Appendix A
Determinants of Electricity
Demand Growth in Maryland

PPRP has historically conducted a program of independent electric load forecasts as part of its efforts to both monitor the adequacy of future power supplies and to independently evaluate the potential for excess generating capacity. With the restructuring of the retail electric industry in Maryland brought about by the enactment of the Maryland Electric Customer Choice and Competitive Act of 1999 (the Act), the preparation of load forecasts (energy sales and peak demand) for the individual investor-owned electric utilities operating within Maryland would not provide the information required to assess the adequacy of planned supply.

Under restructuring, the primary issues relating to power supply affecting Maryland consumers are the adequacy of generating capacity and the adequacy of transmission system capacity. The issue of excess generating capacity, of extreme importance under the historical regulatory arrangements, is of much less importance under restructuring since captive ratepayers no longer bear the cost burden of the excess generating capacity. To assess and monitor the sufficiency of generating and transmission capacity, PPRP has modified its load forecasting program from focusing on the individual electric utilities serving consumers in the State to forecasting energy requirements and peak demands for the State as a whole and for the various regions within the State.

The PPRP forecast studies, those performed for the service areas of the individual utilities as well as the State-wide forecast currently under development, use economic theory as the organizing principle to model the demand for electricity, and rely on econometric methods for estimation and projection. The data that are used to run these models, both historical and projected, are comprised of variables assumed a priori to significantly affect the demand for electricity. Some of these variables are economic and some are non-economic in nature. Economic variables include income, the price of electricity, and employment; non-economic variables include population and weather. Historical information is required for estimation purposes, while projected data are necessary to forecast the demand for power econometrically.

This appendix provides an overview of the basic theoretical foundations upon which these forecast studies rest and an analysis of the trends of some of the economic and non-economic determinants of the demand for electricity. The Maryland data presented here have been obtained from the Maryland Department of Planning, the Bureau of Economic Analysis of the U.S. Department of Commerce, and the Bureau of Labor Statistics of the U.S. Department of Labor. For comparison, some national data are also included. The national data were obtained from the U.S. Departments of Commerce and Labor.

This appendix is composed of five sections. The following section presents a brief discussion of the theoretical foundations for modeling the demand for electricity econometrically. This section sets the stage for the rest of the appen-

dix, which examines economic and demographic trends for Maryland by region. The Maryland Department of Planning divides the State into six regions, defined in Table A-1, for statistical purposes. The section covering the theoretical foundations is followed by a section discussing trends in per capita income which in turn is followed by a section discussing trends in employment. Trends in population and the number of households follow the employment section. A final section presents a brief summary.

Table A-1   Principal Regions in Maryland

Region	Counties	Predominant Electric Utility
Baltimore	Anne Arundel Baltimore City Baltimore County Carroll Harford Howard	Baltimore Gas and Electric Company
Lower Eastern Shore	Dorchester Somerset Wicomico Worcester	Choptank Electric Cooperative
Southern Maryland	Calvert Charles St. Mary's	Southern Maryland Electric Cooperative
Upper Eastern Shore	Caroline Cecil Kent Queen Anne's Talbot	Conectiv and Choptank Electric Cooperative
Washington, D.C.	Frederick Montgomery Prince George's	Potomac Electric Power Company
Western Maryland	Allegany Garrett Washington	Allegheny Power

Theoretical Foundations for Econometrically Modeling the Demand for Electricity

The PPRP forecast studies use the economic theory of demand as the organizing principle to econometrically model the demand for electricity. The total demand for any good or service, including electricity, is simply the sum of the demands of the individual consumers in the market. The portion of market demand for residential use of electricity is driven by factors to which individual residential consumers are sensitive. Similarly, for the commercial sector portion of the market demand for electricity, the factors affecting demand are those to which producers are sensitive. Well-established economic theory allows us to identify these factors and their effects on the demand for electricity.

In the case of residential demand, electricity forms part of the basket of goods and services purchased by the consumer. The residential demand for electricity is assumed to result from the exercise of choice by which the consumer maximizes his welfare subject to a budget constraint. Consumer demand for a good or service is taken to be a function of its price, consumer income, weather, and the price of related commodities (i.e., substitutes and complements). It is important to note that electricity, in and of itself, conveys no benefits to the consumer. Rather, the consumer benefits from the services of the stock of appliances that require electricity. These services include space conditioning, refrigeration, cooking, clothes washing and drying, and numerous other services and functions. Consequently, the demand for electricity can be appropriately viewed as a derived demand, that is, it results from the demand for the services provided by electricity-consuming appliances.

