 2007 onwards; this would have serious negative impact on economic growth. In the absence of private financing and in order to: (a) ensure that power exchange increases; (b) improve the reliability of power systems to avoid brown-outs and load shedding; and (c) increase the prospects for stabilization and growth of the economies in the region, the IFIs should sustain or increase their support to these countries, including through financing priority investments in energy efficiency, transmission, distribution and generation along with providing policy advice.
Tables A1 and A2 represent energy consumption and supply indicators for selected countries in southeastern Europe together with Slovenia.
### Table A1. Energy Consumption and Carbon Dioxide Emissions in Selected Balkan Countries 1999

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Net Energy Consumption</th>
<th>Carbon Dioxide Emissions*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Quadrillion Btu)</td>
<td>(Million metric tons)</td>
</tr>
<tr>
<td></td>
<td>Petroleum</td>
<td>Natural Gas</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>0.09</td>
<td>52%</td>
</tr>
<tr>
<td>Croatia</td>
<td>0.41</td>
<td>48%</td>
</tr>
<tr>
<td>F.Y.R. of Macedonia</td>
<td>0.13</td>
<td>39%</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.27</td>
<td>44%</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>0.61</td>
<td>22%</td>
</tr>
<tr>
<td>Subtotal/weighted average</td>
<td>1.52</td>
<td>36.5%</td>
</tr>
<tr>
<td>Albania</td>
<td>0.08</td>
<td>26%</td>
</tr>
<tr>
<td>Total/weighted average</td>
<td>1.59</td>
<td>36.0%</td>
</tr>
</tbody>
</table>

* Includes carbon dioxide emissions from the consumption of petroleum, natural gas, and coal, and from the flaring of natural gas. Tons of carbon can be converted to tons of carbon dioxide gas by multiplying by 3.667.

### Table A2. Energy Supply Indicators—Selected Balkan Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Fossil Fuel Proved Reserves</th>
<th>Fossil Fuel Production, 2000</th>
<th>Electric Generating Capacity, 1/1/01</th>
<th>Crude Oil Refining Capacity, 1/1/01</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crude Oil, 1/1/01 (Thousand barrels)</td>
<td>Dry Natural Gas, 1/1/01 (Billion cubic feet)</td>
<td>Coal, 12/31/00 (Million short tons)</td>
<td>Petroleum* (Thousand barrels per day)</td>
</tr>
<tr>
<td>Albania</td>
<td>165,000</td>
<td>100</td>
<td>N.A.</td>
<td>6.23</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>0</td>
<td>0</td>
<td>N.A.</td>
<td>0</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>15,000</td>
<td>201.21</td>
<td>2.5 billion tons Lignite + 200 million tons sub-bituminous coal</td>
<td>-</td>
</tr>
<tr>
<td>Croatia</td>
<td>80,000</td>
<td>1,187</td>
<td>39</td>
<td>24.45</td>
</tr>
<tr>
<td>F.Y.R.O.M.</td>
<td>0</td>
<td>0</td>
<td>N.A.</td>
<td>0</td>
</tr>
<tr>
<td>Romania</td>
<td>1,400,000</td>
<td>14,324</td>
<td>1-Bituminous including anthracite + 35 Sub-bituminous + 1,421 Lignite 1.457</td>
<td>0.501</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>77,000</td>
<td>1,700</td>
<td>64-Bituminous including anthracite + 1,460 Sub-bituminous + 14,732 Lignite 16.256</td>
<td>16.17</td>
</tr>
<tr>
<td>Total</td>
<td>1,737,000</td>
<td>37,432</td>
<td>-</td>
<td>46.852</td>
</tr>
</tbody>
</table>

Petroleum*. 1999 figures.

Regional Electricity Balance in 2001
Figure B1 presents structure of the installed capacities of the observed SEE countries. This structure varies from the countries with mainly hydro installed capacities (Albania, Montenegro) to countries whose electricity generation is based on thermal units (Bulgaria, Romania).

In figure B2, the third Wednesdays electricity balances (consumption and production on every Wednesday in every month) for countries of the Second UCTE Zone are presented. The third Wednesday is a representative day for all UCTE members for comparing electricity balance of their electric power systems.

The analyses of regional consumption, production and the installed capacities for the year 2001 did not include Greece and Turkey. The influence of these countries is now considered by analyzing their electricity consumption and production recorded in 2001 and their installed capacities, in comparison with other countries in the region. Figure B3 illustrates the electricity consumption within the region, including Turkey and Greece. Electricity consumption in Turkey was 118.5 TWh and in Greece 44.7 TWh, or 37 percent and 14 percent of the total SEE regional electricity consumption in 2001, respectively.

Regional Electricity Production over 2001
The influence of these two countries on the regional energy profile is presented in figures B4 and B5, which illustrate the share in electricity production and installed capacities by country and by type of plant. As can be seen in figure B4, Turkey and Greece contributed 36 percent and 14 percent respectively to regional electricity production in 2001. Considering the production structure by technology type, the share of thermal and nuclear generation in 2001 was 66 percent and 8 percent, respectively. Concerning installed capacities, Turkey has 26 percent and Greece 12 percent of the total.

