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BULGARIA DEMAND SIDE MANAGEMENT ASSESSMENT

Final Report

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EXECUTIVE SUMMARY

S.1 INTRODUCTION (Please refer to Chapter 1 for more details)

S.1.1 Project Overview

This report presents partial results of work performed as part of the energy sector assistance provided to Bulgaria by the U.S. Agency for International Development. It was prepared as part of Task 1 - Electricity Sector Study and Action Plan, in coordination with the European Community, by RCG/Hagler, Bailly, Inc. The report investigates opportunities to improve management of demand, through a demand-side management (DSM) program.

S.1.2 Background and Recent History of Electricity Demand

Beginning in 1990, the Bulgarian economy went into severe recession. Production decreased from most factories, traditional markets and trading partners were lost, centralized production structures were dismantled, state subsidies were cut drastically, prices increased, and unemployment grew rapidly. During this period, Bulgaria was faced with particularly acute energy problems, including power outages.

Total consumers' electric energy demand in Bulgaria in 1992 was 25% less than the maximum recorded in 1988. Reductions in annual energy sales (comparing 1992 with 1988) were 34% for industrial, 4% for households (no real price increases occurred in this sector until 1991), and 28% for other consumers (agriculture, transportation, public buildings). Analysis of the load duration curves reveals that most of the reduction in demand has occurred during summer months, and that some reduction has occurred during off-peak periods in the winter.

Peak power demand (absolute maximum gross MW recorded during the year) has reduced less than energy demand, and is now 15% less than the maximum recorded in 1989. During 1991 (the base year for this study), the maximum was recorded in January (7,500 MW), and August experienced the lowest peak (4,300 MW).

S.2 RESULTS OF INDUSTRIAL ENERGY SURVEY AND ENERGY AUDITS (Please refer to Chapter 2 for more details)

S.2.1 Industrial Energy Survey

A survey of the NEK's 106 largest electrical consumers was commissioned by Hagler, Bailly and carried out by Dimitar Baev - DBC, a Bulgarian firm. Sixty-one firms responded to the basic survey, 35 of which responded to more detailed follow-up questions. The survey included questions on business and operating conditions, current and projected electricity usage, installed equipment for electricity generation and use, and energy conservation.

In general, the survey responses reflected the dire economic conditions and the need to find new markets. However, on balance it seems that these plants may have reached the bottom, with 1993 production and electricity usage not expected to decline much further.

According to NEK, Bulgaria now has nine large industrial cogenerators (with capacities of 20 MW or greater). Six of the 61 plants surveyed can generate their own electricity, but the survey discovered that two of these do not operate their generators regularly.

Electric motors and lighting are the dominant loads in the plants surveyed, and less than half have installed efficient lighting systems (such as high pressure sodium). Process loads are significant in the chemicals and metals industries for electrolysis, heat treatment, furnaces, and rolling mills.

Most plants surveyed are interested in energy conservation, and are willing to invest in such projects. Most have ideas for projects, but have not implemented them for lack of funds or for fear that they might disrupt production. Energy audits have been conducted in half the enterprises, but respondents indicated problems with the quality of the energy audits.

S.2.2 Industrial Energy Audits in Bulgaria

Under funding provided by the USAID Emergency Energy Project, energy audits were carried out in eight industrial enterprises in Bulgaria in 1991 by International Resources Group (IRG) of Washington DC. These audits revealed that substantial opportunities exist to improve energy efficiency. Problems were identified in many areas, including management, instrumentation, motivation, training, communications, organization, financing, accountability, and investment decision-making. The audits recommended that focus be placed on short-term, low-cost measures.

Hagler, Bailly's experience in energy audits in other countries in eastern Europe, together with experience in Bulgaria conducting the Industrial Energy Efficiency project since 1992, was used to develop a list of candidate measures for electric energy efficiency.

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S.3 DEMAND FORECAST (Please refer to Chapter 3 for more details)

S.3.1 Review of Previous Forecasts of Electricity Demand

Several forecasts of electricity demand in Bulgaria have been completed over the past several years. Prior forecasts differ because of differences in scenarios, differences in forecasting techniques, and differences in data. However, the more recent forecasts that build on the data obtained after the initiation of Bulgaria's transition to a market economy will more accurately capture the Bulgarian economy's energy response to this transition and the probable future of electricity demand.

The forecasts are summarized graphically in Exhibit S-1, and listed below.

- Forecast by NEK, the guidance from the World Bank, in 1992, with three variants:
  - -- most likely scenario
  - -- high demand scenario
  - -- low demand scenario
- Forecast by Equipe Cousteau for the EBRD in 1992
- Forecast by Prof. Gordon Hughes for the World Bank in 1991
- Energoproekt forecast 1991 (high and low demand scenarios)
- Forecast by Hagler Bailly in 1993

These forecasts establish a range of expected demand in the year 2000 from 35-50 TWh[1]. The spread of these forecasts indicates a high level of uncertainty.

[1] The NEK most likely scenario shows 46 TWh in year 2000.

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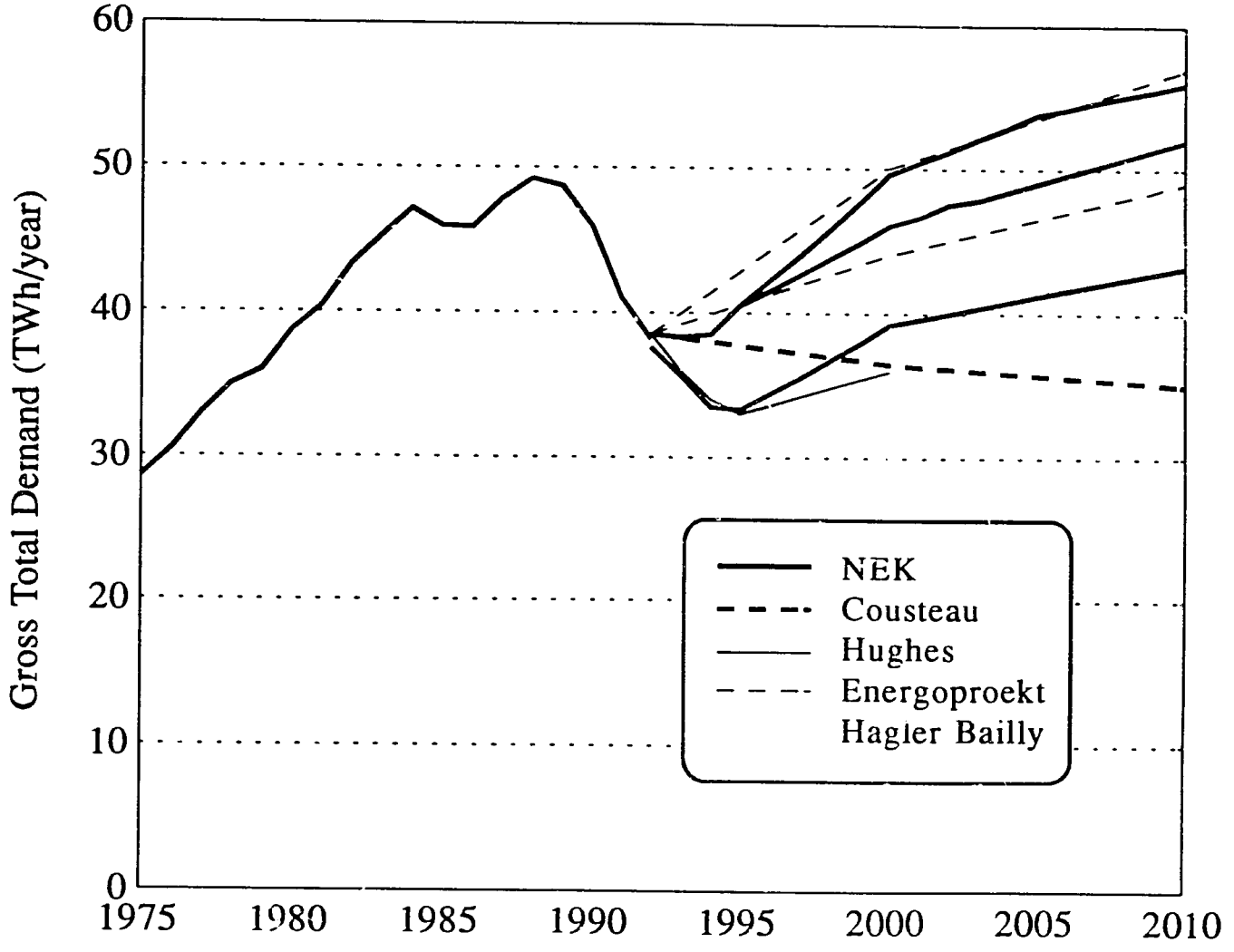
Exhibit S-1

Bulgaria - Total Electricity Demand

Comparison of Previous Forecasts



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S.4 CREATING A POLICY FRAMEWORK TO PROMOTE EFFICIENT USE OF ELECTRICITY IN BULGARIA (Please refer to Chapter 4 for more details)

S.4.1 Integrated Resource Planning

Integrated resource planning (IRP) is a concept in which the simultaneous consideration of supply-side and demand-side options is required, in order to minimize the cost of energy services to customers, and society as a whole. In the United States, the Energy Policy Act of 1992 requires IRP by all the states, and IRP techniques have been adopted by several countries in Europe. The legal and regulatory framework for energy and electricity is currently being developed in Bulgaria, and the IRP concept is recommended. In Bulgaria, the IRP process should include several actions, carried out in parallel:

- require that electricity agencies (Committee of Energy, National Electric Company, and others) assume IRP responsibilities, through enactment of appropriate legislation, regulations, and institutional development:
- develop a least-cost investment plan, considering all supply-side and demand-side options available to Bulgaria, not only from NEK itself but also other sources;
- evaluate electricity tariffs in comparison with long-run marginal costs determined by the least-cost investment plan, and restructure tariffs as required;
- carry out demonstrations under Bulgarian conditions of DSM policies, DSM technologies, DSM implementation strategies, and DSM financing options;
- based on successful demonstrations, develop policy to promote demand-side management (DSM), analyze DSM options in comparison to base case investment plan, and from those measures that are cost-effective, develop a DSM program.

Hagler, Bailly provides analysis and recommendations to develop some of these concepts further, particularly those related to DSM policy (Chapter 4) and DSM programs (Chapter 5).

S.4.2 Preliminary Evaluation of Electric Tariffs

Although a detailed estimate of the marginal cost of electricity service in Bulgaria is beyond the scope of our work, Hagler, Bailly has developed preliminary estimates, in order to begin evaluation of the tariffs.

As a basis for analysis, investments are assumed for rehabilitation of thermal capacity and reduce environmental emissions. The analysis shows that annualized marginal cost of delivering 1 kW of capacity on-peak, varies from $33 to $55 per year, depending on the voltage level. In addition, the marginal cost of delivering 1 kWh of energy on-peak, varies from $0.026 to $0.030, depending on the voltage level.

Exhibit S-2 shows a summary preliminary estimate of the medium-term[2] marginal cost of supply for each tariff class, broken out by 1) capacity costs and 2) energy costs, and 3) added together into a simple energy-based tariff (one part, on kWh only), as NEK uses now. The total energy-based marginal cost varies (depending on the customer class, season of the year, and peak/off-peak) between $0.016 (night, for large high-voltage customer) to $0.069 (winter, household customers).

[2]Approximately through the year 2000.

Exhibit S–2
BULGARIA
ESTIMATE OF MARGINAL COST
BY TARIFF CLASS

1. Marginal costs for capacity ($/kW) including capacity and customer costs

	WINTER COST, $/kW/MONTH			SUMMER COST, $/kW/MONTH		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	$2.79	$0.23	$0.09	$1.40	$0.09	$0.05
C&I – MV	3.33	0.28	0.11	1.66	0.11	0.06
C&I – LV	4.63	0.39	0.15	2.32	0.15	0.08
Households	8.59	0.72	0.29	4.30	0.29	0.14

2. Marginal costs for energy ($/kWh) including energy only

	WINTER COST, $/kWh			SUMMER COST, $/kWh		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	$0.026	$0.026	$0.016	$0.026	$0.026	$0.016
C&I – MV	0.027	0.027	0.016	$0.027	$0.027	$0.016
C&I – LV	0.030	0.030	0.018	$0.030	$0.030	$0.018
Households	0.030	0.030	0.018	$0.030	$0.030	$0.018

3. Total marginal costs on per kWh basis including energy, capacity, and cusotmer costs

	WINTER COST, $/kWh			SUMMER COST, $/kWh		
	Peak	Day	Night	Peak	Day	Night
C&I -- HV	$0.031	$0.026	$0.016	$0.029	$0.026	$0.016
C&I – MV	0.034	0.027	0.017	0.031	0.027	0.017
C&I – LV	0.042	0.031	0.019	0.036	0.030	0.018
Households	0.069	0.033	0.019	0.049	0.031	0.019

EXHS-4-1.WK1

As far as promoting energy efficiency, the current NEK tariffs include several positive features:

- tariffs for C&I customers based service voltage, rather than other considerations (such as whether the customer is industrial, commercial, institutional, or agricultural);
- different tariffs for C&I customers for winter and summer, and time of day;
- separate tariffs for household customers for day and night usage;
- a time-of-day tariff for purchase of power by NEK from other generators.

The current tariff includes several features which we regard as negative:

- large subsidies for household customers;
- no specific charges in the C&I tariff for capacity (kW); all charges are lumped into an energy charge (kWh);
- no incentives are offered for power factor (cos phi) improvement;
- the power purchase tariff also includes no specific payments for capacity (kW), only for energy (kWh).

The preliminary analysis indicates serious deficiencies in the tariff structure. The tariff structure gives pricing signals to customer which will continue to affect their demand for energy services, and hence NEK's operations and investment planning. Hagler, Bailly recommends that the structure be modified to a structure which reflects the long-run marginal cost of service, based on the results of a detailed tariff study.

S.4.3 Private Power, and Independent Power Generation

As part of Integrated Resource Planning, consideration must be made of all sources of supply. Independent power generation usually relates to supply of electricity to the grid by facilities not under the ownership or direct control of the electric utility (such as NEK). In Bulgaria, such projects would be developed by the private sector, and could be a first step toward privatization of electricity services.

The potential benefit of independent power to Bulgaria is greater economic efficiency, obtained through competition in power generation, access to financing and additional capital, optimal use of energy resources through combined heat and power, and transfer of new technology.

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As part of this A.I.D.-funded project, a separate report was prepared by Hagler Bailly on this subject, entitled "Independent Power Generation in Bulgaria: Assessment of Potential, Impediments and Options", August 1993.

S.4.4 Demand-Side Management (DSM)

Demand-side management (DSM) refers to a wide variety of activities which are carried out to improve the efficiency of electricity usage by customers, with cooperation from the electric utility company. DSM thus represents a partnership between the electric company and its customer. There can be other partners in DSM programs, such as private sector energy services companies, financial institutions, and energy engineering firms.

DSM includes programs to encourage conservation, energy efficiency, and load management actions. DSM can also include actions to increase power sales in the off-peak periods. DSM is chosen over a supply-side option when DSM is clearly shown to offer a lower cost alternative to the economy of Bulgaria.

However, whereas the calculation may show DSM to be the least cost option for the country as a whole, the calculation may be different when investigated from the utility's perspective. Thus, in some countries, electric utilities have been reluctant to implement DSM, because financial issues have not been adequately resolved. Implementing DSM has not been in the utilities' interest in those countries where the local regulatory process ties revenues only to energy (kWh) sales. In these cases, savings in energy from demand-side programs reduce the sales of the utility (revenues are lost). In some countries, management (and other employee) compensation or bonuses may even be tied to revenue or kWh sales.

For DSM to succeed, it is necessary that the Bulgarian electric utilities be given the proper financial incentive, so that their decisions are able to mirror what is best for the country. The recommended first incentives are:

- allow DSM capital investments by the utility to earn a rate of return which is high enough to encourage the utility to make the investment;
- allow other (non-capital) DSM expenses incurred by the utility to be recovered through tariffs in the same year they are incurred;
- provide utility employee incentives based on services and efficiency, rather than energy sales.

S.5 DEVELOPMENT OF AN ILLUSTRATIVE DEMAND-SIDE MANAGEMENT PROGRAM FOR BULGARIA (Please refer to Chapter 5 for more details)

S.5.1 Selection of DSM Measures

The NEK load shape and Bulgarian conditions were used to develop a set of criteria for DSM program design in Bulgaria:

- End-use - addressing the industrial and buildings sectors
- Load shape - addressing the need for peak demand reduction in winter
- Relative costs - recognizing the need to favor low-cost measures
- Equipment and services availability in Bulgaria - recognizing the current economic crisis and the transition to private enterprise and a market economy

Using the limited data available, a DSM measure screening and cost-benefit analysis was carried out, and the following measures appear best able to satisfy the criteria for Bulgaria:

- Low-cost improvements in homes heated with electricity, such as window coverings, weatherstripping, and thermostats
- Low-cost improvements in homes where hot water is heated with electricity, such as improved insulation, flow restrictors, and thermostats
- Retrofit of some incandescent lighting with fluorescent in homes,
- High-efficiency refrigerators,
- Direct load control in the residential and industrial sectors,
- Industrial management, technical, production and energy audits,
- Industrial operations and maintenance improvements,
- Interruptible service and expanded self-generation in industry,
- Computer-based energy management (load monitoring and control) systems in industry.

Other DSM technologies are also likely to find application in Bulgaria, including investments in high efficiency lighting, high efficiency electric motors, and variable speed drive systems.

S.5.2 Potential of DSM Measures

These measures were evaluated for their potential peak demand reduction and energy savings. Three levels of potential DSM impacts were considered in this step: Technical/Economic Potential, Market Potential, and DSM Program Potential. The three levels are described in Exhibit S-3.

Technical/Economic Potential assesses the energy savings and coincident peak demand savings possible if the commercially available, technically applicable, and economically feasible DSM measures were fully implemented. The analysis was carried out at the sector level (industry or buildings). Based on the data sources available to us (as listed previously), we estimated that the technical/economic potential for electric energy efficiency measures in Bulgaria amounts to:

Peak demand reduction of more than 2,800 MW (48% of current maximum)

Energy savings of more than 7 TWh (29% of current consumption)

A "supply curve" is useful to illustrate the quantity of a good available at various prices. An energy efficiency supply curve plots the various technical measures in rank order on the basis of their cost of conserved energy (CCE, $/kWh). The CCE for each measure is plotted vs. the technical/economic potential of the measure (GWh/year). The supply curve of technical/economic potential for measures in the buildings sector is shown in Exhibit S-4. The curve only shows technologies which have a CCE less than the estimated marginal cost of energy supply (about $0.03/kWh). Exhibit S-5 illustrates the supply curve for the industrial sector. The curve includes two load management technologies that limit peak demand (MW) and are expected to be cost-effective. Because these measures are designed to reduce peak demand, rather than save energy, their CCE is higher than the cost of energy supply.

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Exhibit S-3
Evaluating DSM Potential

Technical/Economic Potential

Which DSM measures are both technically applicable and economically feasible?

What savings (kW and kWh) are possible from these DSM measures?

Market Potential

What proportion of cost-effective DSM measures will be ultimately accepted by consumers on their own (without help from the utility)?

How long will it take for them to accept them?

What savings (kW and kWh) will result?

Illustrative DSM Program Potential

What proportion of cost-effective DSM measures will be ultimately accepted by consumers, if the utility provides appropriate incentives through a DSM program?

How long will it take for them to accept them?

What savings (kW and kWh) will result?

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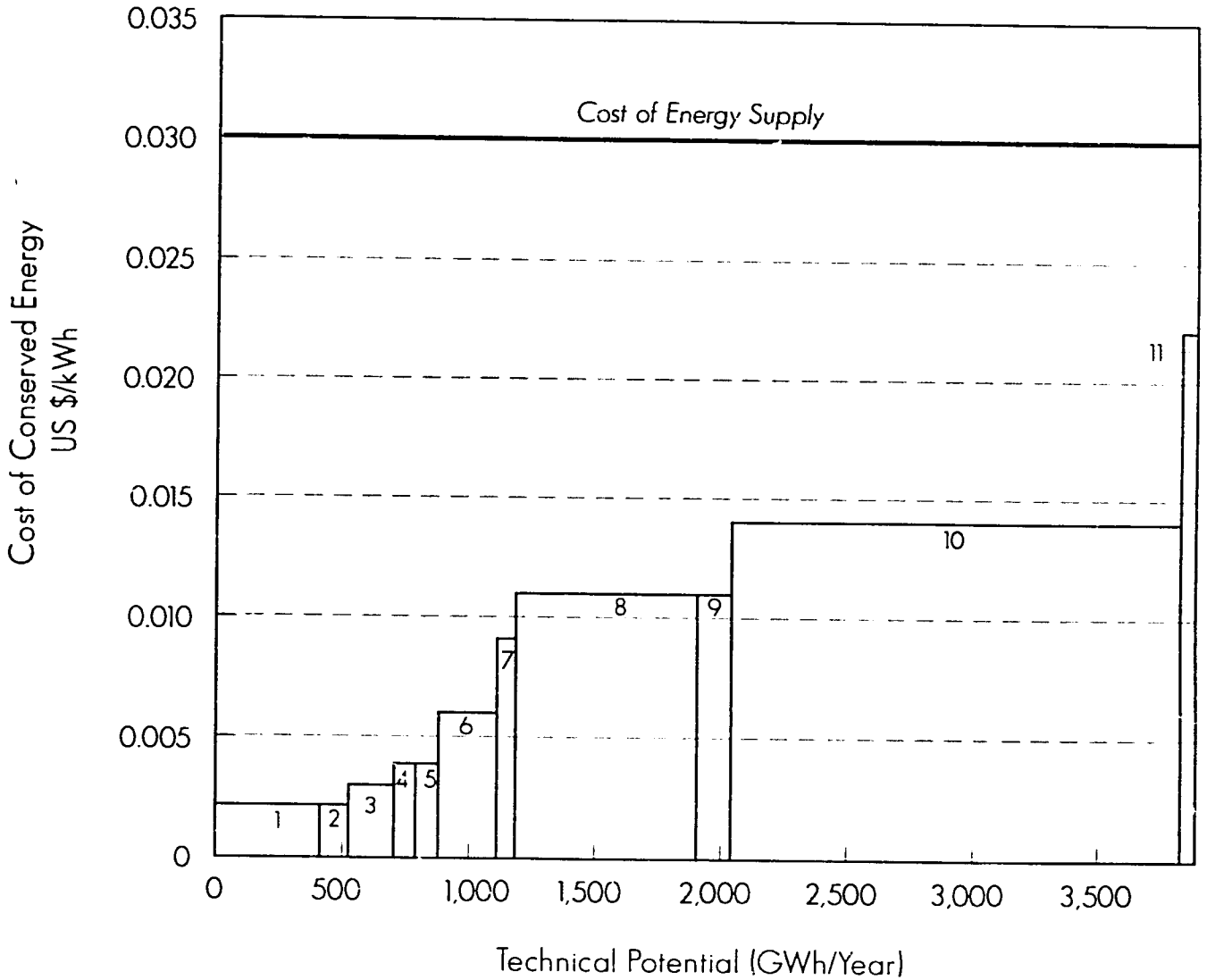
Exhibit S-4

Bulgaria

Supply Curve -- Technical/Economic Potential (Buildings Sector)

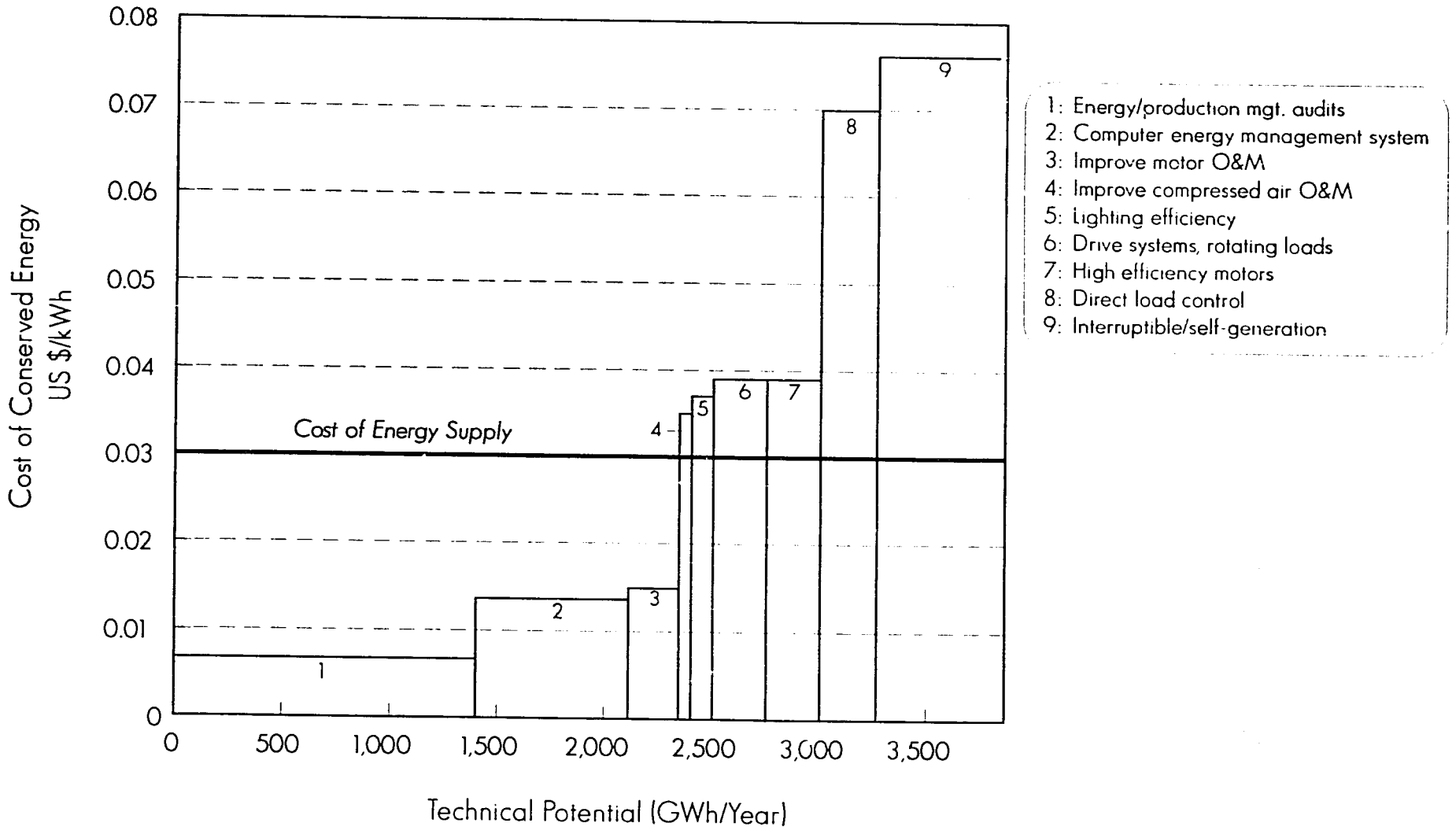


1: Commercial lighting reflectors
2: Water heater controls
3: Thermostats in heating systems
4: Window coverings
5: Water heater timers
6: Residential flourescent lighting
7: Hot water flow restrictors
8: High efficiency refrigerators
9: Caulking, weatherstripping
10: Heating -- convert to gas
11: Hot water insulation

Exhibit S-5

Bulgaria

Supply Curve -- Technical/Economic Potential (Industry Sector)



Market potential assesses the likelihood that the technical potential will in fact be realized, based on normal market forces alone, such as electricity prices and consumer behavior. Some of these market forces influencing market potential in Bulgaria are listed in Exhibit S-6.

Market potential depends on decision maker preferences. A DSM measure that is technically feasible and physically applicable may not be considered cost-effective by different individual home, building, or factory decision makers. Usually decision makers in the same market segment, evaluating the same DSM measure at a given levelized cost may or may not consider it cost-effective to install because of different investment preferences and acceptance criteria.

Market potential indicates the fraction of cost-effective DSM measures that will actually be undertaken by consumers, without a utility-sponsored DSM program. There are many reasons why even cost-effective DSM measures are not implemented: alternative uses of capital, severe limitations on the availability of capital, disinterest in energy conservation, management focus on other concerns or crises, differing opinions regarding other product attributes, perceptions of technical risk, lack of knowledge of the measure, and numerous other normal market frictions and transaction costs which result in a lower number of DSM measures actually being undertaken than are cost-effective.

The estimates of the market potential are based on assumptions regarding market penetration for each measure. These assumptions show low rates of market penetration achieved over a 10-20 year period, consistent with experience in the U.S. and developing countries. In summary, we estimate that the market potential for DSM measures in Bulgaria amounts to 5-7% of the technical/economic potential:

Peak demand reduction of 150 MW (about 2% of current maximum load from industrial and buildings sectors)

Energy savings of 590 GWh (2% of current consumption by industrial and buildings sectors)

Exhibit S-6
Factors Influencing Investments
In Energy Efficiency In Bulgaria

Financial Constraints: There may be insufficient capital available, or the financial risk for energy efficiency may be perceived as being too high. A survey of the 106 largest Bulgarian electrical customers was carried out in December 1992 by DBC. Lack of financing was identified as the key reason for not undertaking energy efficiency investments by 53% of the firms who responded.

Equipment Availability: High efficiency equipment may not be available, or other technological limitations may exist. This was cited as the reason for not undertaking energy efficiency investments by 25% of the firms in the Bulgarian survey.

Subsidized Energy Prices: Energy prices may not provide the consumer with a sufficient price signal to justify energy efficiency investments. Low electricity prices was identified as the reason for not investing in energy efficiency by approximately 9% of the firms responding to the survey.

Lack of Information: Energy users may not be aware of energy efficiency opportunities or may not know how to get the measure implemented.

Non-Economic Behavior: Consumers may not make strictly economic behavior but make choices according to other considerations.

Ownership: Renters may pay the utility bill, but are unwilling to make improvements to buildings owned by landlords or the state.

The illustrative DSM Program Potential estimates the results of a utility-based incentive program designed to overcome the market imperfections, and thereby increase customer acceptance of energy efficiency measures. Despite the provision of incentives and subsidies, utility-sponsored DSM programs may only result in an actual implementation of 25-50% of the technical potential.

The survey of Bulgarian industries provides some information on market potential. Without incentives (the current situation), the survey found that 57% of the firms interviewed had not implemented energy efficiency measures, even though three-fourths of the total firms were aware of potential options. The survey found that 76% of those interviewed would be interested in energy efficiency programs, if incentives were offered.

While there are several means of establishing impact and cost-effectiveness, assessing market potential generally requires implementing pilot programs. Pilot programs are the best way to obtain actual customer response to the program offered by the utility.

