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REBIS: GIS
Volume 2: Electricity demand forecast

Final report

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Complete GIS Report

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Abbreviations, Acronyms and Glossary

Atkins	Atkins International, a partner firm in the consortium
Beneficiary Countries	Albania, Bosnia and Herzegovina, Croatia, Serbia/Montenegro, Kosovo (pursuant to UN resolution 1244) and the former Yugoslav Republic of Macedonia
CAGR	Compound Annual Growth Rate
CARDS	Community Assistance for Reconstruction, Development and Stabilisation
CEER	Council of European Energy Regulators
CHP	Combined Heat and Power
CIDA	Canadian International Development Agency
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EE	Eastern Europe
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GW	Giga Watt
GWh	Giga Watt hour
GIS	Generation Investment Study
IFI	International Funding Institution
MWH	Montgomery Watson Harza, a sub contractor to the PwC Consortium
MWh	Mega Watt hour
MW	Mega Watt
PwC	PricewaterhouseCoopers LLP, the firm leading the Consortium
PwC Consortium	The PwC/CMcK/Atkins Consortium, led by PwC, that has been awarded the contract to implement the project
REM	Regional Electricity Market
SECI	South East Europe Cooperative Initiative
SEE	South East Europe
SEEC	South East Europe Consultants Ltd, a sub-contractor to MWH
ToRs	Terms of Reference, Regional Electricity Market Action Plan and Infrastructure Development Prioritisation, EuropeAid Directorate A, 26 May 2003
UCTE	Union for the Co-ordination of Transmission of Electricity
UNMIK	United Nations Mission in Kosovo
USAID	US Agency for International Development
WASP	Wien Applied System Planning (Generation Expansion plan modelling tool)
WB	World Bank

2 Demand forecasting

2.1 Objectives

The demand forecast is a key input to the GIS. Understanding the level and profile of electricity demand to 2020 for each of the jurisdictions concerned, and for the region as a whole, is essential to identifying which electricity plant and transmission lines might be required built and where.

The ToRs for the study require that the demand forecast takes into account the impact of sector reform and economic development in the region. Given that this is a regional study, a methodology has been chosen that:

1. Can be applied consistently in the nine jurisdictions;
2. Reflects differences in structural adjustment to market economies in the nine jurisdictions;
3. Is transparent; and
4. Reflects modern economic and statistical practices and is acceptable to the International Financing Institutions[1];

In summary, the ToRs require that:

- A common framework and methodology should be adopted to integrate all available data into a regional model, while preserving information on individual power systems;
- The electricity demand forecast should be updated for all power systems in the region;
- The disaggregation of electricity demand by consumer categories should be checked to make sure that it is consistent throughout the region. (The main consumer categories are likely to involve industry, agriculture, transport, services and households);
- A "most-likely demand" scenario should be developed, as well as "low demand" and "high demand" scenarios;
- The forecast should be extended to 2020; and

[1] At the request of the World Bank, the PwC Consortium demand forecasting methodology has been subject to peer review by Economic Consulting Associates (ECA). ECA have reported to the Consortium and the World Bank that the methodology we have adopted is appropriate and meets these criteria. We have documented the output of the ECA review in Appendix 6 of this report.

- Scenarios should be developed to reflect key variations in the economic outlook specifically;

    1. prices moving into line with economic costs (and the consequent inter-fuel substitution impacts and increases in energy efficiency), which could be linked with economic reforms;
    2. faster or slower economic growth (which again may be a function of the pace of economic reform) causing higher or lower growth in energy demand through income elasticities.

Existing data and internationally published data on the impact of electricity demand of such factors as changes in prices and the adoption of energy efficiency measures should be utilised as much as possible.

It is important to note the requirements in the terms of reference state that that “Given the time-frame and resources available for the analysis, the project team will work as much as possible with the existing models, methodology and data. Thus, the emphasis will be on assessing the extent to which the existing assumptions are reasonable; and whether appropriate consideration has been given to likely changes in relative fuel prices, changes in economic and industrial structure and income growth.”

2.2 What are we forecasting?

2.2.1 Data requirements for WASP and GTMax

The main purpose of undertaking the demand forecast is to provide input data for the system planning tools WASP (for the generation sector) and GTMax (for transmission). The demand forecasting produces the following outputs for the generation and transmission modelling.

For generation:

- Annual end use consumers demand for electricity (a GWh figure) for each year to 2020;
- An estimate of system losses (technical and other) for each year to 2020;
- Peak load on the system (a GW figure) for each year to 2020;
- For each forecast year:
  - the ratio of peak monthly demand to annual system peak;
  - the percentage of total demand accounted for by the peak month.

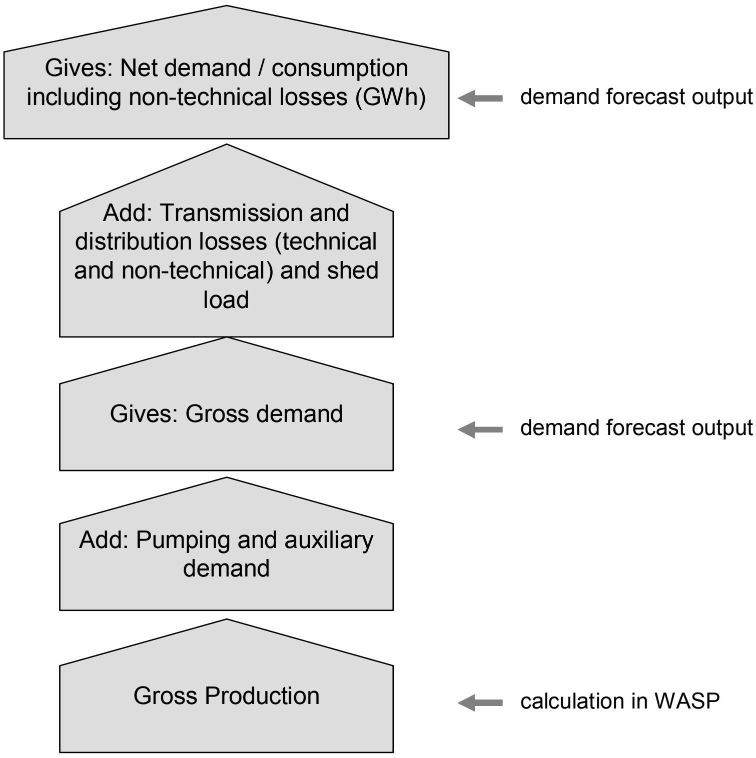
In addition, for transmission:

- Annual end use consumers demand for electricity (a GWh figure) for each year to 2020;
- An estimate of system losses (technical and other) for each year to 2020;
- Peak load on the system (a GW figure) for each year to 2020;
- For each forecast year:
  - the ratio of peak monthly demand to annual system peak;
  - the percentage of total demand accounted for by the peak month; and
- Hourly demand for four typical weeks (168 hours for the third week of January, April, July and October) for each forecast year.

2.2.2 What is meant by electricity demand

Electricity demand is a widely used term and can be used in a range of different contexts to mean different things. In this report we use the term electricity demand to mean energy demand (as measured by GWh) and peak demand to refer to local peak (as measured by MW). As Figure 2.1 demonstrates, there are several points along the electricity value chain that could be interpreted as electricity demand.

Figure 2.1: A breakdown of the components electricity demand



For the purposes of this demand forecast we have used the following definitions:

- *Gross production:* total generation including (where data is available) the generator's own use of electricity for generation purposes (specifically the electrical consumption of ancillary equipment associated with the power plant such as pumps and fans) and any auxiliaries and pumped storage consumption[2];

- *Gross demand:* net demand including transmission and distribution losses;

- *Net demand/consumption:* also referred to as end user demand. This is net generation sent out including non-technical losses, plus imports, minus exports, and with transmission and distribution losses netted off.

[2] The hourly demand load profiles provided to us for this study by NEK in Bulgaria included auxiliary demand and pumping demand, while the utility in Romania included auxiliary demand. We have made appropriate adjustments to their figures as such information is calculated for forecast years by WASP and GTMax, as generation portfolios and pumping capacity vary in future years. Details of this adjustment can be found in Appendix 4.

The demand forecasts prepared for the WASP and GTMax runs are net consumption. As intermediate steps in preparing our estimates we have also estimated losses and gross consumption.

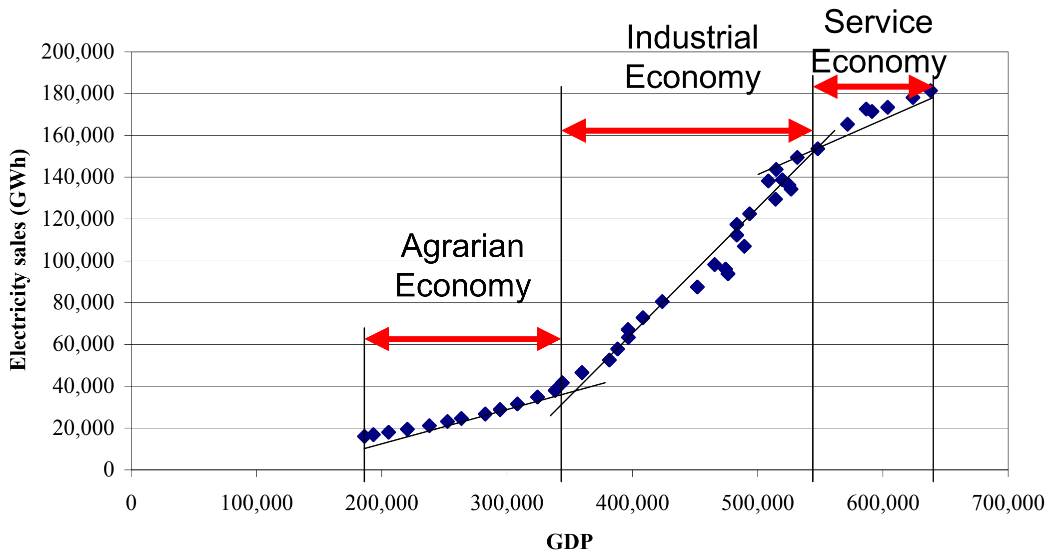
2.3 Background

2.3.1 The drivers of electricity demand

In principle the demand for electricity depends upon the following main factors:

- The price of electricity. The rising price of electricity leads to substitution into other fuels, more efficient use of electricity and to conservation (using less energy);
- Prices of other fuels. If prices of other fuels (such as natural gas) rise this could lead to consumers switching to electricity;
- Incomes. Rising incomes and output leads to higher electricity consumption; and
- Changing economic structure can lead to a move from more electricity intensive activity (industry) to less electricity intensive ones (services). This point is demonstrated in Figure 2.2 below which shows end user electricity consumption over the period 1960 to 2001 for South Africa. During this period GDP per capita in South Africa more than doubled. The demand for electricity initially increased rapidly then, at higher levels of GDP, the rate of growth in electricity demand slowed. This reflects the changing structure of the South African economy over this period. The South African example illustrates possible impacts on demand growth in each of the jurisdictions in our study.

Figure 2.2: South Africa: total electricity demand vs GDP 1960 to 2001



Source: Eskom & Central Bank of South Africa

- Technology. Technology improves over time which will reduce electricity consumption and intensity per unit of per capita income;

- Changes in energy policy. Sector reforms are expected to result in significant efficiency improvements in all SEE countries. While timing and progress of reform is uncertain, it is clear that whenever it happens (certainly within the study planning horizon) it will have an impact on energy demand.

The impact of these factors is discussed below.

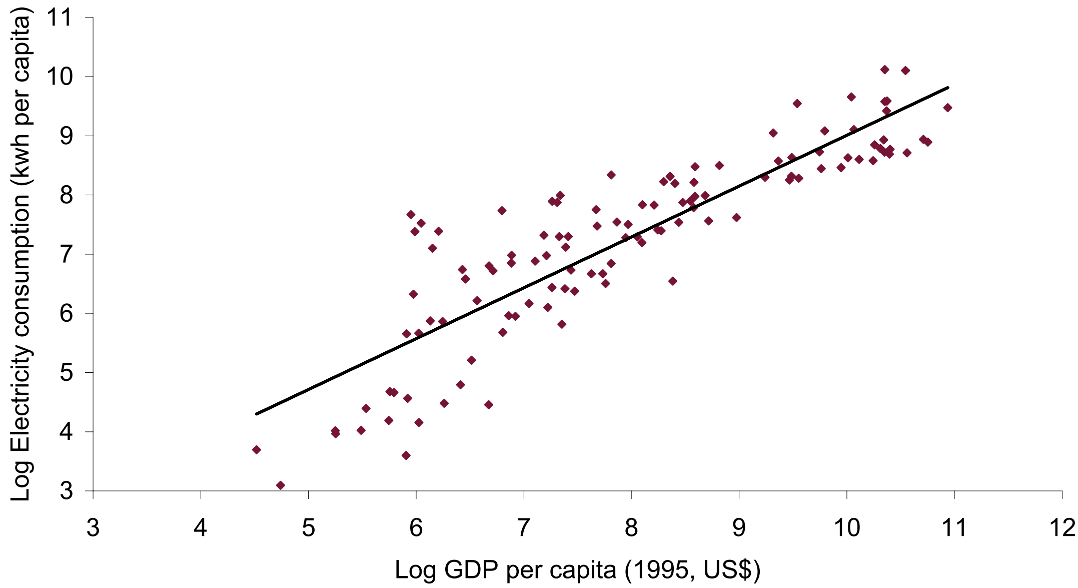
2.3.2 The importance of incomes

Past studies have suggested that there is a one-to-one relationship between GDP per capita and electricity demand per capita. The studies we have reviewed as part of this work are listed in Appendix 1.