Turkey is the largest electricity consumer and producer in southeast Europe. Regional energy trade patterns will depend on whether Turkey becomes a major player in the regional market. Analysis of regional market development should comprise scenarios with and without Turkey as a market participant.
FIGURE B1: THE INSTALLED CAPACITIES STRUCTURE IN THE SEE COUNTRIES

Albania - Installed capacities in 2001

- Hydro: 11%
- Thermal: 89%

B&H - Installed capacities in 2001

- Hydro: 47%
- Thermal: 53%

Croatia - Installed capacities in 2001

- Hydro: 37%
- Thermal: 55%

Bulgaria - Installed capacities in 2001

- Hydro: 31%
- Thermal: 25%

Montenegro - Installed capacities in 2001

- Hydro: 24%
- Thermal: 76%

Macedonia - Installed capacities in 2001

- Hydro: 70%
- Thermal: 30%

Serbia - Installed capacities in 2001

- Hydro: 66%
- Thermal: 34%

Romania - Installed capacities in 2001

- Hydro: 73%
- Thermal: 22%
Turkey dominates the regional demand forecast with a share of around 50 percent of the total. The forecast for Turkey assumes a significant increase of electricity consumption over the next ten years, reflecting levels recorded in the 1990s (the annual average gross electricity consumption growth rate in Turkey in the period 1992-2001 was 6.53 percent).

**Regional Electricity Demand in period 2002-2012**

Figure B6 illustrates regional electricity demand and peak load forecast for the period 2002-2012 for all SEE countries, including Greece and Turkey. Estimated electricity demand for the whole region in 2012 is 600 TWh under a moderate growth scenario. In this scenario, participation of the countries that are the largest consumers in the total regional electricity consumption are: Turkey 53 percent, Romania and Greece 11 percent each, Bulgaria 10 and Serbia about 6. Estimated regional peak load for the moderate scenario, without Greece and Turkey, is 38.2 GW in
2012, while with these two countries it is 103.8 GW. The forecasted share of the Turkish power system in the regional peak load is 53 percent for the moderate scenario.

Regional electricity demand forecasts for all SEE countries for years 2002, 2007 and 2012—including Greece and Turkey—are presented in figure B7. In figure B8, the regional peak load forecast for target years is presented.

On the generation side, Turkey plans to invest in new capacity to meet demand. It also plans to connect to the UCTE network from 2006. Import/export patterns in SEE will depend on these and other developments in the Turkish power system.
Regional Electricity Production in period 2002-2012

Albania

The installed capacities in 2001 amounted to 1.6 GW, and there is an assumption that they will remain unchanged until 2012. In 2012, the peak load is 1.8 GW, this under a moderate demand growth scenario. Under this scenario, the installed capacities will be insufficient to cover peak load. The capacity deficit in a moderate demand growth scenario is 200 MW from 2009.
(Moderate Scenario)

Target Years Consumption (GWh) - Moderate Scenario

(Moderate Scenario with Greece and Turkey)

Target Years Consumption (GWh) - Moderate Scenario

(Moderate Scenario without Greece and Turkey)
FIGURE B8: REGIONAL PEAK LOAD FORECASTS FOR 2002, 2007 AND 2012
(Moderate Scenario)

Target Years Peak Load (MW) - Moderate Scenario

(Moderate Scenario with Greece and Turkey)

Target Years Peak Load (MW) - Moderate Scenario

(Moderate Scenario without Greece and Turkey)
FIGURE B9: INSTALLED CAPACITIES IN 2012, Moderate Scenario

Albania
Installed Capacities in 2012 - Moderate Scenario

Bosnia & Herzegovina
Installed Capacities in 2012 - Moderate Scenario

Bulgaria
Installed Capacities in 2012 - Moderate Scenario

Croatia
Installed Capacities in 2012 - Moderate Scenario

Macedonia
Installed Capacities in 2012 - Moderate Scenario

Montenegro
Installed Capacities in 2012 - Moderate Scenario

Romania
Installed Capacities in 2012 - Moderate Scenario

Serbia
Installed Capacities in 2012 - Moderate Scenario
Even if the thermal generation expansion plan of Albania is completely realized (an increased share of thermal production is planned), the country will not be able to satisfy forecasted electricity demand. Existing thermal power plants have serious problems in Albania due to aging and availability of units, low efficiency and fuel shortages. Over 95 percent of electricity production comes from hydro power plants, leading to big problems during dry seasons. As a consequence, Albania will continue to import electricity in the forthcoming decade, and for that reason it will be necessary to improve and upgrade internal transmission capacities as well as interconnection lines with the neighboring countries.

Problems faced by Albania in recent years, such as relatively low electricity tariffs, high non-technical losses and illegal connections to the grid, no generation expansion and economic instability, bring into question the practicality of realizing generation expansion plans, and highlight the importance of energy efficiency measures and increased trade.

**Bosnia and Herzegovina**

2001 production was higher than in the ten preceding years (11.4 TWh). Installed capacities in BiH (3842 MW in 2001) will enable peak load covering over the entire observed period. The reserve margin in 2012 will amount to 49.6 percent. If the generation expansion plan of BiH is completely realized then this country will not have any problems meeting electricity demand until 2012. The most important problems that this country has to solve are improvement of electricity infrastructure, and reconnection of the transmission network. In addition, the first step in improving and increasing the generation capacities should be reconstruction of hydro and thermal power plants.

**Bulgaria**

In 2001, electricity production was 43.9 TWh, out of which the exports amounted 8.0 TWh (3.8 TWh exported to Turkey). The forecast is that Bulgaria will have a negative electricity balance continuing to 2012, when the deficit will amount 10.6 TWh (8.0 TWh deficit in 2007). Hydro power plants, whose share is 25 percent of the total installed capacity in Bulgaria, contributes only 5-8 percent to total annual electricity production, and therefore has no significant influence on the region (serve for the purpose of peak shaving). The country’s installed capacities will be insufficient to cover the national peak load during the observed time horizon. In 2012, there will be lack of 1.5 GW (626 MW in 2007). Even if all generation capacities planned within the generation expansion plan are built, Bulgaria will still have problems in covering the electricity consumption till 2012.