We estimate that the illustrative DSM program potential for Bulgaria amounts to about 35% of the technical potential:

> Peak demand reduction of more than 1,000 MW (16% of current maximum load from industrial and buildings sectors)
>
> Energy savings of 2.8 TWh (10% of current consumption by industrial and buildings sectors)

Thus, the estimated net benefit of the DSM program (subtracting the energy efficiency improvements that would have happened without a program) are:

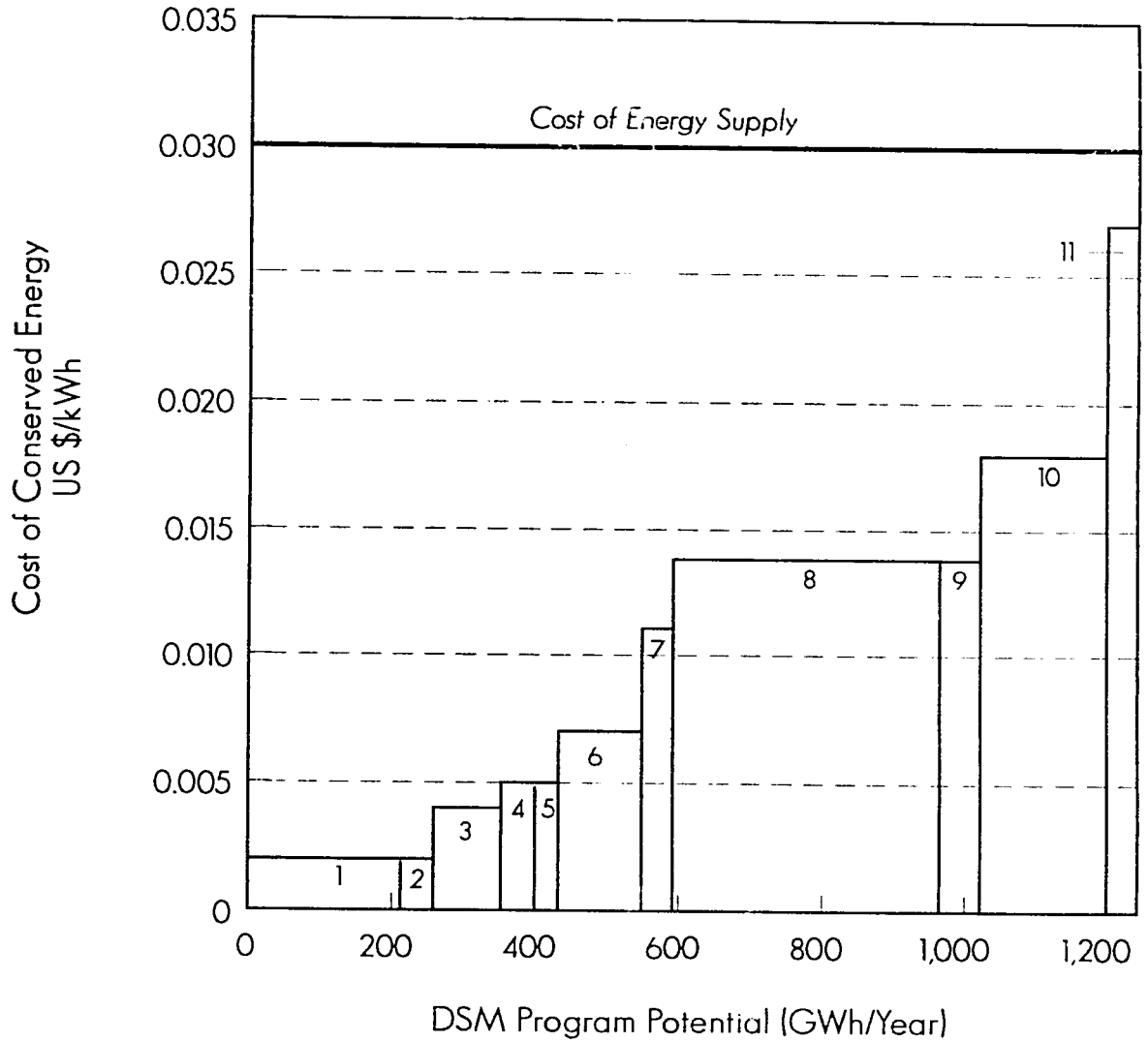
> Peak demand reduction of more than 900 MW (15% of current maximum load from industrial and buildings sectors)
>
> Energy savings of 2.2 TWh (9% of current consumption by industrial and buildings sectors)

A set of energy efficiency supply curves was generated for the Illustrative DSM program, using DSM Program Potential GWh/year and costs of conserved energy which include the cost of the DSM program development, administration, and evaluation. The supply curve of the Illustrative DSM Program for measures in the buildings sector is shown in Exhibit S-7. The curve only shows technologies which have a CCE less than the estimated marginal cost of energy supply (about $0.03/kWh). Exhibit S-8 illustrates the supply curve for the industrial sector.

Exhibit S-7

Bulgaria

Supply Curve -- Illustrative DSM Program (Buildings Sector)

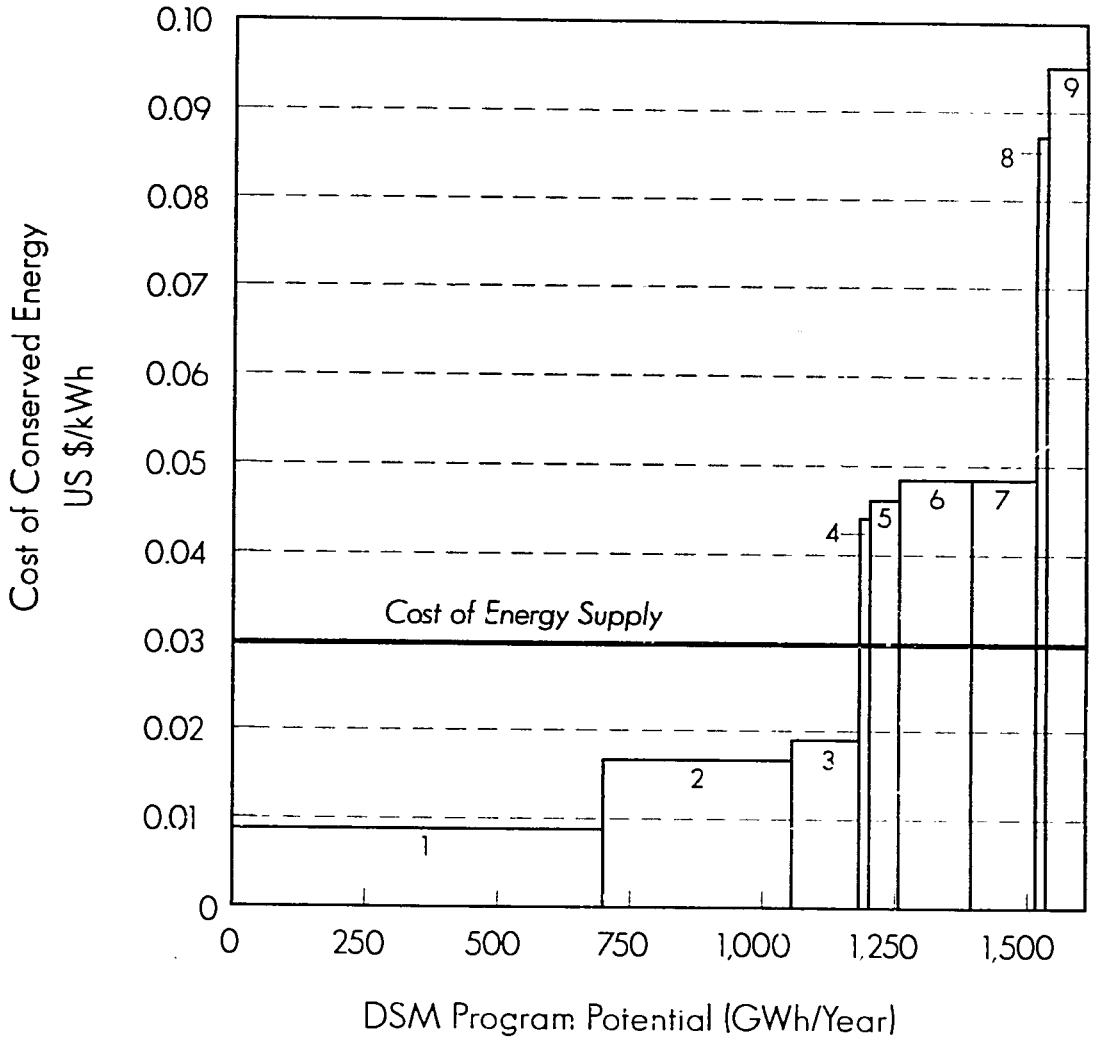


1: Commercial lighting reflectors
2: Water heater controls
3: Thermostats in heating systems
4: Window coverings
5: Water heater timers
6: Residential flourescent lighting
7: Hot water flow restrictors
8: High efficiency refrigerators
9: Caulking, weatherstripping
10: Heating -- convert to gas
11: Hot water insulation

Exhibit S-8

Bulgaria

Supply Curve -- Illustrative DSM Program (Industry Sector)



1: Energy/production mgt. audits
2: Computer energy management system
3: Improve motor O&M
4: Improve compressed air O&M
5: Lighting efficiency
6: Drive systems, rotating loads
7: High efficiency motors
8: Direct load control
9: Interruptible/self-generation

S.5.3 Benefit-Cost Analysis of Illustrative DSM Program

The costs of energy efficiency improvements under the Illustrative DSM Program are substantial, peaking at $76 million per year once the program gets fully under way:

Year 1:	$4 million
Year 2:	$5 million
Year 3:	$10 million
Year 4:	$19 million
Year 5:	$38 million
Years 6 - 9:	$76 million per year

An economic analysis was carried out to determine if these costs could be justified. Based on the annual net benefits (benefits minus costs), and using a discount rate of 10% over an investment planning horizon of 20 years, the following economic evaluation results:

Net Present Value (NPV):

DSM in buildings	$129 million
DSM in industry	$183 million
Total Illus. DSM Program	$312 million

Benefit/Cost Ratio (total resource cost, TRC):

DSM in buildings	3.35
DSM in industry	2.28
Total Illus. DSM Program	2.58

Internal rate of return (IRR):

DSM in buildings	92%
DSM in industry	38%
Total Illus. DSM Program	48%

Another evaluation is the cost of conserved energy (CCE). In this calculation, the NPV of the annual cost stream is divided by the NPV of the annual energy savings stream to obtain an estimate in $/kWh. This calculation is somewhat distorted, since it puts all costs against energy, giving no recognition to peak demand reduction. However, it does give a direct basis for comparison against the marginal cost of energy supply, which we calculated as about $0.03/kWh. The CCE for the Illustrative DSM Program is calculated as:

DSM in buildings	$0.013/kWh
DSM in industry	$0.024/kWh
Total Illus. DSM Program	$0.020/kWh

The values of IRR are well above the common values of minimum acceptable rate of return (hurdle rates) used in project evaluation by the World Bank, EBRD, or other lenders. The cost of the energy conserved is only a little more than half the marginal cost of energy supply. The other economic evaluation criteria all show very positive results, and thus we conclude that the Illustrative DSM program is a very attractive investment for Bulgaria.

S.5.4 Effect of the Illustrative DSM Program on the Demand Forecast

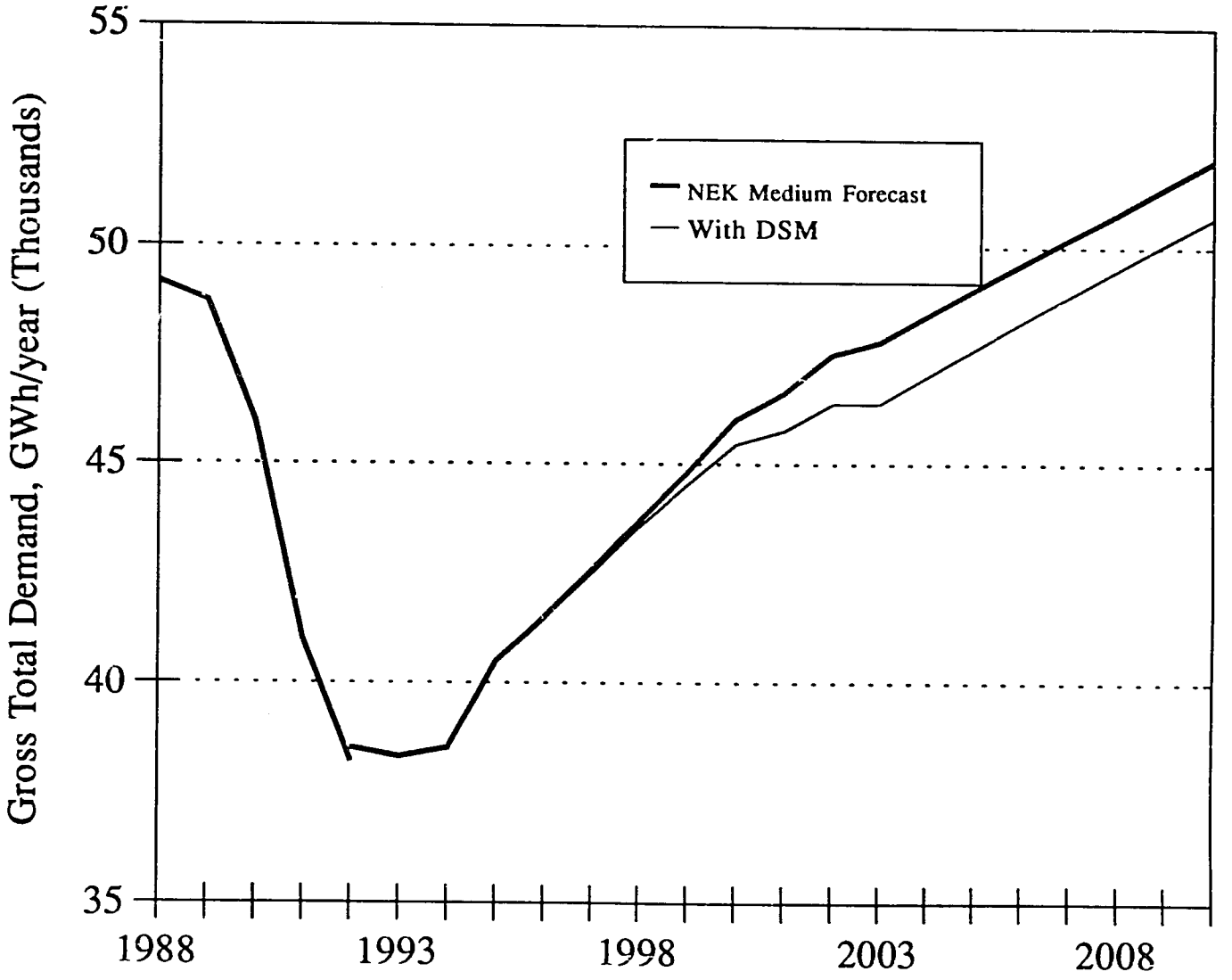
Finally, the net effect of the Illustrative DSM Program was incorporated into the NEK medium-case demand forecast, so that the impact on annual energy requirements can be seen.

Exhibit S-9 illustrates the impact of the Illustrative DSM program on annual energy demand. The effect is to reduce the growth of demand until about year 2004. After that time, energy demand will begin to grow unless more DSM measures can be implemented.

Exhibit S-9

Bulgaria - Total Electricity Demand

Effect of Illustrative DSM Program



S.5.5 Action Plan to launch DSM Program in Bulgaria

Implementing DSM appears to be part of a least-cost power sector investment program for Bulgaria. Initiating activities in DSM will require a demonstration project, in order to establish the local context in which DSM technologies, policies, financing mechanisms can succeed.

The Illustrative DSM Program described in this report is based on preliminary data, which is very limited. This limited data is insufficient to fully evaluate the very large investments required.

However, the preliminary analysis in this report serves as a basis for identifying the next steps to implementing the program. These activities should be pursued in parallel to achieve early success. The key actions for the next 1-2 years are summarized below.

- **Develop and Implement Pilot DSM Programs:** To gain more experience and collect data in Bulgaria, pilot DSM programs for the buildings and industrial sectors should be designed and implemented at one or more distribution branches of NEK. One of the key tasks is the development of the level of incentives or other expenditures to be made by NEK for the program, and the method by which NEK will recovery revenues lost by the energy savings. Developing pilot DSM programs also involves a number of tasks to resolve issues such as market research, program design, selection of technical measures, screening of applications, financing options, implementation by private sector firms, collection of payments by NEK, independent evaluation, and program redesign.

- **Institutional Development**: A parallel step is needed to develop laws and regulations necessary to implement utility Integrated Resource Planning. Within the IRP framework, regulations next need to be put in place to ensure that development of the DSM potential proceeds at the optimum rate. Further, COE and NEK should establish departments responsible for IRP, DSM, and customer service.

- **Load Research and DSM Assessment:** The customer service department at NEK would be assigned to carry out load research, to collect data on energy usage by customers. This project will measure the dynamics of specific loads and then combine these data with statistical and building simulation models to evaluate DSM potential. These additional data should be used to perform a detailed DSM cost-benefit assessment.

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1. INTRODUCTION

1.1 PROJECT OVERVIEW

This report presents partial results of work performed as part of the energy sector assistance provided to Bulgaria by the U.S. Agency for International Development. It was prepared as part of Task 1 - Electricity Sector Study and Action Plan, in coordination with the European Community, by RCG/Hagler, Bailly, Inc. The report investigates opportunities to improve management of demand, through a demand-side management (DSM) program.

1.1.1 Background and Perspective

The Natsionalna Elektricheska Kompania (NEK, or the National Electric Company of Bulgaria), is a joint stock company now wholly owned by the state. The Committee of Energy (COE) serves as the government organization responsible for oversight of NEK and national planning in the power sector.

An integrated electric utility company, NEK is responsible for the production, transmission and distribution of electricity and the production and sale of heat. The company was established by Decree No. 46 of November 7, 1991 of the Council of Ministers of Bulgaria. NEK's assets amount to approximately 100 billion leva (U.S. $4 billion). NEK operates through a network of 28 electricity supply branches and ten generation branches. Its total staffing is approximately 30,000.

In 1991 total installed capacity in Bulgaria was 12,074 MW, of which 10,460 MW is owned by NEK. District heating companies have an installed capacity of 574 MW in combined heat and power . Industrial enterprises have an installed capacity of 1,040 MW, mostly also combined heat and power.

1.1.2 Objective and Scope

The objective of this study area was to develop recommendations for improving load management.

The scope of the analysis was limited to analysis of the following data:

- reports and other published data provided by NEK and COE;

- electronic spreadsheets of monthly energy consumption for 1991-92 for 106 largest consumers, provided by NEK;
- survey of largest consumers, carried out by Hagler, Bailly and DBC on behalf of COE;
- energy audits carried out by International Resources Group in Bulgaria under the USAID Emergency Energy Program.

The scope of work is described below:

a. Document current and historical use of electricity in Bulgaria, using data obtained from COE and NEK.

b. Review demand forecasts prepared by NEK and others.

c. Carry out a survey of the largest electric energy users to determine their use of electricity and plans for the future.

d. Review the results of energy audits conducted in Bulgaria and other countries in the region to determine potential demand management.

e. Carry out a survey of the largest electric energy users to determine their use of electricity and attitudes toward energy conservation.

f. Develop an illustrative demand-side management investment program.

g. Estimate the potential for electrical energy conservation in industry and buildings.

h. Estimate the potential for peak load management and load-shifting.

i. Develop a draft demand-side management investment program.

j. Present the results to NEK and COE.

1.2 HISTORICAL ELECTRICITY USE

Beginning in 1990, the Bulgarian economy went into severe recession. Export markets, which had been focused on the Soviet Union, disappeared as the economies of the former Soviet Republics weakened substantially. Bulgaria was unable to reorient its markets to the West and to other countries in Central Europe, previously under the domination of the Soviets, because of political and institutional barriers and the inferior quality of the products available for export.

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The lack of markets and the inability to sell products initially raised inventory levels, but eventually resulted in reduced plant operations and, in many cases, the shutdown of the plants, either temporarily or permanently. Some industries were hit harder than others.

Exhibit 1-1 illustrates the historical electrical energy balance in Bulgaria for 1975 and 1980-92.

Key points shown in Exhibit 1-1 include the following:

- Total consumers' electric energy demand in Bulgaria has taken a sharp drop, and is now 25% less than the maximum recorded in 1988. After dropping about 6% in 1990, total energy demand plummeted more than 13% during 1991 and dropped a further 7% during 1992.

- However, the reduction in electricity usage was not uniform across all sectors. Until 1992, the drop in demand was concentrated, for the most part, in the industrial sector as this sector fought to adjust to a market economy.

- Transmission and distribution losses increased substantially in 1991. This is probably due to energy diversion following increases in tariffs.

- Peak power demand (absolute maximum recorded during the year) has reduced, but much less than energy demand, and is now 15% less than the maximum recorded in 1989. The drop in 1990 (from 8,332 MW to 8,111 MW) amounted to 2.6% and in 1991 a further 7.7% to 7,489 MW and finally to 7,050 MW in 1992.

- Classifying energy sales (GWH/year) into three groups, reductions since 1988 are as follows:

  -- industrial sales are down 34%

  -- household sales are down 4%

  -- other (agriculture, transportation, public buildings) sales are down 28%

- Power generation by industrial enterprises peaked in 1985 at 4,688 GWh, and has since declined by 33%.

Exhibit 1-2 presents the peak demand for each month of 1991. The maximum was recorded in January (7,500 MW), and August experienced the lowest peak (4,300 MW). The difference of more than 3,000 MW is attributed to the demand for heating.

Exhibit 1–1

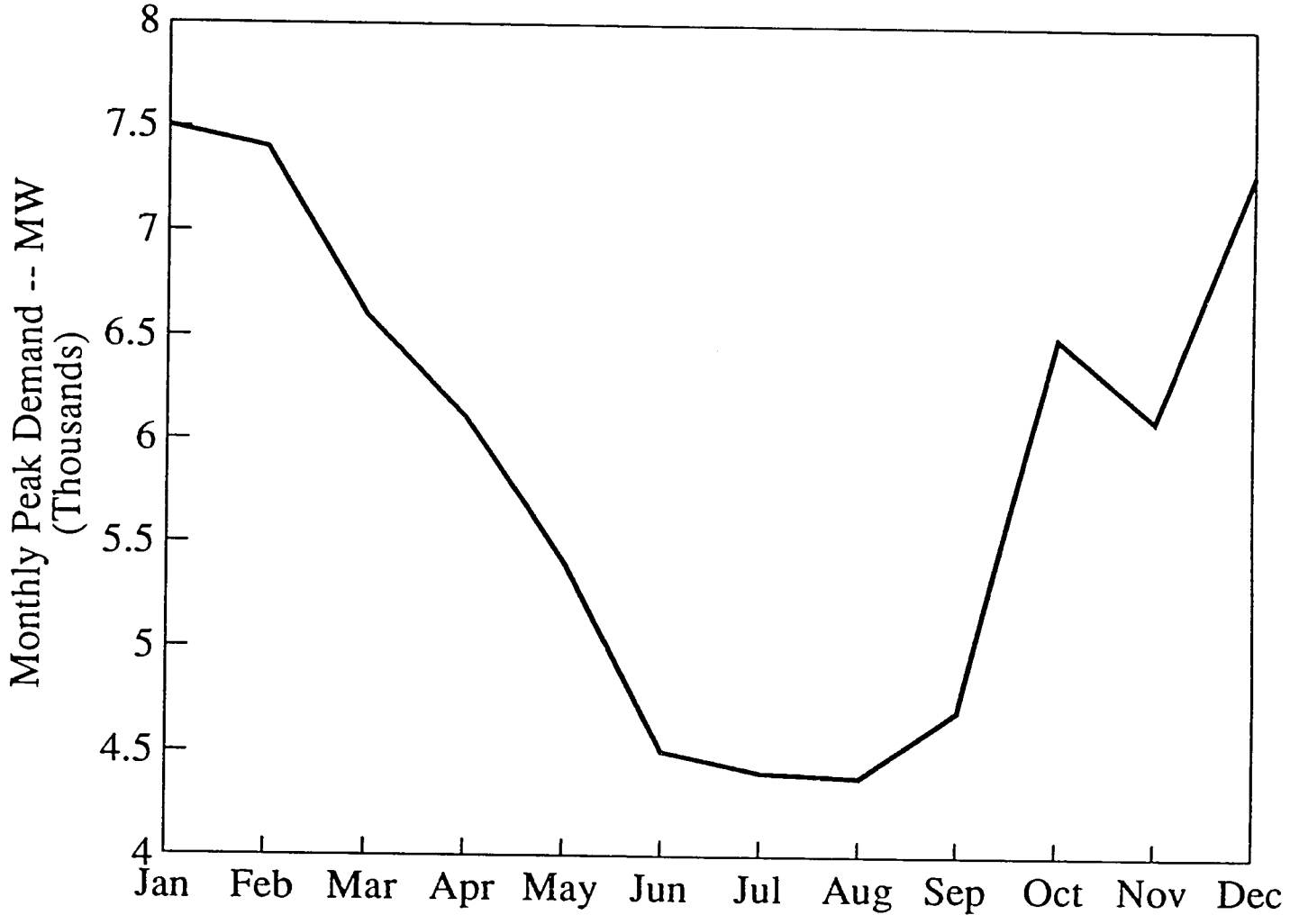
BULGARIA
HISTORICAL ELECTRICITY BALANCE

	GWh/year													
	1975	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Gross Generation	24,965	34,841	37,045	40,634	42,863	44,672	41,633	41,821	43,474	45,007	44,327	42,121	38,891	36,437
Power Plant Auxiliaries	2,668	3,640	3,897	4,315	4,577	4,661	4,544	4,595	4,766	4,897	4,841	4,623	4,221	3,986
Auxiliaries (pct of net production)	10.7%	10.4%	10.5%	10.6%	10.7%	10.4%	10.9%	11.0%	11.0%	10.9%	10.9%	11.0%	10.9%	10.9%
Net Generation	22,296	31,201	33,148	36,319	38,286	40,011	37,089	37,226	38,708	40,110	39,486	37,498	34,670	32,451
Imports	3,902	4,698	4,497	4,441	4,582	4,636	5,959	4,571	4,673	4,450	4,937	5,387	3,082	2,700
Exports	279	866	1,095	1,794	2,221	2,243	1,655	599	324	304	548	1,597	959	1,000
Power Purchases from Factories & Others										773	774	735	754	750
Total For Distribution	25,920	35,033	36,551	38,966	40,647	42,403	41,393	41,198	43,056	44,256	43,875	41,288	36,793	34,151
Distribution Losses	2,387	3,454	3,695	3,888	4,046	4,301	4,016	4,170	4,413	4,762	4,656	4,443	5,191	4,576
Losses (pct of for distribution)	9.2%	9.9%	10.1%	10.0%	10.0%	10.1%	9.7%	10.1%	10.2%	10.8%	10.6%	10.8%	14.1%	13.4%
Final Sales	23,533	31,579	32,856	35,077	36,601	38,102	37,376	37,027	38,643	39,494	39,219	36,845	31,602	29,575
Household Sector	4,588	6,844	6,992	8,105	8,516	9,444	9,552	8,685	9,445	9,935	10,183	10,475	10,404	9,541
Industry Sector	14,306	17,524	18,498	19,227	20,004	20,414	20,038	20,283	20,674	21,208	20,815	19,386	15,013	14,013
Other Sectors	4,640	7,211	7,366	7,746	8,081	8,244	7,786	8,059	8,524	8,351	8,221	6,984	6,185	6,021
Factory Self–Generation	3,000	4,500	4,500	4,500	4,500	4,553	4,688	4,378	4,435	4,339	4,281	3,751	3,547	3,150
Total Consumers' Demand	26,533	36,079	37,356	39,577	41,101	42,655	42,064	41,405	43,078	43,833	43,500	40,596	35,149	32,725
Gross Peak Demand (MW)		6,922					7,878	7,514	7,853	8,114	8,332	8,111	7,489	7,500
Load factor														
based on Total for Distribution		0.58					0.60	0.63	0.63	0.62	0.60	0.58	0.56	0.52
based on Net Generation		0.51					0.54	0.57	0.56	0.56	0.54	0.53	0.53	0.49
based on Gross Generation		0.57					0.60	0.64	0.63	0.63	0.61	0.59	0.59	0.55

HISTOR.WK1

Exhibit 1-2

Peak Demand by Month
Bulgaria 1991



1991

Exhibit 1-3 presents the load duration curve for the NEK system for two years, 1982 and 1991. The difference between the two curves shows that most of the reduction in demand has occurred during summer months, and that some reduction has occurred during off-peak periods in the winter.

Exhibit 1-4 shows the daily load curve for typical working days in January 1991 and July 1991. The load swing in winter is only about 13% between peak and minimum, whereas in summer it is more than 25%.

1.2.1 Industrial and Commercial Sales by NEK

Industrial electric energy sales remained fairly constant during the latter part of the 1980s at 20-21,000 GWh per year through 1989. In 1990, sales decreased about 7% and in 1991, sales decreased a further 23%.

Data were provided by NEK for the breakdown of electricity consumption by industrial sector, and individually for the 106 largest electricity consumers. These data are summarized in Exhibit 1-5.

The dramatic drop in industrial electricity use in 1991 from 1990 was virtually universal across all sectors. Plants reduced their operations significantly and some shut down completely. The data indicate the greatest declines (using 1989 as a base) in the following sectors:

- chemicals (38%)
- pulp & paper (45%)
- timber (34%)
- food & beverage (25%)
- construction (30%)
- public sector buildings (34%)

1.2.2 Household Sales by NEK

During the decade of the 1980s, the price of electricity to households remained constant, and so, with inflation, the real price of electricity drifted downwards. No real increases in household tariffs occurred until 1992.

Referring back to Exhibit 1-1, household electricity demand increased steadily over the several years leading up to 1991. During 1991, while total electricity consumption was decreasing almost 15%, household consumption decreased by less than 1%. However, with substantial increases in tariffs, reductions in demand began in 1992, and sales were down about 8%.