Based on the general findings of these papers, we have undertaken an analysis of income (GDP per capita in constant 1995 prices) and electricity consumption data (net consumption per capita, GWh) for a number of countries using the *2003 World Development Indicators* CD-ROM published by the World Bank, for the period 1960 to 2001[3]. This analysis demonstrates, as shown in Figure 2.3, that there is a clear positive relationship between per capita incomes and net electricity demand.

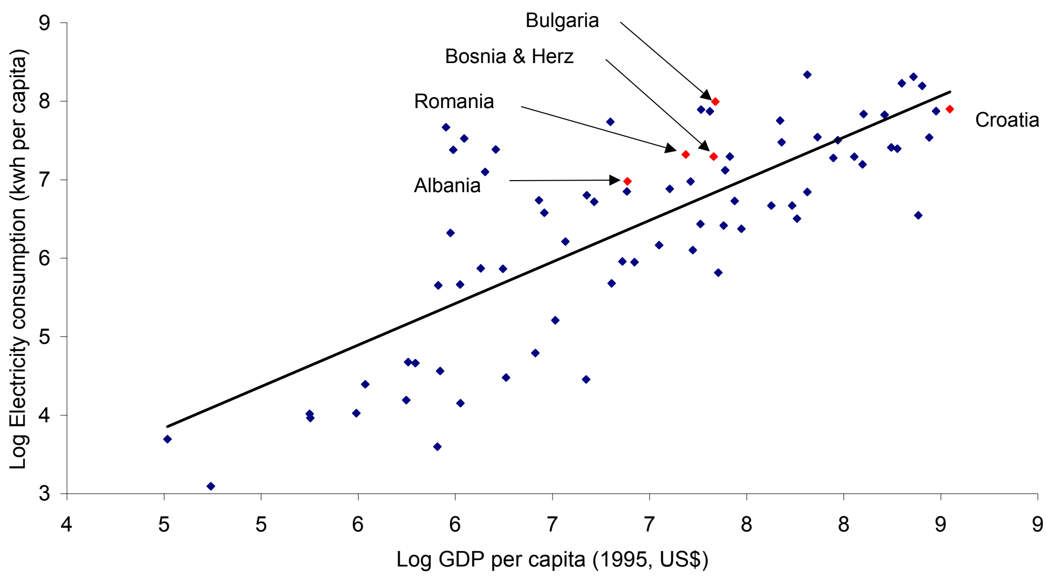
[3] It should be noted that the number of available annual data observations for Bosnia and Herzegovina and Croatia were less than ten and hence gave very limited information. No data were available for UNMIK, Serbia (excluding UNMIK) or Montenegro; and there were no data on electricity consumption per capita for Macedonia, we have supplemented WDI data with data provided by the utilities as appropriate.

Figure 2.3: Relationship between ln (GDP per capita) and ln (electricity consumption per capita) year 2000



We then segmented our data set to analyse countries with a GDP per capita less than US$ 5,000, which is closer to the level achieved in the Balkans (the Balkan countries are highlighted in red in Figure 2.4 below.)

Figure 2.4: Relationship between ln (GDP per capita) and ln (electricity consumption per capita) year 2000 with GDP per capita <US$5000[4]



[4] Not all the jurisdictions for this study are included with complete enough data in the WDI database, which is why a limited number are shown in Figure 3.4 for demonstration purposes.

Two observations arise which are important foundations for our demand forecasting modelling:

1. For economies with GDP per capita less than US$5,000[5] in 2000 there was clear positive relationship between incomes and electricity consumption;
2. Most of the SEE economies are above the estimated regression line, suggesting that the legacy of their economic structure is a high electricity intensity implying high electricity usage relative to other countries with similar GDP per capita. This trend may have arisen from non-cost-reflective pricing of electricity in the past or an emphasis on economic development using energy intensive heavy industry. In the long run, however, we would expect that the transition into a market economy should bring these countries back towards the trend line, as market forces push electricity usage more in line with GDP. We discuss this further in Section 2.3.4 below.

2.3.3 The importance of prices

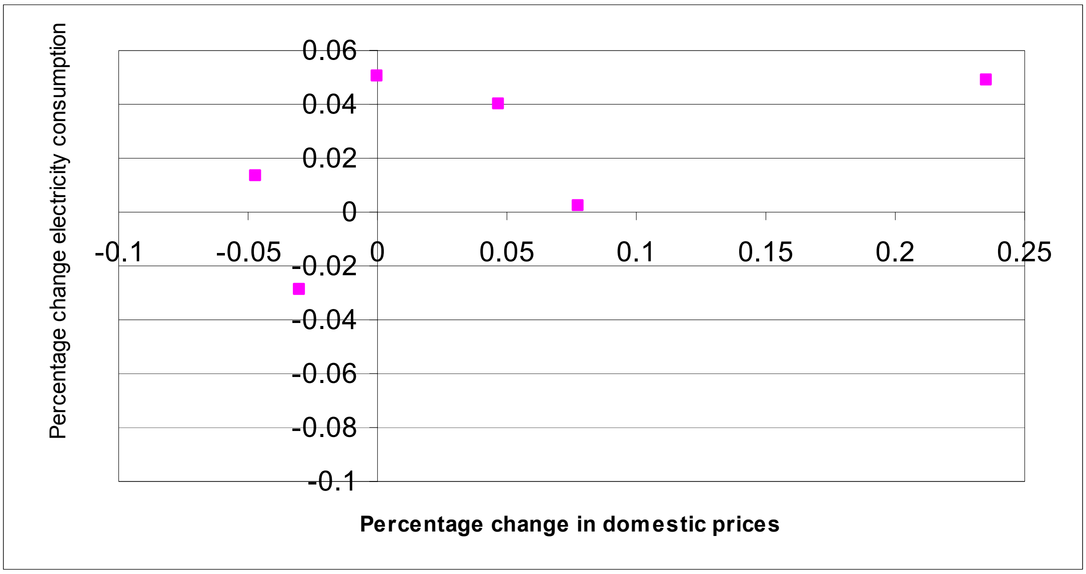
Electricity prices are a major influence on electricity demand. However, when examining historical data, it is not always possible to disentangle the influence of electricity prices from other events that also affect demand. This is true in Western economies where changes in economic development and electricity prices are gradual, but in the economies of Central and Eastern Europe it is almost impossible to discern the influence of price during the 1990s when there were so many other economic changes underway. This is not to suggest that electricity prices do not have an influence but rather that electricity prices and general economic reforms tend to happen simultaneously and it is impossible to separate their effects.

We undertook time-series analysis, based on four comparator transitional countries (Czech Republic, Poland, Hungary and Slovakia) using available price data for household and industry electricity prices. The results suggested that the effects of price could not be identified during the transition period. This finding is consistent regardless of whether household or industrial prices (or both) are used.

Figure 2.5 demonstrates this point graphically by showing the relationship between the percentage change in household electricity prices and the percentage change in electricity consumption for Poland for the period 1995-2000. The limited number of observations are spread widely, suggesting little formal statistical relationship between household prices and changes in electricity consumption. The poor results may also reflect the poor quality of the data on prices.

[5] In 1995 prices.

Figure 2.5: Relationship between household prices and electricity consumption in Poland 1995-2000



The Consortium also undertook an extensive literature survey of other electricity demand models using similar approaches. Many studies, especially in the developing countries, have faced problems getting good price data, including most recently Fatai, Oxley & Scrimgeour (further details can be found in Appendix 1). Furthermore, in the uncertain, rapidly changing environment of the transition economies, accurate relationships between prices and demand may be quite difficult to ascertain.

This does not lead to the conclusion that price impacts should be rejected in the model but rather that they should not necessarily be incorporated directly. On this basis we do not directly model the impact on prices on electricity demand but capture the impact of the transition of prices on electricity demand via the electricity intensity effect described below and in Section 2.6.

2.3.4 The importance of electricity intensity

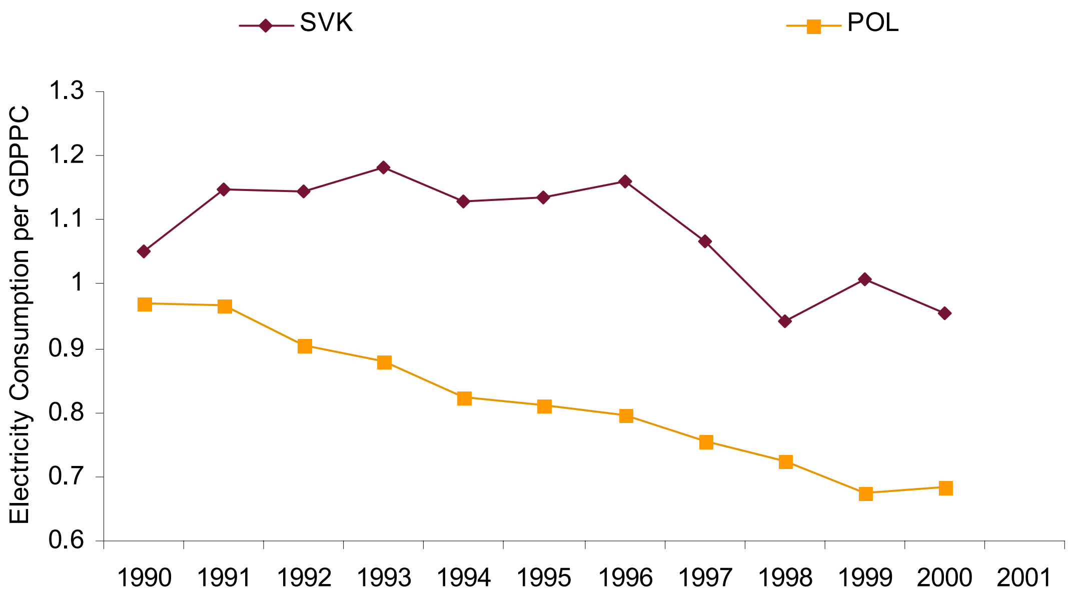
Our analysis of the relationship between per capita GDP and net electricity consumption in Section 2.3.2 demonstrated that, in a number of SEE jurisdictions, electricity consumption per US$ of 1995 GDP is significantly higher than the trend, reflecting the economic/industrial heritage of those countries. Forecasting demand for these countries should take into account an element of structural adjustment to a level comparable with nations that have made the adjustment already.

The changing electricity intensity between the SEE jurisdictions and the benchmark comparator countries will capture a number of effects:

- The impact of structural adjustment in the economies (particularly the closure of high energy intensity industrial processes);

- Adoption of energy efficiency measures;
- Development of cost reflective pricing for electricity and competing fuels.[6]

Figure 2.6: Examples of adjustments to electricity intensity from other countries



As an example of this particular point, Figure 2.6 compares the year 2001 levels of electricity intensity for Slovakia (SVK) and Poland (POL) for the period 1990 to 2000.

As the reform process took place in both countries, substantial reductions in electricity intensity were achieved. In Poland, electricity intensity over the ten years 1990 to 2000 fell by approximately 30%, and electricity consumption itself also fell. Falls were also registered in Slovakia with electricity demand falling by 8% in total over the ten year period.

A key point to note is that the starting electricity intensities in Poland, Slovakia and the other Central and Eastern European countries is significantly lower than the intensity levels in Bulgaria (electricity intensity in 2001 of 2.1[7]) or Serbia (approximately 3.2 in 2001) for example, making the likely adjustment required by the SEE jurisdictions greater than those seen in the comparator set of countries.

[6] Following the presentation of our findings at the Athens Forum, we have investigated, together with ECA, whether the impact of electricity intensity changes could be decomposed into price reform, structural changes and energy efficiency components for the benchmark countries. We found that reliable data does not exist to undertake an analysis of this form and that available data could not support such a decomposition.

[7] Electricity consumption per $ of GDP stated in 1995 terms.

2.3.5 Electricity demand drivers: Conclusions

Based on our analysis of electricity demand drivers above, we have reached the following conclusions:

- Income (as measured by GDP per capita) is a key driver of net electricity consumption;
- While prices are key drivers of electricity demand in principle, in practice their impact is difficult to explicitly factor into a demand forecasting methodology for the nine SEE jurisdictions. This is due to a lack of consistent pricing data. However, when the electricity intensity factor is included in the demand forecasting modelling, the methodology implicitly takes account of the impact of changing prices;
- The electricity intensity adjustment factor is a robust method of factoring into electricity demand estimation the effects of:
  - economic transition;
  - price reform; and
  - energy efficiency measures.

2.4 Approach

2.4.1 Choice of approach

Our choice of approach to electricity demand forecasting for the nine jurisdictions is informed by a combination of ensuring consistency and data availability.

Approaches to electricity demand forecasting largely fall into one of three categories:

- Data intensive “Bottom-up” studies in which demand forecasts are based on assessments of the trends affecting individual users of electricity. In this approach, estimates of domestic electricity demand would consider heating, air conditioning and other electricity requirements, while industrial and commercial demand forecasts would be based on individual enterprises;

- Projections of the future electricity demand based on recent trends in demand; or

- Projections that assess electricity demand based on an analysis of key macro level drivers of demand.