Decommissioning of generating units in NPP Kozloduy represents very serious problem for Bulgaria in next ten years. If the plan for decommissioning of two units is realized in 2006, as requested by EU, and not in 2010 and 2012 as previously planned, Bulgaria and the whole region will have a more serious problem in covering electricity demand. Most of the power plants need upgrading and modernization, since inefficiency and wasteful use of energy are present. Furthermore, Bulgaria has low electricity prices and the reforms within the energy sector have not been fully implemented yet.

**Croatia**

Electricity generation in 2001 was 11.3 TWh. Installed capacities will be sufficient for peak load covering. In 2012, the reserve margin will be 13 percent if all planned generation capacities are built, and Croatia will be able to meet its own electricity demand. Existing problems in power sector in Croatia mostly comprise low electricity prices and high share of residential consumption. In the last ten years, Croatia was an electricity importer and it seems that such a trend will be continued in the forthcoming period.

Besides increasing the efficiency of the existing generation units, in the next period Croatia has to solve asset ownership problems related to generation capacities located in other SEE countries, including Slovenia (NPP Krsko).
**Macedonia**
Electricity generation in 2001 was 5.8 TWh, while maximum electricity production in the last ten years was recorded in 1998 (6.5 TWh). Installed capacities in Macedonia will not be sufficient for covering the peak load starting from 2007 if investments are not realized and the forecast deficits in 2012 would exceed 2.0 TWh. In 2012, the country would have a lack of capacity amounting to 219 MW.

**Romania**
In 2001, this country produced 53.9 TWh while electricity consumption amounted 52.6 TWh. Romania had positive electricity balance and surplus in generation of 1.3 TWh. If the amount of electricity produced in 2001 is taken as the base for forecast, even if no rehabilitation and/or new investments take place, Romania will cover forecasted electricity consumption till 2004. After that, deficit in electric energy will amount to 3.2 TWh in 2005, and 14 TWh in 2012. In 2012, the reserve margin will be 21 percent if the generation expansion plan is realized. Romania has started restructuring its power sector. Romania intends to rehabilitate 2.3 GW of capacity, while 4.0 GW is to be shut down.

**Montenegro**
Electricity generation in 2001 amounted 2.4 TWh, which is 58 percent of the national gross electricity consumption. Negative electricity balance will continue in the next decade if investments are not realized. Considering that electricity production of HPP was 2.2 TWh in 1996 (maximum in the last ten years), and in comparison with the amount recorded in 2001 (1.8 TWh), it is clear that better hydrology conditions will not eliminate the forecast deficit.

Montenegro has been experiencing problems covering electricity demand in recent years. One way of solving the balance problem would be to lease generation capacities in neighboring countries. Transmission losses have increased more than twice in the period 1991-2001. Low electricity prices have resulted in rapid increasing of electric energy consumption. There were no additional investments in generation capacities for more than 20 years and there is a need for rehabilitation of existing power plants.

**Serbia**
Electricity generation in 2001 amounted to 32.7 TWh, or 96 percent of the gross electricity consumption recorded in 2001. If the generation expansion plan is realized in the period to 2012, Serbia will be able to cover its own electricity demand. Low electricity prices resulted in wasteful use of electric energy. In the past ten years, there were no investments in generation capacities, while maintenance and rehabilitation were very poor. Recent measures include increasing electricity tariffs and electric energy substitution.
As a general rule, energy prices should, at a minimum, reflect economic costs. Energy prices play a crucial role in bringing energy supply and demand into balance and also have a strong influence on the level of energy intensity, energy efficiency and investments. In many economies in transition, including SEE countries, energy prices are still below economic levels, despite having been significantly increased in recent years. This is particularly the case in the residential sector, where prices have been raised but at a slower rate than in the industrial sector. The consumer’s ability to pay, has been an important consideration in deciding the extent and rate of energy price increases.

Since the nineties, countries in SEE have adopted policy frameworks for power based on market principles including tariff reform. Energy prices remain under state control, however, and tariff setting continues to be politicized. The balance between the benefits of market pricing and other policy goals is often not easily resolved.

Average electricity prices for 1992 and 2001 for industry, commercial sector and households in selected South Eastern European countries are presented in figures C1, C2 and C3. Industry prices have declined in some countries, such as Bulgaria and Romania, but prices in households have risen, in some cases more than 60 percent. Regardless of increases in the past ten years, the level of prices is still low compared to EU countries. The average residential price in Greece in 2001 was $0.0568 per kWh in 2001. All countries except Bosnia and Herzegovina, Croatia, and Romania have lower residential prices than Greece. Electricity prices for residential consumers are greater than for industry in Bosnia and Herzegovina, Macedonia, Romania, and Serbia.