Exhibit 1-3

Load Duration Curve
Bulgaria -- 1991 and 1982

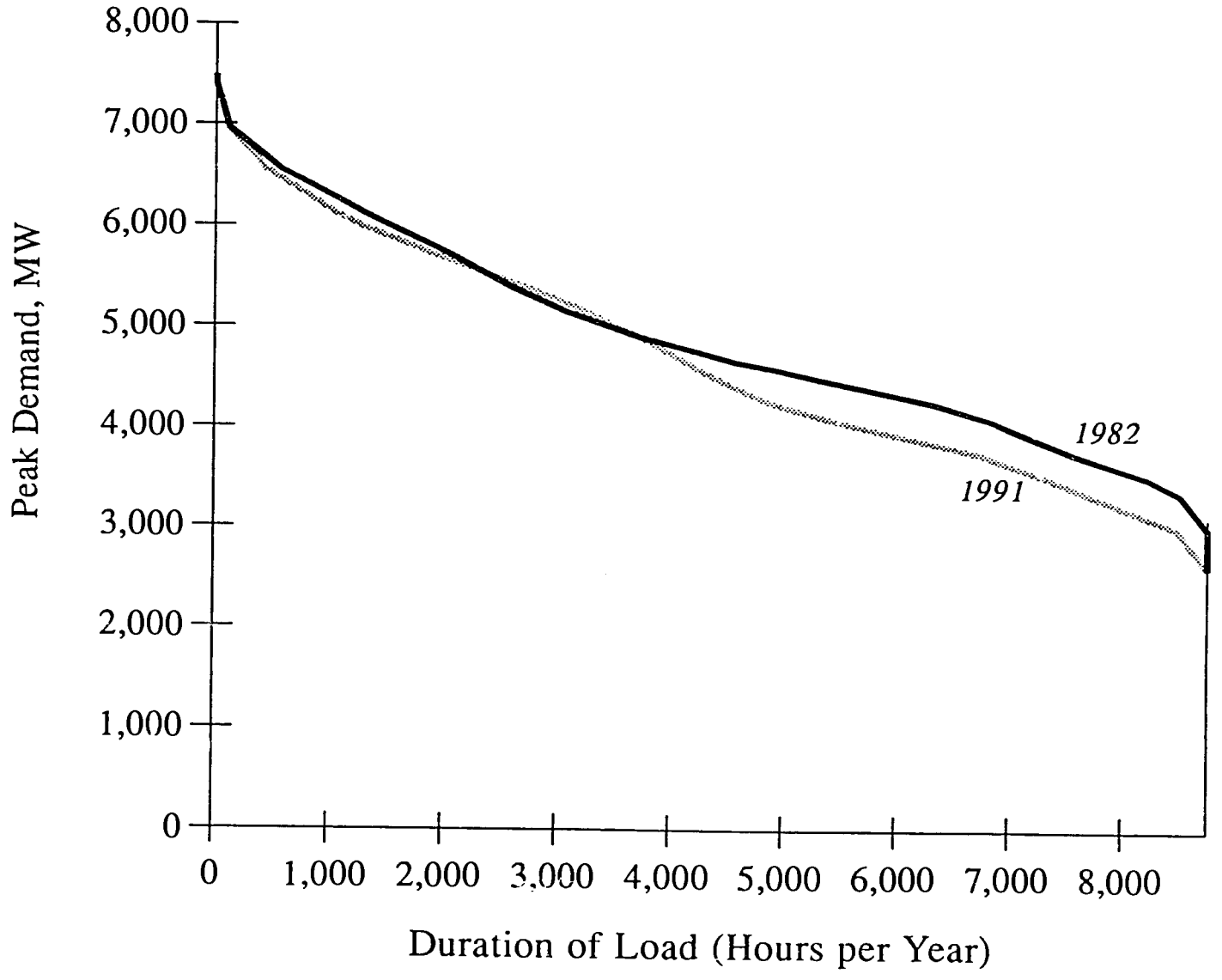


Exhibit 1-4

Daily Load Profile - Bulgaria

Average Day in January & July

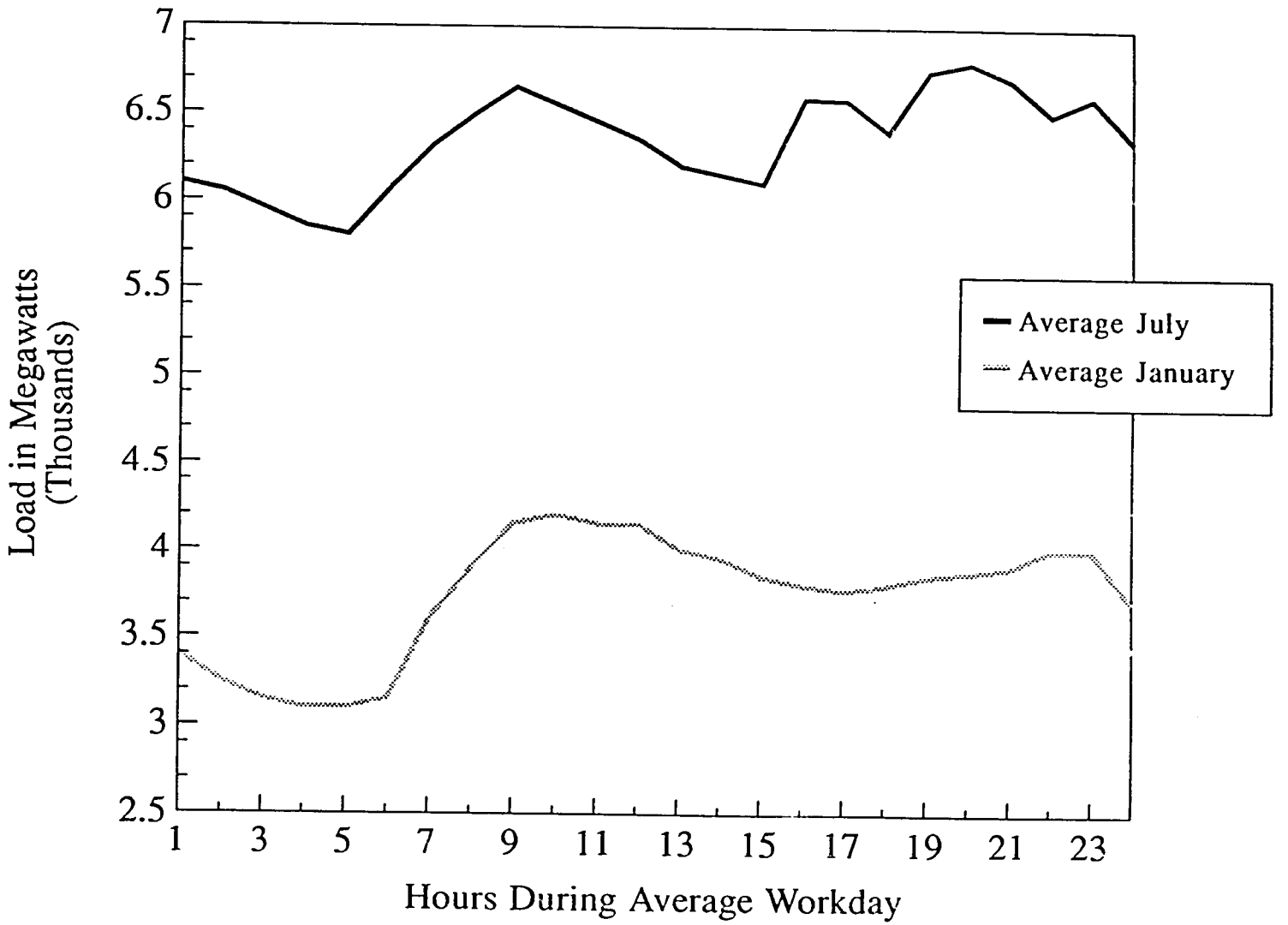


Exhibit 1–5
BULGARIA
RECENT ELECTRICITY SALES
TO INDUSTRY SECTORS AND LARGEST CUSTOMERS

	1987	1988	1989	1990	1991	1992
Ferrous Metals	2,988	3,029	2,980	2,869	2,640	2,481
Promet (S)					37	44
Kremikovtsi (S)					849	764
Stomana					446	487
Other					1,308	806
Non–ferrous Metals	**1,878**	**1,906**	**1,863**	**1,777**	**1,635**	**1,537**
Medril Mihi					44	54
Chiprovech					15	22
Polimet					41	40
MDP "Elatsite"					0	17
GORYBSO–AD IVru					27	26
OTSK–OOD					118	117
Olovo i Tsink					24	22
OP "Elatsite"					161	400
Redki Metali					34	18
Medodobiven K. (S)					152	260
D. Blagoev (S)					198	200
Alumina					35	34
OTSM (S)					41	40
Other					746	286
Chemicals	**6,350**	**6,378**	**4,443**	**3,771**	**3,017**	**2,752**
Kaltsit (S)					50	55
Neftohim (S)					195	116
Agropolihim					143	123
Polimeri					347	114
TK "Sodi"–star					192	38
F "Neohim"					207	175
Agrabiohim					576	581
HIMKO					452	455
Yambolen					50	54
Plasthin					17	21
Lateks (S)					10	7
Geoson					25	23
Gavril Genov (S)					14	13
P. Karaminchev					12	13
Smyadovo–OOD					11	5
Odesos (S)					10	13
Antibiotik (S)					107	109
Other					601	837
Engineering – metallic products			**2,212**	**2,159**	**1,987**	**1,867**
Energorem. 3–D (S)					25	19
K–t za Traktori					18	12
Osam					26	10

Exhibit 1–5
BULGARIA
RECENT ELECTRICITY SALES
TO INDUSTRY SECTORS AND LARGEST CUSTOMERS

	1987	1988	1989	1990	1991	1992
Akumikar					13	17
Fitingi					30	24
LEKO–KO					102	34
SLZ (S)					149	21
ZTM–OOD (S)					25	16
Korabostr. –OOD					10	11
Madara					45	21
G. Dimitrov (S)					16	14
TKEP "6 Sept." (S)					18	11
ZMM–AD (S)					14	15
MK "VMZ"					88	84
Progres					17	13
Varn. Korabostr. (S)					31	41
Veslets 91					39	52
KAMET (S)					99	36
Rekora (S)					5	15
Other					1,215	1,400
Electrical & Electronics			**817**	**700**	**686**	**648**
B. Kolarov					12	26
Eltos					10	11
Feromagniti					21	20
Svetlkna					19	15
Elprom–Dinamo					14	9
Elprom–ZEM–ad (S)					0	14
D S U					29	17
Elima					22	19
Elkom (S)					9	12
Other					551	506
Building Materials		**1,395**	**1,305**	**1,161**	**1,068**	**1,004**
Beloiz. Tsiment					88	55
Devn. Tsiment					120	103
Bulkan					33	37
Izida					16	16
Pl. Tsiment					50	60
Zl. Panega					84	89
Han Asparuh (S)					18	16
Kaolin (S)					8	18
Other					652	610
Timber			419	380	304	277
Pulp & paper, wood products			**637**	**481**	**385**	**351**
Rulon–Iskar (S)					26	27
PHHI					29	24
TKTSH					34	57
ZMK (S)					76	32

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Exhibit 1–5
BULGARIA
RECENT ELECTRICITY SALES
TO INDUSTRY SECTORS AND LARGEST CUSTOMERS

	1987	1988	1989	1990	1991	1992
Lesil					49	17
St. Kirajiev (S)					55	55
TKHTS (S)					31	13
Other					85	126
Glass			**424**	**504**	**494**	**466**
Belopal					42	38
Kitka					29	25
Fayans					24	26
Rubin					35	25
Drushba					44	44
Kvarts					22	18
Diamant (S)					21	21
Other					276	269
Textiles		**784**	**767**	**662**	**609**	**572**
Manuela					18	23
Dobruja					8	9
Sliteks					21	21
Vratitsa					18	14
Other					543	505
Food & Beverage		**1,454**	**1,521**	**1,312**	**1,207**	**1,135**
N. Vaptsarov					6	33
Tyot. Kombinat (S)					12	11
MEZ "Kambana" (S)					8	8
SKPPPMYA (S)					14	8
Other					1,167	1,075
Other Industries			**1,047**	**1,066**	**981**	**922**
Bules (S)					14	11
Cherno More (S)					8	9
Construction	1,091	1,139	994	896	740	696
Agriculture	1,143	1,094	1,070	995	870	873
Transport & Communications	1,441	1,489	1,493	1,483	1,400	1,392
Public Sector	4,849	4,629	4,664	3,610	3,175	3,061

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1.3 FACTORS INFLUENCING DEMAND

Several factors influence the demand for electricity. The two primary effects are:

- *Income* - For the industrial sector, the health of the economy, both local and worldwide, determines the demand for goods and services, and in turn, this determines the demand for electricity. For households, income affects ability to buy electric appliances or even electric energy itself.

- *Price* - Low electricity tariffs encourage greater consumption, and higher prices should lead to conservation. The structure of tariffs (for example, amount charged to large industrial customers as compared to households) is very important in determining sector demand.

Secondary effects are:

- *Structure of industry* - As the prices of energy and inputs increase, the cost of producing goods increases. Those goods that have the greatest increases in productivity or are the most energy efficient in production will tend to be relatively lower cost industries, and the demand for goods will shift towards these industries. This shift will bring about a scale effect as inefficient plants close and a substitution effect as demand is shifted to the more electricity-efficient industries.

- *Energy conservation programs* - The government can directly affect the demand for electricity through the level of its promulgation of energy conservation programs.

- *Privatization* - The government indirectly affects the use of electricity by its industrial policies. The industries that the government promotes through either subsidies or by assisting in the privatization process should become more healthy, affecting the eventual demand for electricity.

- *Commercial services* - The privatization process will also spur the development of the commercial sector, which will require electricity for lighting, cooking, refrigeration, heating, ventilation and air conditioning.

- *Weather conditions* - Bulgaria's peak demand increases by more than 3,000 MW in the winter, so a cold winter will cause an increase in demand.

- *Household formation* - Population growth and residential construction leads to the formation of new households and the creation of new customers. Since 1980, population growth has average only about 0.2% per year in Bulgaria.

- *Regional differences* - The demand for electricity varies by region, because of the concentration of industry, the size of the population, and differing weather patterns. The historical regional distribution of electricity sales is provided in Exhibit 1-6. The change in electricity use varies over time by district, with some districts increasing their share as their decreases in electricity use are less than other those of other districts.

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Exhibit 1-6
SALES OF ELECTRICITY BY REGION (GWh)

Year	1985	1986	1987	1988	1989	1990	1991
Sofia City	5,109	4,935	5,054	5,193	5,150	4,694	4,025
Sofia District	4,126	4,278	4,564	4,653	4,649	4,308	3,497
Pleven	4,723	4,671	5,025	5,049	4,773	4,914	4,199
G. Oryahvitza	4,069	3,926	4,196	4,373	4,319	4,096	3,493
Varna	4,743	4,614	4,523	4,694	4,626	4,335	3,629
St. Zagora	5,398	5,506	5,751	6,063	6,030	5,666	4,979
Plovdiv	6,269	6,244	6,583	6,671	6,723	6,494	5,579
Total	34,437	34,174	35,696	36,696	36,270	34,507	29,401

2. RESULTS OF INDUSTRIAL ENERGY SURVEY AND ENERGY AUDITS

2.1 INDUSTRIAL ENERGY SURVEY

A survey of the NEK's 106 largest electrical consumers was commissioned by RCG/Hagler, Bailly as part of the project. Hagler, Bailly subcontracted with Dimitar Baev - DBC, a private Bulgarian firm, to carry out the work.

2.1.1 Objective

The objective of the survey was to poll the 106 largest industrial electricity consumers with respect to their electricity consumption, business and economic activity, electrical generation at the facility (if any) and energy efficiency.

2.1.2 Activities

The project included the following tasks:

1) An English draft survey instrument was developed by Hagler, Bailly, and subsequently a Bulgarian version of the survey questionnaire by DBC, taking into account locally-accepted survey techniques by means of network of interviewers, as well as the recommendations of the experts from the Committee of Energy.

2) A test run of the survey was made in 7 enterprises in Sofia to verify that the survey instrument was acceptable. Based on the results, Hagler, Bailly determined that a two-stage methodology was required.

3) The survey instrument was distributed to the 106 largest electric consumers, and personal visits were made to each site in an attempt to achieve a high response rate to the survey.

4) For those who agreed to participate, on-site interviews were done by a nationwide network of interviewers (comprising over 20 interviewers) over the period November - December 1992.

5) A follow-up survey was conducted in the cooperating industries in December 1992 - January 1993 to obtain more quantitative data on energy consumption and production, and to evaluate the plant's attitudes toward energy conservation.

6) A data base was created containing the data from all the responses of the questionnaires.

7) Statistical analysis of the results was carried out by DBC.

8) Reports were prepared for both the main and the follow-up surveys by DBC, and provided to Hagler, Bailly and Committee of Energy.

2.1.3 Description of the survey

2.1.3.1 Conditions in which the survey was conducted

The survey was influenced by number of factors, characteristic of the state of the Bulgarian economy and industry:

- deep economic recession, and decrease of the production;
- loss of most of Bulgaria's traditional markets and trading partners;
- de-monopolization and disintegration of old production structures;
- considerable increase in the percentage of unemployment;
- slow rates of the progress of restructuring of the economy and privatization;
- substantial decrease of state subsidies and increase of the debts of the enterprises.

During this period, Bulgaria was faced with particularly acute energy problems, including power outages. The period of the survey also coincided with government decisions for substantial increases in electricity tariffs and other energy prices.

Finally, another important fact should be taken into account - that in Bulgaria there is no tradition for conducting such surveys in industry.

2.1.3.2 Survey interview techniques

The enterprises, subject to the survey are situated over the whole territory of Bulgaria, most of them being some distance from the large cities. From the point of view of the number of

questions as well as from the point of view of it's content, the study could be classified as technically complicated.

The officials which took part in the filling up of the questionnaires, were as follows:

- Top managers of the enterprises (general directors, executive directors);
- Deputy directors, responsible for the economics or production;
- Chief power engineering specialists, or Heads of departments "Power engineering";
- Heads of departments "Planning and Economics";
- Experts and specialists;

As a rule several of them took part successively in the responding of the questionnaires. The mean time to receive the full response was 15-20 days. During that time it was necessary for the interviewers to visit the enterprise several times in order to stimulate a response to the questionnaires.

From the total of 106 questionnaires send, 61 responded (57% rate), and 35 of these responded to the follow-up survey (33% response rate to full survey). In certain sectors of industry as coal mining, iron and steel, timber, construction and other branches the response rate was 100%. Of those who did not respond, some of the more important reasons were the following:

- The enterprises refuse in principle to accept questionnaires, because of the following motives:

  -- the questions represent firm's secrets;
  -- there are apprehensions of misuse of the information against the interests of the enterprise;
  -- essential structural and personnel changes are in progress;
  -- it is considered a priori that this is a pure waste of time.

  This group includes about 20 % of those who didn't answer.

- Enterprises which accepted the questionnaires, but didn't respond because of the following reasons:

  -- responding to the survey is of low priority, compared with the current operative tasks;

- -- it is impossible to create organization for joint completion of the questionnaires;
- -- fear of responsibility;
- -- during the progress of the filling up it is realized that more effort is necessary than originally considered;
- -- the questionnaire is left without control to somebody's working place, etc.

This group is the largest and includes about 75% of those who didn't answer.

- The enterprise said that the questionnaires were completed and sent to the interviewers by post, but were lost. This is about 5% of those not responding.

2.1.4 Summary of the Results

2.1.4.1 Business and operating conditions

Exhibit 2-1 shows the results of part 1 of the survey, which was intended to summarize business conditions and operating characteristics. The exhibit shows each survey item and a summary of the responses, by percentage. The percentages do not add up to 100% in those cases in which one or more respondents did not answer an item or judged two choices equal.

As shown in Exhibit 2-1:

- Employment is in decline, and is expected to decline further in 48% of the sites;

- Plant capacity utilization declined significantly in 1991 (number of plants operating at 50% capacity or less went from 11% to 28%) and slightly in 1992 (35% of plants at 50% capacity or less), the largest declines were in the engineered products and chemicals/petroleum sectors;

- Capacity utilization is forecast to improve slightly in 1993 (only 20% at 50% capacity or less, with the food industry particularly optimistic);

- The principal factor required for recovery:

  - -- new markets (mentioned by 57%);
  - -- better management, efficiency, productivity or quality (20%);
  - -- new technology (14%);
  - -- supply of raw materials (14%);
  - -- higher prices (6%);
  - -- economic recovery (6%).

- Half of the plants have made significant investments in the past two years, and 43% expect to make significant investments in 1993 (metallurgy industries expect to invest, pulp & paper does not);
- Privatization is expected in the next two years by only 20% of the plants;
- Backlogs of manufacturing orders are fairly good, and inventories are not excessive;
- Most plants work multiple shifts - 17% have changed working hours since 1990, and 9% expect to change in 1993;
- Hours of operation correspond with NEK peaks, and 59% work 24 hours per day;
- Solving manufacturing problems (such as marketing, raw material supply, quality, and productivity) are judged higher priorities than energy cost reduction;
- Among energy costs, electricity was the highest priority.

EXHIBIT 2-1
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 1 – SUMMARY OF OPERATIONS AND BUSINESS CONDITIONS

HOW MANY NUMBER OF EMPLOYEES AT THIS FACILITY?

less than 1000	1000–2000	2000–5000	over 5000
38%	32%	18%	5%

HOW HAS THE NUMBER OF EMPLOYEES CHANGED IN THE LAST YEAR?

same	increased	reduced by: 5–10%	reduced by: 10–20%	reduced by: more than 20%
21%	9%	39%	11%	13%

HOW DO YOU EXPECT THE NUMBER OF EMPLOYEES TO CHANGE OVER THE NEXT YEAR?

same	increased	reduced by: 5–10%	reduced by: 10–20%	reduced by: more than 20%
52%	7%	23%	9%	5%

WHAT IS THE BUSINESS OUTLOOK FOR YOUR INDUSTRIAL SECTOR?

optimistic	pessimistic	not clear
46%	2%	46%

APPROXIMATELY WHAT PERCENT OF MAXIMUM CAPACITY DID YOUR ENTERPRISE PRODUCE?

Year	less than 25%	25–50%	51–75%	76–100%
1990	4%	7%	27%	48%
1991	7%	21%	41%	18%
1992	5%	30%	43%	11%

APPROXIMATELY WHAT PERCENT OF MAXIMUM CAPACITY DOES YOUR ENTERPRISE EXPECT TO PRODUCE IN 1993?

less than 25%	25–50%	51–75%	76–100%
0%	20%	41%	21%

HAS YOUR ENTERPRISE MADE ANY SIGNIFICANT CAPITAL INVESTMENTS?

	Yes	No
In the last 2 years	50%	43%
In the last 6 months	25%	61%

EXHIBIT 2–1
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 1 – SUMMARY OF OPERATIONS AND BUSINESS CONDITIONS

DOES YOUR ENTERPRISE PLAN TO MAKE SIGNIFICANT INVESTMENTS IN THE NEXT YEAR?

Yes	No
43%	48%

WHEN DO YOU ANTICIPATE THAT THIS ENTERPRISE WILL BE PRIVATIZED?

already done	0–12 months	12–24 months	more than 24 months	not likely ever
0%	11%	9%	36%	36%

APPROXIMATELY HOW LONG IS YOUR ENTERPRISE'S BACKLOG OF ORDERS?
months of production at current production rate

less than 1	1 – 2	2 – 4	4 – 6	6 – 9	9 – 12
11%	20%	11%	6%	11%	6%

APPROXIMATELY HOW LARGE IS YOUR ENTERPRISE'S INVENTORY OF FINISHED PRODUCTS?
months of production at current production rate

less than 1	1 – 2	2 – 4	4 – 6	6 – 9	9 – 12
23%	17%	6%	0%	0%	3%

HOW DOES THE ENTERPRISE OPERATE DURING THE DAY?

24 hours/day	2 shifts	1 shift
59%	29%	13%

HOW MANY HOURS PER WEEK DOES THE MAIN PRODUCTION PROCESS OPERATE?

less than 24	24–48	48–72	72–96	96–120	120–144	144–168
9%	17%	9%	12%	3%	9%	41%

EXHIBIT 2–1
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 1 – SUMMARY OF OPERATIONS AND BUSINESS CONDITIONS

WHAT ARE THE HOURS OF OPERATION OF THE PRODUCTION PROCESS AT YOUR ENTERPRISE?

hours of operation	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
0 – 1	62%	65%	65%	65%	65%	59%	56%
1 – 2	62%	65%	65%	65%	65%	59%	56%
2 – 3	62%	65%	65%	65%	65%	59%	56%
3 – 4	62%	65%	65%	65%	65%	59%	56%
4 – 5	62%	65%	65%	65%	65%	59%	56%
5 – 6	68%	71%	71%	71%	71%	62%	59%
6 – 7	76%	76%	76%	76%	76%	65%	65%
7 – 8	82%	82%	82%	82%	82%	68%	68%
8 – 9	100%	100%	100%	100%	100%	74%	68%
9 – 10	100%	100%	100%	100%	100%	74%	68%
10 – 11	100%	100%	100%	100%	100%	74%	68%
11 – 12	100%	100%	100%	100%	100%	74%	68%
12 – 13	100%	100%	100%	100%	100%	74%	68%
13 – 14	100%	100%	100%	100%	100%	71%	68%
14 – 15	100%	100%	100%	100%	100%	71%	68%
15 – 16	100%	100%	100%	100%	100%	71%	68%
16 – 17	91%	91%	91%	91%	91%	71%	68%
17 – 18	79%	79%	79%	79%	79%	65%	65%
18 – 19	79%	79%	79%	79%	79%	65%	65%
19 – 20	79%	79%	79%	79%	79%	65%	65%
20 – 21	79%	79%	79%	79%	79%	65%	65%
21 – 22	76%	76%	76%	76%	76%	62%	62%
22 – 23	74%	74%	74%	74%	74%	62%	62%
23 – 24	71%	71%	71%	71%	71%	62%	62%

HAVE THERE BEEN ANY CHANGES TO THESE HOURS SINCE 1990?

Yes	No
17%	77%

DO YOU EXPECT ANY CHANGES TO THESE HOURS IN 1993?

Yes	No
9%	86%

EXHIBIT 2–1
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV -- DBC"

PART 1 – SUMMARY OF OPERATIONS AND BUSINESS CONDITIONS

WHAT ARE NOW THE SHORT–TERM PRIORITIES IN YOUR ENTERPRISE?

Description of the problem	Percentage who ranked it (5 is top priority) 5	4	3	2	1	0	Score	Rank
Finding a way to sell more of our finished products	63%	14%	6%	3%	3%	11%	3.97	1
Obtaining reliable sources of raw materials	34%	20%	3%	11%	6%	26%	2.89	2
Reducing the cost of production, not including energy	26%	14%	23%	11%	6%	20%	2.83	3
Improving the quality of our products	20%	17%	17%	9%	0%	37%	2.37	4
Reducing the cost of electric energy	17%	20%	14%	9%	3%	37%	2.29	5
Managing people and improving labor productivity	20%	6%	26%	9%	9%	31%	2.26	6
Maintaining our equipment, reducing break–downs	14%	14%	26%	3%	3%	40%	2.14	7
Reducing the cost of fuel energy	14%	17%	11%	14%	6%	37%	2.09	8
Reducing pollution, improving ecology	17%	11%	11%	17%	6%	37%	2.06	9
Obtaining reliable sources of electric energy	9%	11%	20%	11%	3%	46%	1.74	10
Dealing with inefficient government bureacracy	11%	6%	23%	9%	0%	51%	1.66	11
Reducing the cost of heat energy	6%	17%	17%	6%	3%	51%	1.63	12
Privatizing our plant	9%	11%	23%	0%	3%	54%	1.60	13
Changing our plant to produce different products	6%	11%	14%	11%	6%	51%	1.46	14
Obtaining reliable sources of heat energy	14%	6%	0%	11%	6%	63%	1.23	15
Reducing operations to meet the market conditions	3%	6%	17%	11%	3%	60%	1.14	16
Obtainining reliable sources of fuel energy	0%	14%	9%	6%	11%	60%	1.06	17
Other	3%	0%	0%	3%	0%	94%	0.20	18

2.1.4.2 Current and projected electricity usage

Exhibit 2-2 shows the results of part 2 of the survey, which concerned electricity usage. Again, the exhibit shows each survey item and a summary of the responses, by percentage. The percentages do not add up to 100% in those cases in which one or more respondents did not answer an item.

As shown in Exhibit 2-2:

- 83% of the sites have a load of 10 MW or more;
- 1992 electricity consumption was reduced from 1991 in 46% of the plants:
- 1992 reductions were significant (10% or more) in 31% of the plants, and very large (20% or more) in 20% of the plants;
- 1993 electricity consumption and peak usage is forecast to be the same as 1992, or higher, in 91% of the plants;
- Peak demand (MW) seems be about the same as day MW;
- Reductions in peak demand have been significantly less than reductions in energy consumption, and this trend is expected to continue;
- The expected changes in electricity consumption are well correlated with the expected changes in production;

EXHIBIT 2-2
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 2 – CURRENT AND PROJECTED ELECTRIC ENERGY USAGE

WHAT IS THE ELECTRIC ENERGY CONSUMPTION FOR YOUR ENTERPRISE FOR 1992?

Period:	Gigawatt-hours (GWh): less than 2	2 – 5	5 – 10	10 – 20	20 or more
peak GWh	9%	51%	17%	9%	11%
day GWh	3%	14%	34%	23%	23%
night GWh	14%	40%	9%	20%	14%
TOTAL GWh	3%	0%	11%	40%	43%

HOW IS YOUR ELECTRIC ENERGY CONSUMPTION DISTRIBUTED FOR 1992?

Peak energy	Day energy	Night energy
22%	45%	32%

HOW HAS THE TOTAL ELECTRIC ENERGY CONSUMPTION CHANGED IN COMPARISON WITH 1991?

CHANGE	the same	increased by...	decreased by...
0	31%		
1–5%		6%	14%
5–10%		0%	0%
10–20%		8%	11%
20–50%		9%	17%
> 50%		0%	3%
TOTAL	31%	20%	46%

HOW DO YOU EXPECT THE TOTAL ELECTRIC ENERGY CONSUMPTION TO CHANGE IN 1993, COMPARED WITH 1992?

CHANGE	the same	to increase by...	to decrease...
0	51%		
1–5%		11%	0%
5–10%		3%	0%
10–20%		6%	3%
20–50%		11%	6%
> 50%		9%	0%
TOTAL	51%	40%	9%

EXHIBIT 2-2
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 2 – CURRENT AND PROJECTED ELECTRIC ENERGY USAGE

HOW DID THE ENERGY CONSUMPTION DURING PEAK HOURS CHANGE IN 1992, COMPARED WITH 1991?

CHANGE	the same	increased by...	decreased by...
0	29%		
1–5%		9%	0%
5–10%		9%	3%
10–20%		9%	6%
20–50%		14%	14%
> 50%		6%	3%
TOTAL	29%	47%	26%

HOW DO YOU EXPECT THE ENERGY CONSUMPTION DURING PEAK HOURS TO CHANGE IN 1993, COMPARED WITH 1992?

CHANGE	the same	to increase by...	to decrease by...
0	51%		
1–5%		9%	0%
5–10%		6%	0%
10–20%		3%	6%
20–50%		20%	0%
> 50%		3%	0%
TOTAL	51%	41%	6%

CORRELATION OF RESPONSES TO QUESTIONS ON ENERGY USAGE AND PRODUCTION:
HOW DO YOU EXPECT THE LEVEL OF PRODUCTION OUTPUT TO CHANGE IN 1993?
HOW DO YOU EXPECT THE TOTAL ELECTRIC ENERGY CONSUMPTION TO CHANGE IN 1993?

Production Output:	Electric energy consumption: the same	up 1–10%	up 10–20%	up > 20%	down 1–10%	down 10–20%	down > 20%	TOTAL
the same	73%	9%	9%	9%	0%	0%	0%	31%
up 1–10%	33%	33%	17%	17%	0%	0%	0%	17%
up 10–20%	57%	14%	0%	14%	0%	0%	14%	20%
up more than 20%	29%	0%	0%	57%	0%	0%	14%	20%
down 1–10%	0%	0%	0%	0%	0%	0%	0%	0%
down 10–20%	0%	0%	0%	0%	0%	0%	0%	0%
down more than 20%	0%	50%	0%	0%	0%	50%	0%	6%
TOTAL	51%	14%	6%	20%	0%	3%	6%	

EXHIBIT 2-2
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 2 – CURRENT AND PROJECTED ELECTRIC ENERGY USAGE

WHAT IS THE MAXIMUM ELECTRIC POWER DEMAND FOR YOUR ENTERPRISE FOR 1992?

	Megawatts:				
Period:	0 – 5	5 – 10	10 – 20	20 – 50	50 or more
peak MW	29%	39%	6%	6%	6%
day MW	32%	32%	10%	6%	3%
night MW	42%	23%	10%	6%	3%

HOW DID THE MAXIMUM DEMAND (MW) CHANGE IN 1992, COMPARED WITH 1991?

CHANGE	the same	increased by...	decreased by...
0	51%		
1–5%		3%	0%
5–10%		3%	3%
10–20%		6%	9%
20–50%		6%	14%
> 50%		0%	0%
TOTAL	51%	18%	26%

HOW DO YOU EXPECT THE MAXIMUM DEMAND (MW) TO CHANGE IN 1993, COMPARED WITH 1992?

CHANGE	the same	to increase by...	to decrease by...
0	63%		
1–5%		6%	0%
5–10%		3%	0%
10–20%		9%	3%
20–50%		11%	3%
> 50%		0%	0%
TOTAL	63%	29%	6%

EXHIBIT 2–2
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 2 – CURRENT AND PROJECTED ELECTRIC ENERGY USAGE

WHAT IS YOUR ESTIMATED COST FOR PURCHASED ENERGY 1992?
MILLIONS OF LEVA

	0–5	5–10	10–20	20–50	50–100	more than 100	no answer
Electricity	3%	23%	23%	17%	6%	6%	23%
Heat	6%	9%	0%	3%	0%	0%	83%
Gas	9%	6%	9%	3%	0%	3%	71%
Oil	14%	6%	14%	3%	6%	3%	54%
Coal	14%	0%	0%	3%	0%	0%	83%

2.1.4.3 Equipment installed for electricity generation and use

Exhibit 2-3 shows the results of part 3 of the survey, which concerned equipment available for power generation, and principal electricity using equipment. Again, the exhibit shows each survey item and a summary of the responses, by percentage. The percentages do not add up to 100% in those cases in which one or more respondents did not answer an item.

According to NEK, Bulgaria now has nine large industrial cogenerators (with capacities of 20 MW or greater). Six of the 61 plants surveyed can generate their own electricity, but the survey discovered that two of these do not operate their generators regularly.