For commercial and industrial customers, electricity is a factor of production—an input. In the PPRP forecast studies, the demand for electricity is assumed to result from decisions made by the producer to maximize profits. For the profit-maximizing producer, demand for a commodity (including electricity) is driven by its price, the price of related inputs, and the level of output. Producer demand is also driven by other factors, including weather.

Both the residential and non-residential demand for electric power is discussed above in terms of the individual consumer or producer. The market demand for electric power, for example, in Maryland or within regions in Maryland, is also dependent on the number of consumers (households) and the level of goods and services produced in the region. Residential demand is therefore forecasted on a per-customer basis which, when multiplied by the projected number of residential customers, provides a forecast of total residential demand. Commercial and industrial electric sales are projected per employee, which are then multiplied by the number of forecasted employees to project total commercial and industrial demand for electricity. Employment is

State-wide Forecast of Electricity Demand

With the advent of electric utility restructuring in Maryland following enactment of the Maryland Electric Customer Choice and Competition Act fo 1999 (the Act), PPRP recognized that the historical approach used to help monitor the adequacy of generation capacity to satisfy electric power demands in the State needed to be modified to accommodate the new industry structure. Specifically, independently forecasting sales and peak demands for the individual utilities, which has been the basis of PPRP's load forecasting program since the early 1980s, needed to be modified to reflect the market changes being brought about with implementation of the Act. To help ensure the adequacy of generation resources as well as transmission capacity, PPRP is in the process of developing a State-wide forecast of electric energy demand and peak loads.

The State-wide forecast is being developed using an econometric approach similar to the approach relied upon historically by PPRP with energy demand being projected for residential, commercial, and industrial sectors. Total energy demand for the State will be projected and allocated to the various regions within the State based on differential projected growth in such factors as population, employment, and real per capita income, as discussed in the body of this Appendix.

Peak demand (summer and winter) for the State as a whole will also be projected, with regional contributions to the State-wide peaks to be allocated to the six regions within the State. Projected peak demands for the regions will provide important information regarding adequacy of the transmission system as well as the adequacy of generation resources.

used in lieu of, and as a proxy for, output since no satisfactory time series of output data is available at a suitably disaggregated level.

Per Capita Income Trends

Income is an important determinant of the residential demand for electricity and changes in income will affect the quantity of electricity purchased. Changes in income affect electric power consumption in two ways. First, a change in income will induce a change in the intensity of use of the existing stock of electricity-consuming appliances. Second, an income change will induce changes in the stock of electricity-consuming appliances. As income changes, therefore, the demand for electricity will rise or fall. The PPRP forecast studies demonstrate a positive and, typically, statistically significant relationship between income and the residential demand for electricity.

The PPRP forecast studies, including the State-wide forecast presently being prepared, use real (i.e., inflation adjusted) per capita income as an explanatory variable. Real per capita income figures are reported in Table A-2 for the Maryland regions defined by the Maryland Department of Planning. Table A-2 summarizes historical and projected data as well as average annual growth rates for the period 1980 through 2010. As shown by the historical data, all regions within the State, with the exception of Western Maryland, experienced a substantial slowing in the growth of real per capita income during the 1990 to 1998 period in comparison to the 1980 to 1990 period. For the State as a whole, growth in real per capita income declined to 0.78% per year between 1990 and 1998 compared to an average annual growth rate of 2.60% between 1980 and 1990.

Table A-2   Per Capita Income in Maryland, 1980-2010 (1996 Dollars)

Region	1980[1]	1990[1]	1998[1]	2005[2]	2010[2]	Annual Rate of Growth			
						1980-1990	1990-1998	1998-2005	2005-2010
Baltimore	21,099	26,402	28,484	32,024	33,445	2.27	0.95	1.69	0.87
Lower Eastern Shore	14,547	20,162	21,313	24,122	25,474	3.32	0.70	1.78	1.10
Southern Maryland	17,720	24,164	26,000	30,521	32,617	3.15	0.92	2.32	1.34
Upper Eastern Shore	17,418	23,465	24,671	27,921	29,414	3.02	0.63	1.78	1.05
Washington	24,247	32,314	33,601	37,206	38,684	2.91	0.49	1.47	0.78
Western Maryland	16,490	18,810	20,931	23,523	24,508	1.33	1.34	1.68	0.82
State of Maryland	21,382	27,638	29,413	32,984	34,457	2.60	0.78	1.65	0.88

Data Sources and Notes:

[1] Historical nominal data (1980, 1990, and 1998) were obtained from the Bureau of Economic Analysis, Table CA05 [http://fisher.lib.virginia.edu/reis/], July 21, 2000. Nominal figures deflated by the all items Consumer Price Index.