Table 3.1 shows that there is a great difference in electricity prices for industry in SEE countries. Serbia has the lowest level ($0.014/kWh), while Croatia has the highest level ($0.088/kWh). A similar situation exists in the residential sector; the lowest level for residential tariffs is in Montenegro at $0.017/kWh, while the highest level is in Bosnia and Herzegovina at $0.061/kWh.
Figure C1: Electricity Prices in Industry
1992 and 2001

Source: UNECE&PiEE

Figure C2: Electricity Commercial Prices
2001

Source: PiEE
Figure C3: Electricity Prices in Households
1992 and 2001

Table C1: Electricity Prices in Industry
Commercial and Domestic Sectors, 2001

<table>
<thead>
<tr>
<th>Country</th>
<th>Prices $/kWh</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Industrial</td>
</tr>
<tr>
<td>Albania</td>
<td>0.042</td>
</tr>
<tr>
<td>Bosnia (EPBiH)</td>
<td>0.027</td>
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<tr>
<td>Bosnia (EP HZ BiH)</td>
<td>0.027</td>
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<tr>
<td>Bosnia (EP HZ BiH)</td>
<td>0.051</td>
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<tr>
<td>Bulgaria</td>
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<tr>
<td>Croatia</td>
<td>0.088</td>
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<tr>
<td>Macedonia</td>
<td>0.025</td>
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<tr>
<td>Montenegro</td>
<td>0.019</td>
</tr>
<tr>
<td>Romania</td>
<td>0.039</td>
</tr>
<tr>
<td>Serbia</td>
<td>0.014</td>
</tr>
</tbody>
</table>

Source: PiEE
On September 26th 1991, all electric power system connections between Eastern and Western part of Former Yugoslavia were broken off (the last one was disconnection of 400 kV transmission line Ernestinovo–Tumbri)—that is, all ties with West European electrical power system interconnection were destroyed. Since then, the electric power systems (EPSs) of Yugoslavia, FYR of Macedonia, Greece, part of Bosnia and Herzegovina, and Albania remained in synchronous parallel operation, disconnected from main part of UCTE (excluding Croatia and part of Bosnia and Herzegovina).

Subsequently, a number of studies concerning re-connection of EPSs of Bulgaria and Romania and reconnection of UCTE network were undertaken. As a result, during October 1993, trial parallel operations of Romanian and Bulgarian power systems were realized. In April 1994, the above EPSs in the Balkans (EPSs of Yugoslavia, FYR of Macedonia, Greece, part of BiH and Albania) were extended by inclusion of Romanian EPS into synchronous parallel operation and in April 1996 by inclusion of Bulgarian EPS.

A large number of studies have been made in order to investigate the aspects of UCTE network reconnection. The most important is “Stability of the Synchronously Interconnected Operation of the Electricity Networks of UCTE/CENTREL, Bulgaria and Romania,” DVG, 2001. The main results of this study were:

- The system interconnection of Bulgaria and Romania to UCTE/CENTREL and the simultaneous restoration of interconnected operation in southeastern Europe is possible from the stability point of view under the special aspects of load flow resulting from the planned disconnection point in Hungary.
- Minimum necessary interface requirements, resulting from the load flow analyses, are at least three of four 380 kV circuits:
  - Sandorfalva (Hungary)–Arad (Romania), Sandorfalva (Hungary)–Subotica (Serbia)
  - Mukacevo (Ukraine)–Rosiori (Romania),
Adriatic Line
Ernestinovo (Croatia)–Mladost (Serbia),
as well as all available 220 kV circuits: Zakuca–Mostar, Mrac–Prijedor, Meduric–Prijedor,
Djakovo–Gradacac and Djakovo–Tuzla.
Also some additional recommendations for maintaining small signal and transient stability are proposed (supervision of export/import amount, installation of additional power-system stabilisers (PSS), checking existent equipment, etc.).

In May 2001, a Memorandum of Understanding on “Realization of the UCTE Northern with the Southern Synchronous Interconnected Area” was signed between UCTE and utilities of Serbia, Bosnia and Croatia. The UCTE and other parties are undertaking initiatives towards EU accession.

For reconnection of the Second UCTE network with the main UCTE grid, two important projects are in progress:

The Third Electric Power Reconstruction Project (POWER III) Loan, B&H Utilities. ”The Adriatic Line” is one of the first priorities of POWER III project. This project combines continuation of the post-war reconstruction of BiH power sector with support for restructuring and reform. A major objective would be to rehabilitate the damaged 400 and 220 kV network in order to enable BiH to operate its power system on an integrated basis and to rejoin the UCTE.

The principal project components are:
- Rehabilitation of high voltage transmission network lines
- Reconstruction of key 400/220/110kV substations
- Establishment of SCADA and associated telecommunication facilities.
This project is financed by IDA (WB), EIB, EBRD, EC, Governments of Germany, Norway, Spain, Switzerland, UK and USA. Finalization of this project is planned for the end of 2003.

Commercial Loan: Croatia.
The project consists of reconstruction of the 400/110kV substation in Ernestinovo in eastern Slavonia, which was destroyed during the war and associated investments in transmission network and building of the 400/220/110 kV substation Zerjavinec. This project would restore reliability and security of power supply in Slavonia as well as in neighboring Bosnia and Herzegovina and Federal Republic of Yugoslavia.

The project would be completed by end-2003.

Test of Bulgarian and Romanian EPSs
In 2001, tests in isolated operation of Bulgarian and Romanian networks were performed, prior to connection to the UCTE interconnection system. After twelve weeks of tests in winter and twelve weeks in summer, next conclusions were made concerning the connection of Bulgarian and Romanian EPSs:

- The active power control (primary and secondary control) works correct, the “ground rules concerning primary and secondary control of frequency and active power within the UCTE” are satisfied. The behavior of the system frequency during both normal and disturbed operation of the system is acceptable. The power exchange deviations and the hourly average values of the Area Control Error are within the limits fixed in the “catalog of measures.”
- Continuous monitoring during the tests in interconnected operation must prove that necessary amount of primary control is available at all times.
The network power frequency numbers of both countries have to be reduced for compatibility and stability reasons (inter-area oscillations) after interconnection with UCTE by adapting the parameter settings of turbine controllers.