As shown in Exhibit 2-3:

- Six of the plants responding have a generator, of these three are in the chemicals and petroleum sector, two in non-ferrous metals and one in glass;
- Of those six that have a generator, two do not operate regularly, but probably could do so;
- Among those six that have a generator, only half felt that the purchase price of power paid by NEK is too low;
- Among those six that have a generator, the following reasons were given for not increasing the output:
  - -- three (50%) said they were at their technical potential;
  - -- one said because of the reduced production rate;
  - -- one said because of low electricity prices;
  - -- one said because of lack of fuel.
- Among those that do not have a generator, only 2% considered it possible to install one (25% no answer or did not know);
- Motors driving pumps, fans, compressors, and other equipment were cited as primary loads by 77% of the respondents;
- Less than half of the plants use efficient lighting systems (sodium vapor, metal halide, or compact fluorescent).
- For the specific process equipment identified (some of which are relevant only to specific industrial sectors), the following totals were developed:
  - -- electrolysis (chemicals) 27 MW

--	heat treatment (metals)	25 MW
--	rolling mills (metals)	24 MW
--	compressors	20 MW
--	electric furnaces (metals)	18 MW
--	water pumps	16 MW
--	catalytic cracking (petroleum)	15 MW
--	motors for other uses	15 MW
--	machine tools (engineered products)	11 MW
--	fans	10 MW

EXHIBIT 2–3
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 3 – EQUIPMENT INSTALLED FOR ELECTRICITY GENERATION AND USE

IS THERE AN ELECTRIC GENERATOR AT THIS FACILITY?

Yes	No
11%	88%

IF SO, DOES THE GENERATOR OPERATE REGULARLY?

Yes	No
67%	33%

(FOR THOSE WHO HAVE A GENERATOR) IS THE PRICE PAID BY NEK FOR PURCHASED POWER TOO LOW?

Yes	No
50%	50%

IS THERE A POSSIBILITY OF INCREASING THE OUTPUT OF YOUR EXISTING GENERATOR?

Yes	No
33%	67%

IS THERE A SIGNIFICANT REQUIREMENT FOR STEAM OR HOT WATER AT YOUR FACILITY?

Yes	No
71%	14%

IF YOU DO NOT HAVE A GENERATOR, IS IT POSSIBLE TO INSTALL ONE?

Yes	No
2%	73%

WHAT ARE THE PRIMARY CONSUMERS OF ELECTRIC ENERGY IN YOUR ENTERPRISE?

	Mentioned by:
Motors driving pumps, fans, compressors	77%
Lighting	61%
Electric heating, furnaces, boilers	52%
Welding	34%
Machine tools, metal working	25%
Electrochemical processes	14%
Refrigeration	11%
Other	7%

EXHIBIT 2–3
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 3 – EQUIPMENT INSTALLED FOR ELECTRICITY GENERATION AND USE

WHAT TYPES OF LIGHTS ARE USED AT YOUR ENTERPRISE?	Mentioned by:
Fluorescent	89%
Incandescent	86%
Mercury vapor	75%
Sodium vapor	45%
Metal halide	27%
Compact fluorescent	14%
Other	0%

2.1.4.4 Energy conservation experience, opportunities, and attitudes

Exhibit 2-4 shows the results of part 4 of the survey, which concerned energy conservation. Again, the exhibit shows each survey item and a summary of the responses, by percentage. The percentages do not add up to 100% in those cases in which one or more respondents did not answer an item.

As shown in Exhibit 2-4:

- Some 13% of plants could curtail usage during peak periods a significant amount, and another 50% could reduce slightly;

- Some 77% are interested in pursuing energy conservation opportunities in their plant;

- 69% of the respondents are aware of ideas to improve energy efficiency, the measures could be grouped in the following way:

  -- expedient technological changes and improvements (65% of respondents);
  -- improvements in lighting systems and controls (20%);
  -- correct operations of production processes, such as loading of equipment and coordination of energy consumers (20%);
  -- measures for improvement of cos Φ (power factor) (9%);

- The reasons why these improvements have not yet been implemented are:

  -- lack or scarcity of funds, finances (53% of respondents);
  -- production process limitations, such as continuous operations (25%);
  -- lack of incentives, existing energy prices (9%);
  -- lack of suitable organization (6%);
  -- lack of suitable projects (6%);

- About half the plants are willing to invest in energy efficiency projects, including borrowing from a bank if necessary;

- Energy audits have been conducted in 50% of the enterprises:

  -- 58% of audits were conducted by external organizations (institutes and design organizations in energetics and automation),
  -- 27% were conducted by specialists of the enterprises themselves,
  -- 15% were joint studies by external organizations and specialists from the enterprise.

- Of the plants that had energy audits, 6% were completely satisfied with the results, 62% found the audits to be partially satisfactory, and 28% found the audit to be useless;

- 70% of the plants would be willing to participate in an energy audit program financed by COE or NEK, and 14% refuse;

- 42% of the plants would be willing to hire an energy auditor (and about one-quarter of these had already done so);

- Only 14% of the plants were aware of any energy efficiency activities in Bulgaria by Western experts.

EXHIBIT 2–4
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 4 – ENERGY CONSERVATION EXPERIENCE, OPPORTUNITIES AND ATTITUDES

COULD THE ENTERPRISE CURTAIL ALL OR PART OF ITS ELECTRICAL USE DURING PEAK PERIODS?

Yes, significant amount	Yes, a little	None at all
13%	50%	34%

COULD THE ENTERPRISE SWITCH SOME OF ITS ELECTRICAL USAGE TO FUELS?

Yes, significant amount	Yes, a little	None at all
13%	20%	68%

DO YOU KNOW OR EXPECT THAT THERE ARE OTHER ENERGY EFFICIENCY MEASURES APPLICABLE TO YOUR FACILITY?

Yes, significant amount	Yes, a little	None at all
14%	55%	29%

WOULD YOU BE INTERESTED IN IMPLEMENTING ENERGY EFFICIENCY MEASURES AT YOUR FACILITY

Yes, very interested	Yes, somewhat interested	No
50%	27%	9%

WOULD YOU MAKE THE EXPENDITURE REQUIRED FOR ENERGY SAVING PROJECTS?

Yes	49%
No, we have no money available	34%
No, we have other priorities for our money	9%

WOULD YOU BORROW MONEY FROM A BANK TO INVEST IN AN ENERGY EFFICIENCY PROJECT?

Yes, we have already done this	9%
Yes, but we need help to arrange credit	23%
Yes, but we don't know of any appropriate investment projects	20%
No, we have other priorities for investment	40%

WOULD YOU BE INTERESTED IN LEARNING MORE ABOUT WAYS TO REDUCE ENERGY COSTS?

Yes, very interested	Yes, somewhat	No, energy is low priority	No, we already know how
57%	29%	3%	6%

HAS AN ENERGY AUDIT BEEN CONDUCTED AT YOUR ENTERPRISE?

Yes	No
50%	46%

EXHIBIT 2–4
BULGARIA
SURVEY OF LARGEST ELECTRICAL CONSUMERS
DECEMBER 1992 BY ET "DIMITAR BAEV – DBC"

PART 4 – ENERGY CONSERVATION EXPERIENCE, OPPORTUNITIES AND ATTITUDES

IF YOUR PLANT HAS RECIEVED AN ENERGY AUDIT, HOW SATISFACTORY WERE THE RESULTS?	
Yes, we had energy audit and are absolutely satisfied	3%
Yes, we had energy audit and are partially satisfied	31%
Yes, we had energy audits, and it turned out to be useless	14%
No, we have not had an energy audit	46%

WOULD YOU BE INTERESTED AN ENERGY AUDIT PAID FOR BY COE/NEK?		
Yes	No	Maybe
70%	14%	14%

WOULD YOUR FIRM BE WILLING TO PAY FOR ENERGY AUDIT BY BULGARIAN EXPERTS?	
Yes, in fact we already hired someone	11%
Yes, we would pay a market price	31%
No, only if we can get it at no cost	31%
No, not interested in an energy audit	17%

ARE YOU AWARE OF ANY ENERGY EFFICIENCY PROGRAMS CARRIED OUT IN BULGARIA BY FOREIGN EXPERTS?	
Yes	No
14%	80%

DID YOU HEAR ABOUT THE 1991 INDUSTRIAL ENERGY EFFICIENCY PROGRAM IN BULGARIA SPONSORED BY USAID?	
Yes	No
3%	89%

2.2 RESULTS OF ENERGY AUDITS IN BULGARIA

Under funding provided by the USAID Emergency Energy Project, energy audits were carried out in eight industrial enterprises in Bulgaria in 1991 by International Resources Group (IRG) of Washington DC. The enterprises audited were:

- Kremikovtzi Steel Company, Cold Rolling Mill (iron & steel sector)
- Serdika Milk Processing Plant (food processing)
- "Pharmacia" Company, Stanke Dimitrov (pharmaceuticals)
- Izida Ceramic Works (ceramics)
- Dobritch Poultry Company (food processing)
- "Parvi Mai" Textile Mill, Varna (textiles)
- Devnia Soda Ash Plant (mineral processing)
- Chimco Ammonia and Urea Plant (petrochemical fertilizer)

The scope of these audits focussed on thermal energy, not electricity, however general findings are expected to be similar. The summary findings of IRG are quoted below[1]

> Attention to energy conservation varied widely; however energy inefficiency was evident in every plant. The inefficiencies exist for a number of reasons. Lack of instrumentation required for effective energy monitoring and the use of inherently inefficient Eastern Bloc technologies are two main causes of industrial energy inefficiency. Equally important, subsidized energy inputs into the production process have historically discouraged efficient energy use. Moreover, until the initiation of the Emergency Energy Program, with its emphasis on energy efficiency, managers in all the demonstration plants were too overwhelmed with the pace and magnitude of economic changes to devote adequate time and consideration to any single problem, including energy efficiency.
>
> Neither management nor technical staff were given guidance or encouragement on energy efficiency from the previous regime, and consequently they were simply unaware of the magnitude of easily preventable energy losses. With the demise of the former government, myopic production considerations ceased to be the focus of enterprise

[1] "Industry Profile Report - Bulgaria", May 1992, for U.S. AID by International Resources Group, Washington DC.

management. Instead, efficiency and profitability, hallmarks of free market economies, gained transcendence.

Communication in large organizations is rarely as effective as needed under the best of circumstances. The legacy of central planning and single party rule, with its emphasis on idealogy, has further complicated the communication process, by making Bulgarian workers eager to "keep a low profile and not make waves."

The demonstration plants were organized along functional lines, with production/ operations, maintenance, packing and shipping, finance, utilities, engineering/technical services, and administrative/purchasing divisions. However, these enterprises differed from Western organizations insofar as they did not have internal sales or marketing divisions, since this function was handled by separate large state-owned trading companies. Since 1990, enterprise managers, previously concerned only with production, were forced to expand their marketing functions, despite relative inexperience in this area. Consequently, marketing became a high management priority in nearly every production plant.

State-owned companies and plants in Bulgaria historically were not subject to complete financial accountability, owing to government subsidies. Consequently, they had less incentive to save energy. Although the situation has now changed, and energy efficiency is an important factor in economic survival, Bulgarian managers have largely ignored the potential for low-cost and no-cost energy savings measures. To some extent, this inaction is the lack of awareness of the magnitude of avoidable energy (and financial) losses due to energy efficiency.

Even in instances where industrial managers and technical staff are aware of the importance of efficient energy use, institutional issues have inhibited widespread improvement in energy efficiency. Lack of financial resources (local or hard currency) and the lack of availability of most instrumentation needed for energy audits, monitoring and control, have made the purchase of even inexpensive monitoring equipment and capital intensive control systems difficult for most plants.

Moreover, industrial management inexperience with investment decision-making can result in haphazard use of investment resources that are available. Standardized investment decision-making practices are rare and inadequate. Industrial decision-makers in Bulgaria do not have sufficient understanding of the value of small energy saving initiatives, and are more interested in complex technologies. Overall, managers have not, until recently (the energy audits and in-part training programs made managers aware of the costs of energy) been aware of the magnitude of the value of what appeared to be small energy losses. For example, few plants gave any consideration to the effective

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performance of steam traps or to steam condensate recovery programs[2], both of which are low-cost, high payback initiatives.

Owing to increased awareness of the importance of small energy losses, managers at all the demonstration plants have become very interested in analyzing and implementing smaller-scale, low cost energy conservation initiatives. However, efforts to promote a "efficiency ethic" have been limited, and little attention is given to basic measures such as keeping furnace doors, building doors and windows closed and turning out lights in vacant rooms. Few effective energy management programs exit in Bulgaria, again owing to the lack of equipment availability and lack of management understanding of the benefits of energy management. Ultimately, however, economic survival imperatives, combined with increasing energy prices, will promote increased interest in energy saving initiatives throughout Bulgaria.

[2] Hagler, Bailly expects that similar situations exist for electrical energy; one example would be the use of motors which are too large for the actual load.

2.3 FINDINGS OF ENERGY AUDITS IN OTHER EASTERN EUROPEAN COUNTRIES

Since 1991, Hagler, Bailly has carried out management, technical and energy audits in more than 30 industrial enterprises in the region (in Hungary and Yugoslavia in 1991 and Latvia, Estonia, and Russia in 1992, and Poland in 1993). In the project in Hungary, factories carried out process changes, management changes, and organization changes that led to energy cost savings of more than $1 million per year in several cases. Measured improvements to the ratio of energy to production quantity of more than 30% was achieved in one factory and more than 20% in another factory, both at the same production level. In addition, traditional heat and power energy saving projects were carried out which saved 5-10% in several factories.

Since 1992, Hagler, Bailly has been conducting the Industrial Energy Efficiency project in Bulgaria on behalf of USAID, as a follow-up to the 1991 Emergency Energy Project. We recognize that there are significant differences between Bulgaria and other countries, however we have also observed similarities in technology and management approaches. This section summarizes technical findings from work in many countries in the region, with notes on their relevance to electricity demand management in Bulgaria.

Any improvements in energy efficiency can only be achieved by taking specific, detailed actions. These actions involve changes to operations, maintenance, or equipment. Some actions may cost nothing, and others may require million dollar investments. An energy efficiency program typically involves 10-20 actions, each of which improve efficiency by 1-2%.

Achieving and maintaining good energy efficiency in an enterprise is a never-ending process, and must be fully integrated into the normal course of business operations. The standard of efficiency is always increasing over time, as dictated by the competition in any given market.

There are many techniques for improving industrial energy efficiency, but these are often simplified by categorizing them in groups, on the basis of the investment required:

A. Management and organizational improvements, which generally require little or no investment;

B. Low-cost measures to improve operations and maintenance, projects which provide a payback of one year or less;

C. Minor investments to upgrade existing equipment, projects which provide a payback of two years or less, based on energy savings;

D. Major investments to acquire new, modern equipment, which should provide multiple benefits in productivity, quality, and energy efficiency.

2.3.1 Examples of "Type A" Actions, Management and Organizational Improvements

- Hire professionals with expertise in the specific industrial process to work together with plant senior staff (General Director, Economics Director, Technical Director) to carry out a "management audit", an executive review of the production organization, management, marketing, accounting, finance, operations, and investment program to identify ways to reduce costs and improve productivity, efficiency and quality. Use the results of this audit to develop an action plan.

- Change ownership so that a new "owner's mentality" and sense of purpose for the future is created. The owner must establish a management commitment to quality, productivity and efficiency. The owner may take an active approach to seek out foreign joint venture partners.

- Change organizational structure to place responsibility for energy efficiency (including identification and implementation of energy saving ideas and projects) at the production department, where most energy is consumed. Two possible approaches to do this:

  -- make the energy department subordinate to production, like other suppliers of raw materials;

  -- if a cogeneration facility exists, establish energy department as a profit center, "selling" energy to production department.

- Establish energy accounting systems and management information systems to allow management to monitor efficiency in time to take control actions.

- Create working conditions that motivate all employees (especially those in the production departments) to improve efficiency, productivity and quality, including financial incentives and feedback of results.

- Provide information and training appropriate to employees at management and engineering levels in energy efficiency technology and techniques.

- Establish a "total" quality and efficiency management program in the plant, based on employee participation in a process of continuous improvement based on planning, testing, action, feedback of results, and refinement.

- Organize a market-driven decision-making process for difficult, but essential, management decisions which are urgently required, but are being delayed, such as:

- -- Which markets to be in
- -- Which products to produce
- -- Level of quality needed by the market
- -- Type of packaging needed by the market
- -- Transportation needed to get to the market in time
- -- Which parts of the plant are obsolete and must be closed

- Establish a marketing department with sufficient staffing and funding[3] to increase sales, so that the plant can operate at higher capacity factor, and thereby spread fixed energy consumption over more units of production.

- Establish a production process R&D department to learn the state-of-the-art in the selected markets/products, and plan the future modernization of the plant. Provide a budget for experts to carry out market research and feasibility studies[4].

- Optimize operations, so that production is carried out using the most efficient equipment in the factory in the most efficient way (least-cost production).

2.3.2 Examples of "Type B" Actions, Low-Cost Improvements to Operations and Maintenance

- Hire professionals with expertise in the specific industrial process to work together with plant senior staff (Technical Director, ·ief Engineer) to carry out a "technical audit", an engineering and economic review of the production operations, technology, maintenance, and investment program to identify opportunities to reduce costs and improve productivity, efficiency, and quality. Use the results of this audit to develop an action plan.

- Hire professionals with expertise in industrial energy conservation to work together with plant senior staff (Chief Energetics) carry out an "electrical energy audit", an engineering and economic review of the plant electrical systems and equipment to identify opportunities to reduce energy cost. Use the results of this audit to develop an action plan.

- Upgrade the general standard of maintenance throughout the plant, and provide maintenance personnel with tools, training, status, and management reinforcement to carry out the job.

---

[3] Many western companies spend 20% of revenues, or more, on marketing.

[4] Many Western companies allocate 10% of revenues to R&D and new product development.

- Establish teams dedicated to specific efficiency-related tasks on electrical equipment such as lighting, motors, drive systems, rotating equipment (pumps, fans, compressors), and piping systems for compressed air, water, and refrigeration. Provide these teams with the necessary diagnostic instruments, repair tools, and budgets. These teams will have several tasks:

  -- To identify obvious energy waste, such as leaks, idling equipment or underloaded operations, and carry out necessary repairs.
  -- To identify low-cost improvements to operations and maintenance, and to establish new procedures.
  -- To identify minor retrofit improvements needed, and to develop cost and benefit estimates
  -- To develop specifications for future procurement, and thereby upgrade the standard of efficiency over time.

- Upgrade the level of instrumentation in the plant, especially for energy flows and efficiency-related parameters, and establish procedures based on instrument readings.

- Establish a preventive maintenance system in the plant, with necessary monitoring instruments, procedures, and dedicated staff, to improve equipment reliability (reduce downtime) and thereby increase efficiency.

- Provide information and training in energy efficiency technology and techniques, appropriate to employees at various production, operations and maintenance levels.

2.3.3 Examples of "Type C" Projects, Minor Investments in Equipment Upgrading

- Improve quality control equipment to reduce scrap generated by production process.

- Install recycling equipment to convert scrap generated at intermediate stages of the process.

- Rehabilitate electric furnaces and heat exchangers to clean radiant and convective heat transfer surfaces and repair casing leaks.

- Rehabilitate process equipment to improve reliability and reduce start/stops and downtime.

- Install efficient lighting systems, variable speed drives and other cost-effective retrofits where feasible.

2.3.4 Examples of "Type D" Projects, Capital Investments in Modernization

- Convert the plant to produce a different, but related, product that offers a higher value-added for a given level of energy consumption.

- Install new process technology for the same product to improve productivity, increase reliability, improve quality, and reduce specific energy consumption.

- Install new motors, turbines, and prime movers that offer higher efficiency.

- Install cogeneration (combined heat and power systems), possibly sized to generate excess power for sale to NEK grid or sale of heat to the neighboring district.

3. BULGARIA ELECTRICITY DEMAND FORECAST

Several forecasts of electricity demand in Bulgaria have been completed over the past several years. Prior forecasts differ because of differences in scenarios, differences in forecasting techniques, and differences in data. However, the more recent forecasts that build on the data obtained after the initiation of Bulgaria's transition to a market economy will more accurately capture the Bulgarian economy's energy response to this transition and the probable future of electricity demand.

The forecasts are summarized graphically in Exhibit 3-1, and described briefly below.

3.1 World Bank forecast by Prof. Gordon Hughes in 1991

Professor Gordon Hughes performed a forecast in 1991, based on a pooled regression model. He obtained the coefficients for the model from previous analyses of centrally planned economies and analyses of vaguely similar economies in Europe. His forecasts show severe declines in aggregate electricity demand over several time periods as follows:

1989 to 1992	-29%
1989 to 1995	-44%
1989 to 2000	-47%

Prof. Hughes further uses an energy industry input-output model to look at alternative policy scenarios, where the main policy response is that to electricity price changes. Under this long run interindustry approach, he estimates the following changes to electricity demand:

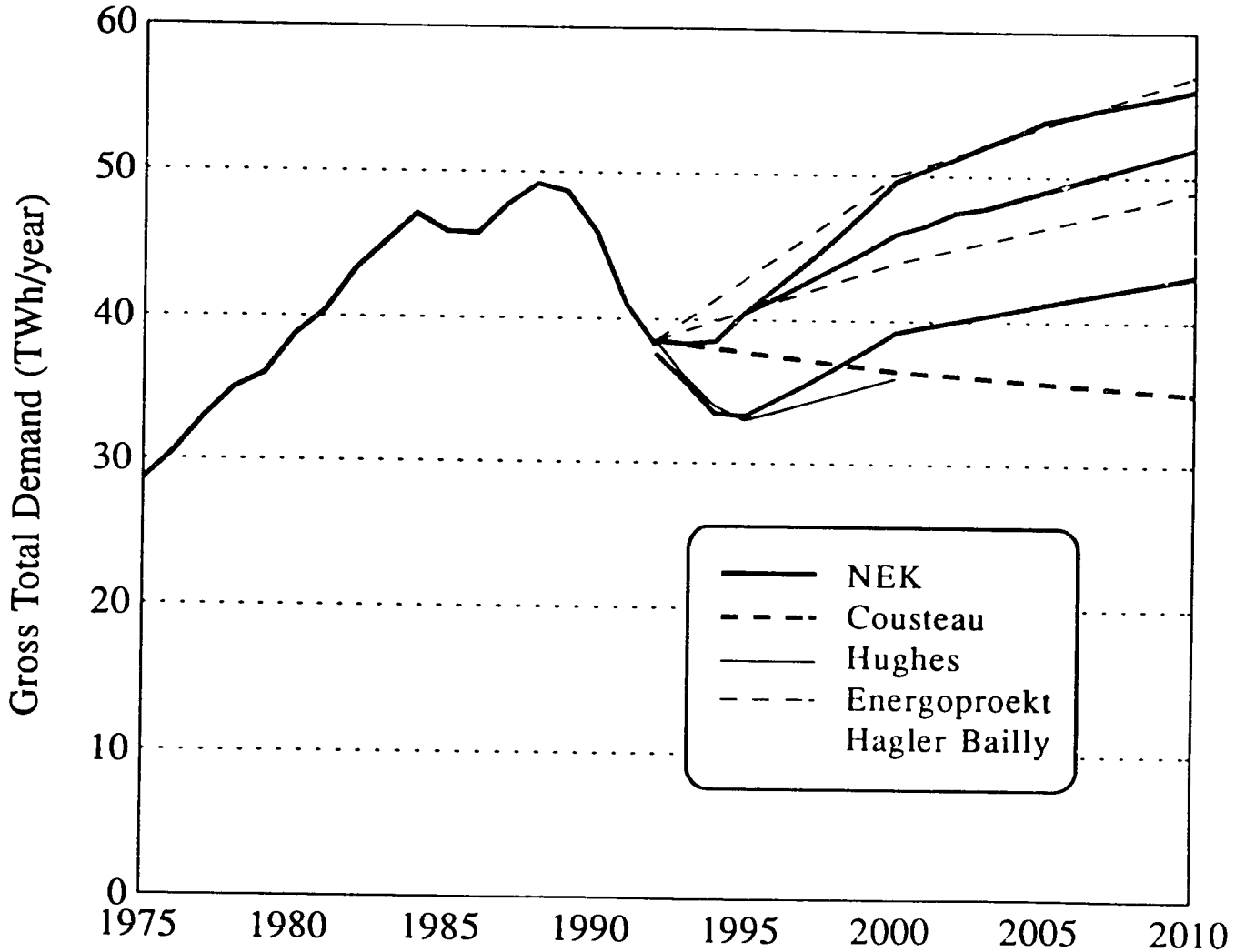
	1989 to 1995	1989 to 2000
Main Projection	-32%	-15%
Low Response	-27%	-16%
High Response	-32%	-14%

The response represents changes in electricity demand due to large changes in the price of electricity, deemed necessary to reach appropriate prices for operating a profitable utility.

Exhibit 3-1

Bulgaria - Total Electricity Demand

Comparison of Previous Forecasts



3.2 FORECAST BY NEK, WITH GUIDANCE FROM THE WORLD BANK, IN 1992

For a power system study of the Bulgarian power system at the request of the Group of 7, the World Bank requested a set of demand forecasts from NEK, then worked with NEK in November 1992 to make slight adjustments.

In this forecast, there are three scenarios: maximum, medium, and minimum. The maximum scenarios assumes the most rapid economic growth and the least adjustment by industry to the anticipated higher prices of electricity. The minimum scenario assumes lower economic growth and more adjustment by industry. It also assumes that 450,000 households convert from electricity heating to gas heating after the year 2000. The medium scenario assumes an economic growth between the other two and assumes no major conversions of households to gas heating.

In the medium scenario, electricity demand increases to 52,000 GWh in 2010, and to 56,000 GWh in the maximum scenario. In the minimum scenario, electricity demand increases to 43,200 GWh in 2010. The annual rates of growth in the electricity demand are quite different among these scenarios as can be seen below:

	1993 to 2000	2000 to 2010
Medium	2.25%	1.23%
Maximum	3.69%	1.22%
Minimum	0.60%	0.98%

The electricity demand in 2010 for the maximum scenario is approximately 30% larger than that of the minimum scenario. The medium scenario is much closer to the maximum scenario than to the minimum scenario.

3.3 ENERGOPROEKT FORECASTS

Energoproekt has furnished several forecasts of electricity demand in the Bulgarian economy. One forecast was done for the United Nations Economic Commission for Europe (ECE) in 1990. This forecast had Bulgarian GDP increasing at about 1.94% per year from 1990 to 2000, with electricity demand increasing from 39,000 GWH to 50,000 GWH, an increase of about 2.5% per year.

In 1991, Energoproekt published a forecast with two scenarios, a high scenario and a low scenario. Both scenarios were based on a GDP growth rate of approximately 2% per year to 2010 (1.94% from 1990 to 2000 and 2.1% from 2000 to 2010). The high forecast shows an increase in electricity demand to 50,000 GWh in 2000 and 57,000 GWh in 2010. This

represents an annual rate of increase of 2.5% from 1990 to 2000, and an increase of 1.3% from 2000 to 2010. The low scenario incorporates some energy efficiency into the forecast and forecasts a growth in electricity demand to the year 2000 of 44,000 GWh (an increase of 1.2% per year) and an electricity demand of 49,000 GWh (an increase of 1.1% per year) in the year 2000.

3.4 FORECAST BY EQUIPE COUSTEAU FOR THE EBRD IN 1992

In 1992, Equipe Cousteau prepared a study of the Bulgarian energy future for the European Bank for Reconstruction and Development (EBRD). This study, in collaboration with International Consulting on Energy, was called "Energy in the Danubian Countries, Current Situation, Outlook, and Energy Policy Proposals." The study used the methodology that Energoproekt has used for analyzing the Bulgarian economy, but expanded the methodology to analyze changes in industry structure and improvements in energy efficiency over time. This study assumed that GDP would grow at 2% per year until 2000 and then at 3% per year from 2000 to 2010. Using these assumptions and a decrease in final energy intensity from 0.93 in 1989 to 0.7 in 2000 and 0.5 in 2010, electricity demand decreases from 39,000 GWh in 1989 to 36,500 GWh in 2000 and 35,000 GWh in 2010. This represents a decrease of about 0.67% per year to 2000 and 0.42% per year from 2000 to 2010.

3.5 FORECAST BY HAGLER BAILLY IN 1993

A forecast was developed by Hagler Bailly, based on a scenario which reflects a continued difficult economic environment in Bulgaria with low exports, a continued retrenching of industry, high unemployment, high inflation, and high interest rates. Electricity use in industry is also lower in this scenario because of successful conservation programs and because of the reduction in industry output.

In this forecast:

- demand for electricity in the household sector continues to decline, reaching a minimum of 8,400 GWh in 1995, then climbs, reaching 11,000 GWh in 2010.
- in the industrial sector, demand drops slightly, with a minimum of 13,300 GWh in 1994-96, and then begins a gradual climb to 17,000 GWh in 2010.
- total electricity sales reach a minimum of 28,000 GWh in 1994-96 and then rise gradually to its 1988 level of 35,600 GWh around year 2008.

- peak demand reaches a minimum of 6,500 MW in 1994-95, then increases to 9,600 MW by 2010. The 1989 peak of 8,332 MW is reached again in year 2005.

3.6 BASE FORECAST CHOSEN FOR COMPARISON AND DSM ANALYSIS

The NEK medium scenario forecast is chosen as the base forecast, for the purposes of projecting the impact of DSM programs.

4. CREATING A POLICY FRAMEWORK TO PROMOTE EFFICIENT USE OF ELECTRICITY IN BULGARIA

4.1 INTEGRATED RESOURCE PLANNING

Integrated resource planning (IRP) is a concept in which the simultaneous consideration of supply-side and demand-side options is required, in order to minimize the cost of energy services to customers. In the United States, the Energy Policy Act of 1992 requires IRP by all the states, and IRP techniques have been adopted by several countries in Europe.

4.1.1 IRP Framework

An overview of a regulatory framework is presented in Exhibit 4-1. The utility regulatory agency adopts IRP, and requires each of the electric utility companies to submit an integrated resource plan. Regulatory approval of tariff increases would require that a least-cost plan for supplying electricity-related energy services be developed, with both the supply-side and the demand-side being adequately considered. DSM programs are developed which are evaluated against supply-side options in an IRP.

The steps used in IRP are shown in Exhibit 4-2. In the IRP approach, first the utility develops a set of objectives for its planning activities in response to its regulatory framework, the incentives available, and external factors and constraints. These external factors often include customer characteristics and preferences. In the development of an IRP, considerable involvement from outside parties is usually encouraged in order to obtain their ideas and address their concerns.

Next, the utility develops the demand forecast and other external constraints[1]. This establishes the need for new resources and forms the basis for the baseline supply-plan and the avoided costs.

Next, the need for new resources is determined by comparing the demand forecast with capacity available from existing resources and facilities currently under construction. Supply-side alternatives are examined to determine the least-cost expansion plan. The avoided cost, both capacity and energy, of the base supply-side scenario is calculated, and used to evaluate other supply-side and demand-side options.

[1] For example, revisions to environmental emissions regulations will require the utility to undertake new investment.