[2] Projections (2005 and 2010) were developed from growth rates computed from "Demographic and Socio-Economic Outlook (Revised September 1999)," Maryland Department of Planning [http://www.mdp.state.md.us/MSDC/] July 5, 2000.

The projections for growth in real per capital income for the 1998 to 2005 period exceed the growth experienced over the first eight years of the 1990s, but are lower than the growth rates experienced during the 1980s. Western Maryland is the only exception to this general trend, with growth for the 1998 through 2005 period expected to average 1.68% per year compared to 1.33% per year for the 1980s. Between 1998 and 2005, real per capita income is expected to increase at an average annual rate of 1.65% for the State as a whole, compared to the 2.60% growth rate experienced in the 1980s. The most rapid increase in real per capita income is expected in the Southern Maryland region (2.32% per year), with the slowest growth over the 1998 to 2005 period projected for the Washington region (1.47% per year).

Per capita real income is expected to grow at a slower rate in the 2005 to 2010 period relative to the projections for the 1998 to 2005 period, with average annual growth for the State as a whole projected to be 0.80%. As was the case for the 1998 to 2005 period, growth in real per capita income for the 2005 to 2010 period is expected to be most rapid in the Southern Maryland region. Growth in real per capita income is expected to be slowest in the Western Maryland and Washington regions.

Employment Trends

The non-residential demand for electricity is largely driven by the level of output. The PPRP forecast studies, however, do not use output as an explanatory variable because quarterly output data at the county level are not available on a consistent basis. Hence, a proxy for output must be used. Non-farm employment has typically been relied upon for this purpose. It is a sound alternative and it is not subject to data consistency problems. Employment data by major employment sector are reported in Tables A-3 and A-4.

Table A-3   Structure of Non-agricultural Employment in Maryland and the U.S., 1985 and 1998 (Percentages)*

Sector	Maryland		United States	
	1985	1998	1985	1998
Mining	0.16	0.09	1.14	0.54
Construction	6.84	6.36	5.34	5.60
Manufacturing	9.54	6.35	16.40	12.46
Transportation and Public Utilities	4.44	4.39	4.87	4.88
Wholesale Trade	4.61	4.01	5.07	4.68
Retail Trade	17.77	17.00	16.74	17.00
Finance, Insurance, and Real Estate	7.46	8.44	7.84	7.79
Services	28.25	35.05	25.81	31.77
Government	20.06	17.23	15.89	13.97

*Totals may not sum to 100 due to rounding.

Data Source: Bureau of Economic Analysis, Table CA25 [http://www.fisher.lib.virginia.edu/reis], July 21, 2000.

Table A-3 reports sectoral shares for Maryland and the United States for 1985 and 1998. Sectoral distribution within Maryland has been subject to important changes over time. This is particularly so for the shares reported for government, services, and manufacturing. These changes are consistent in both the local and the national economy. Government, for example, has become a less significant source of employment largely as a result of downsizing at the federal level. Services have become the largest source of employment as the local economy continues to move away from manufacturing and heavy industry. Manufacturing employment as a proportion of total employment declined in Maryland, mirroring the decline nationally, which reflects movement towards a service-based economy. The distribution of employment in the State continues to resemble that for the country as a whole.

Sectoral changes are expected to continue as a result of not only a horizontal migration of workers across sectors, but also as a result of increases in the workforce. As shown in Table A-4, every region of the State is expected to experience employment growth. Growth is projected to be most rapid in the Southern Maryland region and slowest in Western Maryland and Baltimore. For the State as a whole, average annual growth in employment for the 1998 to 2005 period is expected to exceed the growth over the 1990 to 1998 period (1.45% per year compared to 0.95%). The projections for all of the regions in Maryland during the 1998 to 2005 period are projected to be below the rates of growth experienced between 1980 and 1990.