Each of these three methods have their merits and limitations. For the purposes of the study we have opted for the third approach (developing projections based on an assessment for the macro drivers of electricity demand) because of:

- The absence of a set of measures of disaggregated economic activity which are consistent with measures of corresponding disaggregated electricity consumption for both all of the jurisdictions in the study as well as a sufficiently large international country benchmark database;

- The requirement for a consistent, generic approach applicable with little modification to all jurisdictions and easily comparable to international benchmarks of electricity consumption that is robust in the long term; and

- The simple projection of electricity demand would not take into account the effects of macroeconomic transition and post conflict recovery in the region.

Having selected the third approach, and defined the drivers of demand for electricity, our forecasting methodology and data requirements are described below.

2.4.2 The steps in our approach

Our approach is based on the following key steps:

- Establishment of a long term equilibrium relationship between GDP per capita and GWh per capita, based on a survey of other countries;

- A review of the economic analysis of the relationship between national income and demand. Most studies tend to suggest that for each 1% increase in GDP per capita, electricity demand increases by between 0.9% and 1.2% depending on the country and time period under consideration. Our own analysis of transition economies suggests that a 1% increase in GDP per capita results in a 1.2% increase in net electricity consumption in the long term;

- Establishment of how a jurisdiction moves from a disequilibrium level of electricity demand towards equilibrium. This requires taking into consideration:
  - The relative electricity intensity (measured as GWh per US$ of GDP in 1995 terms) of the jurisdictions under consideration when compared with other economies that have been through transition;
  - The lagged effect of electricity demand in the previous year;
  - Where appropriate, the impact of structural adjustment in the economy on electricity demand by examining and adjusting for differences in the intensity of electricity usage per US$ of GDP; and
  - The movement of a jurisdiction toward equilibrium is modelled by trending the intensity from its present level to the target that is the average of a sample of Eastern European countries (the comparator countries). The model reduces electricity intensity toward this target at an annual rate calculated by the econometric modelling, however we ensure that the rate of decrease toward benchmark levels is not greater than has been observed historically in the comparator counties;
- Using the two relationships described above to predict net electricity demand in GWh each year;
- Making adjustments to demand forecasting for any specific large customer demands in each jurisdiction;
- Developing load shape forecasts for a number of representative days and weeks for each jurisdiction based on changing levels and patterns of demand; and
- Aggregation of the individual results for each jurisdiction to create a regional electricity (GWh) and peak (MW) demand forecast capturing the effect of non-simultaneous peak demand.

2.4.3 Developing annual load profiles

In addition to understanding how electricity demand will grow over the period to 2020 it is also important to understand how the load profile will adjust over time, for example increasing peakiness could require the addition of different types of plant to the network than a constant increase in demand levels.

Our approach to developing annual load profiles has been to:

- Use the annual load profile for each jurisdiction for a base year (either 2001, 2002 or 2003 depending upon jurisdiction and availability of data[8]); then
- For each forecast year we adjust the base year load profile:
  - to ensure that the GWh total demand for the year matches the total GWh demand projected for the year by our demand forecast calculations;
  - by a factor to ensure that the MW peak demand for the year is consistent with the expected MW peak on the system for the year; and
  - by a monthly profiling factor to adjust the load shape for the system to reflect changes in load shape as the economy and industry in the jurisdiction develops.

We have assumed that the load shapes of each jurisdiction will move towards the seasonal load shape currently seen in Croatia, until reaching 8.0% in July (as a share of annual energy demand). We have demonstrated this transition for Macedonia in Figure 2.7 below and there are some exceptions to this assumptions as summarised in Table 2.1. Full details can be found in Appendix 4.

Recent historical trends in Croatia and other countries surrounding SEE show that summer demand is increasing as a share of total and compared to winter demand. There are two drivers; increased summer demand from air conditioning and cooling and decreased winter heating demand from fuel substitution.

We forecast that, for most countries, each months' share of annual demand will increase or decrease by up to 0.1% each year, following the recent trend seen in Croatia. Croatia is likely to be an appropriate indicator of future changes in monthly demand for other countries in the region as it has a higher GDP per capita (one of the main drivers of air conditioning demand) and has a similar in temperature profile across the seasons in other jurisdictions.

[8] The average of the available base years data was used for Bulgaria, Albania and Montenegro as temperature variations led to significant swings in the share of energy accounted for by each month in the base years.

Figure 2.7: Transformation of load shapes based on monthly ratios to annual system peak demand: Example Macedonia

Monthly GWh/Annual GWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	11.4%	8.9%	8.7%	8.0%	6.8%	6.7%	7.0%	6.7%	6.9%	8.3%	9.4%	11.3%
2003	10.0%	9.7%	9.6%	8.2%	6.7%	6.6%	7.0%	7.0%	6.8%	8.2%	9.2%	11.1%
2004	9.9%	9.7%	9.5%	8.2%	6.7%	6.7%	7.1%	7.1%	6.9%	8.1%	9.1%	10.9%
2005	9.8%	9.6%	9.5%	8.2%	6.7%	6.8%	7.3%	7.3%	6.9%	8.1%	9.1%	10.8%
2006	9.7%	9.5%	9.5%	8.2%	6.7%	6.9%	7.4%	7.4%	6.9%	8.1%	9.0%	10.6%
2007	9.5%	9.5%	9.4%	8.2%	6.7%	7.1%	7.6%	7.5%	6.9%	8.1%	8.9%	10.5%
2008	9.4%	9.4%	9.4%	8.2%	6.8%	7.2%	7.7%	7.7%	7.0%	8.1%	8.8%	10.3%
2009	9.3%	9.3%	9.4%	8.2%	6.8%	7.3%	7.9%	7.8%	7.0%	8.1%	8.7%	10.2%
2010	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2011	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2012	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2013	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2014	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2015	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2016	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2017	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2018	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2019	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%
2020	9.2%	9.3%	9.4%	8.2%	6.8%	7.5%	8.0%	8.0%	7.0%	8.1%	8.6%	10.0%

Based on our discussions with utilities and other stakeholders in the region, we have applied the variation in seasonality differently between countries as summarised in the table below:

Table 2.1: Adjustments to forecast load shapes by jurisdiction

Jurisdiction	***Assumed seasonal demand profile change***
Albania	Continue historical level (7.3%) to 2007. Post 2007 increase July share to 7.8% which is reached by 2010 then stable.
Bosnia and Herzegovina	Reaches 8.0% in 2007 from the present level of 7.4%.
Bulgaria	Increases from the current level of 6.7% to 7.9% by 2010 (following discussions with NEK).
Croatia	Remain at 2003 monthly demand profile with 8% demand in July.
UNMIK	We forecast UNMIK demand using a demand profile corrected for shed load (described in section 2.5.3.5). We forecast the corrected July share (7.0%) to 2007, and increase this share to reach 8.0% by 2014.
Macedonia	Modify each month from 2004 until July reaches target of 8.0% in 2010.
Montenegro	No change because of a very high system load factor dominated by single industrial user. Domestic demand changes not expected to influence profiles in future.
Romania	Continuation of historical average.
Serbia (excluding UNMIK)	Increases to 7.6% by 2010[9].

[9] Following discussions of these assumptions with EPS who have noted that the summer air conditioning load in Balkans countries may not be the same as in the Mediterranean/Adriatic coast (which tends to have electricity demand reflecting tourism patterns in part of the country) and therefore may not expect to see the full extent of the changes in load shape experienced in Croatia.

Specifically:

- We describe here the changes to July only as a proxy for the changes to all other months in the year. We have assumed a profile of changes for each of the 12 months; winter months decrease their share while summer months increase their share, with July and December the peak increase and decrease months respectively. The sum of the twelve month's changes is zero.

- We have not applied the shift in seasonality at all to either Romania or Montenegro[10]. Seasonality trends in Montenegro are largely offset by the flat load profile of the smelter and other large users, which account for some 60% of total demand. For Romania, there is already a high share of gas used for winter heating, so there is limited fuel substitution remaining to take place. Demand in July is already at 8.1% of annual total demand. While there has been some increase in air conditioning load in recent years, Transelectrica expects it to stabilise from now on.

- We have delayed the onset of the change in seasonal demand in Albania and UNMIK as we believe the extensive load shedding and unstable operation of these systems will not allow seasonal changes in trends to emerge until a more stable supply regime is established and consumers respond correctly to price signals. We have therefore delayed the effect until 2008 and from that point assume the monthly demand will vary in line with the historical trend of Croatia. UNMIK is forecast to reach 8% July share of annual demand in 2014 while Albania is forecast to reach 7.8% by 2010.

- The historical UNMIK hourly electricity demand profiles exhibit very high levels of instability and even when corrected for shed load are not considered to be characteristic of a stable system. We have therefore historical KEK hourly demand data, but instead constructed an 'idealised' demand profile for UNMIK which reflects all characteristics of the UNMIK system except the fluctuating demand.

- For the remaining countries, we assume that they continue or begin to experience changes in seasonal demand from 2004. Bulgaria is forecast to increase the July share of annual energy demand from 6.8% in 2003 to 7.9% in 2010. Macedonia is forecast to increase from 7.0% in 2003 to 8.0% in 2010, Croatia remains at its current level of at 8.1%, BiH increases from 7.4% in 2003 to 8% by 2007. For the SEE region a whole, we forecast a shift in July energy from 7.3% in 2003 to 7.9% in 2020.

2.5 Assumptions and data sources

2.5.5 Forecast assumptions

In this section we detail the key assumptions which drive the electricity demand forecasts for the study. We present in Appendix 4 a discussion of the sources of the data used in this study, as well as a description of the adjustments made to that data.

[10] Following discussions with the utilities.

2.5.5.1 Jurisdictions

Demand forecasts are being prepared for each of the following jurisdictions separately:

- Albania;
- Bosnia and Herzegovina;
- Bulgaria;
- Croatia;
- UNMIK;
- FYR Macedonia;
- Montenegro;
- Romania; and
- Serbia (excluding UNMIK.)

2.5.5.2 Period

All forecasts are to the end of 2020 and based on calendar years. The starting points for the forecasts vary by jurisdiction and depend upon availability of reliable data for recent years as summarised below.

Table 2.2: Start dates for forecasts

Jurisdiction	**Latest year for which historical end consumer demand and population figures available**
Albania	2003
Bosnia and Herzegovina	2003
Bulgaria	2003
Croatia	2002
UNMIK	2003
FYR Macedonia	2003
Montenegro	2003
Romania	2003
Serbia	2003

For countries where we were unable to begin the demand forecast from 2003, we have been able to obtain the gross demand from summing the hourly demand profiles we received from the utilities. Net consumption for 2003 has then been calculated from 2003 gross consumptions using losses figures for 2002.

2.5.5.3 GDP growth and population projections and other forecast assumptions

The assumptions used for the demand modelling fall into two main categories:

- The macroeconomic assumptions driving the overall level of electricity demand in the jurisdictions and the region; and

- Jurisdiction specific adjustments to the demand forecasts representing factors such as industrial loads etc.

GDP per capita growth for each jurisdiction have been derived from three sources; on the basis of data from the jurisdictions and utilities where this has been made available, the Economist Intelligence Unit (EIU) and PwC's analysis of the long term growth assessments. These are explained in detail in Appendix 3 to this report and are summarised in Table 2.3.

Table 2.3: GDP per capita growth rate assumptions

		2003	2004	2005	2006-20	Source
Albania	Case 1	6.00[11]	3.82	3.82	2006-2010: 3.17 2011-2015: 2.33 2016-2020: 3.00	Government of Albania, Ministry of Energy and Industry, National Agency of Energy *"First Part of the National Energy Strategy*", 2001
	Case 2	6.00	5.94	5.94	2006-2010: 5.27 2011-2015: 4.36 2016-2020: 5.07	
	Case 3	6.00	6.83	6.83	2006-2010: 6.20 2011-2015: 5.29 2016-2020: 6.00	
Bosnia and Herzegovina	Case 1	3.5	3.8	4.0	3.0	PwC analysis
	Case 2	3.5	3.8	4.0	4.0	PwC analysis
	Case 3	3.5	3.8	4.0	4.5	PwC analysis
Bulgaria	Case 1	5.6	4.7	4.5	4.5	PwC analysis
	Case 2	5.6	4.7	6.0	2006-2009: 6.2 2010, 2011: 6.5 2012, 2013: 6.2 2014, 2015: 6.9 2016: 6.4 2017: 4.5 2018, 2019: 4.0 2020: 3.5	NEK
	Case 3	5.6	4.7	6.0	2006-2009: 6.2 2010, 2011: 6.5 2012, 2013: 6.2 2014, 2015: 6.9 2016: 6.4 2017: 4.5 2018, 2019: 4.0 2020: 3.5	NEK
Croatia	Case 1	4.2	3.5	3.5	3.5	PwC analysis
	Case 2	4.2	4.2	4.2	4.2	Government of Croatia
	Case 3	4.2	4.9	4.9	4.9	PwC analysis

[11] Source: EBRD, Office of the Chief Economist, by private correspondence 14 October 2004.