Exhibit 4-1
Regulatory Framework to Encourage Efficient Use of Electricity

Regulatory Agency

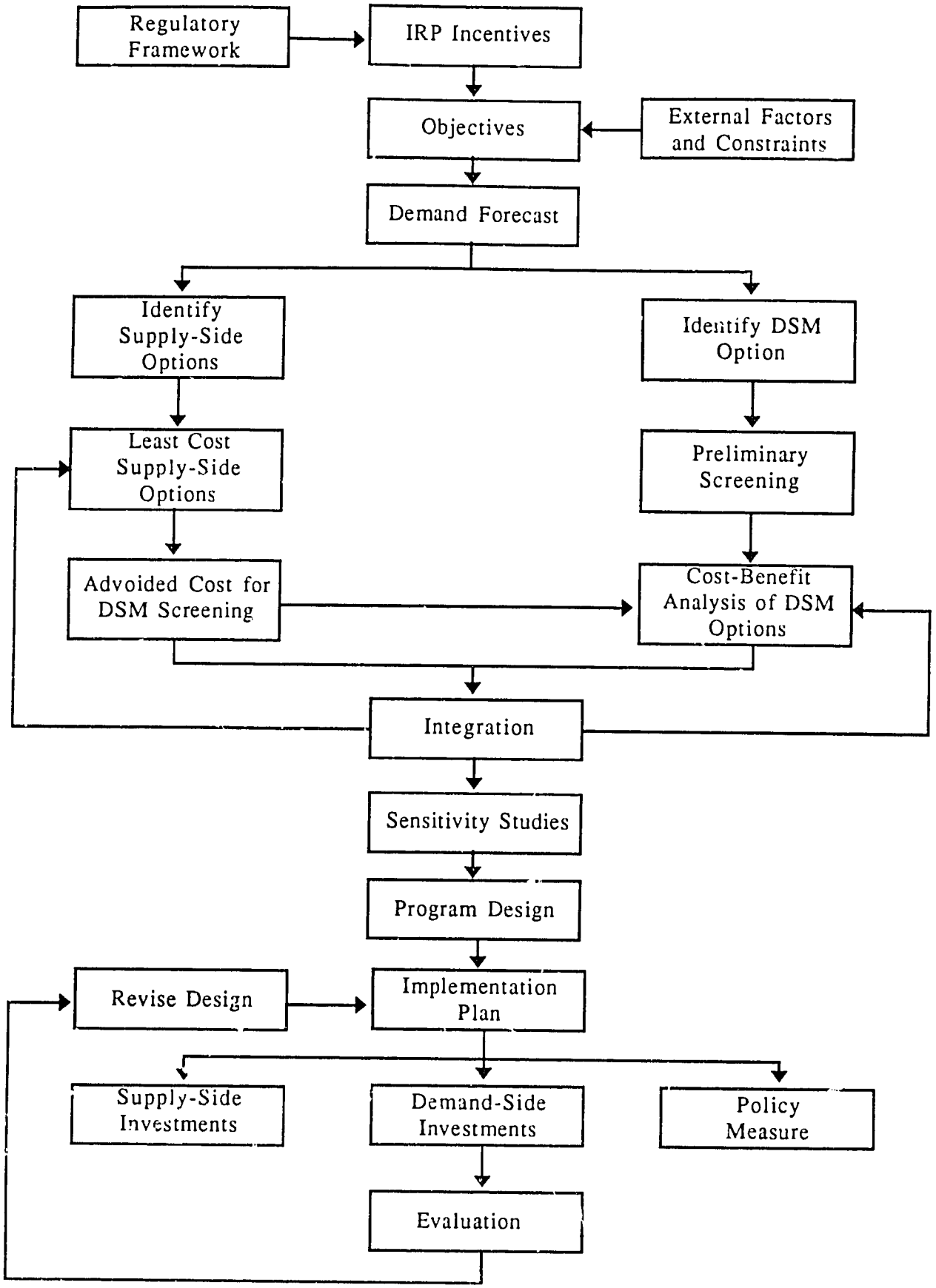
- Requires Integrated Resource Plans (IRP) from the electric utilities
- Reviews and approves assumptions made in each IRP, including the load forecast and environmental emissions
- Reviews and approves the investment plan in the IRP, resulting in approval of:
  - Budgets for supply-side investment (generation, transmission, distribution)
  - Budgets for demand-side management (DSM) investment

Electric Utility Companies

- Perform the studies, pilot programs and research necessary to prepare an IRP
- Identify the least-cost means of satisfying customers' demand for energy services, considering both demand- and supply-side options
- File an IRP with the appropriate regulatory agency, and defend the plan in hearings
- After gaining approval from the regulatory agency, implement the investment program, including supply-side and demand-side measures

Figure 4-2

Overview of Integrated Resource Planning



Demand-side options, called demand-side management (DSM), are developed, beginning first with a list of DSM alternative measures. A preliminary screening is performed to eliminate options that do not meet criteria for end-use objectives, availability and applicability. Following this initial screening, a cost-benefit assessment is performed using the avoided costs of the supply-side option.

The next step is integration, which usually requires several iterations between supply-side and demand-side options. A new supply-side plan is developed for this revised level of resources. The avoided cost from this revised plan is then used to re-screen DSM options. Additional cost-effective options from this new screening step are included and the process begins again. Several iterations may be required.

Integration can also involve more detailed analysis of the cost-effectiveness of DSM options. More detailed data may need to be collected and used to perform a more accurate assessment of the cost-effectiveness of the DSM option.

The final result of the integration step is the least-cost scenario of supply-side investment and demand-side options. This scenario and other scenarios are examined in a series of sensitivity studies, which review the cost-effectiveness under a wide range of assumptions.

Once the preferred course of action is identified, an action plan is developed to implement the plan. An action plan includes the tasks to implement the DSM options, including developing data collection tasks and pilot programs, as well as performing full scale DSM programs. The action plan also includes a plan for the development of the supply-side resources included in the preferred scenario.

4.1.2 Recommendations for Bulgaria

The legal and regulatory framework for energy and electricity is currently being developed in Bulgaria. There are early drafts of laws governing power plant licensing, building standards, and energy efficiency.

The time is right, therefore, to address the institutional framework and include integrated resource planning requirements in the laws establishing the regulatory framework for the utility.

We recommend that Bulgaria adopt the Integrated Resource Planning approach. This will require the following activities in the short term carried out in parallel:

- require that electricity agencies (Committee of Energy, National Electric Company, and others) assume IRP responsibilities, through enactment of appropriate legislation, regulations, and institutional development;

- develop a least-cost investment plan, considering all supply-side and demand-side options available to Bulgaria, not only from NEK itself but also other sources;

- evaluate electricity tariffs in comparison with long-run marginal costs determined by the least-cost investment plan, and restructure tariffs as required;

- carry out demonstrations under Bulgarian conditions of DSM policies, DSM technologies, DSM implementation strategies, and DSM financing options;

- based on successful demonstrations, develop policy to promote demand-side management (DSM), analyze DSM options in comparison to base case investment plan, and from those measures that are cost-effective, develop a DSM program.

In the remainder of Chapter 4, and in Chapter 5, we provide analysis and recommendations to develop some of these concepts further, particularly those related to demand-side management policy (Chapter 4) and programs (Chapter 5).

4.2 IRP OBJECTIVES

IRP objectives should be identified in the mission statement for Bulgaria's electricity sector. We propose the following statement:

> *It is the mission of the electricity sector to provide a reliable supply of electricity-related energy services at the lowest achievable cost, while satisfying all legal and regulatory requirements, especially those related to safety, environmental protection, and electricity pricing.*

Use of the term "energy services" indicates that consumers do not need electric energy (kWh) per se, but rather rotational shaft power (for pumping, ventilation, or material handling), heat, light, and hot water. By focusing on energy services, IRP considers that the customers' demand can be satisfied by other means.

During the winters of 1990/91 and 1991/92, Bulgaria suffered rolling blackouts. Improved reliability is thus an important objective. Modification of the daily load profile (such as

limiting peak demand, or shifting load from peak periods to off-peak) could help achieve improved reliability.

To provide power at least economic cost, in most cases minimizing the use of imported electricity and imported oil and coal used for electricity generation should be an objective.

It is common that government-owned utilities are directed to have further social objectives. An IEA study encourages governments that: "Sectoral cross-subsidies should be removed, and social policies should be kept distinct from energy policies."[2] The need for economic efficiency requires that electricity tariffs be set based on the cost of service for each customer class. If electricity rates are set too low, consumers waste electricity.

Minimizing the environmental impact of electric power generation is another objective. Total emissions can be reduced by installing improved emissions controls, switching to cleaner fuels, by reducing transmission and distribution losses, or by DSM (which reduces the generation required to provide a given level of energy services). Ideally, the economic cost of these impacts should also be considered in the context of the IRP, and consideration of the costs of "environmental externalities" has begun in some states in the U.S.

[2] International Energy Agency, Electricity Supply in the OECD, Paris; 1992, p. 9.

4.3 ELECTRICITY TARIFFS

Pricing is the most important step toward promoting the efficient use of electricity, and hence the management of electricity demand. Customers respond to pricing signals, and it is important that the signals reflect the real conditions, such as the cost of service.

4.3.1 NEK's Present Tariff Structure

In Bulgaria, as in most countries, electricity tariffs have evolved over the years to a complicated system of prices[3]. The current NEK tariff structure is shown in Exhibit 4-3.

The tariff includes the following features:

- separate tariffs for large customers (commercial and industrial, commonly known in the U.S. as C&I customers), depending on their service voltage;
- different tariffs for C&I customers for winter and summer;
- different tariffs for C&I customers for time of day, by three periods (peak, day and night);
  - for the six months October - March:
    peak hours: 0800-1100 and 1800-2100 (total 6 hours)
    day hours: 0600-0800, 1100-1800 and 2100-2200 (10 hours)
    night hours: 2200-0600 (8 hours)
  - for the six months April - September:
    peak hours: 0800-1200 and 2000-2200 (total 6 hours)
    day hours: 0700-0800, 1200-2000 and 2200-2300 (10 hours)
    night hours: 2300-0700 (8 hours)
- household customers pay much lower prices per kWh than C&I customers;
- separate tariffs for household customers for day and night usage;
- a tariff for purchase of power by NEK from other generators, which is based on the three periods of time of day (peak, day and night).

[3] Latest tariffs available at the time of Hagler Bailly's research were established January 1, 1993, based on Instruction No. 262 of the Council of Ministers on December 28, 1992.

Exhibit 4–3
BULGARIA
EXISTING NEK ELECTRICITY TARIFFS
as of January 1, 1993

	WINTER TARIFF, Leva/kWh			SUMMER TARIFF, Leva/kWh		
	Peak	Day	Night	Peak	Day	Night
C&I – time–of–day (TOD) metered:						
High voltage	1.395	0.757	0.374	1.217	0.655	0.322
Medium voltage	1.447	0.783	0.386	1.255	0.679	0.333
Low voltage	1.515	0.818	0.405	1.317	0.711	0.350
C&I – single kWh meter (non TOD)						
High voltage	1.125	1.125	1.125	0.978	0.978	0.978
Medium voltage	1.161	1.161	1.161	1.009	1.009	1.009
Low voltage	1.218	1.218	1.218	1.058	1.058	1.058
Households	0.440	0.440	0.233	0.440	0.440	0.233

Power purchase tariff, sold to NEK from non–utility generators (Leva/kWh)

Peak	Day	Night
0.938	0.520	0.228

EXHB4–3.WKT

4.3.2 Preliminary Estimate of the Marginal Cost of Service

4.3.2.1 Introduction to Marginal Cost Pricing

The marginal cost of a good is the incremental cost of producing one additional unit of that good. In a properly functioning competitive market, the price of a good will be approximately equal to the marginal cost of the good. Under these circumstances, the value to consumers of the last unit consumed will be equal to the value of the resources used to produce that unit. In the short-run, competition will drive prices down toward the marginal cost of production from existing capacity. In the long-run, as demand increases, marginal costs must increase to meet the need to expand or rebuild production capacity. The competitors in an ideal competitive marketplace will optimize short-run and long-run considerations, given the level of demand and competitive situation at a particular time. Thus, competitive market forces will result in marginal-cost pricing, and will ensure that society's resources and needs are balanced in the most efficient manner.

In a monopoly situation, there are no market forces tending to optimize prices. In the absence of a competitive market, it is nevertheless true that the economic benefit to society will be maximized by marginal cost pricing. If prices are set below marginal costs, demand will be increased above the economic optimum, and this increased consumption will be subsidized by the supplier. If prices are set above marginal costs, demand will be reduced below the economic optimum, and excessive profits will go to the supplier.

4.3.2.2 Preliminary estimate of marginal costs in Bulgaria

A detailed estimate of the marginal cost of electricity service in Bulgaria is normally carried out in a full tariff study, which is beyond the scope of our work. However, based on limited information from Bulgaria and our experience in conducting tariff studies in other countries, Hagler, Bailly has developed preliminary estimates.

In order to develop costs for analyzing and screening DSM options, we must develop estimates of the long-run marginal cost (LRMC) for capacity (kW) and energy (kWh). For Bulgaria, the installed capacity (approximately 12,000 MW) is apparently sufficient to meet the peak demand (approximately 7,400 MW). However, the poor availability of some plants has not proven sufficient to reliably meet the peak. Furthermore, environmental emissions from existing thermal plants are high. Therefore, investments will be required to rehabilitate and modernize the marginal existing capacity.

The cost of rehabilitating capacity will vary with the individual plant. We estimate costs of $50-100 per kW of generation capacity for basic emission controls, such as improved electrostatic precipitators. This does not include the cost of other upgrading for life extension, availability improvement or sulfur emissions control, which we estimate at a

further $100-500 per kW, or more. These costs approach the cost of a new gas turbine, which, based on recent experience, we estimate as $400 per kW. For the purposes of estimating avoided peak power (kW) cost, we will use the cost of a "rehabilitation project" proxy. This rehabilitation project includes not only generation, but also transmission, and distribution elements.

To estimate avoided energy (kWh) cost, we use the value of electricity generated from a marginal coal-fired plant as a proxy for avoided energy costs.

Exhibit 4-4 shows our preliminary estimate of the medium-term[4] marginal cost of supply, broken out by capacity costs and energy costs, for each voltage level.

[4] Approximately through the year 2000.

Exhibit 4–4
Bulgaria
Estimate of Long–Run Marginal Cost of Electricity Supply

1. Marginal Capacity Cost:

Assume: thermal plant rehabilitation and life extension project

Discount rate	10%
Generation:	
Generation reserve margin	25%
T & D losses	13%
kW generation capacity required	1.41 kW for 1 kW load
Life of generator	20 years
Installed cost, US$/kW	$200
Fixed O&M cost, US$/kW/year	$10
Annualized cost, US$/kW/year	$33 per peak kW
Transmission:	
Life of system	40 years
Installed cost, US$/kW	$50
Fixed O&M cost, US$/kW/year	$1
Annualized cost, US$/kW/year	$6 per peak kW
Distribution:	
Life of system	40 years
Installed cost, US$/kW	$100
Fixed O&M cost, US$/kW/year	$5
Annualized cost, US$/kW/year	$15 per peak kW
Annualized cost per delivered peak kW	
High voltage	$33 per peak kW
Medium voltage	$40 per peak kW
Low voltage	$55 per peak kW

2. Marginal Energy Cost:

Assume: marginal peak or off–peak generation from thermal steam plants

	Peak or Day:	Night:
Rated Load	300 MW	300 MW
Heat Rate at rated load	10,000 kJ/kWh	11,000 kJ/kWh
Heat Rate at part load	11,000 kJ/kWh	12,000 kJ/kWh
Fuel Used	Imported coal	Domestic lignite
Fuel Cost	$2.00 US$/GJ	$1.00 US$/GJ
Variable O&M (% of fuel cost)	10%	20%
Station use of power	7%	10%
Network losses		
Transmission	3%	3%
Distribution	9%	9%
Total	**12%**	**12%**
Cost per delivered kWh		
High voltage	$0.0260 per kWh	$0.0160 per kWh
Medium voltage	0.0268 per kWh	0.0165 per kWh
Low voltage	0.0296 per kWh	0.0182 per kWh

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In the medium-term, we assume that investments will be required to rehabilitate capacity and reduce environmental emissions, and we have developed estimated costs on that basis. The marginal cost of delivering 1 kW of capacity on-peak, varies from $33 to $55, depending on the voltage level. In addition, the marginal cost of delivering 1 kWh of energy on-peak, varies from $0.026 to $0.030, depending on the voltage level.

Exhibit 4-5 shows assumptions used to convert these estimates of marginal supply costs to marginal customer costs, along the lines of the current NEK tariff structure. The assumptions concern the distribution of customers' energy use across the times of day and seasons of the year. Assumptions are also made concerning the fixed cost of serving a customer, such as the cost of meters, service connection, meter-reading, and billing. Assumptions are also made concerning the distribution of occurrence of forced outages of generation plants.

Exhibit 4-6 provides our preliminary estimate of the marginal cost of service in Bulgaria. The estimate is provided according to customer class, seasons and time of day for both capacity (kW) and energy (kWh). A unified estimate is provided, giving the totals in the form of energy, for direct comparison with the current NEK tariff.

The total energy-based marginal cost varies (depending on the customer class, season of the year, and peak/off-peak) between $0.016 (night, for large high-voltage customer) to $0.069 (winter, household customers).

4.3.3 Evaluation of the NEK tariffs

Exhibit 4-7 provides our evaluation of the NEK tariffs, as compared to our preliminary estimates of marginal costs. Our analysis indicates that tariffs for large customers generally are equal to or greater than marginal costs, but that tariffs for household customers are far below marginal costs. During the peak hours in winter, medium voltage C&I customers pay 168% of the marginal cost of service, but household customers pay only 26% of the marginal cost of service.

As far as promoting energy efficiency, the current NEK tariffs include the following general features, which we regard as positive:

- tariffs for C&I customers based service voltage, rather than other considerations (such as whether the customer is industrial, commercial, institutional, or agricultural);
- different tariffs for C&I customers for winter and summer and time of day;
- separate tariffs for household customers for day and night usage;

Exhibit 4–5
BULGARIA
ASSUMPTIONS FOR ESTIMATE OF MARGINAL COST BY TARIFF CLASS

1. Summary of estimated marginal costs:

Estimated Marginal Capacity Cost:	Annualized cost per delivered kW
High voltage	$33 per peak kW/year
Medium voltage	$40 per peak kW/year
Low voltage	$55 per peak kW/year

Estimated Marginal Energy Cost:	Cost per delivered kWh	
	Peak or Day:	Night:
High voltage	$0.0260 per kWh	$0.0160 per kWh
Medium voltage	0.0268 per kWh	0.0165 per kWh
Low voltage	0.0296 per kWh	0.0182 per kWh

Estimated Marginal Customer Cost	
fixed cost per month for connection equipment metering & billing	$4 per customer

2. Assumptions – Customer Characteristics:

	Peak Load kW	Avg. Load Factor	Annual Usage MWh	Winter Usage pct	Summer Usage pct
C&I – HV	10,000	0.7	61,320	55%	45%
C&I – MV	1,000	0.6	5,256	55%	45%
C&I – LV	100	0.5	438	60%	40%
Households	1	0.3	2.63	65%	35%

	WINTER ENERGY DISTR.			SUMMER ENERGY DISTR.		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	30%	45%	25%	30%	45%	25%
C&I – MV	30%	45%	25%	30%	45%	25%
C&I – LV	30%	50%	20%	30%	50%	20%
Households	30%	50%	20%	30%	50%	20%

	WINTER ENERGY MWh			SUMMER ENERGY MWh		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	10,118	15,177	8,432	8,278	12,417	6,899
C&I – MV	867	1,301	723	710	1,064	591
C&I – LV	79	131	53	53	88	35
Households	0.51	0.85	0.34	0.28	0.46	0.18

2. Assumptions – distribution of annual generation forced outages, which result in load–shedding

Winter	Peak	60%	of outages occur in this period
	Day	5%	
	Night	2%	
Summer	Peak	30%	
	Day	2%	
	Night	1%	
Total		100%	

Exhibit 4–6
BULGARIA
ESTIMATE OF MARGINAL COST
BY TARIFF CLASS

1. Marginal costs for capacity ($/kW) including capacity and customer costs

	WINTER COST, $/kW/MONTH			SUMMER COST, $/kW/MONTH		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	$2.79	$0.23	$0.09	$1.40	$0.09	$0.05
C&I – MV	3.33	0.28	0.11	1.66	0.11	0.06
C&I – LV	4.63	0.39	0.15	2.32	0.15	0.08
Households	8.59	0.72	0.29	4.30	0.29	0.14

2. Marginal costs for energy ($/kWh) including energy only

	WINTER COST, $/kWh			SUMMER COST, $/kWh		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	$0.026	$0.026	$0.016	$0.026	$0.026	$0.016
C&I – MV	0.027	0.027	0.016	$0.027	$0.027	$0.016
C&I – LV	0.030	0.030	0.018	$0.030	$0.030	$0.018
Households	0.030	0.030	0.018	$0.030	$0.030	$0.018

3. Total marginal costs on per kWh basis including energy, capacity, and cusotmer costs

	WINTER COST, $/kWh			SUMMER COST, $/kWh		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	$0.031	$0.026	$0.016	$0.029	$0.026	$0.016
C&I – MV	0.034	0.027	0.017	0.031	0.027	0.017
C&I – LV	0.042	0.031	0.019	0.036	0.030	0.018
Households	0.069	0.033	0.019	0.049	0.031	0.019

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Exhibit 4–7
BULGARIA
EVALUATION OF TARIFF

1. Tariff existing as of January 1, 1993

	WINTER TARIFF, Leva/kWh			SUMMER TARIFF, Leva/kWh		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	1.395	0.757	0.374	1.217	0.655	0.322
C&I – MV	1.447	0.783	0.386	1.255	0.679	0.333
C&I – LV	1.515	0.818	0.405	1.317	0.711	0.350
Households	0.440	0.440	0.233	0.440	0.440	0.233

based on exchange rate: 25.00 Leva = $1.00

	WINTER TARIFF, $/kWh			SUMMER TARIFF, $/kWh		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	$0.056	$0.030	$0.015	$0.049	$0.026	$0.013
C&I – MV	0.058	0.031	0.015	0.050	0.027	0.013
C&I – LV	0.061	0.033	0.016	0.053	0.028	0.014
Households	0.018	0.018	0.009	0.018	0.018	0.009

2. Tariff existing as of January 1, 1993 as percentage of marginal costs

	WINTER TARIFF, pct of COST			SUMMER TARIFF, pct of COST		
	Peak	Day	Night	Peak	Day	Night
C&I – HV	177%	114%	92%	169%	100%	80%
C&I – MV	168%	114%	92%	164%	100%	80%
C&I – LV	143%	107%	87%	147%	95%	76%
Households	26%	54%	48%	36%	57%	49%

EXHIB4–7.WK1

- a time-of-day tariff for purchase of power by NEK from other generators.

The current tariff includes several features which we regard as negative:

- subsidies for household customers;
- no specific charges in the C&I tariff for capacity (kW); all charges are lumped into an energy charge (kWh);
- no incentives are offered for power factor (cos phi) improvement;
- the power purchase tariff also includes no specific payments for capacity (kW), only for energy (kWh).

4.3.4 Recommendations for Tariff Reform

The preliminary analysis indicates serious deficiencies in the tariff structure. The tariff structure gives pricing signals to customer which will continue to affect their demand for energy services, and hence NEK's operations and investment planning. Hagler, Bailly recommends that the structure be modified to a structure which reflects the long-run marginal cost of service, based on the results of a detailed tariff study.

4.3.4.1 Tariff Study

The essence of an economic tariff setting methodology is based upon the recognition that an effective and acceptable set of tariffs can only be arrived at by a compromise between the following set of multiple objectives, some of which may be conflicting: to encourage economic efficiency in resource utilization, to ensure financial viability of the power authority including its ability to finance future resource mobilization, and to recognize the social welfare consequences of a tariff as well as other sociopolitical priorities of equity, fairness, sectoral and regional development.

The tariff study includes several steps:

1. engineering analysis of the cost of service, including seasonal, time-of-day, and reliability considerations, as well as review of the planned least-cost investment program.
2. development of a sales forecast for the electric utility.

3. economic analysis, to estimate of the long-run marginal cost (LRMC) of supplying electricity.

4. financial analysis, to estimate the average revenue requirement target of the electric utility, in $/kWh, to ensure the financial viability.

5. analysis of customer billing records to develop the profile of sales to customers under each tariff class.

6. development of strict LRMC tariff, based on economic cost of service to each customer class.

7. development of revenue-neutral LRMC tariff, based on allocation of the financial revenue requirement across customer classes

8. development of practical tariff, adjusting the revenue-neutral LRMC to account for social, political, developmental and other considerations.

9. development of adjustment provisions, to handle external influences such as fuel price changes or inflation

10. development tariffs for special situations, such as purchase of power from other sources, or for interruptible supply

An important objective of the tariff study in Bulgaria must be to transfer the know-how of tariff design to NEK staff. The tariff study sets the strategy for continuous involvement of key individuals in the important task of price-setting. A select group of key members of the NEK's management and technical staff must first be identified in the functional areas of relevance to this project. These areas include system planning (generation, transmission and distribution), load forecasting and load research, finance, metering, and billing.

4.3.4.2 Implementation of Tariff Restructuring

Ultimately, the success of the tariff study project will be judged not by the report, but by the changes made to the tariffs. After completion of the report, in order to get the tariff implemented, there are several other steps that will be required in Bulgaria:

1. Possible revisions to the analysis based on the presentations to COE and NEK

2. Prepare a submission to seek regulatory authority (or government) approval.

3. Defend the tariff to the authority.

4. Possibly revise the tariff and financial analysis based on the decision of the authority.

5. Prepare the Gazette announcement.

6. Prepare customer information explaining the new tariff and its rationale.

7. Defend the tariff in meetings with customer, and in the public media.

8. Change metering systems, where necessary.

9. Change billing systems.

10. Test the new billing system.

11. After some months, analyze the effect of any structural changes made on revenue collection.

12. Revise tariff structure if performance is not as expected.

4.4 PRIVATE POWER, AND DEVELOPMENT OF INDEPENDENT POWER PRODUCTION (IPP)

As part of Integrated Resource Planning, consideration must be made of all sources of supply. Independent power generation usually relates to supply of electricity to the grid by facilities not under the ownership or direct control of the electric utility (such as NEK). In Bulgaria, such projects would be developed by the private sector, and could be a first step toward privatization of electricity services.

The potential benefit of independent power to Bulgaria is greater economic efficiency, obtained through competition in power generation, access to financing and additional capital, optimal use of energy resources through combined heat and power, and transfer of new technology.

As part of this A.I.D.-funded project, a separate report was prepared by Hagler Bailly on this subject, entitled "Independent Power Generation in Bulgaria: Assessment of Potential, Impediments and Options", August 1993.

4.5 DEMAND-SIDE MANAGEMENT (DSM)

Demand-side management (DSM) refers to a wide variety of activities which are carried out to improve the efficiency of electricity usage by customers, with cooperation from the electric utility company. DSM thus represents a partnership between the electric company and its customer. There can be other partners in DSM programs, such as private sector energy services companies, financial institutions, and energy engineering firms.

DSM includes programs to encourage conservation, energy efficiency, and load management actions. DSM can also include actions to increase power sales in the off-peak periods. DSM is chosen over a supply-side option when DSM is clearly shown to offer a lower cost alternative to the economy of Bulgaria.

However, whereas the calculation may show DSM to be the least cost option for the country as a whole, the calculation may be different when investigated from the utility's perspective. Thus, in some countries, electric utilities have been reluctant to implement DSM, because financial issues have not been adequately resolved. Implementing DSM has not been in the utilities' interest in those countries where the local regulatory process ties revenues only to energy (kWh) sales. In these cases, savings in energy from demand-side programs reduce the sales of the utility (revenues are lost). In some countries, management (and other employee) compensation or bonuses may even be tied to revenue or kWh sales.

For DSM to succeed, it is necessary that the Bulgarian electric utilities be given the proper financial incentive, so that their decisions are able to mirror what is best for the country.

There is a distinction between DSM "measures" and DSM "programs". Measures refer to a discrete DSM action or technology. A DSM program includes one or more DSM measures in a package that can be marketed and provided to the customer. An example of a DSM measure is replacing standard-efficiency electric motors with high-efficiency motors. An example of a DSM program would be a system of incentives offered by the utility to help implement the measure, such as a rebate of 50% of the purchase price of motors which qualify as high-efficiency motors. The program would include a system for utility or contract personnel to go to the customer's plant, examine the customer's motors, and determine whether it is appropriate to replace the motors. Alternatively, a bidding program could be used, in which case the customers make proposals to the utility for partial funding of measures which meet a general criteria.

The DSM analysis is presented in two parts. In this section, we evaluate the need for DSM incentives in Bulgaria. In the next chapter, we assess the potential for DSM in Bulgaria.

4.5.1 Sources of Data

The primary sources of data used in the DSM analysis were:

- DBC's Survey of the 106 largest electricity customers in Bulgaria, as described in Chapter 2. This survey included items concerning production plans, electricity use, and previous experience with energy conservation.

- Energy Audits of 8 enterprises in Bulgaria, carried out in 1991 by International Resources Group (IRG), under the U.S. Agency for International Development (AID) Emergency Energy Project[5].

- Interviews of energy professionals in Bulgaria, carried out in 1992 and January 1993 by Hagler, Bailly. These professionals represented the Committee of Energy, NEK, Ministry of Industry, Technical University of Sofia, EC energy center, engineers providing energy efficiency services (such as energy audits and energy-saving equipment), and industrial plant managers.

- Experience gained by the Hagler, Bailly project staff through DSM program design and energy efficiency in the U.S. and other countries over the past 20 years was applied where inadequate data were available for Bulgaria.

This study goes as far as possible in developing a basic DSM assessment with the existing information. In many instances, data on electricity end-use in Bulgaria were not available. The same situation occurred in the early experience of U.S. utilities. When DSM programs were first considered in the United States, data were not available to perform cost-benefit studies. As they gained experience with implementing DSM programs, utilities developed the procedures and data needed.

4.5.2 The Need for Incentives for DSM

In many countries, electric utilities have been reluctant to implement DSM, and Bulgaria is no exception. There are several factors involved, including:

- Management incentives
- Traditional familiarity with, and focus on, supply-side options
- Profit incentives due to regulatory structure

[5] The results of these audits were augmented by the results of 52 other energy audits carried out in other Eastern European countries under the AID Emergency Energy Project.

Management (and other employee) compensation or bonuses may be tied to revenue, sales or profit growth. In some Eastern European countries, a bonus is paid to employees based on kWh sales. Management often operates under the concept that "bigger is better", a concept at odds with implementing DSM programs that are often associated with decreasing sales, revenues, and profits.

Utilities have traditionally focused on supply-side options. Of course, utilities and their personnel take pride in their power plants and other capital assets. DSM measures are something new and different to utility personnel.

The largest area of concern, however, is that implementing DSM has often not been in the utilities' interest because of the way the regulation has been implemented. In essence, the regulatory process has resulted in a situation where growth in sales results in additional profit for a utility, or savings in energy from demand-side programs reduces the profit of the utility.

Another feature of the regulatory approach that could be a factor working against DSM is the electricity tariff-setting procedure, based on a fixed historical or expected future level of expenses and sales. Typically, an expected level of expenses is divided by the expected level of sales to determine the rates to be charged to customers. The level of expenses and sales can be either a historical level (historical test-year) or projected level (future test-year).

The actual revenue and profit earned by the utility will vary from that determined in the rate setting procedure because both the level of expenses and sales will likely be different from that used in the rate setting proceeding. Between rate cases, each additional kWh of sales will result in additional profit for the utility. Utilities in the normal mode, growth and marginal revenue exceeding marginal cost, will receive additional profit from growth. If a utility implements DSM measures to reduce sales, the reduction in sales will cut into profit created by growth.

This reduction in revenue because of DSM programs is often referred to as the "lost revenue" problem. Because DSM programs introduce technologies that over their lifetimes more than pay back the investment in energy savings, the amount of revenue lost by the utility will be much more than the direct cost of DSM programs.

4.5.3 Alternative Incentive Approaches to DSM

A number of approaches have been proposed, and several adopted, to provide incentives for utilities to invest in DSM. A few of the more important proposals are briefly discussed below.

- **Adjusting rates to cover revenue losses (decoupling)** - The approach adjusts the utility's actual recovery of revenues to match the amount approved by the regulatory agency so that there is no additional profit from growth or loss of profit from DSM measures. Decoupling addresses both the incentive for growth and the lost revenue problem.

- **Adjustment clause to recover expenditures for DSM** - Significant increases in expenditures to a level not anticipated in the utility rate case, such as the implementation of a large-scale DSM program, can result in expenses not recovered by the utility. An adjustment clause that charges DSM expenditures to customers ensures a utility recovers its program costs in the same year the expenditures are incurred.

- **Rate-basing of DSM investments** - Hardware costs, utility labor costs, and the cost of certain services for DSM can be placed in rate base, for recovery in future years. Rates would be increased to amortize the amount of the expenditures and to allow the utility to earn a return on the investment. Often, an accelerated depreciation or amortization schedule is included as a further incentive. Several utilities use some form of rate basing.

- **Adjusting the rate of return on DSM investments** - The return on DSM investments would receive a premium level of allowed return so that DSM expenditures would be perceived by the utility as being more profitable than supply-side investments. For example, utilities in the states of Washington and Montana are allowed to earn an additional 2% return on DSM expenditures.