Table A-4   Regional Non-Agricultural Employment for Maryland and the U.S., 1980-2010 (Thousands)

Region	1980[1]	1990[1]	1998[1]	2005[2]	2010[2]	Annual Rate of Growth (%)			
						1980-1990	1990-1998	1998-2005	2005-2010
Baltimore	1,125.8	1,397.3	1,460.3	1,578.6	1,627.3	2.18	0.55	1.12	0.61
Lower Eastern Shore	69.6	94.1	103.9	114.8	120.8	3.07	1.24	1.43	1.03
Southern Maryland	47.6	91.1	118.4	140.4	148.8	6.71	3.33	2.47	1.16
Upper Eastern Shore	55.1	77.5	90.8	101.7	106.5	3.47	2.01	1.64	0.91
Washington	653.1	964.5	1,053.4	1,192.2	1,274.0	3.98	1.11	1.78	1.34
Western Maryland	93.9	114.3	127.1	140.4	145.0	1.98	1.34	1.43	0.66
State of Maryland	2,044.9	2,738.7	2,953.9	3,267.1	3,420.8	2.96	0.95	1.45	0.92
United States	110,433.2	136,273.9	157,071.7	172,956.1	188,707.5	2.12	1.79	1.39	1.76

Data Sources and Notes:

[1] Historical non-agricultural employment data (1980, 1990, and 1998) were obtained from the Bureau of Economic Analysis, Table CA05 [http://fisher.lib.virginia.edu/reis], July 21, 2000.

[2] Regional and statewide non-agricultural employment projections for 2005 and 2010 were developed from growth rates computed from "Demographic and Socio-Economic Outlook (Revised September 1999)," Maryland Department Planning [http://www.mdp.state.md.us/ MSDC/] July 5, 2000. U.S. projections were developed from Bureau of Labor Statistics and Standard & Poors/DRI data.

Population is an important causal variable in the PPRP demand forecast models because population trends are used to project the number of residential customers. Two demographic concepts closely related to population are the number of households and average household size. These concepts can be important since the number of households affects the number of residential customers purchasing electricity and changes in average household size can affect usage per customer. Population growth and the rate of household formation are closely related, and both affect the residential use of electricity. Increases in population lead to increases in the number of households (and hence residential customers) although rates of change need not coincide due to changes in the size of households. Population and household data are reported in Tables A-5 and A-6.

Population data at regional, State and national levels are reported in Table A-5. The table summarizes historical and projected data, as well as average rates of growth for the period 1980 through 2010. The rates of growth in population have been positive since 1980 for every region of Maryland. Between 1980 and 1998, population growth in Maryland has been about 1% per year on average. The growth in population for the State is projected to slow to approximately 0.84% between 1998 and 2005, and further slow to approximately 0.7% between 2005 and 2010. The pattern of slowing growth for the State as a whole also characterizes the expected pattern of growth in most of the six separate regions. The exception is Western Maryland. In Western Maryland, growth in population is expected to increase to an average annual rate of 0.27% between 1998 and 205 then increase at an average annual growth of 0.35% between 2005 and 2010.

Table A-5   Regional Population for Maryland and the U.S., 1980-2010 (Thousands)

Region	1980[1]	1990[1]	1998[1]	2005[2]	2010[2]	Annual Rate of Growth (%)			
						1980-1990	1990-1998	1998-2005	2005-2010
Baltimore	2,177.7	2,355.1	2,441.3	2,529.1	2,588.4	0.79	0.45	0.51	0.46
Lower Eastern Shore	145.2	163.6	176.0	185.6	192.9	1.20	0.92	0.76	0.77
Southern Maryland	168.5	230.2	277.5	323.2	354.3	3.17	2.36	2.21	1.85
Upper Eastern Shore	151.9	181.6	203.7	220.3	230.1	1.80	1.45	1.13	0.87
Washington	1,364.1	1,642.0	1,802.7	1,949.4	2,033.9	1.87	1.17	1.12	0.85
Western Maryland	220.1	225.0	228.9	233.2	237.3	0.22	0.22	0.27	0.35
State of Maryland	4,227.6	4,797.4	5,130.1	5,439.8	5,635.8	1.27	0.84	0.84	0.71
United States	227,224.7	249,464.4	270,248.0	287,746.5	299,893.8	0.94	0.80	0.90	0.83

Data Sources:

[1] Regional and State-wide national population data for 1980, 1990, and 1998 were obtained from the Bureau of Economic Analysis, Table CA05, [http://fisher.lib.virginia.edu/reis/] July 21, 2000.

[2] The Regional and State-wide projections for 2005 and 2010 were developed from rates computed from "Demographic and Socio-Economic Outlook (Revised September 1999)," Maryland Department of Planning [http://www.mdp.state.md.us/MSDC/] July 5, 2000. The U.S. projections were developed from "Annual Projections of the Total Residents Population," U.S. Census Bureau, January 13, 2000.