For different reasons, the automatic Load Frequency Control (LFC) of Transelectrica (Romania) did not work correct for 13 days during the winter tests and for two days during the summer tests. Transelectrica has however planned measures to ameliorate the safe operation of the LFC in the year 2002.

1. The voltage control of both countries is satisfactory, limits are kept at all times in Romania at most times in Bulgaria. With termination of maintenance works in the substation Kozloduy in the beginning of 2002 also the seldom slight violations of the voltage limits in this substation will not occur any more. The PSS tests in the time domain show good damping behavior for the local mode. For the frequency domain there are partly results with poor damping for the regional mode, whereas the behavior for inter area oscillations seems to be sufficient. According to experiences during the trial operation of the synchrony operation with UCTE, it could be necessary, that PSS settings have to be optimized. Due to fact that results for frequency-domain are based on one power plant location in Bulgaria only, this test should be performed at least at one additional power plant location in Romania.

2. The comparison with results of CENTREL tests in isolated operation, shows that statistical values from Bulgaria and Romania during the tests in isolated operation are better or equal to the respective CENTREL values.

Generally, the tests in isolated operation performed from the electrical power systems of Bulgaria and Romania have been carried out successfully.

**Preparation of Turkish Electric Power System Connection**

The Turkish system is not running in synchronous mode with the systems in SEE countries. Following the request of TEAS (the Turkish Electric Generation & Transmission Company) to PPC (Greek electric power company, member of UCTE in that time) and relevant application made by PPC on behalf of TEAS, UCTE Steering Committee has brought up the decision to consider all possibilities of synchronously interconnecting the Electric Power System of Turkey to the UCTE Network.

Since the early 1990s, several studies were carried out to investigate the possibilities for connecting Turkish network to UCTE, at that time via the Greek, and later on via Greek and Bulgarian Networks. Most recently, during 2000-2001, an elaborate set of studies was financed by European Commission and performed in the frame of TEN (Trans European Networks Program). The EKC (2000) study “Feasibility and Evaluation Study of the Electricity Interconnection Greece–Turkey” includes system studies and cost benefit analysis. It was performed by a team of utilities in the area, namely PPC (Greece), TEAS (Turkey), NEK (Bulgaria), and EKC (Yugoslavia). In this study, several scenarios were investigated for connecting Turkey via Bulgaria and Greece. It is expected to connect electric power system of Turkey not earlier than in year 2005 (2006).

**Present Electric Interconnections in SEE Countries**

The existing interconnections between investigated region and neighboring countries constitute possible infrastructure for energy transactions in the region. The connections between SEE countries and neighboring countries are:

- Croatia and Hungary (one 400 kV line)
- Croatia and Slovenia (double and single 400 kV line and three 220 kV lines)
- Yugoslavia and Hungary (one 400 kV line)
- Romania and Hungary (one 220 (400) kV line)
- Bulgaria and Moldova (one 400 kV line)
- Romania and Ukraine (one 750 kV line)
- Greece and Italy (one DC 400 kV line-cable)

Interconnections do not exist between the following neighboring Balkan countries:
- Albania and FYR of Macedonia
- FYR of Macedonia and Bulgaria
- Greece and Turkey

This fact complicates bilateral energy exchange and is a serious obstacle to development of electricity transactions between the aforementioned countries, due to inclusion of third parties as transits and increases the cost of exchanged energy by transit fees.

There is only one interconnection line of 400 kV between the following neighboring Balkan Countries:
- Albania and Greece
- Greece and Macedonia
- Greece and Bulgaria
- Bulgaria and Yugoslavia
- Romania and Yugoslavia
- Yugoslavia and Croatia
- Bulgaria and Turkey
- Yugoslavia and Bosnia and Herzegovina

and only one interconnections of 220 kV between:
- Albania and Montenegro
- Albania and Serbia

### Table D1: Main Characteristics of SEE Countries’ Transmission Networks

<table>
<thead>
<tr>
<th>Voltage level (kV)</th>
<th>Installed capacities (M/A)</th>
<th>Length of the overhead lines and cables (km)</th>
<th>Length of the overhead lines and cables (km)</th>
<th>Length of the overhead lines and cables (km)</th>
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<td>1360</td>
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<td>630</td>
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<td>9167</td>
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<tr>
<td>(750+ 400+) only</td>
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</table>
Review of the Operational Constraints

The objective of this section is to identify the technical obstacles to SEE countries operation. Regional interconnected system is examined from a safe and efficient operation point of view, as well as transfer capability evolution. Generally, national grids must be provided with the following facilities (or they must upgrade the relevant old facilities that they already have) (Phare 1999):

- Telecommunication links between networks, in order to exchange operational data between Dispatching Centers (network status, voltage status, available energy for interchange, hydrology, weather conditions, etc).
- For prevention of expanding big disturbances to neighboring networks, it is essential that all interconnections be equipped with high accuracy and very high-speed protection relays according to UCTE rules.
- All interconnection lines must be equipped with metering devices, including voltage and current transformers, and energy meter readings have to be transmitted in real time to Dispatching Centers.
- Common scheduling methodology regarding operation of the power systems taking into consideration: system needs, interchange programs with neighboring systems, independent producers and eligible customers’ transactions.
- It is essential for every network operator to have required hardware and software tools for transfer capability calculations of the interconnections, in order to be aware of the free margin of each interconnection. The above calculation would take into account any network restrictions that might limit the interconnection loading.
- Common methodology for the assessment of transmission reliability margin, capacity benefit margin and tariffication.