		2003	2004	2005	2006-20	Source
UNMIK	Case 1	5.5	3.0	3.0	3.0	ESTAP Report
	Case 2	5.5	5.0	5.0	5.0	ESTAP Report
	Case 3	5.5	8.0	8.0	8.0	ESTAP Report
FYR Macedonia	Case 1	3.0	3.8	4.5	3.0	PwC analysis
	Case 2	3.0	3.8	4.5	4.0	PwC analysis
	Case 3	3.0	3.8	4.5	4.5	PwC analysis
Montenegro	Case 1	3.0	5.0	3.0	3.0	PwC analysis
	Case 2	3.0	5.0	4.5	4.5	PwC analysis
	Case 3	3.0	5.0	6.5	6.5	PwC analysis
Romania	Case 1	4.8	6.0	5.0	3.0	PwC analysis
	Case 2	4.8	6.0	5.0	4.5	PwC analysis
	Case 3	4.8	6.0	5.0	6.0 to 2010 5.5 2011 – 2015 5.2 2016 – 2020	Ministry of Economy and Commerce
Serbia[12] (excluding UNMIK)	Case 1	1.5	3.0	3.0	2006: 3.5% 2007: 4.0% 2008-2011: 4.5% 2012: 4.0% 2013: 3.5% 2014- 2020 3.0%	Least Cost Investment Plan for Serbia Electricity Sector: Workshop III Demand and Least Cost Models Belgrade 2 July 2004
	Case 2	1.5	3.0	3.0	2006: 3.5% 2007: 4.0% 2008-2011: 4.5% 2012: 4.0% 2013: 3.5% 2014- 2020 3.0%	
	Case 3	1.5	3.0	3.5	2006: 4.5% 2007-2011: 6.0% 2012-2013: 5.5% 2014: 4.0% 2015- 2020 4.5%	

In addition to understanding GDP per capita growth, the total demand for electricity is driven by population growth in each jurisdiction. We have used estimates of population growth for provided by each jurisdiction where available. The compound growth rates in population for each jurisdiction are shown on Table 2.4 below.

Table 2.4: Population growth rates assumptions

	2003-2020 CAGR (%)	Source
Albania	1.1%	National Strategy of Energy [28]
Bosnia &	0.28%	US Census Bureau

[12] EPS has made us aware of higher GDP per capita growth rate assumptions than those presented here. In Nov 2004, EPS requested that we use 4.5% in 2004, and 3.0%, 3.5% and 4.5% for 2005 in Cases 1, 2 and 3 respectively. We have not adopted these alternative assumptions as they would undermine the consistency of assumptions both with the LCIP study for Serbia as well as with the forecasts made in early to mid 2004 for the other countries in this study.

	2003-2020 CAGR (%)	Source
Herzegovina		
Bulgaria	-0.66%	NEK
Croatia	0.34%	Government of Croatia Energy Masterplan [3]
UNMIK	1.1%	ESTAP Report
FYR Macedonia	0.3%	US Census Bureau
Montenegro	-0.05%	US Census Bureau
Romania	0.0%	Ministry of Economy and Commerce "Road Map for Energy Field in Romania Official Journal No.451".
Serbia	0.0%	Least Cost Investment Plan for Serbia Electricity Sector: Workshop III Demand and Least Cost Models Belgrade 2 July 2004
SEE Region	0.09%	Based on the individual jurisdictions

Specific assumptions affecting the demand forecasts each jurisdiction are summarised in Section 2.5.3 below.

2.6 Forecasting model

2.6.5 The importance of incomes in driving electricity demand

Past studies have suggested that there is a one-to-one long-term relationship between electricity consumption and GDP per capita. In the short to medium run however, this one-to-one relationship will not hold due to short run fluctuations in both GDP and electricity consumption. It is important to assess whether the long term relationship exists before identifying the impact of short term fluctuations. Full details can be found in Appendix 2.

The table below shows the long term GDP coefficients for a range of countries. These coefficients represent the relationship between electricity demand and a country's GDP in steady-state, i.e. in absence of short-run fluctuations.

Table 2.5: Regression results: long run relationship between GDP per capita and net electricity demand

	Long term coefficient of net electricity demand per capita on GDP per capital
Romania	2.413
Albania	1.987
Bosnia	0.336
Croatia	0.868
Hungary	1.110
Czech	0.913
Poland	0.189
Slovakia	0.427
Slovenia	0.581
Estonia	0.490
Portugal	1.418
Turkey	2.783
Greece	1.281
Spain	1.536
Ireland	0.909
Indonesia	2.550
Malaysia	2.139
Philippines	1.007
Thailand	1.637
Brazil	1.524
Chile	1.361
Mexico	0.394
Average of Comparators	**1.236**
Median of Comparators	**1.196**

Based on the results, we estimate the median coefficient for the long-term GDP relationship for the whole set of regressions to be 1.196, implying that for every 1% increase in GDP per capita there is a 1.196% increase in net electricity demand per capita[13]. This coefficient is used as the basis of the long-term relationship between electricity demand and GDP per capita for our projection modelling.

2.6.6 Moving from disequilibrium

Having developed a model that is able to relate net electricity consumption per capita to explanatory variables in the long term, the next step is to factor the impact of adjustments in electricity intensity into the demand forecasts. We have used the following approach:

[13] ECA requested that we consider the impact of reviewing a limited number of transition economies from the sample to test the sensitivity of the demand forecast to different elasticities. This increases the median coefficient to 1.321 as explained in Appendix 6. The impact of this change in GDP elasticity on the demand forecasts results in an increase in 2020 regional demand of 5% over the Consortium base case elasticity of 1.196.

- We first calculated the 'distance' the country is at present from what it should be according to our long-run analysis of market economies. This is done by looking at the individual country's energy intensity (net electricity use per GDP) as compared to a selection of comparative countries[14]. This distance is an estimate of how "over-used" electricity is compared to what would be expected, based on our sample of comparator countries;

- We then align the constant so that our starting point (i.e. our latest available data point) reflects this distance. We make an adjustment to the constant term in the regression to reflect the different electricity intensities between the different jurisdictions;

- The treatment for Croatia is slightly different. Although Croatia is currently at a lower level of electricity intensity than our comparators, we have projected continued energy intensity improvement of 1% pa, following discussion with the World Bank and HEP. A check-point for this is that the level of electricity intensity is similar to that of Hungary, which Croatia's economy appears to be moving towards.

We then use a model that includes a short run reversion to trend:

LELCO = Constant(i) + 0.889 LELCO (-1) + 0.133 LGDPPC[15]

The coefficient of the lag term (0.889) in the model reflects how long it takes electricity demand to return to the energy intensity levels in comparator countries. In our model this is obtained by calculating the average lag for the group of Western European comparators from the regression results.

The rationale for the use of Western European comparators is that a large number of historical observations are required to reliably estimate the degree of persistence, and sufficient data is not available for Eastern European countries.

The extent of disequilibrium, i.e. the distance a jurisdiction is at present from where it should be according to our model, varies by jurisdiction. We have varied the constant to control the degree to which the model assumes that electricity intensity is above the level for comparator countries. The jurisdictions with the largest reductions to be made to reach the long-term trend in electricity intensity are Serbia (excluding UNMIK), Montenegro, Bulgaria and UNMIK. This adjustment to longer term average electricity intensity is likely to be a dominant factor in electricity demand forecasts for these countries in the medium term.

[14] Countries include Poland, Hungary, Czech Republic, Latvia, Estonia, Lithuania and the Slovak Republic. Since per capita incomes in the Western economies were significantly higher than in SEE, we consider that the SEE jurisdictions considered by our study will reach that level of economic development (and electricity intensity) in the forecast period of Eastern European, rather than Western European countries.

[15] We have presented the effect of GDP figures converted using a PPP basis in Appendix 6. Our analysis of the PPP data suggests that it is unclear how reliable the PPP data for the economies in the region is at present.

Following interactions with the utilities, government and regulators in a number of the jurisdictions covered by this study, we have made some specific adjustments to the basic methodology used by the consortium. These variations impact either the extent of the adjustment to electricity intensity or whether the adjustment profile is non-linear (as in our benchmark dataset) or linear. Details of the specific cases and jurisdictions to which these variations apply are detailed in Section 2.7.

2.7 *Results and validation*

This section presents the gross demand forecasts for each of the nine jurisdictions and SEE based on the methodology, data and assumptions presented above. We present results for three cases, as specified in the ToRs. The assumptions used for each of the three cases are also described on a jurisdiction by jurisdiction basis below.

We have compared our electricity demand forecasts with forecasts that have been provided to the Consortium either by IFI's or the utilities/regulators in each jurisdiction. We present here those comparisons, and show that our forecasts coincide closely with most other estimates. The main exceptions to this finding are Serbia and Montenegro, where the strength of the energy intensity adjustment serves to offset the effects of economic growth.

Table 2.6 below summarises the compound annual growth rate in gross electricity consumption for each of the nine jurisdictions and South East Europe based on the Consortium's demand forecasts. The three cases represent the different assumptions used[16], Case 2 should be considered as Consortium's preferred case.

Table 2.6 SEE Electricity demand forecasts CAGR 2003-2020

	Compound annual growth value in gross electricity demand 2003-2020		
	Case 1	**Case 2**	**Case 3**
Albania	2.0%	4.0%	4.9%
Bosnia and Herzegovina	2.3%	3.0%	3.4%
Bulgaria	0.8%	1.6%	2.5%
Croatia	2.5%	3.2%	3.9%
UNMIK	1.7%	3.2%	4.3%
FYR Macedonia	1.5%	2.5%	3.0%
Montenegro	-1.3%	0.7%	1.2%
Romania	1.2%	2.6%	3.6%
Serbia (excluding UNMIK)	1.1%	1.1%	1.6%
SEE	**1.3%**	**2.3%**	**3.1%**

2.7.5 Albania

2.7.5.1 The Consortium cases

The key assumptions during the consortium's three cases for demand projections for Albania are shown in Table 2.7. The key difference between the cases is the assumed rate

[16] Details are provided in the remainder of this Section.

of GDP per capita growth, which is based on the low, medium and high scenarios as laid out in the Government of Albania's *"First Part of the National Energy Strategy."*

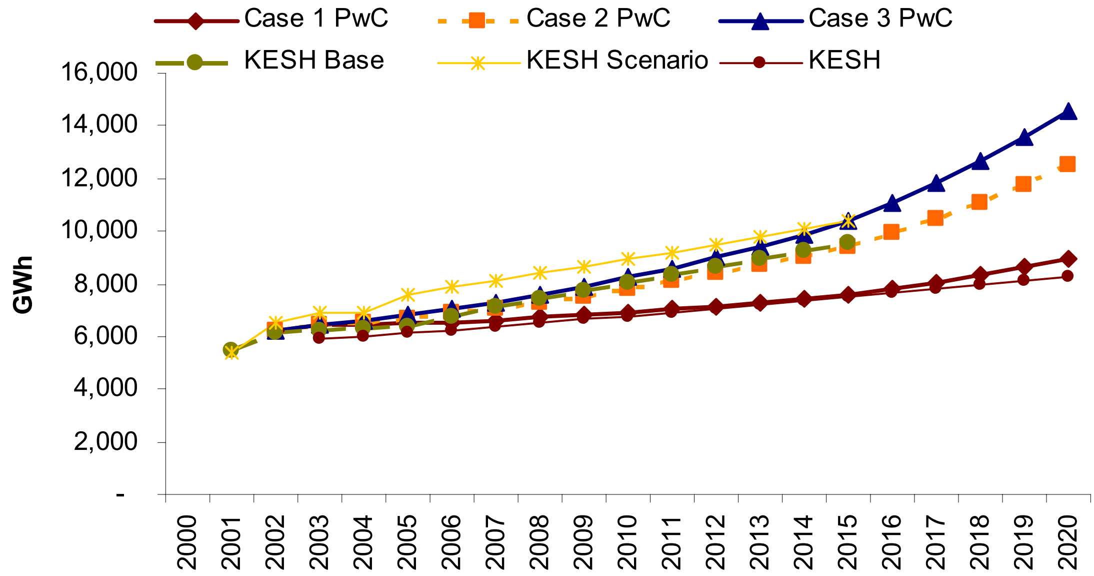
Table 2.7 Albania demand forecast scenario assumptions

	Case 1	**Case 2**	**Case 3**
GDP per capita annual growth rate	2003: 6.00 2004-2005: 3.82 2006-2010: 3.17 2011-2015: 2.33 2016-2020: 3.00	2003: 6.00 2004-2005: 5.94 2006-2010: 5.27 2011-2015: 4.36 2016-2020: 5.07	2003: 6.00 2004-2005: 6.83 2006-2010: 6.20 2011-2015: 5.29 2016-2020: 6.00
Structural adjustment to intensity	Converge to comparator country levels	Converge to comparator country levels	Converge to comparator country levels
Speed of movement to equilibrium	Moderate transition based on consortium methodology	Moderate transition based on consortium methodology	Moderate transition based on consortium methodology
Population	1.1% pa	1.1% pa	1.1% pa
Losses	Technical to 14% by 2015 Non-technical to 5% by 2015	Technical to 14% by 2015 Non-technical to 5% by 2015	Technical to 14% by 2015 Non-technical to 5% by 2015

2.7.5.2 Results

As is shown in Figure 2.8 below, the range of GDP assumptions used results in a range of demand forecasts.

Figure 2.8 Albania: Gross electricity demand: projections to 2020



The demand forecasts "add back" an estimate of the load that would have been shed (the WASP and GTMax modelling will provide an estimate of the load that would be shed in Albania for the forecast period.)

The central PwC Case 2 forecast predicts a compound average growth rate in gross demand of 4.0% pa. By 2020, under the Case 2 assumptions, demand would be 95% higher than the 2003 level based on our forecast.

2.7.5.3 Comparison with other forecasts

Comparison with other demand forecasts is particularly difficult as for many of the comparator forecasts we have been provided with, it is unclear the extent to which the adjustment for shed load has been included. However we have included forecasts provided to us by KESH for comparison and note the Consortium's forecast for Case 2 is closely comparable with the KESH Base forecast both in terms of compound growth rates (KESH 2.5% pa and Case 2 2.3% pa) and absolute growth (KESH 53% and Case 2 46%) in electricity demand to 2015.