- **Performance criteria for rate of return incentive** - The utilities rate of return is adjusted if the utility achieves a certain level of DSM — a specified level of peak demand (MW) or energy (MWh) savings. For example, the Public Service Commission of Wisconsin offered Wisconsin Electric Power Company an additional 1% rate of return for conservation expenditures for each 125 MW reduction in peak demand.

- **Incentives proportional to savings** - Utilities are offered a fixed payment per unit of peak demand or energy savings. The payment would be set based on a calculation designed to share the savings between customers and the utility.

4.5.4 Recommended DSM Incentives for Bulgaria

For DSM to succeed, it will be necessary that the Bulgarian electric utilities be given a profit incentive, which would be totally consistent with an IRP regulatory framework. A technical

assistance program provided by foreign experts would enable Bulgaria to benefit from the many years of DSM experience which has been obtained in the U.S. and other countries.

The recommended first incentives are summarized below.

- Allow DSM capital investments by the utility to earn a rate of return which is high enough to encourage the utility to make the investment;

  Appropriate DSM investments should be included in the capital rate base. The types of investments to be included will mainly be for capital investments for hardware projects. The amortization period should be 3-10 years, depending on the type of investment.

  As a further incentive, to compensate for years of inattention to the demand-side, the rate of return for DSM expenditures should be set higher than that allowed for conventional supply-side expenditures. An appropriate level of incentive would be 2-5% higher.

- Allow other (non-capital) DSM expenses incurred by the utility to be recovered through tariffs in the same year they are incurred.

  The utility should be allowed to recover the full cost of incidental (non-investment) expenditures for DSM. Expenses such as utility labor costs, promotion materials, services by outside agencies would be allowed to be recovered. These expenses should be recovered in the year they are incurred, as part of the budget process.

- Provide utility employee incentives based on services and efficiency, rather than energy sales.

  Utility personnel should be given salary bonuses or incentives based on energy services and efficiency improvements. Any performance incentives still based on kWh generated or kWh sold should be replaced with efficiency-related incentives.

5. DEVELOPMENT OF AN ILLUSTRATIVE DEMAND-SIDE MANAGEMENT PROGRAM FOR BULGARIA

5.1 DEVELOPMENT OF CANDIDATE ENERGY EFFICIENCY MEASURES

5.1.1 Analysis of Existing Load Shape

The monthly variation in peak demand (MW) for the NEK system 1991 is shown in Exhibit 5-1. Peak demand in 1991 was 7,489 MW. The peak occurs in winter; demand in the summer is approximately 3,000 MW lower.

Exhibit 5-2 shows the annual load duration curve for 1982 and 1991. Over this period, the peak demand grew by about 5%, however off-peak usage declined. This indicates that the character of usage (and load factor) is changing. It is especially important to note that a substantial amount of winter heating in residences and other buildings is done by electric resistive heating. The National Electric Company estimates that a substantial part of the difference in peak demand between winter and summer (1,800 MW) is due to heating.

Exhibits 5-3, 5-4 and 5-5 illustrate the daily load shape (MW vs. hour of the day) for January and July. Daily load has two peaks, one in the morning and one in the evening. The evening peak is usually the highest, but in some months (e.g., February 1991) the morning peak was higher. The evening peak is 19 to 20 hours (7:00 to 8:00 pm). Winter load is relatively high for a long period, from 7 hours until 24 hours. In fact, the daily load factor (average load divided by peak load) on the average January weekday is over 0.9, which is exceptionally high. Summer load peaks around midday and stays relatively high until about 23 hours.

Exhibit 5-1

Peak Demand by Month
Bulgaria 1991

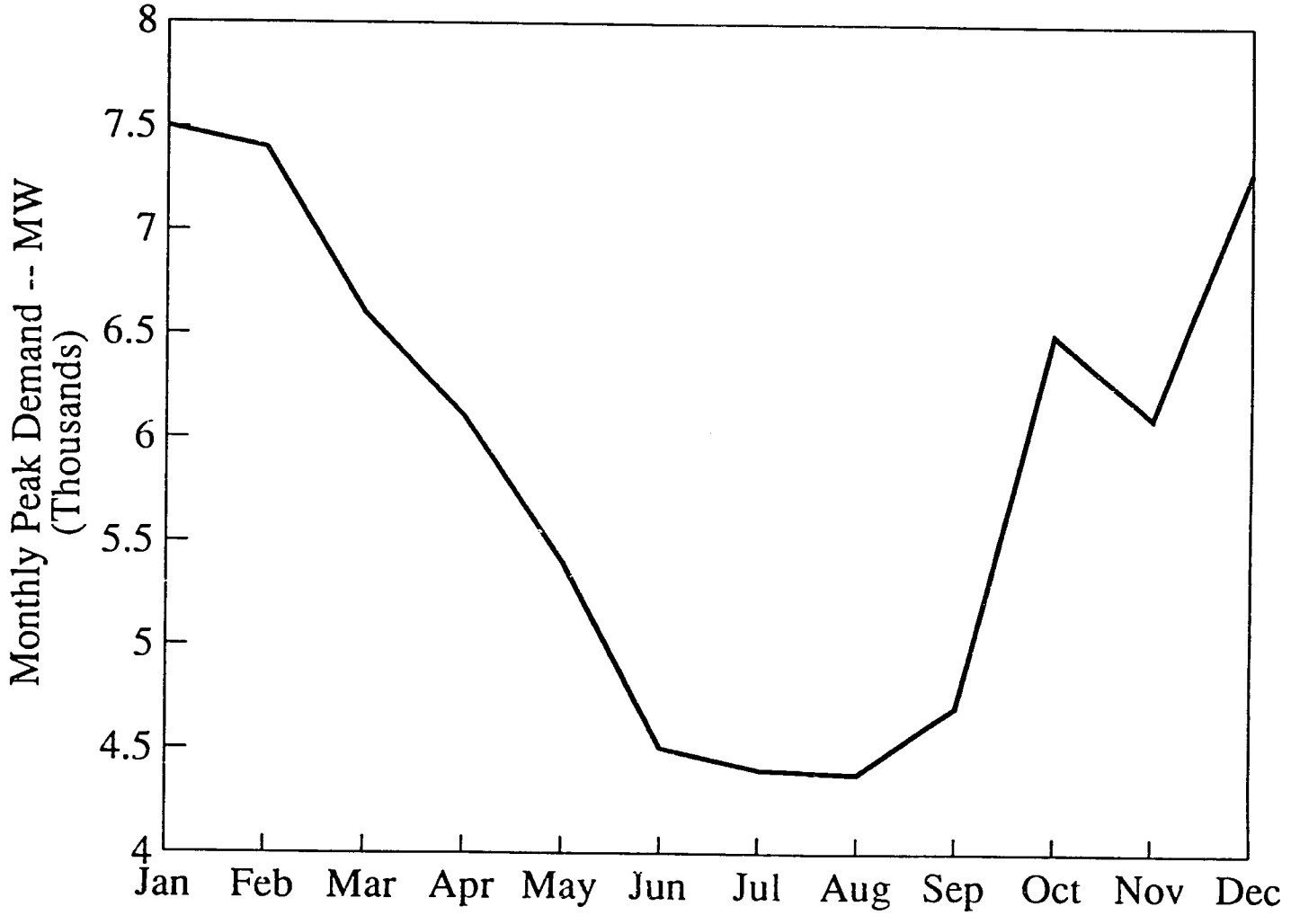


Exhibit 5-2

Load Duration Curve
Bulgaria -- 1991 and 1982

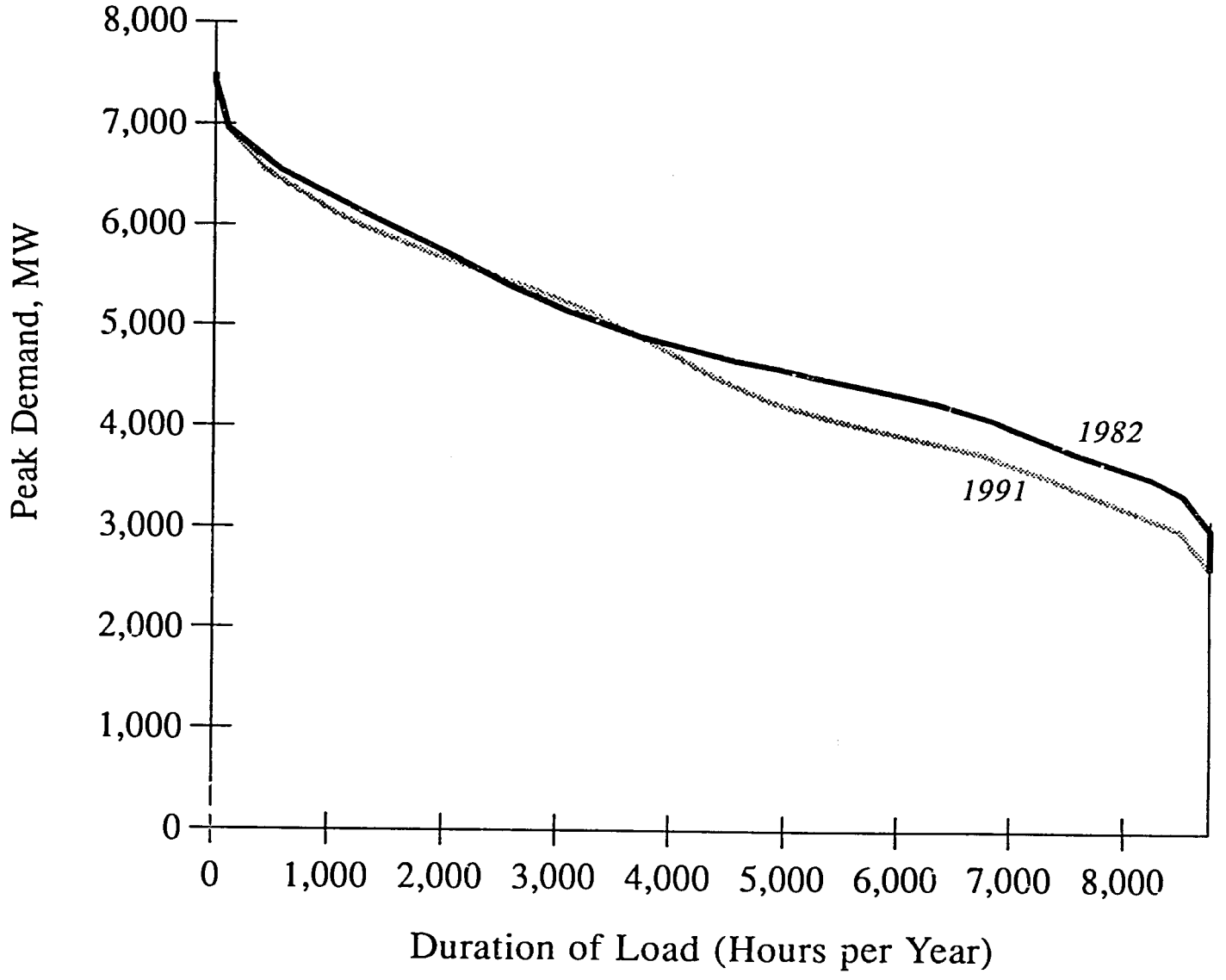


Exhibit 5-3

Daily Load Profile - Bulgaria

Average Day in January & July

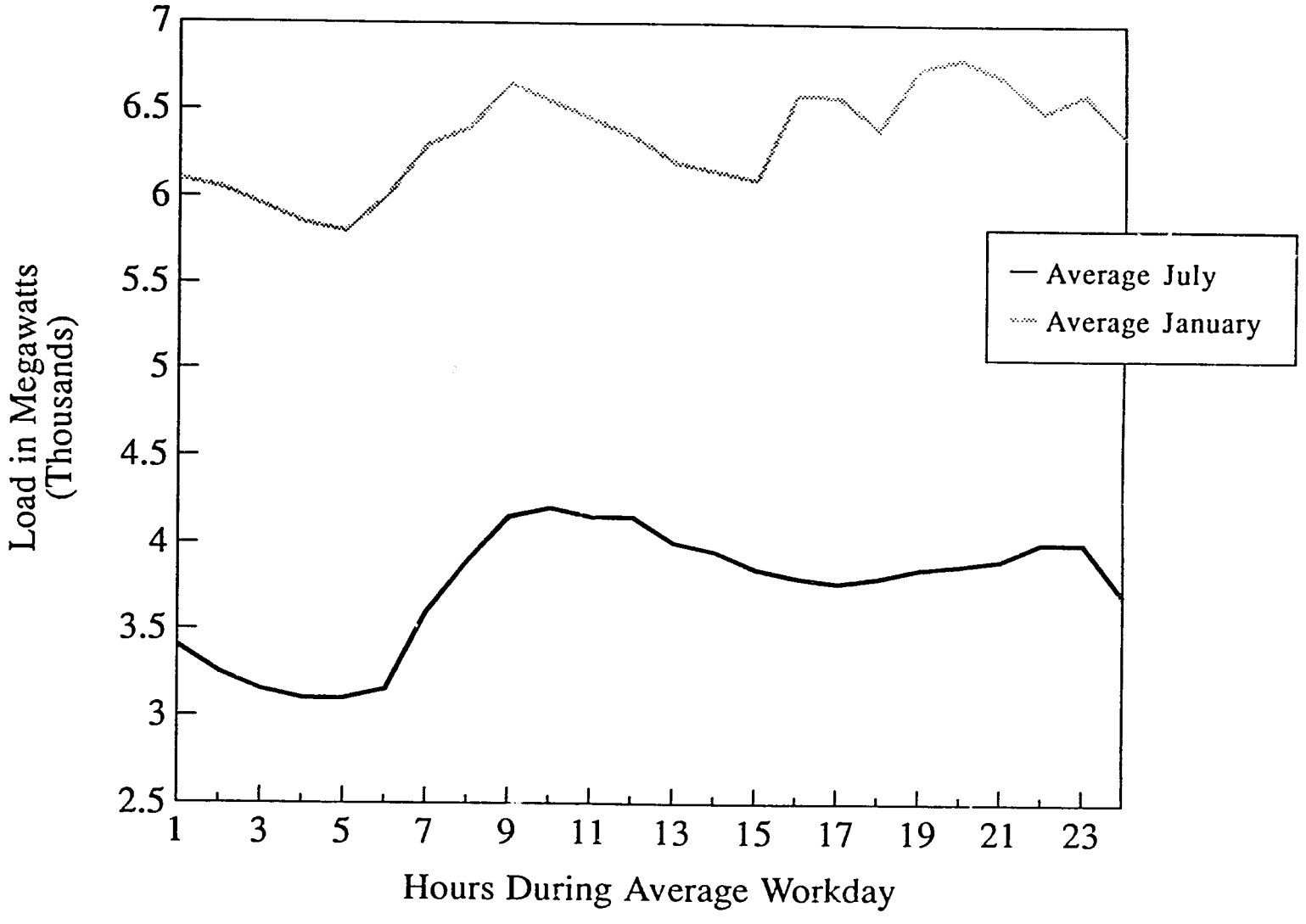


Exhibit 5-4

Daily Load Profile - Bulgaria

Average Day in January

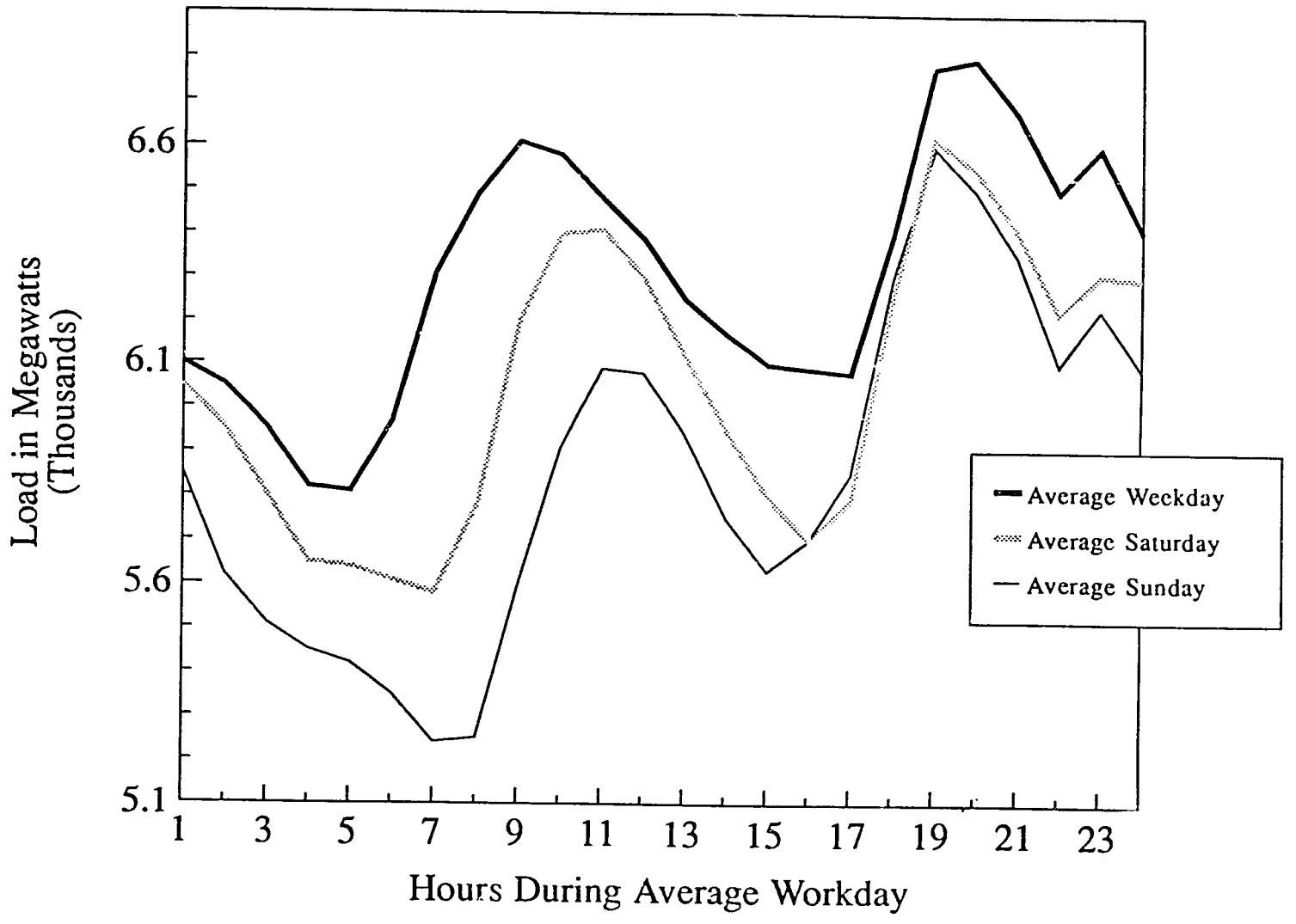
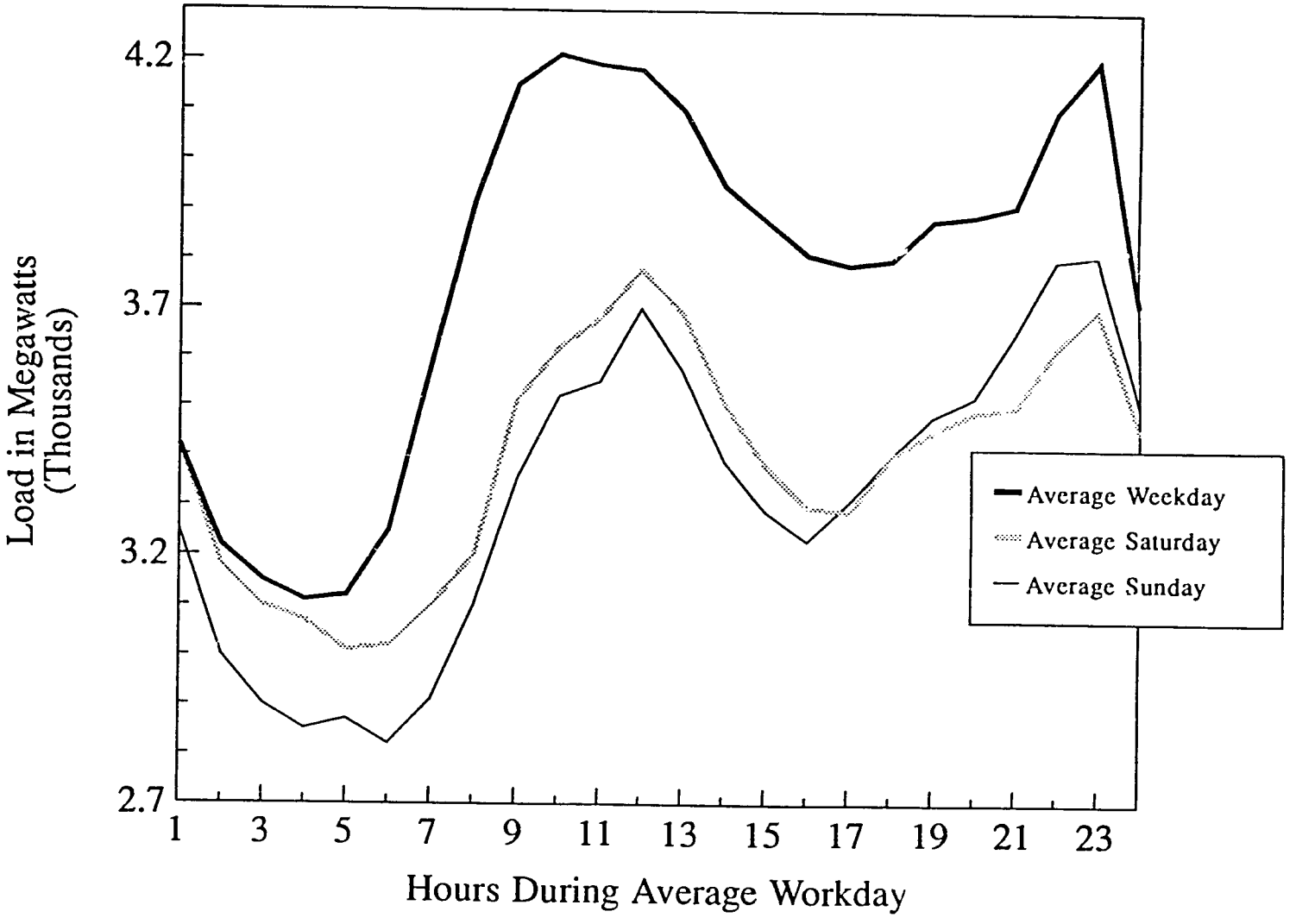


Exhibit 5-5

Daily Load Profile - Bulgaria

Average Day in July



5.1.2 DSM Program Design Criteria

DSM programs are usually designed to achieve specific load-shape modifications, as required by the utility system. Examples of programs are:

- Peak Clipping (reducing peak MW demand)
- Valley Filling (adding kWh sales in off-peak periods)
- Load Shifting (moving kWh from peak to off-peak periods)
- Strategic Conservation (reducing kWh sales in high-cost periods)
- Strategic Load Growth (increasing kWh sales in low-cost periods)
- Flexible Load Shape (interruptible customers)

Based on analysis of the NEK load shapes, we regard the following as a reasonable set of criteria for DSM program design in Bulgaria:

- End-use - addressing the industrial and buildings sectors
- Load shape - addressing the need for peak demand reduction in winter
- Relative costs - recognizing the need to favor low-cost measures
- Equipment and services availability in Bulgaria - recognizing the current economic crisis and the transition to private enterprise and a market economy

Not all forms of DSM are appropriate targets for Bulgaria. In our judgment, the following types of DSM programs should be most encouraging:

- Peak clipping in winter,
- Conservation in winter and summer,
- Flexible load shape in winter

5.1.3 DSM Measure Pre-screening

Based on the characteristics of the system, those DSM measures that appear applicable to Bulgaria were selected from a list of candidate measures.

DSM measures can often be divided into new, replacement, and retrofit measures. Because of high capital costs, few decision-makers will elect to install a new, more efficient piece of equipment unless the old unit is near the end of its economic life or has actually failed and must be replaced. For new- and replacement-related (as opposed to retrofit-related) measures, the economics of the measure should be assessed as the additional cost of the high-efficiency measure compared to the standard efficiency equipment. Replacement is often considered as a function of the life of the equipment to indicate the need for replacement at the end of the life of equipment. Retrofit or add-on measures do not require the replacement of existing capital-intensive equipment.

A core set of measures used in screening was drawn from a library of more than 100 typical DSM measures. The results of the screening are shown in Exhibit 5-6 (for buildings), and Exhibit 5-7 (industrial).

Exhibit 5–6
BUILDINGS SECTORS (RESIDENTIAL, COMMERCIAL, INSTITUTIONAL) DSM MEASURE SCREENING
BULGARIA

DSM Family	Code	Typical US–type DSM Measure	End Use Impacted	Load Shape Impact: Meets End Use Objective	Load Shape Impact: Peak Impact (W/S/ Both)	Load Shape Impact: Significant Energy Savings	Load Shape Impact: Meets Load Shape Objective	DSM Form	Meets DSM Form Objective	Relative Costs	Meets Cost Objective	Bulgaria Equipment Available?	Meets Availability Objective	Recommended: For Data Collection	Recommended: For Load Research	Recommended: For Pilot Programs
Building Heating	101	Increase Ceiling Insulation	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	102	Increase Wall Insulation	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	103	Insulate Doors	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	104	Install Storm Windows	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	105	Add Plastic to Windows	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	106	Caulking/Weatherstripping	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	107	Install air source heat pump	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	108	Add Thermostat/Regulator	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	No	No
	109	Thermal energy storage	Space Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	110	Fuel Conversion: Electric to Gas	Space Heat	Yes	Winter	Yes	Yes	Valley Fill	No	Med/Hi	No	Uncertain	Data Req.	No	No	No
	111	Direct load control – heat	Space Heat	Yes	Winter	No	Yes	Str. Consv.	Yes	High	No	Yes	Yes	Yes	Yes	Fuel Switch
Elect. Water Heating	201	Water Heater Wraps, Pipe Insulation	Water Heat	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low	Yes	Yes	Yes	Yes	Yes	Audit
	202	Flow restrictors	Water Heat	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	More Data
	203	Add Timer to Operate WH Off–Peak	Water Heat	Yes	Both	Yes	Yes	Str. Consv.	Yes	High	No	Uncertain	Data Req.	Yes	No	No
	204	WH Thermostat	Water Heat	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes	Uncertain	Data Req.	Yes	No	No
	205	Water Heater (Direct Load Control)	Water Heat	Yes	Both	Yes	Yes	Peak Clip	Yes	Medium	Yes	Uncertain	Data Req.	Yes	Yes	Curtail. Load
	206	Storage Water Heater	Water Heat	Yes	Both	Yes	Yes	Peak Clip	Yes	Medium	Yes	Uncertain	Data Req.	Yes	No	No
	207	Electric to Gas Water Heater	Water Heat	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes	Yes	Yes	Yes	Yes	Fuel Switch
Cooking	301	New stove – spiral heating elements	Cooking	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes	Uncertain	Data Req.	Yes	Yes	Ap. Standards
	302	Electric Cooking to Gas Cooking	Cooking	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes	Yes	Yes	Yes	Yes	Audit
Refrig.	401	High Efficiency Refrigerator – Import	Refrigeratio	Yes	Both	Yes	Yes	Str. Consv.	Yes	High	No	Yes	Yes	Yes	No	No
	402	High Efficiency Refrigerator – Domestic	Refrigeratio	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes	Uncertain	Data Req.	Yes	Yes	Ap. Standards
Lighting	501	Res. Incandescent to Compact Fluor.	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Aud/Light.
	502	Res. Energy Eff. Incandescent	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Aud/Light.
	503	Res. Incandescent to Std. Fluor. Fixture	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	504	Commercial Incand. to Compact Fluor.	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	505	Fixture replace w/ EELamps & EEBal.	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	506	Fixture replace w/ Delamping & Refl.	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	507	Day Lighting Control	Lighting	Yes	Summer	Yes	No	Str. Consv.	Yes	Medium	Yes	Uncertain	Data Req.	No	No	No
	508	High Efficiency Lamps	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	509	EMS Lighting	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	510	Occupancy Sensors	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	511	Mercury vapor to HPS	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	512	Incandescent to HPS	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	513	Incandescent to Metal Halide	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting
	514	Incandescent to Fluorescent	Lighting	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Low	Yes	Uncertain	Data Req.	Yes	Yes	Lighting

RES_SCR.WK1

Exhibit 5–7
INDUSTRIAL SECTOR DSM MEASURE SCREENING
BULGARIA

DSM Family	Code	Typical US–type DSM Measure	End Use Impacted	Meets End Use Objective	Load Shape Impact: Peak Impact W/S/Both	Load Shape Impact: Significant Energy Savings	Load Shape Impact: Meets Load Shape Objective	DSM Form	Meets DSM Form Objective	Relative Costs	Bulgaria Equipment Available?
Motors (> 10 kW)	201	replace standard motor w/ high eff. motor	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	202	replace failed std. eff. motor w/ high eff.	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low	Uncertain
	203	rewind inefficient motor	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low	Yes
	204	install variable speed drives	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Unknown
	205	replace babbit bearings with roller	Motors	Yes	Both	Small	Yes	Str. Consv.	Yes	Low	Yes
	206	replace V belts with cog belts	Motors	Yes	Both	Small	Yes	Str. Consv.	Yes	Low/No	Yes
	207	downsize motors	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Lo	Yes
	208	high efficiency HVAC motor	HVAC	No	Summer	Yes	No	Str. Consv.	Yes	Medium	Uncertain
	209	replace efficient motor w/ more efficient	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	210	adjust belt tension	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/No	Yes
	211	Survey motor eff., identify ineff. motors	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Eng Mgt	Yes
	212	check/correct load on each phase	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Eng Mgt	Yes
Hydraulics	401	downsize motors	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Lo	Yes
	402	install variable volume pumps	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes
Fans	501	install variable pitch fan blades	Motors	Yes	Both	Yes	Yes	Str. Consv	Yes	Med/Lo	Yes
	502	install inlet/outlet dampers	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Lo	Yes
	503	bypass timer	Motors	Yes	Both	Yes	Yes	Peak Clip	Yes	Low	Yes
	504	install variable speed drives on fans	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Unknown
	505	install HEPA filters	Motors	Yes	Both	Small	Yes	Str. Consv.	Yes	Low	Uncertain
	506	install dryer control systems	Process Ht	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low	Uncertain
Material Handling	601	install energy efficient motors	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	602	replace pneum conveyors w/ mechanical	Motors	Yes	Both	Limited	No	Str. Consv.	Yes	High	Uncertain
	603	install high efficiency blowers	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	604	install VSDs on conveyors	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Unknown
Process Cooling	701	replace dampers with fan controls	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Lo	Unknown
	702	retrofit cooling tower fill material	Pumps	Yes	Both	Yes	Yes	Str. Consv.	Yes	High	Uncertain
	703	use well/ground water	Pumps	Yes	Both	Limited	No	Str. Consv.	Yes	Medium	Uncertain
	704	install variable speed drives on fans	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Unknown
General Mech.	801	install interlocks on equipment	Load Cntl	Yes	Both	Yes	Yes	Peak Clip	Yes	Medium	Uncertain
	802	convert to hydrofoil agitators	Motors	Yes	Both	Limited	Yes	Str. Consv.	Yes	Med/Hi	Uncertain
	803	install insulating jackets	Heating	Yes	Both	Small	Yes	Str. Consv.	Yes	Low	Yes
	804	replace air guns w/ air–airless guns	Comp.	Yes	Both	Limited	Yes	Str. Consv.	Yes	Low	Uncertain
	805	high efficiency transformers	Transfm.r	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes
Pumping (Fixed Flow)	901	trim pump impellers	Pumps	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	902	downsize pump	Pumps	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Lo	Yes
	903	install flow–restricting nozzles	Pumps	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Lo	Yes
	904	oversized piping to reduce flow friction	Pumps	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Yes
Pumping (Variable Flow)	1001	variable speed drive on pump motor	Pumps	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Unknown
	1002	install flow–restricting nozzles	Pumps	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Lo	Yes
	1003	oversized piping to reduce flow friction	Pumps	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Yes
Com–pressed Air	1101	institute leak reduction program	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Eng Mgt	Yes
	1102	install engineered nozzles	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	1103	reduce operating pressure	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/No	Yes
	1104	use outside air intake	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low	Yes
	1105	install controller for compressor(s)	Comp.	Yes	Both	Yes	Yes	Peak Clip	Yes	Medium	Uncertain
	1106	lead/lag controls & rework piping	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes
	1107	low pressure blowers & rework piping	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Yes
	1108	low load unloaders/replace pneum.motors/humidity controls	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	1109	replace pneumatic motors & rework pipes	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Yes