Planned Internal and Interconnection Lines in SEE Countries

In 2001, SECI (Southeastern European Countries Initiative) started a transmission study (SECI Project Group 2001). The main goal of this study was to examine the problems in transmission network of SEE countries and to analyze possibilities of new interconnection lines. All representa-
tives from SEE countries sent their proposed internal transmission connections that will be put into operation within the period 2002-2005.

**Interconnection Reinforcement in SEE Region**

According to information obtained from other sources (Phare 1999), some other interconnections, currently under development or discussion, have been proposed to the Balkan Energy Interconnection Task Force, which was established in 1996 by EC, DG XVII, in the framework of the Synergy program. In total, 19 electricity projects of different levels of maturity and priority were proposed. Most of these projects present a wide regional interest and are expected to contribute to development of appropriate infrastructure for parallel and synchronous operation of power systems in Balkan countries, according to the UCTE standards. These projects would also facilitate and improve the effectiveness of electricity transactions between these countries. Some of the proposed projects have been characterized as “projects of common interest,” according to a set of criteria. The common interest projects have been evaluated and ranked according to their priority, through a methodology based on certain criteria and weighting factors, as shown in table D2.

Regarding the proposed potential interconnections, the following should be noted:

- The projects 3, 2 and 7 concern necessary infrastructure for a safe synchronous operation and regional system capable to serve high volume energy transactions.
- The 400 kV interconnection lines between Albania and Yugoslavia (project 8), in combination with projects suggested by Bosnia and Herzegovina (project 4), are characterized as top priority, creating the Adriatic coast interconnection line to UCTE.
- Proposed interconnections between Macedonia and Bulgaria, Greece and Turkey are also characterized as projects of major importance, as they would constitute the first 400 kV interconnections between these countries.
- Proposed projects on interconnection and reinforcement of the Romanian network, and especially those projects aiming at upgrading the interconnection with Hungary (projects 1 and 6), are of particular interest for the integration of the Balkan System to UCTE main grid.

As aforesaid, the synchronous and parallel interconnection of the Second UCTE zone with the main UCTE grid may be achieved through the minimum three of four existing interconnection:

- 400 kV Arad (Romania)–Sandorfalva (Hungary) and Subotica (Yugoslavia)–Sandorfalva (Hungary),
- 400 kV Rosiori (Romania)–Mukachevo (Ukraine)
- 400 kV Mladost (Yugoslavia)–Ernestinovo (Croatia),
- 400 kV Mostar (Bosnia & Herzegovina)–Konjsko (Croatia).

However, the following should be noted:

- The Arad–Sandorfalva line (with the respective part Sibiu–Mintia–Arad in the Romanian system) will be converted to operate from 220 kV to 400 kV. Furthermore, the final connection point in Hungarian system, the Sandorfalva substation is a destination point also for the Subotica–Sandorfalva line. This sub-station is connected to the rest of Hungarian system with only one 400 kV line (Sandorfalva–Paks) creating thus a weak link with overloading in 120 kV Hungarian network. It is expected that this problem will be overcome when the 400 kV Sandorfalva–Bececsaba line in Hungary is constructed.
- The southwestern part of Ukrainian system, including the Mukachevo substation, is isolated from the main Ukrainian system and will operate in synchronous and parallel mode with UCTE. At this moment, one year of interconnection test is under realization.
The construction of the new 400 kV line Oradea (Romania)–Becescaba (Hungary) will increase transmission and reserve capacity of the network, because it is connected to a different sub-station in Hungarian system.

In the scope of SECI Transmission project (SECI Project Group 2001), in order to define the most promising interconnection projects from regional point of view, technical analysis has been completed. For study purposes Interconnection Study Task Group (ISTG) was formed of experts from Bosnian ZEKC, Bulgarian NEK, Croatian Energy Institute “Hrvoje Pozar,” and EKC. Proposed study includes regional steady state load flow analysis. Every country in the region has nominated some projects (interconnection lines) of regional interest according to its own short- and medium-term plans. A list of candidate interconnections was reviewed and revised as the most probable projects for consideration. Others will be considered as post-2005 options. The time horizon frame for completion of the study is set to year 2005, with winter and summer peak loads to be considered.

Technical and Working Groups have defined characteristic scenarios (possible transits), using production and demand data of each system in the region. Southern part of the region is character-

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**Table D2: Balkan Energy Interconnection Task Force: Common Interest Projects**

<table>
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<tr>
<th>Category A</th>
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<table>
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<tr>
<th>Category C</th>
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<td>14</td>
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Source: Balkan Energy Interconnection Task Force.
ized by summer peak, especially Greece and Turkey, while other countries have the highest load level during winter period. Turkish system is planned to connect to UCTE and scenarios include those variants, too. According to that, summer and winter peak are analyzed. Load flow and steady state analyses will show the influence of every new interconnection line candidate for building from regional point of view.