2.7.6 Bosnia and Herzegovina

2.7.6.1 The Consortium cases

The three cases considered by the Consortium for the BiH demand forecast vary in terms of the GDP per capita growth rate assumption for the period 2006 to 2020, as shown in Table 2.8 below.

A key uncertainty facing the demand forecast for BiH is the role of the aluminium smelter (Aluminij Mostar) in total demand and load profiling and its sensitivity to electricity prices and world aluminium markets. Based on our discussions with the utility there is scope for electricity demand to increase if the facility is privatised and upgraded/expanded. However the timing and nature of this upgrading is uncertain and as a result ZEKC has not provided scenarios for the future demand from the smelter to be included in the demand forecast.

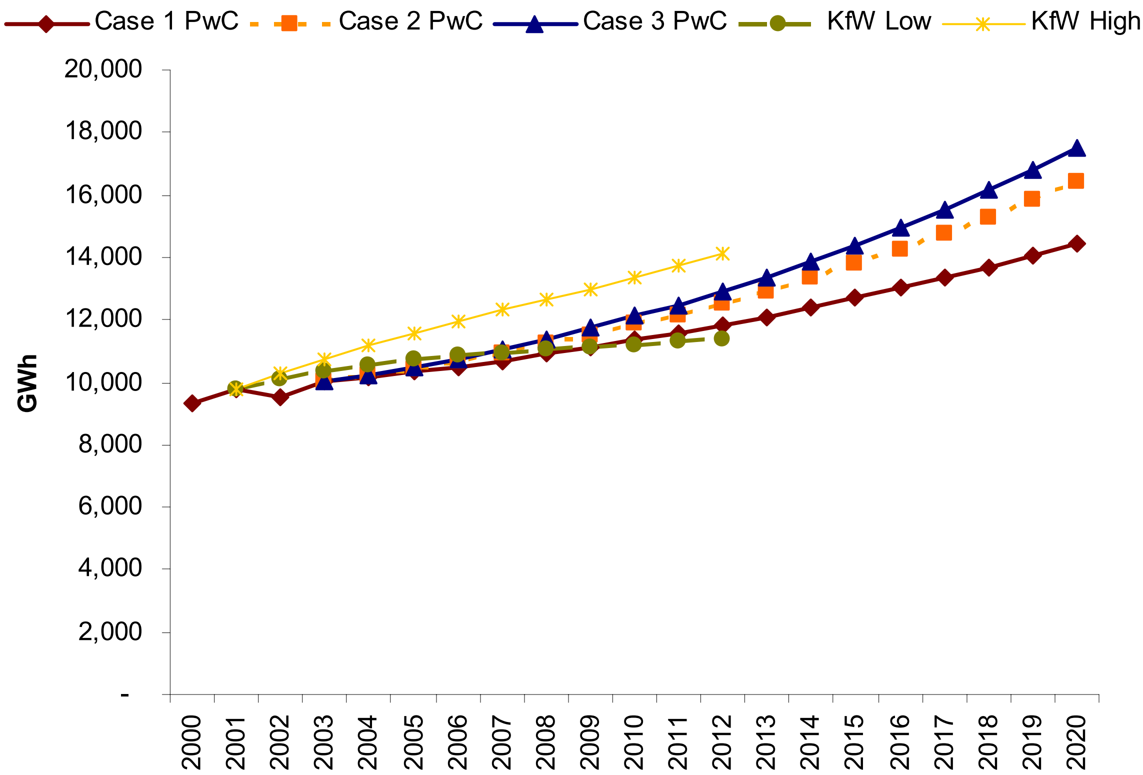
Table 2.8 Bosnia and Herzegovina demand forecast scenario assumptions

	Case 1	Case 2	Case 3
GDP per capita annual growth rate	2003: 3.5% 2004: 3.8% 2005: 4.0% 2006 to 2020: 3.0% (PwC analysis)	2003: 3.5% 2004: 3.8% 2005: 4.0% 2006 to 2020: 4.0% (PwC analysis)	2003: 3.5% 2004: 3.8% 2005: 4.0% 2006 to 2020: 4.5% (PwC analysis)
Structural adjustment to intensity	Converge to comparator country levels	Converge to comparator country levels	Converge to comparator country levels
Speed of movement to equilibrium	Based on consortium methodology	Based on consortium methodology	Based on consortium methodology
Population	US Census Bureau	US Census Bureau	US Census Bureau
Losses	Technical losses reduction to 10% by 2010. Non-technical losses reduced to zero by 2010.	Technical losses reduction to 10% by 2010. Non-technical losses reduced to zero by 2010.	Technical losses reduction to 10% by 2010. Non-technical losses reduced to zero by 2010.

2.7.6.2 *Results*

As shown in Figure 2.9, in all three cases the rate of growth in gross electricity consumption increases post 2010. Over the period 2003 to 2020 demand is forecast to increase by 44% in total over the period in Case 1. Case 2 and Case 3 show a 63% and 74% forecast increase in gross consumption, respectively, over the period.

Figure 2.9 Bosnia and Herzegovina: Gross electricity demand: projections to 2020



Compound annualised growth rates for each case are:

- *Case 1:* 2.3% pa;
- *Case 2:* 3.0% pa;
- *Case 3:* 3.4% pa.

2.7.6.3 *Comparison with other forecasts*

Both of the comparator forecasts that have been available to the Consortium project gross electricity consumption for BiH to 2012 rather than 2020. These forecasts are based on two scenarios from the “Regional Study of Electricity Supply and Demand in South East Europe” undertaken for KfW in 2002 [5].

As is seen in the figure above, our forecasts tend to be similar to or above the low scenario forecasts in the KfW report. As Table 2.9 below demonstrates however there is a broad consensus between the Consortium forecasts and the KfW forecasts in terms of average demand growth over the period to 2012.

Table 2.9 Bosnia and Herzegovina comparison of PwC Consortium results and other forecasts

Case	Total percentage growth in gross consumption 2003 to 2012	Compound annual growth rates (2003 to 2012 - % pa)
PwC Consortium Case 1	18%	1.8%
PwC Consortium Case 2	25%	2.5%
PwC Consortium Case 3	28%	2.8%
KfW Low	10%	1.1%
KfW High	31%	3.1%

2.7.7 Bulgaria

2.7.7.1 The Consortium cases

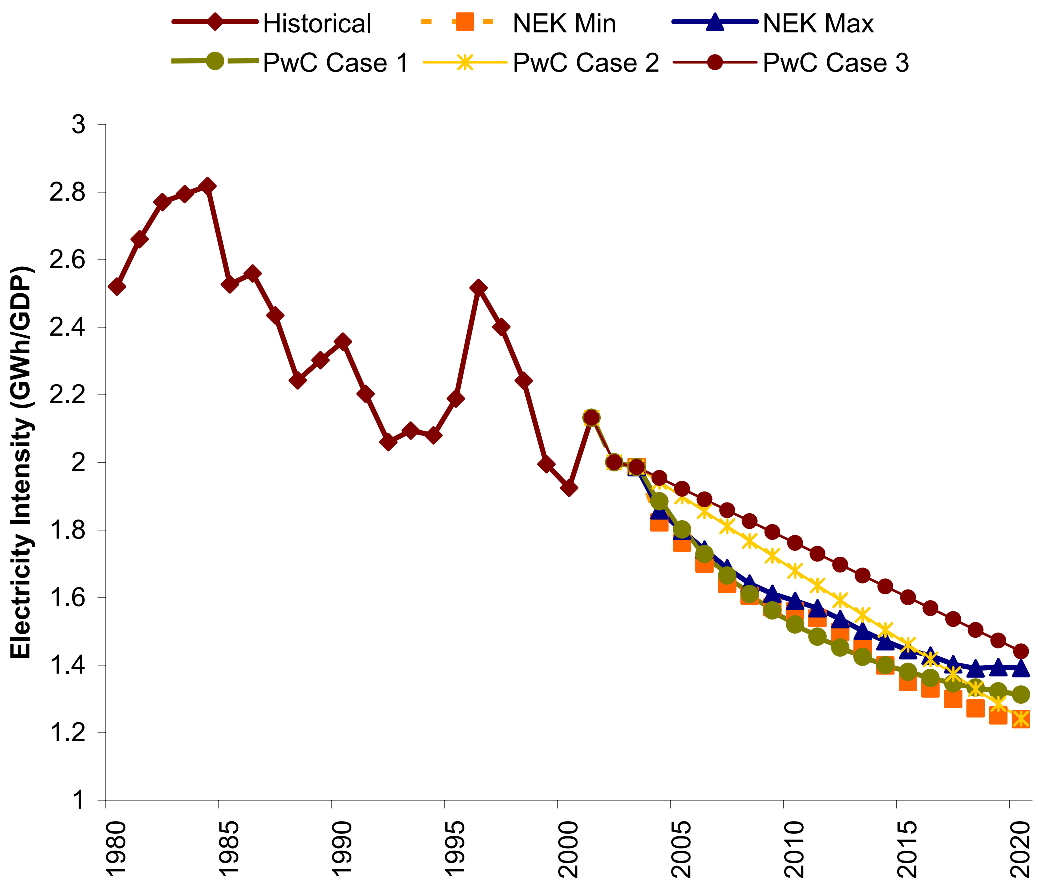
The Bulgarian electricity demand forecasts are concerned mainly with the very high energy intensity of the Bulgarian economy and how this can be expected to decrease in future. Following discussion with NEK and the National Dispatching Centre, three demand forecast scenarios were developed which correspond to the cases shown in Table 2.10 below.

The convergence of the Bulgarian economy to a lower energy intensity would involve significant restructuring and investment in the economy and infrastructure. Bulgaria has already witnessed a correction in electricity intensity in the early 1990's. However consumption has subsequently increased without a corresponding increase in economic output, making Bulgaria one of the highest electricity intensive economies in South East Europe. As shown in section 2.3.4 above, other Eastern European and transitioning economies have reduced their energy intensities over time and we consider different scenarios for this adjustment in our forecasts, which are shown in Table 2.10 below.

Table 2.10 Bulgaria demand forecast scenario assumptions

	Case 1	**Case 2**	**Case 3**
GDP per capita annual growth rate	PwC Assumption 2003 5.6% 2004 4.7% 2005-20 4.5%	NEK Assumption 2003 5.6% 2004 4.7% 2005 6.0% 2006-09 6.2% 2010-11 6.5% 2012-13 6.2% 2014-15 6.9% 2016 6.4% 2017 4.5% 2018-19 4.0% 2020 3.5%	NEK Assumption 2003 5.6% 2004 4.7% 2005 6.0% 2010-11 6.5% 2012-13 6.2% 2014-15 6.9% 2016 6.4% 2017 4.5% 2018-19 4.0% 2020 3.5%
Structural adjustment to intensity	2020 electricity intensity is 62.5% of 2003 intensity (to reflect NEK assumption regarding intensity)	2020 electricity intensity is 62.5% of 2003 intensity (to reflect NEK assumption regarding intensity)	2020 electricity intensity is 72.5% of 2003 intensity
Speed of movement to equilibrium	Non-linear, based on consortium methodology	Linear transition	Linear transition
Population	NEK Forecast	NEK Forecast	NEK Forecast
Losses	NEK Forecast	NEK Forecast	NEK Forecast

Figure 2.10: Comparison of Bulgaria electricity intensity forecast scenarios



In addition to the electricity intensity forecasts for Cases 1, 2 & 3, Figure 2.10 also shows the calculated electricity intensity of the latest NEK forecast adjusted to eliminate pumping demand and auxiliary consumption [1]. Table 2.11 shows the forecast demand, calculation of GDP per capita growth (which differs from the GDP growth forecast due to the forecast population decrease) and losses. We have assumed that NEK forecast constant auxiliary and pumping demand for ease of comparison to the PwC forecast.