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Exhibit 5–7 (continued)
INDUSTRIAL SECTOR DSM MEASURE SCREENING
BULGARIA

DSM Family	Code	Typical US–type DSM Measure	End Use Impacted	Meets End Use Objective	Load Shape Impact: Peak Impact W/S/Both	Load Shape Impact: Significant Energy Savings	Meets Load Shape Objective	DSM Form	Meets DSM Form Objective	Relative Costs	Bulgaria Equipment Available?
	1110	install VSDs on compressors	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Unknown
	1111	multiplexed compressors	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes
	1112	compare system eff. with design specs	Comp.	Yes	Both	Yes	Yes	Str. Consv.	Yes	Eng Mgt	Yes
Incand. Lighting	1201	HID incandescents	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1202	compact fluorescent replacement	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Yes
	1203	incandescent to standard fluorescent	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Yes
	1204	HID new luminaraire	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1205	timeclock, photocell, bypass/delay timer	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Yes
	1206	clean fixtures & reflectors	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/No	Yes
	1207	motion detector: small/large rooms	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Yes
Fluor.	1301	replace std (40 watt) tubes with 34 watt	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1302	install electronic ballasts	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1303	install optical reflectors, delamp	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1304	install new T8 fixtures with electronic ballast	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1305	timeclock, photocell, bypass/delay timer	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Yes
	1306	motion detector: small/large rooms	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Yes
	1307	clean fixtures & reflectors	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/No	Yes
Other Lighting	1401	replace mercury vapor with metal halide	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1402	timeclock, photocell, bypass/delay timer	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Yes
	1403	motion detector: warehouses	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Yes
	1404	retrofit MV with HPS lamp/ballast	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1405	HE Lighting System	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
	1406	replace Metal Halide w/HPS retrofit	Lighting	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low/Med	Unknown
Space Cooling	1501	replace chiller with high efficiency	HVAC	No	Summer	Yes	No	Str. Consv.	Yes	Medium	Uncertain
	1502	install evaporative cooling system	HVAC	No	Summer	Yes	No	Str. Consv.	Yes	Medium	Uncertain
	1503	install fully integrated economizer	HVAC	No	Summer	Yes	No	Str. Consv.	Yes	Medium	Uncertain
	1504	install reflective window film	HVAC	No	Summer	Small	No	Str. Consv.	Yes	Low	Uncertain
	1505	install energy mgmt system	Load Cntl	Yes	Summer	Yes	Yes	Peak Clip	Yes	Medium	Uncertain
Process Heating	1601	improve sealing on furnaces and equip.	Process Ht	Yes	Both	Yes	Yes	Str. Consv.	Yes	Eng Mgt	Yes
	1602	improve insulation on hot equipment	Process Ht	Yes	Both	Yes	Yes	Str. Consv.	Yes	Low	Yes
	1603	improve process heating controls	Process Ht	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	1604	install VSDs on kilns	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Unknown
	1605	install continuous melting system	Process Ht	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Yes
	1606	convert electric furnaces to gas	Process Ht	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Yes
Refrig–	1701	improve control systems	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Eng Mgt	Yes
	1702	use strip containers on doors	Motors	Yes	Both	Small	Yes	Str. Consv.	Yes	Low	Uncertain
	1703	install energy efficient compressors	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Medium	Uncertain
	1704	install electronic variable speed drive	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Unknown
	1705	install additional condensers	Motors	Yes	Both	Yes	Yes	Str. Consv.	Yes	Med/Hi	Yes
Space Heating	1801	replace convective heaters with radiant heaters	Sp. Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Medium	Yes
	1802	replace with variable air volume (VAV)	Sp. Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Medium	Yes
	1803	storage heat	Sp. Heat	Yes	Winter	Yes	Yes	Valley Fill	No	Medium	Yes
	1804	install controls (EMS) on heating system	Sp. Heat	Yes	Winter	Yes	Yes	Peak Clip	Yes	Medium	Uncertain
	1805	building envelope improvements	Sp. Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Lo/Med	Yes
Gas Heat	2001	replace electric furnace w/gas furnace	Sp. Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Med/Hi	Yes
	2002	replace gas furnace w/electric furnace	Sp. Heat	No	Winter	Yes	Yes	Load Build	No	Med/Hi	Yes
	2003	supplement elect. furnace w/infra–red heating	Sp. Heat	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Medium	Yes
Gas Boiler	2401	replace electric boilers with gas boilers	Sp.&Wat.	Yes	Winter	Yes	Yes	Str. Consv.	Yes	Med/Hi	Yes
	2402	replace gas boilers with electric boilers	Sp.&Wat.	No	Winter	Yes	Yes	Load Build	No	Med/Hi	Yes

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5.1.4 DSM Measure Benefit-Cost Analysis

After screening, each measure was subjected to a test of cost-effectiveness. The test used was a test of economic efficiency, called the Total Resource Cost Test (TRC).

First, an estimate of avoided costs is used to provide a supply-side baseline. The estimates of marginal costs described previously in this report (see Exhibit 4-4) were used. In summary, at the low voltage level, the avoided costs are:

$55 per year per kW of peak demand reduction

$0.030 per kWh of energy saved

In the test, a calculation is made of the ratio of life cycle benefits (avoided cost of electricity supply) to life cycle investment costs for the DSM measure. If the ratio is greater than 1.0, the DSM measure is superior to the supply-side baseline.

Based on the pre-screening, the library of industrial DSM measures was customized with Bulgaria-specific DSM measures. The A.I.D.-sponsored energy audits in Bulgaria (and other countries in Eastern Europe) were used as a primary source of additional measures to be considered. Though these audits focused on oil and gas energy efficiency rather than electricity, several measures were clearly identified. These include:

- Optimization of production to meet the demands of the market economy can reduce electrical energy consumption by 10-30%, in those plants that have excess capacity and parallel process lines;

- Improvements to energy monitoring and control, comparing energy to production on a daily basis using low-cost PC-based systems and modern management techniques, can reduce electrical energy consumption by 10% or more;

- Improvements to operations and maintenance of electrical systems, with particular focus on electric motors and drive systems, can save 2% or more;

- Improvements to the operations and maintenance of compressed air systems, including leak repairs, can reduce energy requirements for compressed air by 5-20%;

- Improvements to the operations and maintenance of ammonia refrigeration systems can reduce energy requirements for refrigeration by 5-20%;

- Opportunities exist to reduce peak demand by 5-10% through use of load monitoring and control-systems.

5.1.4.1 End-Use Electricity Consumption Data

Rough approximations for end-use consumption were made to carry out the analysis. Annual energy consumption by residential customers was estimated as 3,000 kWh per year. Industrial customers were assumed to be of average size - 2 MW peak demand and 10,000 MWh per year consumption.

The assumptions for end-use energy consumption are discussed below:

- Lighting: The lighting analysis was performed on a per light basis, while the other end-uses are for total consumption by that end-use. This used a base case of 75 operated for 4 hours per day, 365 days per year, or 110 kWh per year for a 75-Watt lamp. The commercial lighting studies used a base case of a 3x40-Watt fluorescent fixture, operating 8 hours per day, 5 days per week, or 250 kWh per year.

- Refrigerators: Base consumption was developed from the power rating of a 160 liter capacity refrigerator sold in the central department store in Sofia (the "C.U.M." store). The number of hours of operation per year (cycle time) is from a U.S. utility study. The resulting energy consumption is 867 kWh per year.

- Freezers: Consumption in this end-use was assumed to be the same as for refrigerators as these values are usually close.

- Cooking: Electricity use for cooking was assumed to be 200 kWh per year.

- Central and Room Air Conditioning: These end-uses were not estimated because they were eliminated in the qualitative screening as not being appropriate for Bulgaria.

- Space Heating: Hagler, Bailly estimates that electric resistance space heating for an average household in Bulgaria will require approximately 4,500 kWh per year. Most households in large apartment-houses in the cities use district heating instead of this type of system.

- Water Heating: Hagler, Bailly estimates that electric domestic water heating for an average household in Bulgaria will require approximately 1,000 kWh

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per year. Most households in large apartment-houses in the cities use district heating instead of this type of system.

- Industrial: Based on the A.I.D.-sponsored audits, Hagler, Bailly developed an estimated typical energy balance for an industrial plant as follows:

Motors	60%, of which:	
compressed air		1/3 of motor kWh
pumps, fans		1/3
other		1/3
Lighting	15%, of which:	
incandescent		1/20 of lighting kWh
Other (including process)	25%	

The results of the benefit-cost analysis of measures is shown in Exhibit 5-8 for the buildings sector and Exhibit 5-9 for the industrial sector.

Exhibit 5–8

BUILDINGS SECTORS (RESIDENTIAL, COMMERCIAL, INSTITUTIONAL) DSM MEASURES PRELIMINARY COST–BENEFIT ANALYSIS BULGARIA

DSM Family	Code	Typical US–type DSM Measure	Annual Energy: Base Annual Energy Consumption	Annual Energy: Percent Savings From DSM Measure	Annual Energy: Annual Energy Savings	Peak Demand: Base Peak Demand Level	Peak Demand: Percent Savings From DSM Measure	Peak Demand: Winter Demand Savings	Measure Lifetime	Value Of Peak & Energy Savings	Cost per unit	Program Costs (Percent)	Total Resource Cost Test
Building Heating	101	Increase Ceiling Insulation	3,000	6.5%	195	3.0	6.5%	0.2	30	$172	$150	20%	0.95
	102	Increase Wall Insulation	3,000	29.0%	870	3.0	29.0%	0.9	30	767	2,000	20%	0.32
	103	Insulate Doors	3,000	0.7%	21	3.0	0.7%	0.0	20	17	75	20%	0.19
	104	Install Storm Windows	3,000	9.0%	270	3.0	9.0%	0.3	20	215	300	20%	0.60
	105	Add Plastic to Windows	3,000	4.8%	144	3.0	4.8%	0.1	3	33	5	20%	5.58
	106	Caulking/Weatherstripping	3,000	12.0%	360	3.0	12.0%	0.4	5	128	125	20%	0.85
	107	Install air source heat pump	3,000	47.5%	1,425	3.0	47.5%	1.4	15	1,013	Data Req.	20%	N.A.
	108	Add Thermostat/Regulator	3,000	10.0%	300	3.0	10.0%	0.3	20	239	30	20%	6.63
	109	Thermal energy storage	3,000	−0.1%	(3)	3.0	100.0%	3.0	20	1,544	N.A.	N.A.	N.A.
	110	Fuel Conversion: Electric to Gas	3,000	100.0%	3,000	3.0	100.0%	3.0	30	2,644	1,206	0%	2.19
	111	Direct load control – heat	3,000	0.5%	3,000	3.0	50.0%	3.0	30	1,000	200	20%	4.16
Elect. Water Heating	201	Water Heater & Pipe Insulation	1,000	12.7%	127	0.2	8.0%	0.0	10	32	18	20%	1.47
	202	Flow restrictors	1,000	10.0%	100	0.2	10.0%	0.0	5	17	8	20%	1.78
	203	Add Timer to Operate WH Off–Peak	1,000	10.0%	100	0.2	33.0%	0.1	13	52	20	20%	2.16
	204	WH Thermostat	1,000	4.9%	49	0.2	4.9%	0.0	13	16	1	20%	13.08
	205	Water Heater (Direct Load Control)	1,000	−2.0%	(20)	0.2	67.0%	0.1	15	57	90	20%	0.52
	206	Storage Water Heater	1,000	−5.0%	(50)	0.2	100.0%	0.2	13	74	Data Req.	20%	N.A.
	207	Electric to Gas Water Heater	1,000	100.0%	1,000	0.2	100.0%	0.2	10	277	Data Req.	20%	N.A.
Cooking	301	New stove – spiral heating elements	200	20.0%	40	0.100	20.0%	0.020	20	22	Data Req.	20%	N.A.
	302	Electric Cooking to Gas Cooking	200	100.0%	200	0.100	100.0%	0.100	15	96	Data Req.	20%	N.A.
Refrig.	401	High Effeciency Refrigerator–Import	867	38.4%	333	0.103	38.4%	0.040	15	102	285	20%	0.30
	402	High Efficiency Refrigerator–Domestic	867	38.4%	333	0.103	38.4%	0.040	15	102	35	20%	2.42
Lighting	501	Res. Incandescent to Compact Fluor.	110	76.0%	83	0.020	76.0%	0.015	6	16	5	20%	2.67
	502	Res. Energy Eff. Incandescent	117	8.3%	10	0.022	8.3%	0.002	1	0	0	20%	3.25
	503	Res. Incandescent to Std. Fluor. Fixture	117	50.0%	58	0.022	50.0%	0.011	8	14	3	20%	3.74
	504	Commercial Incand. to Compact Fluor.	166	76.0%	126	0.068	76.0%	0.051	2	13	5	20%	2.10
	505	Fixture replace w/ EELamps & EEBal.	250	29.0%	72	0.096	29.0%	0.028	12	28	Data Req.	20%	N.A.
	506	Fixture replace w/ Delamping & Refl.	250	64.5%	161	0.096	64.5%	0.062	12	62	Data Req.	20%	N.A.
	507	Day Lighting Control	250	15.0%	37	0.096	15.0%	0.014	12	14	N.A.	20%	N.A.
	508	High Efficiency Lamps	250	20.4%	51	0.096	20.4%	0.020	12	20	Data Req.	20%	N.A.
	509	EMS Lighting	250	21.2%	53	0.096	21.2%	0.020	12	20	Data Req.	20%	N.A.
	510	Occupancy Sensors	250	15.0%	37	0.096	15.0%	0.014	12	14	Data Req.	20%	N.A.
	511	Mercury vapor to HPS	312	36.6%	114	0.038	36.6%	0.014	12	31	Data Req.	20%	N.A.
	512	Incandescent to HPS	166	75.0%	125	0.068	75.0%	0.051	12	49	Data Req.	20%	N.A.
	513	Incandescent to Metal Halide	166	84.0%	140	0.034	84.0%	0.028	12	43	Data Req.	20%	N.A.
	514	Incandescent to Fluorescent	166	50.0%	83	0.034	50.0%	0.017	12	26	Data Req.	20%	N.A.

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Exhibit 5–9
INDUSTRIAL SECTOR DSM PROGRAM
PRELIMINARY COST–BENEFIT ANALYSIS
BULGARIA

Code	Program	Annual Energy			Peak Demand			Typical Measure Lifetime	Value Of Peak & Energy Savings	Typical Approx. Cost per unit	Typical Admin. Costs	Total Resource Cost
		Typical Base Annual Energy Consumption	Typical Savings From DSM Measure	Typical Annual Energy Savings	Typical Base Peak Demand Level	Typical Savings From DSM Measure	Typical Winter Demand Savings					
		MWh	pct	MWh	kW	pct	kW	yrs	US$	US$	pct	test
P101	Energy/production audit	10,000	10%	1,000	2,000	10%	200	10	$277,000	$50,000	20%	4.62
P102	Motor O&M	6,000	3%	180	1,200	3%	36	10	49,000	20,000	20%	2.04
P103	Compressed Air O&M	2,000	2%	40	400	2%	8	10	11,000	10,000	20%	0.92
P104	High efficiency motors	6,000	3%	180	1,200	3%	36	10	49,000	50,000	20%	0.82
P105	Drives systems, rotating equipt	6,000	3%	180	1,200	3%	36	10	49,000	50,000	20%	0.82
P106	Lighting efficiency	1,500	5%	75	300	5%	15	10	20,000	20,000	20%	0.83
P107	Improve new installations	2,000	20%	400	400	20%	80	20	153,000	500,000	20%	0.26
P108	Fuel switching	1,000	100%	1,000	200	100%	200	20	383,000	750,000	20%	0.43
P109	Interruptible/self–generation	10,000	5%	500	2,000	30%	600	10	320,000	300,000	20%	0.89
P110	Direct load control	10,000	1%	100	2,000	10%	200	10	94,000	50,000	20%	1.57
P111	Energy management system	10,000	5%	500	2,000	10%	200	10	175,000	50,000	20%	2.92

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5.1.4.2 Example DSM Measure Analysis: Compact Fluorescent Lamps (CFL)

Incandescent lamps are widely used in Bulgaria, both in households and other applications. Replacing incandescent lamps with compact fluorescent lamps (CFL) has been found to be cost-effective in certain situations. The CFL has a much higher capital cost, but use only 1/4 as much energy (or peak demand), and CFL bulbs also last up to ten times longer.

While this evaluation appears to be easy, several questions need to be answered before a CFL DSM measure can be evaluated. For example,

- What is the wattage of the old bulb being replaced? An 18 watt CFL might replace an old bulb of between 25-100 watts, so savings could be more or less.
- What proportion of bulbs replaced will normally be operated during peak demand periods, so that it is appropriate to take credit for the peak demand savings?
- How many hours per year is the bulb operated? This is the most critical factor in the decision, since it determines the energy savings resulting from this change.

Exhibit 5-10 illustrates the calculation of the economic benefit-cost ratio (TRC) for the CFL, under a specific set of assumptions. The case is a residential application, where the bulb is replacing a 75 watt incandescent and is in use 4 hours per day. Under these assumptions, the TRC is more than 2.5. Any value much more than 1.0 indicates a good DSM measure. But if the lamp were only used 2 hours per day, the CFL measure would be marginal.

Exhibit 5–10
COMPACT FLUORESCENT LAMP RESIDENTIAL DSM MEASURE

SAVINGS	Value	Units	Comment
Peak Demand Savings			
Base (Incandescent)	75	Watts	
Compact Fluorescent	18	Watts	
Savings	57	Watts	
Proportion on During Peak Hours	27%		
Diversified Peak Reduction	15.39	Watts	
Peak Demand Savings	$55.00	Per kW	
Value of Peak Savings	$4.23		Present Value Over Life of Measure
Energy Savings			
Hours of Operation	4	Hours/day	
Annual Energy Reduction	83.22	kWh	4 hours per day x 365 days x 57 Watts = 83.22 kWh
Lifetime of Bulb	6	Years	10,000 hour life at 1,420 hrs/yr
Lifetime Energy Reduction	499.32	kWh	6 years x 83.22 kWh/year
Energy Savings	$0.030	Per kWh	
Value of Energy Savings	$12.46		Present Value Over Life of Measure
Total Value of Savings	**$16.69**		**Peak Savings + Energy Savings**
COSTS			
Incremental Costs	$5.00		
Program Administration Costs	$1.00		Typical Program Cost Estimate OF 20%
Total Costs	$6.00		
Total Resource Cost Test	2.78		**Ratio of Total Savings to Costs.**

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5.2 ILLUSTRATIVE DSM PROGRAM FOR BULGARIA

5.2.1 Selection of Illustrative DSM Program for Bulgaria

Based on the results of the screening, the DSM measures which appear best able to satisfy the selection criteria for Bulgaria include:

- Low-cost improvements in homes heated with electricity, such as window coverings, weatherstripping, and thermostats
- Low-cost improvements in homes where hot water is heated with electricity, such as improved insulation, flow restrictors, and thermostats
- Retrofit of some incandescent lighting with fluorescent in homes,
- High-efficiency refrigerators,
- Direct load control in the residential and industrial sectors,
- Industrial management, technical, production and energy audits,
- Industrial operations and maintenance improvements,
- Interruptible service and expanded self-generation in industry,
- Computer-based energy management (load monitoring and control) systems in industry.

These measures were assembled into the "Illustrative DSM Program," and were carried to the next stage of analysis.

5.2.2 Estimate of Potential Impact of the Illustrative DSM Program

Next, the Illustrative DSM Program was evaluated for potential peak demand reduction and energy savings, scaling up to the level of the NEK system. Three levels of potential DSM impacts were considered in this step: Technical/Economic Potential, Market Potential, and DSM Program Potential. The three levels are described in Exhibit 5-11 and discussed below.

Exhibit 5-11
Evaluating DSM Potential

Technical/Economic Potential

Which DSM measures are both technically applicable and economically feasible?

What savings (kW and kWh) are possible from these DSM measures?

Market Potential

What proportion of cost-effective DSM measures will be ultimately accepted by consumers on their own?

How long will it take for them to accept them?

What savings (kW and kWh) will result?

Illustrative DSM Program Potential

What proportion of cost-effective DSM measures will be ultimately accepted by consumers, if the utility provides appropriate incentives through a DSM program?

How long will it take for them to accept them?

What savings (kW and kWh) will result?

5.2.2.1 Technical/Economic Potential

Technical/economic potential assesses the energy savings and coincident peak demand savings possible if the commercially available, technically applicable, and economically feasible DSM measures were fully implemented. The analysis was carried out at the sector

level (industry or buildings). Based on the data sources available to us (as listed previously), we estimated the percentage savings that would result from implementing the measures.

The estimates of the technical/economic potential are summarized in Exhibit 5-12. In summary, the technical/economic potential for electric energy efficiency measures in Bulgaria amounts to:

Peak demand reduction of more than 2,800 MW (48% of current maximum)

Energy savings of more than 7 TWh (29% of current consumption)

A "supply curve" is useful to illustrate the quantity of a good available at various prices. An energy efficiency supply curve plots the various technical measures in rank order on the basis of their cost of conserved energy (CCE, $/kWh). The CCE for each measure is plotted vs. the technical/economic potential of the measure (GWh/year). The curve only shows technologies which have a CCE less than the estimated marginal cost of energy supply (about $0.03/kWh).

The supply curve of technical/economic potential for measures in the buildings sector is shown in Exhibit 5-13. Several measures appear attractive, led by commercial lighting reflectors.

Exhibit 5-14 illustrates the supply curve for the industrial sector. Energy and production management audits (covering not only electricity consumption but also the organization and management of the production process) are most attractive, flowed by computer energy management systems.

The industrial curve includes two load management technologies that limit peak demand (MW) and are expected to be cost-effective. Because these measures are designed to reduce peak demand, rather than save energy, their CCE is higher than the cost of energy supply.

Exhibit 5–12
ELECTRIC ENERGY EFFICIENCY FOR BULGARIA
ESTIMATE OF TECHNICAL POTENTIAL
FOR SELECTED MEASURES

Sector	Functional area – Program element	TECHNICAL POTENTIAL					
		Annual Energy			Peak Demand		
		Base Annual Energy Consumption GWh	Percent Savings From DSM Measure	Annual Energy Savings GWh	Base Peak Demand Level MW	Percent Savings From DSM Measure	Winter Demand Savings MW
Bldg	Window coverings	1,800	5%	90	600	5%	30
Bldg	Caulking, weatherstripping	1,800	5%	90	600	5%	30
Bldg	Thermostat	1,800	10%	180	600	10%	60
Bldg	Heating – convert from electric to gas	1,800	100%	1,800	600	100%	600
Bldg	Hot water insulation	1,500	5%	75	300	5%	15
Bldg	Flow restrictors	1,500	5%	75	300	0%	3
Bldg	Water heater timer	1,500	5%	75	300	5%	15
Bldg	Water heater controls	1,500	5%	75	300	5%	15
Bldg	High efficiency refrigerator	2,601	30%	780	309	30%	93
Bldg	Fluorescent lighting (residential)	327	70%	229	61	70%	43
Bldg	Fluorescent lighting (commercial)	1,500	30%	450	288	30%	86
Bldg	Direct load control	12,000	1%	120	2,000	15%	300
Bldg	**Subtotal**	**12,000**	**31%**	**3,679**	**2,000**	**51%**	**1,020**
Indus	Energy/production audit	14,000	10%	1,400	4,000	10%	400
Indus	Motor O&M	8,400	3%	252	2,400	3%	72
Indus	Compressed Air O&M	2,800	2%	56	800	2%	16
Indus	High efficiency motors	8,400	3%	252	2,400	3%	72
Indus	Drive systems, rotating loads	8,400	3%	252	2,400	3%	72
Indus	Lighting efficiency	2,100	5%	105	600	5%	30
Indus	Interruptible/self–generation	14,000	5%	700	4,000	30%	1,200
Indus	Direct load control	14,000	1%	140	4,000	10%	400
Indus	Energy management system	14,000	5%	700	4,000	10%	400
Indus	**Subtotal**	**14,000**	**28%**	**3,857**	**4,000**	**47%**	**1,862**
	Total	**26,000**	**29%**	**7,536**	**6,000**	**48%**	**2,882**

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Note: totals adjusted to account for overlapping

Exhibit 5-13

Bulgaria

Supply Curve -- Technical/Economic Potential (Buildings Sector)

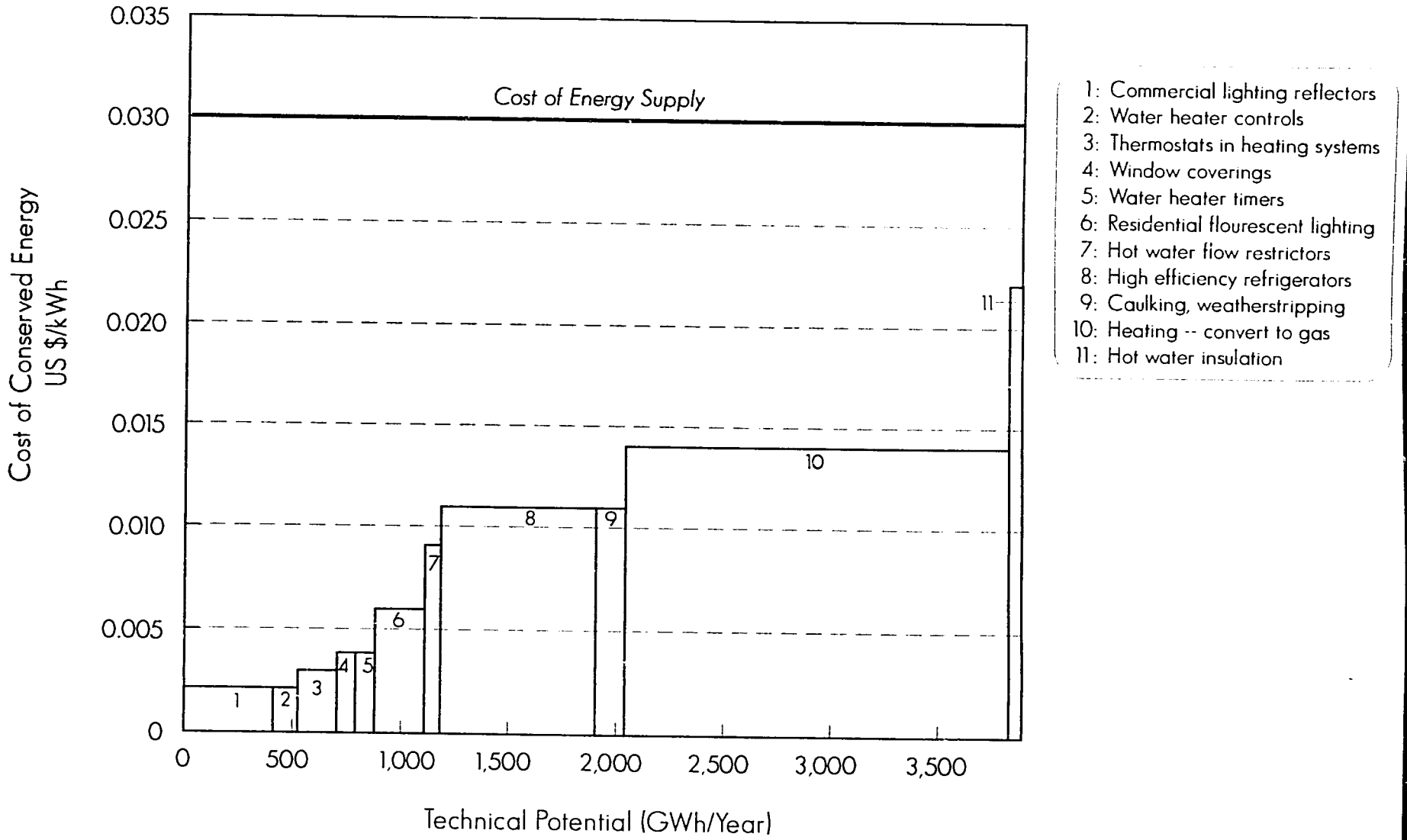
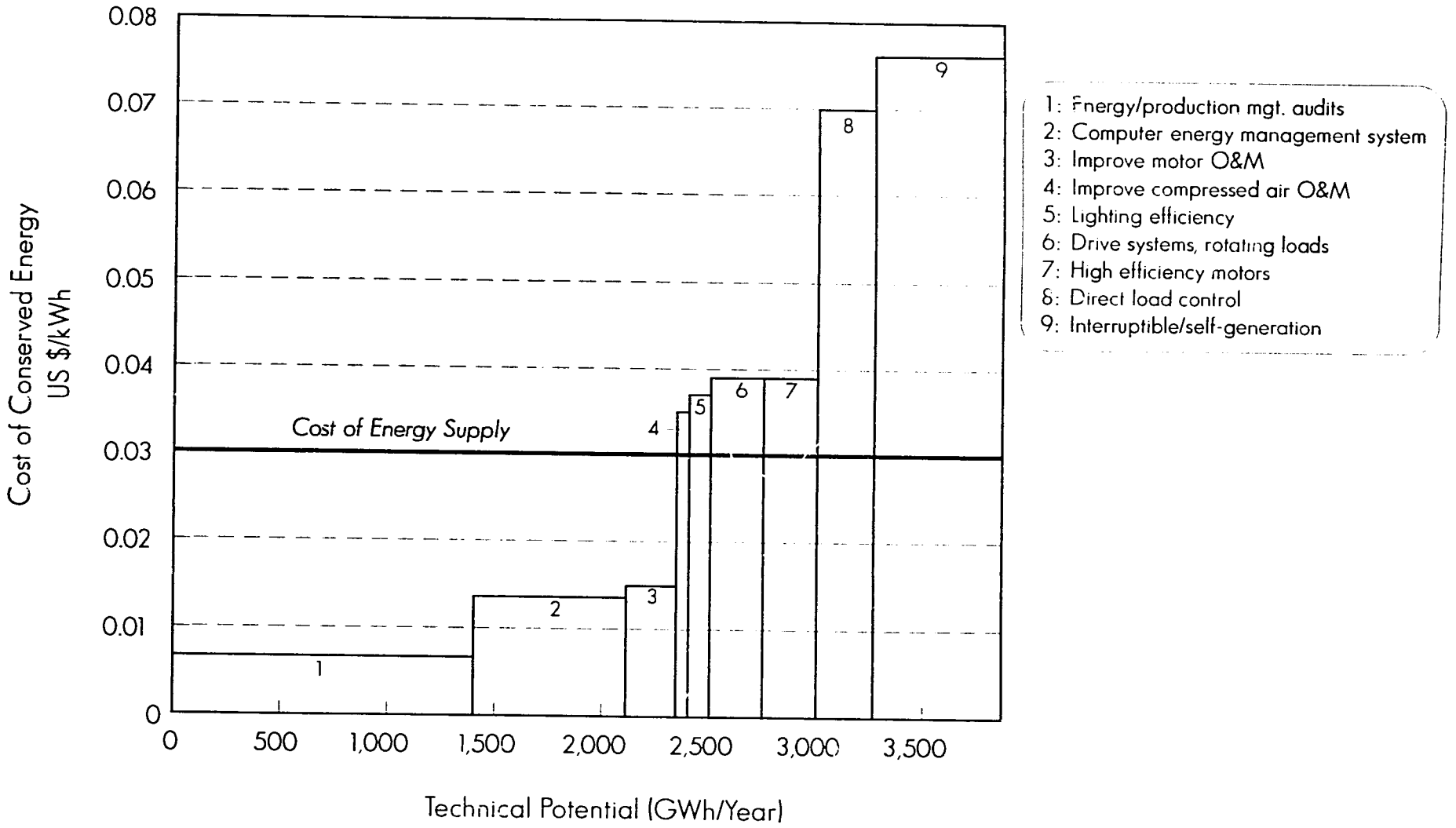


Exhibit 5-14

Bulgaria

Supply Curve -- Technical/Economic Potential (Industry Sector)



5.2.2.2 Market Potential

Market potential assesses the likelihood that the technical/economic potential will in fact be realized, based on normal market forces alone, such as electricity prices and consumer behavior. Some of these market forces influencing market potential in Bulgaria are listed in Exhibit 5-15.