According to results of analyses presented in SECI Project Group (2001), construction of any new line 400 kV from the following list, Podgorica (YUG)-Elbasan (ALB), Nis (YUG)-Skopje 5 (MKD), Sombor (YUG)-Pecs (HUN), Bekescaba (HUN)-Oradea (ROM), Hevitz (HUN)-Cirkovce (SLO), Skopje (MKD)-Tirana (ALB), C.Mogila (BUL)-Stip (MKD), Maritza East 3 (BUL)-Phillipi (GRE), will contribute to increasing the amount of maximal transit from the direction of UCTE to Bulgaria, Greece and Albania for 100 MW, considering winter (energy transfer from west to east). In present topology without new lines, possible transit is 1000 MW. Construction of any new 400 kV line Nis (YUG)-Skopje 5 (MKD), Sombor (YUG)-Pecs (HUN), Ernestinovo (CRO)-Pecs (HUN), Bekescaba (HUN)-Oradea (ROM) or Maritza East 3 (BUL)-Phillipi (GRE) will increase the amount of maximal transit from the direction of UCTE (CENTREL) to Bulgaria, Greece and Albania for 100 MW (energy transfer from to north to the south), in winter scenario. Considering the present network topology, possible additional transit capacity is estimated to be about 1000 MW.

The amount of transit capacity addition is not very significant compared to the existing status, but the new tie line candidates would contribute to improve the security of the power system in the region, especially during the maintenance works on some interconnection lines. Also 400 kV line Podgorica-Elbasan will close the 400 kV loop Yugoslavia-Macedonia-Greece-Albania-Yugoslavia, which enhances the overall regional system operation and security of Albanian network. It would also guarantee, accompanied with lines through Serbia, Bosnia and Herzegovina and Croatia, to secure electricity supply in this area of consumption. Also, it would have positive influence on the power transmission from or to Albanian power system, due to transformation in the substation of Elbasan and increase the possibilities of placing power and energy, which is to be produced in new power plants planned for construction in Montenegro and Albania.
The countries of the region have progressed on different paces on energy sector reforms and restructuring. The governments of all countries have expressed willingness to restructure energy sectors in order to increase its efficiency as the main goal, but also to establish an enabling environment that would attract foreign investments. The Parliaments of the SEE countries have either enacted or are considering new Electricity Acts. The acts will allow the energy sectors of these countries to be restructured and the state-owned vertically-integrated monopolies would be unbundled and involved in the process of private participation to the extent feasible. In addition, a legal environment for creation of an Electricity market in countries where it still does not exist will be set out. Beside legal uncertainties, low level of electricity prices in the region is still a major obstacle to the attraction of foreign investors. Governments of the SEE countries, along with the responsible regulatory bodies and electric power utilities aim to reach electricity prices closer to their economic levels. The pace of realizing such intentions will be determined by the social and political impacts.

The situation as at end-2001 concerning the regulation in the sector is presented in table E1. The electricity market, where it exists, is organized on the national level and liberalized only to a limited extent. The market mechanisms are not fully developed and implemented. Electricity trading, on the international level, is performed between the utilities only. At this moment, adequate mechanisms do not exist for establishing the Regional Electricity Market, but efforts are being made gradually in that direction. The governments should continue closer cooperation in order to harmonize national regulations. The status of the electricity markets in SEE countries at end-2001 is presented in table E2. It should be noted that changes are taking place in the countries and the current status might be more progressive than shown here.

The efforts towards establishment of a Regional Electricity Market (REM) started several years ago. A brief summary of the important events since 1996 through 2002 are noted below:

- The study “Prospects of the Development of a Peripheral Electricity Market in the Balkan Region” (1996) was the first investigation in the domain of creation Regional Electricity Market, and it was performed by six countries of the region. In 1996, Balkan Energy Inter-
connection Task Force worked for one year and resulted in a comprehensive inventory and prioritized list of common interest projects (for electricity, gas and oil sectors).

- Ministerial conference (responsible for energy) of thirteen countries was held in 1997, and the “Bucharest Memorandum” regarding Black Sea Regional Energy Center was signed by Ministers as well as by European Commissioner. This memorandum is recognized as a milestone in the establishment of REM.

- Possibilities of promoting the investment of projects endorsed by the Bucharest Memorandum, was examined within the Synergy project “Energy Interconnections in Southeastern Europe” (Synergy 2000). The project “Study on the Development of a Competitive Balkan Electricity Market” was a follow-up project of the Bucharest Memorandum. This project included a thorough analysis of crucial issues (technical, legislative, commercial, institutional) for the creation of electricity market. It concluded, with recommendations to participating countries, how to proceed in order to establish a regional electricity market based on synthesis of proposals made and endorsed by the participant countries in the later stage of the project’s execution. The recommendations of this project served as a basis for signing a document in which participating countries expressed their common intention to proceed and benefit from the Regional Electricity Market.

- Ministers responsible for energy of six SEE countries and European Commissioner signed the “Declaration of Intent for the establishment of the competitive Regional Electricity Market in South Eastern Europe” in Thessaloniki on September 10, 1999. The countries that signed the document are: Albania, Bosnia and Herzegovina, Bulgaria, Greece, Romania, Yugoslavia, Croatia, Macedonia. Other countries may also join. According to the Thessaloniki Declara-
<table>
<thead>
<tr>
<th>Country</th>
<th>Electricity Installed capacity*</th>
<th>Electricity covering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total GWh</td>
<td>Peak MW</td>
</tr>
<tr>
<td>Albania</td>
<td>5432</td>
<td>1210</td>
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<tr>
<td>Bosnia and Herzegovina</td>
<td>9804</td>
<td>1965</td>
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<tr>
<td>Bulgaria</td>
<td>36210</td>
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<td>14455</td>
<td>2796</td>
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<td>Macedonia</td>
<td>6293</td>
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<td>52577</td>
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<td>Montenegro</td>
<td>4116</td>
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</tr>
<tr>
<td>Serbia</td>
<td>33797</td>
<td>6812</td>
</tr>
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</table>

*data for year 2001
tion of September 10, 1999 and the Athens Memorandum of Understanding of June 2, 2002, representatives of the Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Yugoslavia, Macedonia, Greece and Romania have decided to create regional electricity market in SEE and to integrate it into the European Internal Electricity Market.