Table 2.11: Adjustment to NEK demand forecast

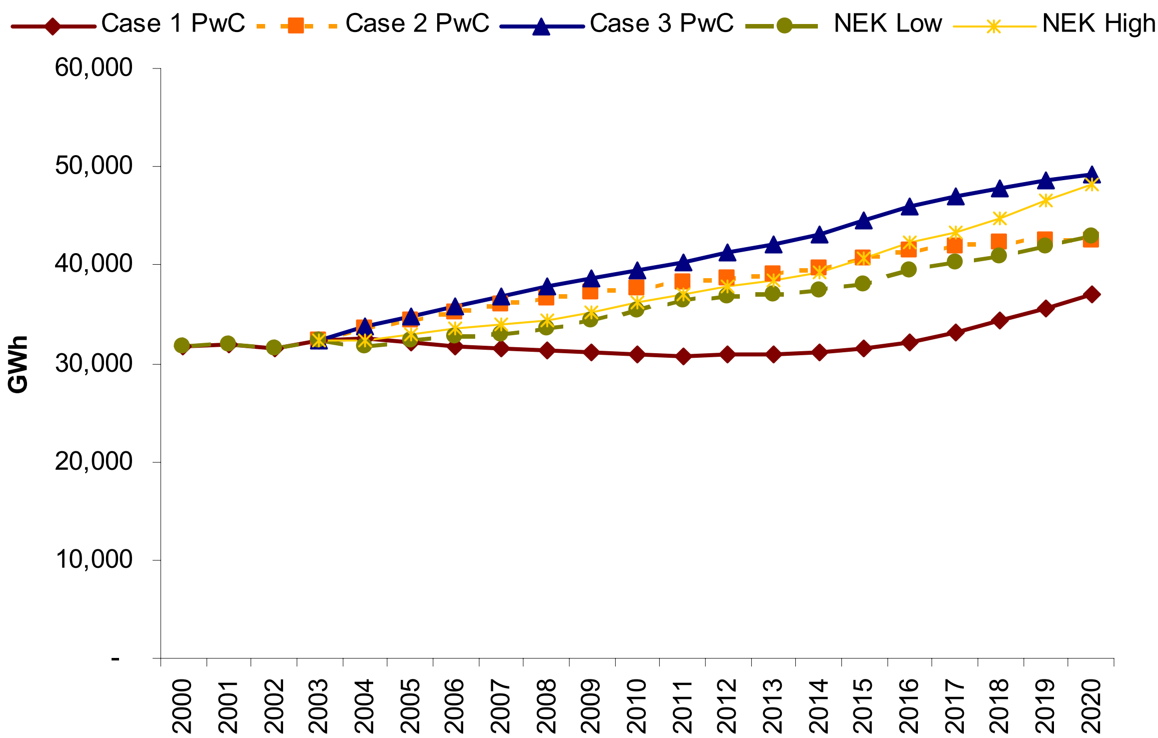
	NEK Minimum forecast										
	GDP 95 US$	Net Dem GWh	Pop '000	GDP/cap 1995 US$	GDP/cap Growth	Net Dem kWh pp	Intensity GWh/GDP	Gross Dem GWh	Aux+pump GWh	G-A-P GWh	Losses %
2001	12,104	25,800	7,913	1,530		3,260	2.13	37,044	5,118	31,926	19.2%
2002	12,658	25,312	7,846	1,613	5.5%	3,226	2.00	36,406	4,943	31,463	19.5%
2003	13,291	26,396	7,801	1,704	5.6%	3,384	1.99	37,057	4,713	32,344	18.4%
2004	13,996	25,510	7,751	1,806	6.0%	3,291	1.82	36,530	4,730	31,800	19.8%
2005	14,738	25,980	7,700	1,914	6.0%	3,374	1.76	36,990	4,700	32,290	19.5%
2006	15,548	26,440	7,650	2,033	6.2%	3,456	1.70	37,580	4,910	32,670	19.1%
2007	16,403	26,910	7,599	2,159	6.2%	3,541	1.64	38,020	5,050	32,970	18.4%
2008	17,306	27,780	7,551	2,292	6.2%	3,679	1.61	38,850	5,190	33,660	17.5%
2009	18,257	28,690	7,503	2,433	6.2%	3,824	1.57	39,000	4,700	34,300	16.4%
2010	19,261	30,020	7,430	2,592	6.5%	4,040	1.56	40,260	4,860	35,400	15.2%
2011	20,321	31,270	7,357	2,762	6.5%	4,250	1.54	41,390	5,040	36,350	14.0%
2012	21,439	32,110	7,309	2,933	6.2%	4,393	1.50	42,020	5,220	36,800	12.7%
2013	22,618	32,770	7,260	3,115	6.2%	4,514	1.45	42,340	5,320	37,020	11.5%
2014	23,862	33,390	7,164	3,331	6.9%	4,661	1.40	42,900	5,500	37,400	10.7%
2015	25,174	33,990	7,068	3,562	6.9%	4,809	1.35	43,750	5,680	38,070	10.7%
2016	26,433	35,180	6,974	3,790	6.4%	5,045	1.33	44,740	5,340	39,400	10.7%
2017	27,622	35,890	6,974	3,961	4.5%	5,146	1.30	45,700	5,500	40,200	10.7%
2018	28,727	36,550	6,974	4,119	4.0%	5,241	1.27	46,620	5,680	40,940	10.7%
2019	29,876	37,380	6,974	4,284	4.0%	5,360	1.25	47,630	5,730	41,900	10.8%
2020	30,922	38,320	6,974	4,434	3.5%	5,495	1.24	48,870	5,940	42,930	10.7%

Source: NEK, Sept 2003

2.7.7.2 Results

The results, shown by Figure 2.11 below, demonstrate that the adjustment to the electricity intensity in part offsets the growth in electricity demand from GDP per capita growth. Case 3, in which a proportion of the required adjustment to electricity intensity does not take place, is most comparable to the NEK high forecast.

Figure 2.11: Bulgaria Comparison of electricity demand forecasts



2.7.7.3 Comparison with other forecasts

The Case 1 demand forecast lies below NEK's projections, whilst Case 3 is comparable to the NEK high case. The key driver of these differences is the timing and the extent to which the adjustment in electricity intensity will take place in Bulgaria.

Table 2.12: Bulgaria comparison of demand forecast growth rates

	Total percentage growth in consumption 2003 to 2020	**Compound annual growth rates (2003-2020% pa)**
PwC Consortium Case 1	14.4%	0.8%
PwC Consortium Case 2	31.3%	1.6%
PwC Consortium Case 3	52.4%	2.5%
NEK low	32.7%	1.7%
NEK high	48.9%	2.4%

2.7.8 Croatia

2.7.8.1 The Consortium cases

Croatian electricity intensity is the lowest in South East Europe. The Consortium cases for Croatia do not focus on the reversion to a long term average electricity intensity as it is relatively close to equilibrium, but assume that electricity intensity will reduce by 1% pa over the forecast period.

On the basis of this assumption, GDP per capita growth is the main variable differing between the cases for the Croatian demand forecast.

Electricity losses have been trending steadily upwards from about 12% in the early 1990s to as high as 17% in 2001. We understand from discussions with HEP that these losses are mostly technical in nature and are due to increased transit flows in Croatia causing line loadings, and hence losses, to increase. We understand that these losses are expected to decrease in future as regional interconnection improves and transits through Croatia become more manageable. Therefore we have agreed with HEP to forecast linearly decreasing transmission and distribution losses to 8% by 2020.

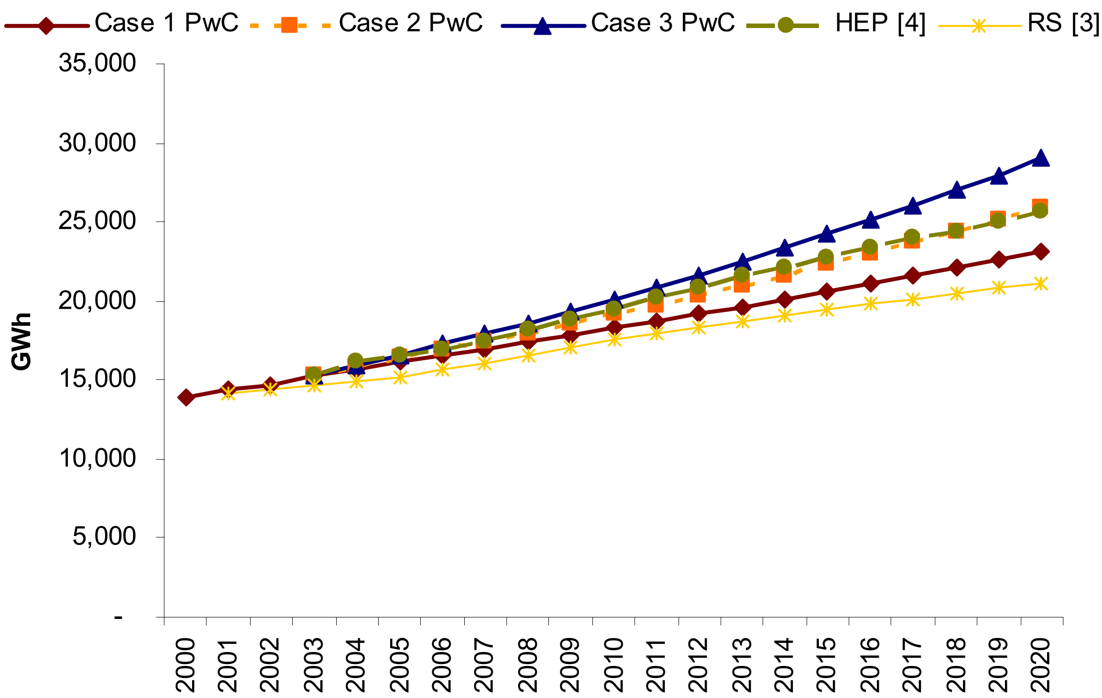
Table 2.13: Croatian demand forecast scenario assumptions

	Case 1	**Case 2**	**Case 3**
GDP per capita annual growth rate	2003: 4.2% 2004-20 3.5% PwC Assumption	2003: 4.2% 2004 – 2020 4.2% Croatian Ministry of Energy Assumption	2003: 4.2% 2004-2020 4.9% PwC Assumption
Structural adjustment to intensity	1% pa reduction in electricity intensity from 2003 to 2020.	1% pa reduction in electricity intensity from 2003 to 2020.	1% pa reduction in electricity intensity from 2003 to 2020.
Speed of movement to equilibrium	Constant percentage adjustment (see above)	Constant percentage adjustment (see above)	Constant percentage adjustment (see above)
Population	HEP Forecast [3] (0.28% pa)	HEP Forecast [3] (0.28% pa)	HEP Forecast [3] (0.28% pa)
Losses	Linear decrease from 13.8% in 2003 to 8% by 2020 as agreed with HEP.	Linear decrease from 13.8% in 2003 to 8% by 2020 as agreed with HEP.	Linear decrease from 13.8% in 2003 to 8% by 2020 as agreed with HEP.

We forecast seasonal shifts in demand to continue their recent trend in Croatia due to increasing consumer demand. We cap this effect at 8.1% July demand and we forecast this will be achieved by 2007, remaining flat thereafter.

2.7.8.2 *Results*

Figure 2.12 Croatia Gross electricity demand projections to 2020



The three PwC Consortium cases suggest strong growth in electricity demand in Croatia, the CAGR for the three cases are:

- *Case 1:* 2.5%;
- *Case 2:* 3.2%;
- *Case 3:* 3.9%.

This growth reflects the fact that Croatia has undergone a significant part of the structural adjustment which drives changes in electricity intensity and the more mixed nature of its economy.

2.7.8.3 *Comparison with other forecasts*

In our conversations and correspondence with HEP they stressed the importance of consistency of assumptions and results. As shown above, where appropriate and available HEP and Government of Croatia assumptions have been used in the Consortium's demand forecasting. This has resulted in a high degree of comparability between the PwC forecasts and those produced in Croatia.

2.7.9 UNMIK

2.7.9.1 The Consortium cases

The assumptions used by the Consortium to drive the three cases for UNMIK are summarised in Table 2.14. The key differences between the Cases are the assumptions regarding the GDP per capita growth rate and the approach taken to modelling changing electricity intensity.

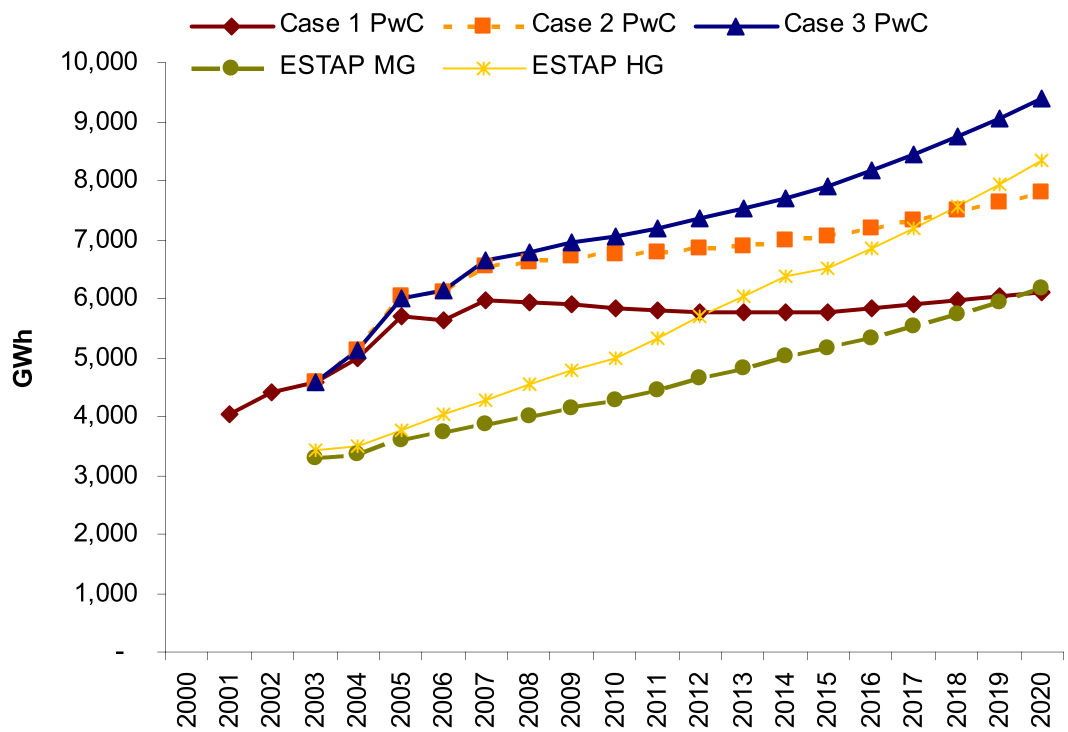
Table 2.14: UNMIK demand forecast scenario assumptions

	Case 1	**Case 2**	**Case 3**
GDP per capita annual growth rate	2003: 5.5% 2004: 3.0% ESTAP report	2003: 5.5% 2004: 5.0% ESTAP report	2003: 5.5% 2004: 8.0% ESTAP report
Structural adjustment to intensity	Converge to comparator country levels	2020 electricity intensity is 75% of the 2003 intensity	2020 electricity intensity is 65% of the 2003 intensity[17]
Speed of movement to equilibrium	Based on consortium methodology	Linear transition	Linear transition
Population	ESTAP report [6]	ESTAP report [6]	ESTAP report [6]
Losses	Non-technical losses are reduced linearly from 23% in 2003 to 5% in 2015. Technical losses are reduced from 22% in 2003 and fall to 15% by 2020	Non-technical losses are reduced linearly from 23% in 2003 to 5% in 2015. Technical losses are reduced from 22% in 2003 and fall to 15% by 2020	Non-technical losses are reduced linearly from 23% in 2003 to 5% in 2015. Technical losses are reduced from 22% in 2003 and fall to 15% by 2020

[17] Case 3 has a lower electricity intensity target for 2020 than Case 2 because of our assumption that higher economic growth can often be achieved through economic transition, which can reduce electricity intensity.