These growth rates compare to the 0.22% rate that the region experienced between 1990 and 1998. Western Maryland population represents about 5% of total State population. Consequently, the population growth rate trends for this region does not significantly affect the trend expected for the State as a whole.

Projected growth in the Baltimore region shows a different pattern of expected change. Between 1990 and 1998, population in the Baltimore region grew at an average annual rate of 0.45%; the growth rate is projected to remain relatively stable over the 1998 to 2010 period at about 0.48% per year.

As suggested by the discussion of population growth in Western Maryland and the Baltimore region, the rates of growth in population are uneven across the state. Historically, the largest growth rates are reported for Southern Maryland and the smallest rates for Western Maryland. In the 1980s, the population growth rate for Southern Maryland was approximately 14 times that of Western Maryland. While disparities are expected to continue, it is anticipated that there

Table A-6   Historical and Projected Number of Households and Average Size of Households in Maryland Region, 1980-2010

Region	1980[1]	1990[1]	1998[1]	2005[2]	2010[2]	Annual Rate of Growth (%) 1980-1990	1990-1998	1998-2005	2005-2010
Number of Households (thousands)									
Baltimore	757	868	918	942	1,029	1.38	1.13	0.52	0.89
Lower Eastern Shore	53	62	67	71	79	1.58	1.56	1.17	1.07
Southern Maryland	51	75	87	101	128	3.93	3.01	3.03	2.40
Upper Eastern Shore	53	67	73	80	91	2.37	1.73	1.85	1.30
Washington	469	593	639	681	768	2.37	1.51	1.28	1.21
Western Maryland	78	85	88	88	94	0.86	0.70	0.00	0.66
State of Maryland	1,461	1,749	1,871	1,963	2,189	1.82	1.36	0.96	1.10
Average Household Size									
Baltimore	2.80	2.64	2.58	2.55	2.45	-0.59	-0.46	-0.23	-0.40
Lower Eastern Shore	2.69	2.50	2.46	2.37	2.30	-0.73	-0.32	-0.74	-0.30
Southern Maryland	3.24	2.97	2.90	2.84	2.71	-0.87	-0.48	-0.42	-0.47
Upper Eastern Shore	2.81	2.65	2.61	2.55	2.47	-0.58	-0.30	-0.46	-0.32
Washington	2.84	2.71	2.69	2.66	2.60	-0.47	-0.15	-0.22	-0.23
Western Maryland	2.70	2.52	2.48	2.40	2.34	-0.69	-0.32	-0.65	-0.25
State of Maryland	2.82	2.67	2.63	2.59	2.51	-0.55	-0.30	-0.31	-0.31

Data Source: Maryland Department of Planning [http://www.mdp.state.md.us/MSDC/] July 5, 2000.

will be a narrowing of the growth rate differentials over the next ten years compared to the 1980s.

Household data for the State and for regions within the State are shown in Table A-6. The table shows a summary of historical and projected data, as well as average rates of growth for the period 1980 through 2010. Average annual growth in the number of households was 1.82% during the 1980s, declined to 136% between 1990 and 1995, and is expected to further decline to approximately 1.1% through 2010. The pattern of slowing growth in the number of households for the State also characterizes the pattern of growth in each of the six regions of Maryland. As was the case for population, growth in the number of households is projected to be most rapid in Southern Maryland and least rapid in Western Maryland.

Since 1980, household size in each of the six Maryland regions has been declining, though the rate of decline is forecasted to moderate. For the State, the average household size of 2.82 people in 1980 declined to 2.63 in 1995, representing an average rate of decline of about 0.5% per year. The rate of decline is expected to be approximately 0.3% per year between 1995 and 2010. The largest declines in household size are projected for Southern Maryland and the smallest for the Washington area.

Summary

This appendix provides a review of the theoretical foundations used for modeling the demand for electricity econometrically in the PPRP forecast studies. In doing so, emphasis is placed on some of the key determinants of the demand for electric power. The determinants of demand are classified into residential and non-residential, as well as into economic and non-economic for purposes of exposition. Per capita income is an explanatory economic variable that influences the residential demand for electricity; population, the number of households, and average household size are non-economic explanatory variables affecting residential electricity consumption. This appendix also shows trends in employment, which affect the non-residential demand for electricity. Selected data on these determinants of demand are reported and trend analyses presented. The broad conclusion to emerge from these trends is that the demand for electricity should continue to grow in Maryland. Growth rates, however, should moderate from those in the past.