- REM countries also issued the Athens Memorandum of Understanding on June 2, 2002. The SEE countries that signed the Memorandum made a commitment to ensure coordination between the initiatives relating to the establishing of REM.

- The first meeting of the South East Europe Electricity Regulation Forum (SEEERF) was held in Athens on June 13-14, 2002. Participants were representatives of the Southeastern European countries (Croatia, Bosnia and Herzegovina, Yugoslavia, Macedonia, Greece, Albania, Bulgaria, Romania), European Commission, international donor community, national regulators, national transmission system operators, the Stability Pact, ETSO, CEER, UCTE, Eurelectric, UNMIK and other organizations. All participants agreed to create a competitive regional electricity market and integrate it within the European Union’s Internal Electricity Market by 2005. Reason for such regional electricity market is a need to create opportunities for regional trade in energy products and services that may satisfy regional demand and supply, and particularly to allow investment security to be enhanced by free flow of goods and services and to avoid the creation of national, regional or sub regional monopolies. This market will be based on the principles set out in the Electricity Directive and other relevant legislations.

The various forums recognized that it was necessary to establish compatible national electricity market models in order to establish an REM. The countries of the region committed to create institutions to support the efforts in this regard, the minimum of which are:

- A National Energy Authority, a government body entrusted with development of energy policy
- A National Regulator, wholly independent of the interests of electricity industry
- National Transmission System Operators
- Distribution System Operators

All countries will then take the first steps to create at a regional level, and to incorporate into national approaches, an action plan for comprehensive tariff reform, the reduction of non-technical losses, an increase in energy efficiency necessary to abate demand and the facilitation of sensible energy substitution, whilst maintaining a free market framework. Also, they will identify infrastructure needs, prepare and implement a regionally-based thermal and hydro power plant rehabilitation plan and implement the trading facilitating mechanisms.

Achievement of the objectives will require close collaboration and involvement of not only the countries in the region but also of the donors such as the EU, the World Bank, KfW, EBRD, EIB, USAID (through SECI initiative), CIDA (through SEETEC organization). Under the guidance of the above mentioned institutions and organizations many projects of regional importance have been started and are in progress.

The European Commission has committed to:

- Undertake a benchmarking exercise annually that shall verify conformity to the Electricity Directive and its derivative legislation, norms and standards, and shall also consult relevant bodies with regard to technical standards.
- Undertake an infrastructure prioritization exercise. The countries of the region commit to cooperate with and positively assist the identification and prioritization of infrastructure projects, to be financed by internal, external and private investors, including international financial institutions. The identification and prioritization process shall have a regional focus.
Help to establish regulators, transmission and distribution system operators in SEE countries.

Undertake a technical rules elaboration concerning grid codes and settlement and trading rules.

Make action plan for tariff reform, reduction of non-technical losses, energy efficiency and energy substitution.

Implement technical norms for operation of national markets, establish method for collaboration and information exchange and conditions for trans-frontier trade.

Design and implement a regional infrastructure optimization and prioritization plan, including a thermal and hydro power plant regeneration plan and a transmission rehabilitation plan.

The World bank, KfW, EBRD and EIB have completed or have in phase of progress national projects. These projects are related to the energy sector improving, and they vary from country to country. The main goal of those projects is improvement and modernization of the existing capacities (transmission and generation).

Besides its national donors projects, SEETEC will provide a report detailing the benefits of regional approach to the difficulties in the electricity sector in the region. They will endeavor to have carried out a simulation of national and regional markets illustrating different regulatory choices. SEETEC will develop regional data base necessary for regional market simulation.

SECI has finalized the Project Regional Teleinformation system among national dispatch centers. The Regional Transmission System study is in the final stages of completion and includes software packages for the load flow simulations, static and dynamic stability and creation of the regional model of the SEE power systems for the contingency analyses. This project would provide insights into the effects of the construction of new interconnection lines. Within this initiative, the project Ancillary Services and the Role of the Hydro Generation in REM was started, whose results are expected during 2003.
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Review of Electricity Supply and Demand in Southeast Europe is part of the World Bank Working Paper series. These papers are published to communicate the results of the Bank’s ongoing research and to stimulate public discussion.

This paper reviews the power sector demand-supply balance in Southeastern Europe during the period 1991-2001 with forecasts through 2012, drawing upon aggregate country level data provided by electric utilities, supplemented by published sources.

The context for this paper is the agreement among Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Former Yugoslav Republic of Macedonia, Greece, Romania, Serbia and Montenegro, and Turkey to form a regional electricity market, soon to be joined by Italy. The study identifies the magnitude of electricity generation investment needed in the evolving market. The paper also proposes mechanisms to reduce those investment requirements via improved efficiency and increased trade—providing an assessment of technical and institutional barriers to electricity trade. It suggests that less investment will be required if countries coordinated investments and shared reserves during noncoincidental peak periods.

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