2.7.9.2 Results

Figure 2.13 UNMIK: Gross electricity demand: projections to 2020



Case 1 forecasts relatively slow growth in demand over the period to 2020 with much of that growth occurring post 2015 by 2020, demand in UNMIK is 34% higher than its 2003 level. In the PwC preferred case, Case 2, demand grows by an average 3.2% per annum and 70% over the forecast period.

Case 3 reflects the sustained high GDP per capita growth rate assumption from the ESTAP report, resulting in an annual growth rate in gross demand of 4.3% per annum.

2.7.9.3 Comparison with other forecasts

At the request of the UNMIK, we have used assumptions for the ESTAP study and also compare our findings with the results of that analysis. The first point of note is that the starting point for the Consortium's forecast is higher than the ESTAP study. This reflects:

- the ESTAP study being published in 2002 and therefore based on pre 2002 data whereas we have been able to take into account demand data for 2003;
- the impact of load shedding, it is unclear whether the shed load has been added back into the ESTAP load forecast for UNMIK;
- The addition of the demand from the Trepca mines and the feronikel plant described above.

The PwC central case, Case 2, shows electricity demand for UNMIK being generally constant for much of the forecast period and then towards the end of the forecast period matching the demand levels from the ESTAP medium growth case.

2.7.10 FYR Macedonia

2.7.10.1 The Consortium cases

The three cases for the Consortium electricity demand forecast for FYR Macedonia vary only in terms of the GDP per capita growth assumption used, as shown in the table below. ESM have signalled their acceptance of our main assumptions and the resulting demand forecast and did not suggest any changes to our basic assumptions.

Table 2.15: FYR Macedonia demand forecast scenario assumptions

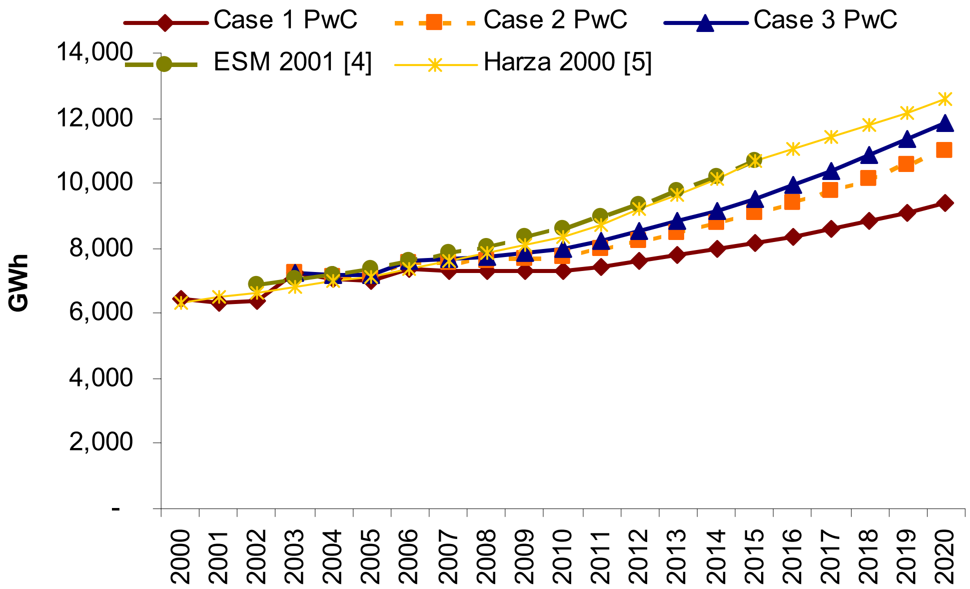
	Case 1	**Case 2**	**Case 3**
GDP per capita annual growth rate	2003: 3.0% 2004: 3.8% 2005: 4.5% 2006 to 2020: 3.0% All based on PwC analysis	2003: 3.0% 2004: 3.8% 2005: 4.5% 2006 to 2020: 4.0% All based on PwC analysis	2003: 3.0% 2004: 3.8% 2005: 4.5% 2006 to 2020: 4.5% All based on PwC analysis
Structural adjustment to intensity	Converge to comparator country levels	Converge to comparator country levels	Converge to comparator country levels
Speed of movement to equilibrium	Moderate transition	Moderate transition	Moderate transition
Population	US Census Bureau data	US Census Bureau data	US Census Bureau data
Losses	Reduction to 10% by 2010	Reduction to 10% by 2010	Reduction to 10% by 2010

Historically, the monthly distribution of demand has demonstrated same stability, particularly in the summer months. We model the load profile for our projections for FYR Macedonia by taking the current load profile and adjusting linearly to the norm by 2010. We have been informed by ESM that a ferro-nickel smelter is planning to increase demand by 2006 by about 375GWh annually and we have added this to our forecast independently of any energy intensity adjustment.

2.7.10.2 Results

Figure 2.14 below shows the demand forecasts for each of the three cases. Over the period 2003 to 2020 gross electricity demand is forecast to grow by 30% in Case 1, 52% and 64% in Cases 2 and 3 respectively, which equate to compound annual growth rates of 1.5%, 2.5% and 3.0% for the three cases.

Figure 2.14 FYR Macedonia: Gross electricity demand: projections to 2020



Our forecasts also suggest the increasing demand over the period will result in an increasing system load factor for FYR Macedonia from the 2003 level of 58% to approximately 64% from 2015.

2.7.10.3 Comparison with other forecasts

The Consortium has been made aware of two other demand forecasts for FYR Macedonia, undertaken by ESM in 2001 and Harza in 2000. Both pre-date the Consortium forecast by a number of years and have predicted demand for 2003 lower than the actual figures we have been able to base our forecast on.

However, our results are broadly consistent with these from previous studies.

2.7.11 Montenegro

2.7.11.1 The Consortium cases

The main drivers of the differences in the Cases used for the demand forecasting for Montenegro are differences in GDP assumptions and also variations in the level of industrial demand, which is a significant proportion of total demand in the country, details are provided below.

Table 2.16: Montenegro demand forecast scenario assumptions

	Case 1	Case 2	Case 3
GDP per capita annual growth rate	2003: 3.0% 2004: 5.0% 2005-2020: 3.0%	2003: 3.0% 2004: 5.0% 2005-2020: 4.5%	2003: 3.0% 2004: 5.0% 2005-2020: 6.5%
Structural adjustment to intensity	2020 electricity intensity is 75% of the 2003 intensity	2020 electricity intensity is 75% of the 2003 intensity	2020 electricity intensity is 65% of the 2003 intensity[18]
Speed of movement to equilibrium	Based on consortium methodology	Linear transition	Linear transition
Population	US Census Bureau data	US Census Bureau data	US Census Bureau data
Losses	Reduction to 10% by 2010	Reduction to 10% by 2010	Reduction to 10% by 2010

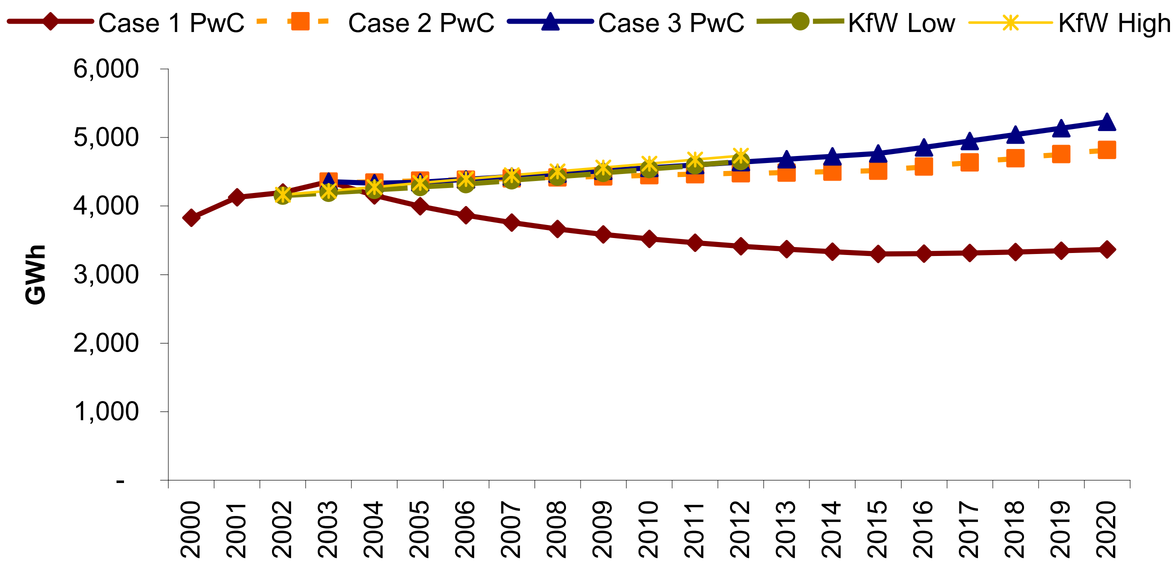
Recent trends in the data show that there is a growing proportion of annual demand being accounted for by the May to August period. This is consistent with a long term load shape assumption that will linearly adjust the current Montenegro load shape to the norm by 2020.

In both scenarios, we have subtracted the 110kV demand (mostly to the KAP aluminium smelter) from the total net consumption figure and then applied our demand forecasting approach to the resulting energy intensity. If the smelter were to be included in the energy intensity calculation it would lead to an over-statement of the energy intensity for Montenegro and a large correction to the intensity and a steeply declining demand forecast. This issue and our approach to resolving it has been discussed at length with the sector regulatory authorities and EPCG in Montenegro.

[18] Case 3 has a lower electricity intensity target for 2020 than Case 2 because of our assumption that higher economic growth can often be achieved through economic transition, which can reduce electricity intensity.

2.7.11.2 Results

Figure 2.15 Montenegro: Gross electricity demand: projections to 2020



The relatively high starting electricity intensity for Montenegro means that much of the forecast period is dominated by an adjustment to long term equilibrium in the PwC forecast cases, with Case 1 having lower demand in 2020 than 2003. Case 2 shows modest growth of average 0.6% pa while Case 3 shows average growth of 1.1% pa over the period 2003 to 2020.

2.7.11.3 Comparison with other forecasts

Generally, the PwC Consortium demand forecast is less positive than the KfW study forecast. The driver for the difference is the inclusion in our modelling for Montenegro of an adjustment to long term equilibrium levels of electricity consumption. The most optimistic case presented here (Case 3) is broadly comparable with the KfW scenarios.

For comparison the compound annual growth rates in cross consumption for 2003 to 2013 are:

- Case 1: -2.2%
- Case 2: 0.6%
- Case 3: 1.1%
- KfW low: 1.2%
- KfW high: 1.3%

2.7.12 Romania

2.7.12.1 The Consortium cases

Our three cases for Romania largely test the sensitivity of gross consumption to alternative GDP per capita growth rate assumptions. At the request of Transelectrica we have included as Case 3 the assumptions used by the Romania Ministry of Commerce into our forecast.

Table 2.17: Romania demand forecast scenario assumptions

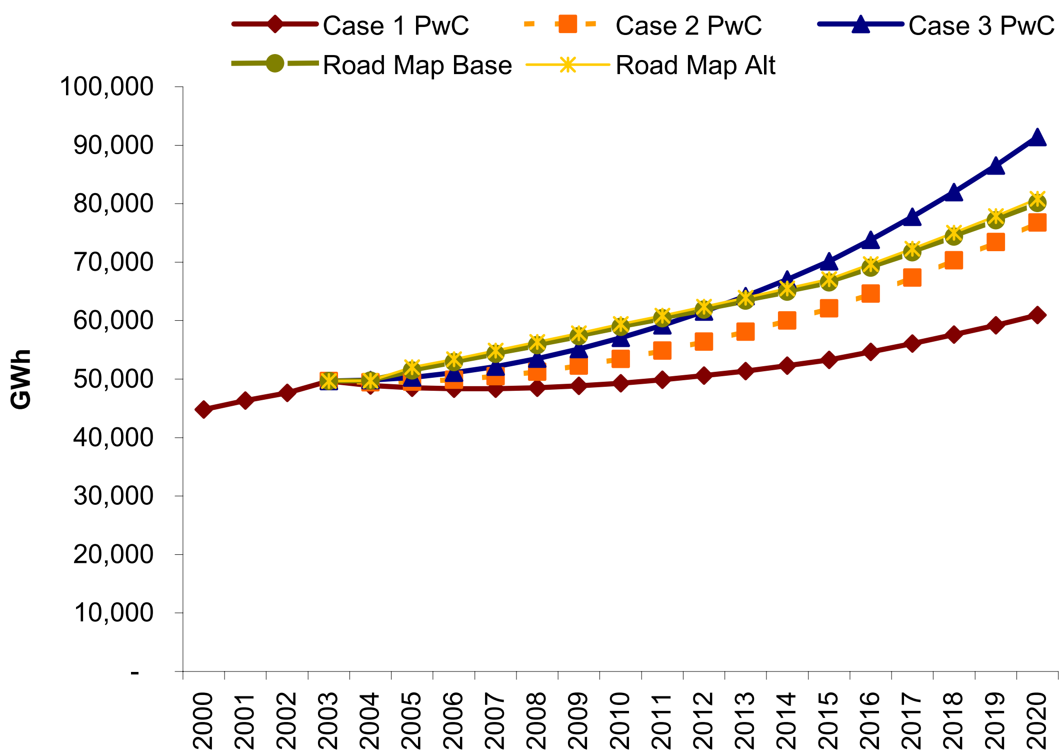
	Case 1	**Case 2**	**Case 3**
GDP per capital annual growth rate	2003: 4.8% 2004: 6.0% 2005: 5.0% 2006-2020: 3.0% (PwC assumption)	2003: 4.8% 2004: 6.0% 2005: 5.0% 2006-2020: 4.5% (PwC assumption)	2003: 4.8% 2004: 6.0% 2005: 5.0% 2006-2010: 6.0% 2011-2015: 5.5% 2016-2020: 5.2% (Data from the Ministry of Economy and Commerce)
Structural adjustment to intensity	Based on consortium methodology	Based on consortium methodology	Based on consortium methodology
Speed of movement to equilibrium	Based on consortium methodology	Based on consortium methodology	Based on consortium methodology
Population	Ministry of Economy and Commerce Forecast	Ministry of Economy and Commerce Forecast	Ministry of Economy and Commerce Forecast
Losses	Reduced to 10% by 2015	Reduced to 10% by 2015	Reduced to 10% by 2015

Following discussion with Transelectrica the seasonal load shape for Romania is not adjusted in any of the scenarios from the 2003 level. The rationale is that Romania has a high penetration of gas supplies, already used for winter heating so the existing seasonal pattern of demand captures, in part, the transition that we consider the other countries.

2.7.12.2 Results

Based on the assumptions presented above, the results for the three Consortium cases for Romania are shown in Figure 2.16 below. Generally our results show accelerating growth in electricity demand in Romania, particularly post 2010. This dynamic is based on the growth in GDP per capita eventually off-setting the adjustment for electricity intensity.

Figure 2.16 Romania: Gross electricity demand: projections to 2020



By the end of the period, the combined effect of the different assumptions used in the three cases leads to a divergence in the demand forecasts, which demonstrates the importance of long term GDP per capita growth rates for electricity demand.

2.7.12.3 Comparison with other forecasts

We have compared the three Consortium demand forecasts with the projections for Romania included in the "Road Map for Energy Field in Romania" which was published in the Official Journal in 2003. The consortium forecasts are broadly in line with those presented by the Government of Romania. The Consortium Case 3 shows an 84% increase in GWh demand between 2003 and 2020 whereas the two Road Map cases show 61% and 63% increases over the same period. A full comparison of total electricity demand growth and compound annual growth rates for the period 2003 to 2020 is shown in Table 2.18 below.

Table 2.18: Romania comparison of PwC Consortium results and other forecasts

Case	Total percentage growth in gross consumption 2003 to 2020	Compound annual growth rates (2003 to 2020 - % pa)
PwC Consortium Case 1	23%	1.2%
PwC Consortium Case 2	55%	2.6%
PwC Consortium Case 3	84%	3.6%
Road Map Base	61%	2.8%
Road Map Alternative	63%	2.9%

2.7.13 Serbia (excluding UNMIK)

2.7.13.1 The Consortium cases

The demand forecasting scenarios for Serbia differ in terms of GDP per capita growth rates and assumed rate of adjustment in electricity intensity. We have assumed that total transmission, distribution and non-technical losses fall to 10% by 2010.

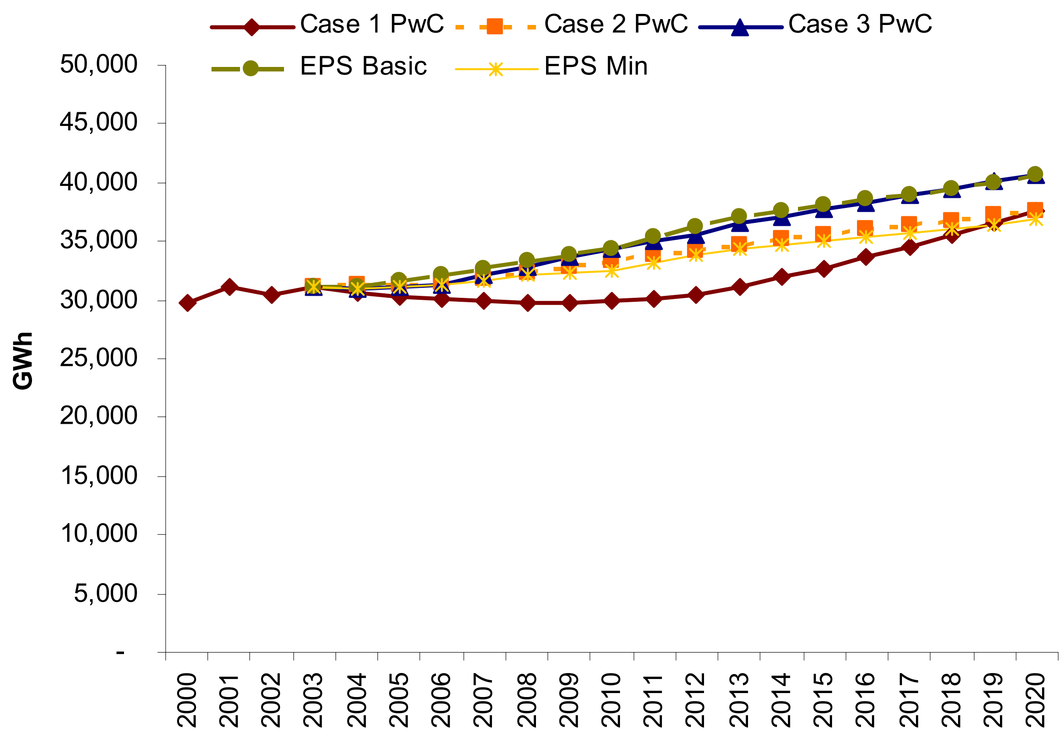
Table 2.19: Serbia (excluding UNMIK) demand forecast scenarios assumptions

	Case 1	Case 2	Case 3
GDP per capita annual growth rate	2003:1.5% 2004-2005: 3.0% 2006: 3.5% 2007: 4.0% 2008-2011: 4.5% 2012: 4.0% 2013: 3.5% 2014- 2020 3.0%	2003:1.5% 2004-2005: 3.0% 2006: 3.5% 2007: 4.0% 2008-2011: 4.5% 2012: 4.0% 2013: 3.5% 2014- 2020 3.0%	2003:1.5% 2004: 3.0% 2005: 3.5% 2006: 4.5% 2007-2011: 6.0% 2012-2013: 5.5% 2014: 4.0% 2015- 2020 4.5%
Structural adjustment to intensity	2020 electricity intensity is 75% of the 2003 intensity	2020 electricity intensity is 75% of the 2003 intensity	2020 electricity intensity is 65% of the 2003 intensity
Speed of movement to equilibrium	Based on consortium methodology	Linear transition	Linear transition
Population	Zero growth: Least Cost Investment Plan for Serbia Electricity Sector: Workshop III	Zero growth: Least Cost Investment Plan for Serbia Electricity Sector: Workshop III	Zero growth: Least Cost Investment Plan for Serbia Electricity Sector: Workshop III
Losses	Linear decrease to 10% by 2010	Linear decrease to 10% by 2010	Linear decrease to 10% by 2010

2.7.13.2 Results

Generally the Consortium's demand forecasts show some moderate growth in the demand. In Case 1 where the electricity intensity correction is strongest the first half of the forecast period is characterised by flat demand, as shown in Figure 2.17. The main driver of our forecast profile is the expected adjustment energy intensity that has been included in the forecast. As described in Section 2.3.4 above, Serbia has one of the highest electricity intensities in the region and this situation may be reasonably expected to change during the forecast period. The strength of this adjustment in the first part of the forecast period is enough to offset the effects of GDP growth.

Figure 2.17 Serbia (excluding UNMIK): Gross electricity demand: projections to 2020



2.7.13.3 Comparison with other forecasts

The Consortium's demand forecasts for Serbia are below those projected by EPS. There is a range of factors driving the slower growth in our forecast for Serbia, largely dependent upon the extent of economic reform during the country's transition. We note that recent tariff increases (15% in 2003) will take some time to impact on demand, which will not yet be apparent but must be expected. We also note that in line with other countries in the region, the government has recently adopted a strategy of fuel substitution for electricity intended to enhance the economics of heating households in Serbia. Again, this initiative will not impact demand immediately, but its economic necessity means it is highly probable.

At the recommendation of the sponsors of this project, we have used the assumptions made available to us from the *"Least Cost Investment Plan for Serbia Electricity Sector"* [7] which is currently being undertaken however our inclusion of the electricity intensity adjustment gives rise to a downward trend in demand in the first part of the forecast period. We have entered into correspondence with the project team undertaking the *"Least Cost Investment Plan for Serbia Electricity Sector"* [7] to understand how they have taken adjustments to electricity intensity into account in their forecasting methodology.

2.7.14 SEE region combined

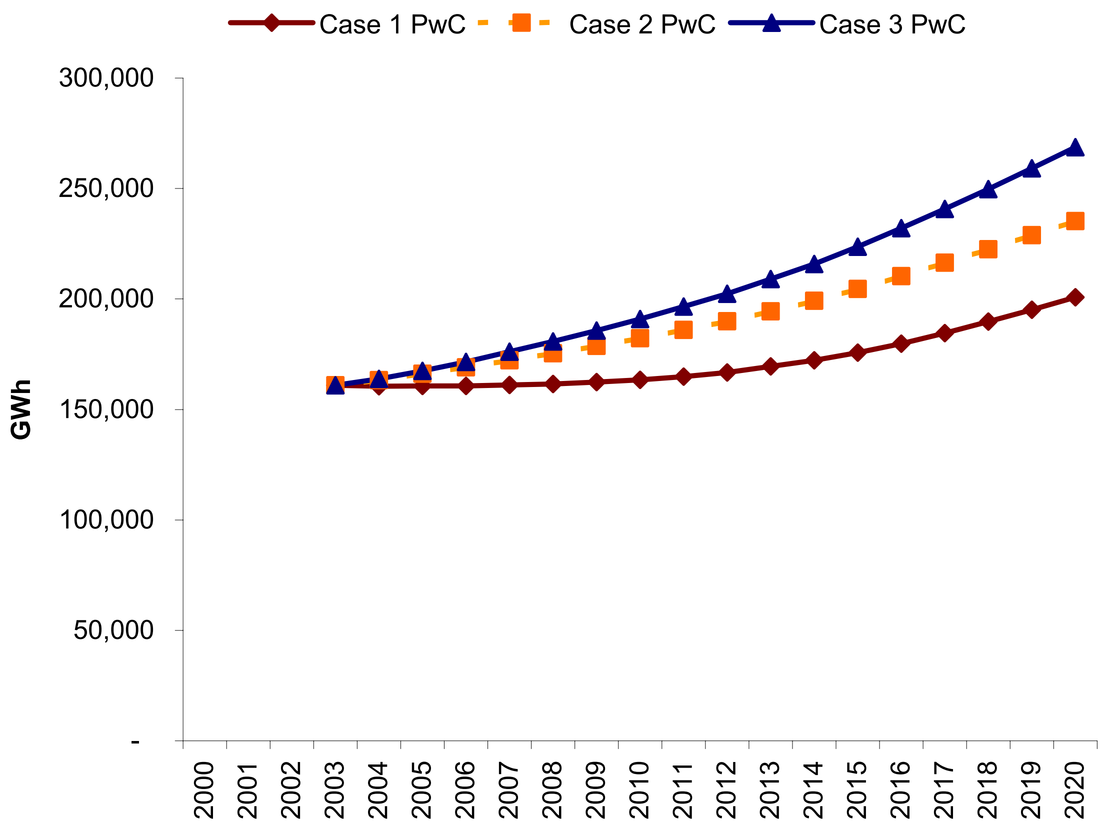
2.7.14.1 The Consortium cases

The demand forecasts for SEE are based on the combination of the individual jurisdiction forecasts. As a result, Case 1 for SEE represents the combination of the Case 1 assumptions for each jurisdiction.

2.7.14.2 Results

Aggregating the demand estimates for each of the jurisdictions above allows us to create a demand forecast for the region, as shown in Figure 3.20 below.

Figure 2.20 SEE Region: Gross electricity demand: projections to 2020



The Consortium's preferred case (Case 2) shows an average compound annual growth rate to 2020 of 2.3%, as with most of the scenarios for the jurisdictions, the growth is largely in the second part of the period, post 2010 once the assumed economic structuring and transition of the SEE region has started to gather pace. Case 3, which includes the higher GDP per capita growth rate assumptions for each jurisdiction shows a 3.1% pa compound growth rate in electricity demand. Case 1, the lowest growth and strongest electricity intensity reduction case, shows a 1.3% average growth rate.

2.7.14.3 Comparison with other forecasts

The other demand forecasts we have reviewed typically cover individual jurisdictions in the region. As such, we have been unable to make comparisons of our regional forecasts.