Market potential depends on decision maker preferences. A DSM measure that is technically feasible and physically applicable may not be considered cost-effective by different individual home, building, or factory decision makers. Usually decision makers in the same market segment, evaluating the same DSM measure at a given levelized cost may or may not consider it cost-effective to install because of different investment preferences and acceptance criteria.

Market potential indicates the fraction of cost-effective DSM measures that will actually be undertaken by consumers. There are many reasons why even cost-effective DSM measures are not implemented: alternative uses of capital, severe limitations on the availability of capital, disinterest in energy conservation, management focus on other concerns or crises, differing opinions regarding other product attributes, perceptions of technical risk, lack of knowledge of the measure, and numerous other normal market frictions and transaction costs which result in a lower number of DSM measures actually being undertaken than are cost-effective.

Exhibit 5-15
Factors Influencing Investments
In Energy Efficiency In Bulgaria

Financial Constraints: There may be insufficient capital available, or the financial risk for energy efficiency may be perceived as being too high. A survey of the 106 largest Bulgarian electrical customers was carried out in December 1992 by DBC. Lack of financing was identified as the key reason for not undertaking energy efficiency investments by 53% of the firms who responded.

Equipment Availability: High efficiency equipment may not be available, or other technological limitations may exist. This was cited as the reason for not undertaking energy efficiency investments by 25% of the firms in the Bulgarian survey.

Subsidized Energy Prices: Energy prices may not provide the consumer with a sufficient price signal to justify energy efficiency investments. Low electricity prices was identified as the reason for not investing in energy efficiency by approximately 9% of the firms responding to the survey.

Lack of Information: Energy users may not be aware of energy efficiency opportunities or may not know how to get the measure implemented.

Non-Economic Behavior: Consumers may not make strictly economic behavior but make choices according to other considerations.

Ownership: Renters may pay the utility bill, but are unwilling to make improvements to buildings owned by landlords or the state.

Market potential indicates what would happen without a utility-sponsored DSM program.

The estimates of the market potential are shown in Exhibit 5-16. The estimates are based on assumptions regarding market penetration for each measure. These assumptions show low rates of market penetration achieved over a 10-20 year period, consistent with experience in the U.S. and developing countries. In summary, we estimate that the market potential for DSM measures in Bulgaria amounts to 5-7% of the technical/economic potential:

> Peak demand reduction of 150 MW (about 2% of current maximum load from industrial and buildings sectors)
>
> Energy savings of 590 GWh (2% of current consumption by industrial and buildings sectors)

The annual projection of peak demand reduction in the base case is shown in Exhibit 5-17. As indicated, peak demand is reduced by 15 MW in 5 years, 87 MW in 10 years, and 151 MW in 20 years.

The annual projection of energy savings in the base case is shown in Exhibit 5-18. The exhibit shows that energy consumption is reduced by 51 GWh per year in 5 years, 308 GWH per year in 10 years, and 560 GWh per year in 20 years.

Exhibit 5–16
ELECTRIC ENERGY EFFICIENCY IN BULGARIA
ESTIMATED MARKET ACCEPTANCE WITHOUT DSM

Sector	Functional area – Program element	Technical Potential		Market Penetration		Market Potential	
		Annual Energy Savings GWh	Winter Demand Savings MW	Final Market pct	Time to Final Market yrs	Annual Energy Savings GWh	Winter Demand Savings MW
Bldg	Window coverings	90	30	10%	10	9	3
Bldg	Caulking, weatherstripping	90	30	10%	10	9	3
Bldg	Thermostat	180	60	10%	10	18	6
Bldg	Heating – convert from electric to gas	1,800	600	0%	20	0	0
Bldg	Hot water insulation	75	15	10%	10	8	2
Bldg	Flow restrictors	75	3	10%	10	8	0
Bldg	Water heater timer	75	15	10%	10	8	2
Bldg	Water heater controls	75	15	10%	10	8	2
Bldg	High efficiency refrigerator	780	93	20%	20	156	19
Bldg	Fluorescent lighting (residential)	229	43	10%	10	23	4
Bldg	Fluorescent lighting (commercial)	450	86	10%	10	45	9
Bldg	Direct load control	120	300	0%	20	0	0
Bldg	**Subtotal**	**3,679**	**1,020**			**290**	**48**
	Savings as pct. of technical potential					7.9%	4.7%
	Savings as pct. of current consumption					3.4%	2.0%
Indus	Energy/production audit	1,400	400	10%	10	140	40
Indus	Motor O&M	252	72	10%	10	25	7
Indus	Compressed Air O&M	56	16	10%	10	6	2
Indus	High efficiency motors	252	72	10%	10	25	7
Indus	Drive systems, rotating loads	252	72	10%	10	25	7
Indus	Lighting efficiency	105	30	10%	10	11	3
Indus	Interruptible/self–generation	700	1,200	0%	20	0	0
Indus	Direct load control	140	400	0%	20	0	0
Indus	Energy management system	700	400	10%	10	70	40
Indus	**Subtotal**	**3,857**	**1,862**			**302**	**106**
	Savings as pct. of technical potential					7.8%	5.7%
	Savings as pct. of current consumption					1.5%	2.7%
	Total	**7,536**	**2,882**			**592**	**154**
	Savings as pct. of technical potential					7.9%	5.4%
	Savings as pct. of current consumption					2.1%	2.4%

DSM_MKT.WK1

Note: totals adjusted to account for overlapping

Exhibit 5–17
Projection of Market Penetration
BASE CASE – NO DSM
Peak Demand Reduction, MW

Functional area – Program element	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BUILDINGS:																				
Window coverings	0	0	0	0	0	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3
Caulking, weatherstripping	0	0	0	0	0	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3
Thermostat	0	0	0	0	1	1	2	2	3	4	4	5	5	6	6	6	6	6	6	6
Heating – convert from electric to gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot water insulation	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2
Flow restrictors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water heater timer	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2
Water heater controls	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2
High efficiency refrigerator	0	0	0	0	1	2	3	4	5	6	6	7	8	[illegible]	10	11	12	13	14	15
Incandescent to fluorescent	0	0	0	0	0	1	1	2	2	3	3	3	4	4	4	4	4	4	4	4
Other lighting upgrades	0	0	0	0	1	2	3	3	4	5	6	7	8	9	9	9	9	9	9	9
Direct load control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal, Buildings	**0**	**0**	**1**	**2**	**4**	**8**	**12**	**16**	**19**	**23**	**27**	**31**	**35**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
INDUSTRY:																				
Energy/production audit	0	0	1	2	4	8	12	16	20	24	28	32	36	40	40	40	40	40	40	40
Motor O&M	0	0	0	0	1	1	2	3	4	4	5	6	6	7	7	7	7	7	7	7
Compressed Air O&M	0	0	0	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	2
High efficiency motors	0	0	0	0	1	1	2	3	4	4		6	6	7	7	7	7	7	7	7
Drive systems, rotating loads	0	0	0	0	1	1	2	3	4	4	5	6	6	7	7	7	7	7	7	7
Lighting efficiency	0	0	0	0	0	1	1	1	2	2	2	2	3	3	3	3	3	3	3	3
Interruptible/self–generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Direct load control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy management system	0	0	1	2	4	8	12	16	20	24	28	32	36	40	40	40	40	40	40	40
Subtotal, Industry	**1**	**1**	**3**	**5**	**11**	**21**	**32**	**42**	**53**	**64**	**74**	**85**	**96**	**106**	**106**	**106**	**106**	**106**	**106**	**106**
Total, Bulgaria	**1**	**2**	**4**	**7**	**15**	**29**	**44**	**58**	**73**	**87**	**102**	**116**	**131**	**145**	**146**	**147**	**148**	**149**	**150**	**151**
Benefits (US$000)	**40**	**96**	**200**	**399**	**798**	**1,597**	**2,395**	**3,194**	[illegible],992	**4,790**	**5,589**	**6,387**	**7,186**	**7,984**	**8,035**	**8,086**	**8,137**	**8,188**	**8,239**	**8,290**

BSE MW WKI

Exhibit 5–18
Projection of Market Penetration
BASE CASE – NO DSM
Energy savings, GWh/yr

Functional area – Program element	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BUILDINGS:																				
Window coverings	0	0	0	0	1	2	3	4	5	5	6	7	8	9	9	9	9	9	9	9
Caulking, weatherstripping	0	0	0	0	1	2	3	4	5	5	6	7	8	9	9	9	9	9	9	9
Thermostat	0	0	0	1	2	4	5	7	9	11	13	14	16	18	18	18	18	18	18	18
Heating – convert from electric to gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot water insulation	0	0	0	0	1	2	2	3	4	5	5	6	7	8	8	8	8	8	8	8
Flow restrictors	0	0	0	0	1	2	2	3	4	5	5	6	7	8	8	8	8	8	8	8
Water heater timer	0	0	0	0	1	2	2	3	4	5	5	6	7	8	8	8	8	8	8	8
Water heater controls	0	0	0	0	1	2	2	3	4	5	5	6	7	8	8	8	8	8	8	8
High efficiency refrigerator	0	1	2	4	8	16	23	31	39	47	55	62	70	78	86	94	101	109	117	125
Incandescent to fluorescent	0	0	1	1	2	5	7	9	11	14	16	18	21	23	23	23	23	23	23	23
Other lighting upgrades	0	1	1	2	5	9	14	18	23	27	32	36	41	45	45	45	45	45	45	45
Direct load control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal, Buildings	1	3	5	11	21	42	64	85	106	127	148	170	191	212	220	228	235	243	251	259
INDUSTRY:																				
Energy/production audit	1	2	4	7	14	28	42	56	70	84	98	112	126	140	140	140	140	140	140	140
Motor O&M	0	0	1	1	3	5	8	10	13	15	18	20	23	25	25	25	25	25	25	25
Compressed Air O&M	0	0	0	0	1	1	2	2	3	3	4	4	5	6	6	6	6	6	6	6
High efficiency motors	0	0	1	1	3	5	8	10	13	15	18	20	23	25	25	25	25	25	25	25
Drive systems, rotating loads	0	0	1	1	3	5	8	10	13	15	18	20	23	25	25	25	25	25	25	25
Lighting efficiency	0	0	0	1	1	2	3	4	5	6	7	8	9	11	11	11	11	11	11	11
Interruptible/self–generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Direct load control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy management system	0	1	2	4	7	14	21	28	35	42	49	56	63	70	70	70	70	70	70	70
Subtotal, Industry	2	4	8	15	30	60	91	121	151	181	211	241	272	302	302	302	302	302	302	302
Total, Bulgaria	3	6	13	26	51	103	154	205	257	308	360	411	462	514	521	529	537	545	553	560

BSE GWHWKT

5.2.2.3 Illustrative DSM Program Potential

The illustrative DSM Program Potential estimates the results of a utility-based incentive program designed to overcome the market imperfections, and thereby increase customer acceptance of energy efficiency measures. Despite the provision of incentives and subsidies, utility-sponsored DSM programs may only result in an actual implementation of 25-50% of the technical/economic potential.

Assessing market potential requires actual consumer responses to DSM programs. The survey of Bulgarian industries provides some information on market potential. Without incentives (the current situation), the survey found that 57% of the firms interviewed had not implemented energy efficiency measures, even though three-fourths of the total firms were aware of potential options. The survey found that 76% of those interviewed would be interested in energy efficiency programs, if incentives were offered.

While there are several means of establishing impact and cost-effectiveness, assessing market potential generally requires implementing pilot programs. Pilot programs are the best way to obtain actual customer response to the program offered by the utility.

The analysis of DSM measures, and development of pilot programs needs to consider the percentage of customers (among those who find a particular DSM measure economically attractive) who actually purchase and install that measure. The utility, the government, and DSM companies can undertake marketing programs to affect the level of adoption of DSM measures, and these can be tested in pilot programs. Various changes in intensity, scope, or scale of programmatic and private (e.g., energy service companies) marketing efforts can significantly impact the level of market penetration. Usually, customers may be more likely to adopt a technology if a utility or government agency encourages its use and provides information through an energy-conservation program.

The estimates of the illustrative DSM program potential are shown in Exhibit 5-19. The estimates are based on revisions to the assumptions regarding market penetration for each measure. These assumptions show higher rates of market penetration achieved over a shorter period of time, consistent with experience in the U.S. In summary, we estimate that the illustrative DSM program potential for Bulgaria amounts to about 35% of the technical/economic potential:

Peak demand reduction of more than 1,000 MW (16% of current maximum load from industrial and buildings sectors)

Energy savings of 2.8 TWh (10% of current consumption by industrial and buildings sectors)

Exhibit 5–19
DSM PROGRAM FOR BULGARIA
ESTIMATED POTENTIAL IMPACT

Sector	Functional area – Program element	Technical Potential		DSM Penetration		DSM Potential	
		Annual Energy Savings GWh	Winter Demand Savings MW	Final Market pct	Time to Final Market yrs	Annual Energy Savings GWh	Winter Demand Savings MW
Bldg	Window coverings	90	30	50%	5	45	15
Bldg	Caulking, weatherstripping	90	30	50%	5	45	15
Bldg	Thermostat	180	60	50%	5	90	30
Bldg	Heating – convert from electric to gas	1,800	600	10%	10	180	60
Bldg	Hot water insulation	75	15	50%	5	38	8
Bldg	Flow restrictors	75	3	50%	5	38	2
Bldg	Water heater timer	75	15	50%	5	38	8
Bldg	Water heater controls	75	15	50%	5	38	8
Bldg	High efficiency refrigerator	780	93	50%	10	390	46
Bldg	Fluorescent lighting (residential)	229	43	50%	5	114	21
Bldg	Fluorescent lighting (commercial)	450	86	50%	5	225	43
Bldg	Direct load control	120	300	25%	10	30	75
Bldg	**Subtotal**	**3,679**	**1,020**			**1,270**	**330**
	Savings as pct. of technical potential					34.5%	32.3%
	Savings as pct. of current consumption					14.8%	13.8%
Indus	Energy/production audit	1,400	400	50%	5	700	200
Indus	Motor O&M	252	72	50%	5	126	36
Indus	Compressed Air O&M	56	16	50%	5	28	8
Indus	High efficiency motors	252	72	50%	5	126	36
Indus	Drive systems, rotating loads	252	72	50%	5	126	36
Indus	Lighting efficiency	105	30	50%	5	53	15
Indus	Interruptible/self–generation	700	1,200	10%	10	70	120
Indus	Direct load control	140	400	20%	5	28	80
Indus	Energy management system	700	400	50%	5	350	200
Indus	**Subtotal**	**3,857**	**1,862**			**1,607**	**731**
	Savings as pct. of technical potential					41.7%	39.3%
	Savings as pct. of current consumption					8.0%	18.3%
	Total	**7,536**	**2,882**			**2,876**	**1,061**
	Savings as pct. of technical potential					38.2%	36.8%
	Savings as pct. of current consumption					10.1%	16.6%

DSM_DSM.WK1

Note: totals adjusted to account for overlapping

Thus, the estimated net benefit of the DSM program (subtracting the base case energy efficiency improvements that would have happened without a program) are:

> Peak demand reduction of more than 900 MW (15% of current maximum load from industrial and buildings sectors)
>
> Energy savings of 2.2 TWh (9% of current consumption by industrial and buildings sectors)

A new set of energy efficiency supply curves is generated for the illustrative DSM program, using DSM Program Potential GWh/year and costs of conserved energy which include the cost of the illustrative DSM program development, administration, and evaluation. The supply curve of the DSM Program for measures in the buildings sector is shown in Exhibit 5-20. The curve only shows technologies which have a CCE less than the estimated marginal cost of energy supply (about $0.03/kWh). Exhibit 5-21 illustrates the supply curve for the industrial sector.

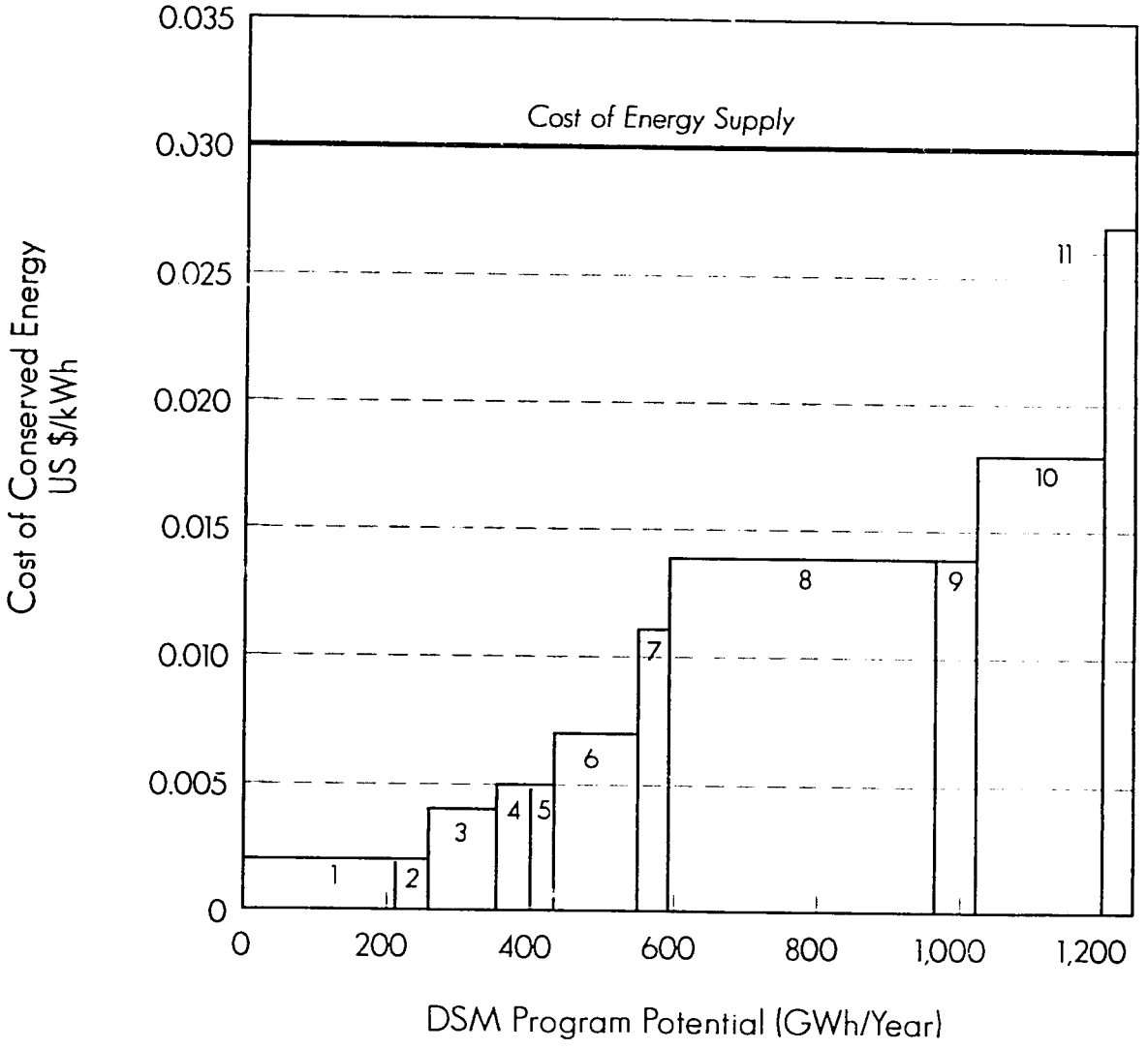
The annual projection of peak demand reduction in the Illustrative DSM Program case is shown in Exhibit 5-22. As indicated, peak demand is reduced by 182 MW in 5 years, 940 MW in 10 years, and 1,061 MW in 20 years.

The annual projection of energy savings in the Illustrative DSM Program case is shown in Exhibit 5-23. The exhibit shows that energy sales are reduced by 508 GWh per year in 5 years, 2,608 GWH per year in 10 years, and 2,876 GWh per year in 20 years.

Exhibit 5-20

Bulgaria

Supply Curve -- Illustrative DSM Program (Buildings Sector)



1: Commercial lighting reflectors
2: Water heater controls
3: Thermostats in heating systems
4: Window coverings
5: Water heater timers
6: Residential flourescent lighting
7: Hot water flow restrictors
8: High efficiency refrigerators
9: Caulking, weatherstripping
10: Heating -- convert to gas
11: Hot water insulation

Exhibit 5-21

Bulgaria

Supply Curve -- Illustrative DSM Program (Industry Sector)

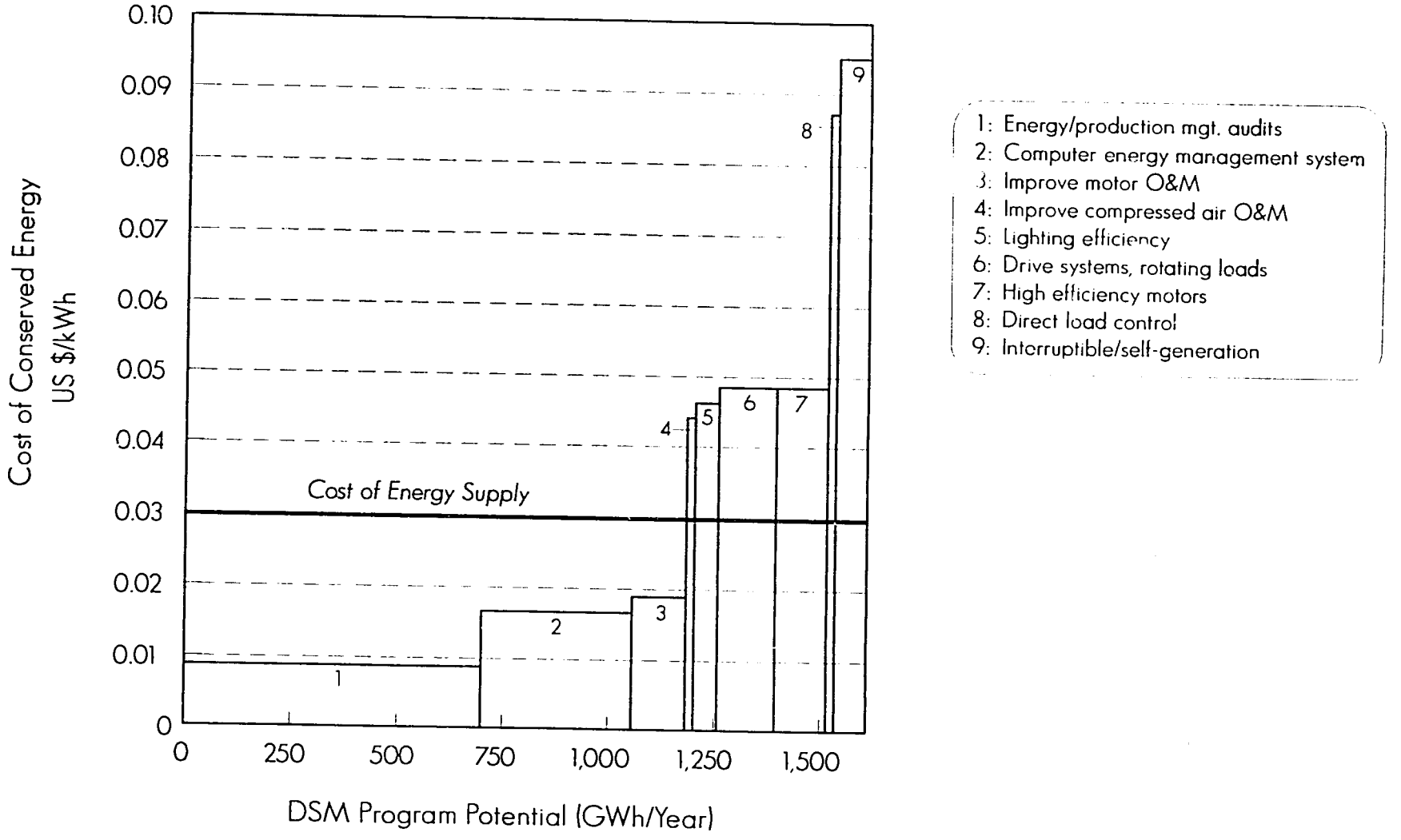


Exhibit 5–22
PROJECTION OF MARKET PENETRATION WITH DSM
PEAK DEMAND REDUCTION, MW

Functional area – Program element	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BUILDINGS:																				
Window coverings	0	0	1	2	3	6	9	12	15	15	15	15	15	15	15	15	15	15	15	15
Caulking, weatherstripping	0	0	1	2	3	6	9	12	15	15	15	15	15	15	15	15	15	15	15	15
Thermostat	0	1	2	3	6	12	18	24	30	30	30	30	30	30	30	30	30	30	30	30
Heating – convert from electric to gas	0	1	2	3	6	12	18	24	30	36	42	48	54	60	60	60	60	60	60	60
Hot water insulation	0	0	0	1	2	3	5	6	8	8	8	8	8	8	8	8	8	8	8	8
Flow restrictors	0	0	0	0	0	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Water heater timer	0	0	0	1	2	3	5	6	8	8	8	8	8	8	8	8	8	8	8	8
Water heater controls	0	0	0	1	2	3	5	6	8	8	8	8	8	8	8	8	8	8	8	8
High efficiency refrigerator	0	1	1	2	5	9	14	19	23	28	32	37	42	46	46	46	46	46	46	46
Fluorescent lighting (residential)	0	1	1	2	4	9	13	17	21	21	21	21	21	21	21	21	21	21	21	21
Fluorescent lighting (commercial)	0	1	2	4	9	17	26	35	43	43	43	43	43	43	43	43	43	43	43	43
Direct load control	0	1	2	4	8	15	23	30	38	45	53	60	68	75	75	75	75	75	75	75
Subtotal, Buildings	**2**	**6**	**12**	**24**	**48**	**96**	**143**	**191**	**239**	**257**	**275**	**294**	**312**	**330**	**330**	**330**	**330**	**330**	**330**	**330**
INDUSTRY:																				
Energy/production audit	2	5	10	20	40	80	120	160	200	200	200	200	200	200	200	200	200	200	200	200
Motor O&M	0	1	2	4	7	14	22	29	36	36	36	36	36	36	36	36	36	36	36	36
Compressed Air O&M	0	0	0	1	2	3	5	6	8	8	8	8	8	8	8	8	8	8	8	8
High efficiency motors	0	1	2	4	7	14	22	29	36	36	36	36	36	36	36	36	36	36	36	36
Drive systems, rotating loads	0	1	2	4	7	14	22	29	36	36	36	36	36	36	36	36	36	36	36	36
Lighting efficiency	0	0	1	2	3	6	9	12	15	15	15	15	15	15	15	15	15	15	15	15
Interruptible/self–generation	1	1	3	6	12	24	36	48	60	72	84	96	108	120	120	120	120	120	120	120
Direct load control	1	2	4	8	16	32	48	64	80	80	80	80	80	80	80	80	80	80	80	80
Energy management system	2	5	10	20	40	80	120	160	200	200	200	200	200	200	200	200	200	200	200	200
Subtotal, Industry	**7**	**16**	**34**	**67**	**134**	**268**	**403**	**537**	**671**	**683**	**695**	**707**	**719**	**731**	**731**	**731**	**731**	**731**	**731**	**731**
Total, Bulgaria	**9**	**22**	**46**	**91**	**182**	**364**	**546**	**728**	**910**	**940**	**970**	**1,001**	**1,031**	**1,061**	**1,061**	**1,061**	**1,061**	**1,061**	**1,061**	**1,061**

DSM_MW.WK1

Exhibit 5–23
PROJECTION OF MARKET PENETRATION
WITH DSM
ENERGY SAVINGS, GWh

Functional area – Program element	Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BUILDINGS:																				
Window coverings	0	1	2	5	9	18	27	36	45	45	45	45	45	45	45	45	45	45	45	45
Caulking, weatherstripping	0	1	2	5	9	18	27	36	45	45	45	45	45	45	45	45	45	45	45	45
Thermostat	1	2	5	9	18	36	54	72	90	90	90	90	90	90	90	90	90	90	90	90
Heating – convert from electric to ga	1	2	5	9	18	36	54	72	90	108	126	144	162	180	180	180	180	180	180	180
Hot water insulation	0	1	2	4	8	15	23	30	38	38	38	38	38	38	38	38	38	38	38	38
Flow restrictors	0	1	2	4	8	15	23	30	38	38	38	38	38	38	38	38	38	38	38	38
Water heater timer	0	1	2	4	8	15	23	30	38	38	38	38	38	38	38	38	38	38	38	38
Water heater controls	0	1	2	4	8	15	23	30	38	38	38	38	38	38	38	38	38	38	38	38
High efficiency refrigerator	2	5	10	20	39	78	117	156	195	234	273	312	351	390	390	390	390	390	390	390
Fluorescent lighting (residential)	1	3	6	11	23	46	69	92	114	114	114	114	114	114	114	114	114	114	114	114
Fluorescent lighting (commercial)	2	5	11	23	45	90	135	180	225	225	225	225	225	225	225	225	225	225	225	225
Direct load control	0	0	1	2	3	6	9	12	15	18	21	24	27	30	30	30	30	30	30	30
Subtotal, Buildings	**10**	**23**	**48**	**97**	**194**	**388**	**582**	**776**	**970**	**1,030**	**1,090**	**1,150**	**1,210**	**1,270**	**1,270**	**1,270**	**1,270**	**1,270**	**1,270**	**1,270**
INDUSTRY:																				
Energy/production audit	7	17	35	70	140	280	420	560	700	700	700	700	700	700	700	700	700	700	700	700
Motor O&M	1	3	6	13	25	50	76	101	126	126	126	126	126	126	126	126	126	126	126	126
Compressed Air O&M	0	1	1	3	6	11	17	22	28	28	28	28	28	28	28	28	28	28	28	28
High efficiency motors	1	3	6	13	25	50	76	101	126	126	126	126	126	126	126	126	126	126	126	126
Drive systems, rotating loads	1	3	6	13	25	50	76	101	126	126	126	126	126	126	126	126	126	126	126	126
Lighting efficiency	1	1	3	5	11	21	32	42	53	53	53	53	53	53	53	53	53	53	53	53
Interruptible/self–generation	0	1	2	4	7	14	21	28	35	42	49	56	63	70	70	70	70	70	70	70
Direct load control	0	1	1	3	6	11	17	22	28	28	28	28	28	28	28	28	28	28	28	28
Energy management system	4	8	18	35	70	140	210	280	350	350	350	350	350	350	350	350	350	350	350	350
Subtotal, Industry	**16**	**38**	**79**	**157**	**314**	**629**	**943**	**1,257**	**1,572**	**1,579**	**1,586**	**1,593**	**1,600**	**1,607**	**1,607**	**1,607**	**1,607**	**1,607**	**1,607**	**1,607**
Total, Bulgaria	**25**	**61**	**127**	**254**	**508**	**1,016**	**1,525**	**2,033**	**2,541**	**2,608**	**2,675**	**2,742**	**2,809**	**2,876**	**2,876**	**2,876**	**2,876**	**2,876**	**2,876**	**2,876**

DSM_GWH.WK1

5.2.3 Projections of Economic Costs

Based on the market penetration rates described above, annual projections of economic costs were developed. These are the total costs of implementing the measures, whether paid fully by the customer (as is assumed in the base case) or paid through a partnership between the customer and the electric utility (as is assumed in the DSM case).

5.2.3.1 Costs Under the Base Case (Market Forces)

The annual economic costs of energy efficiency improvements under the base case are indicated in Exhibit 5-24. Even under the base case, significant investments in energy efficiency are expected to occur, e.g. $6.5 million per year in years 6 though 14.

5.2.3.2 Costs Under the Illustrative DSM Program

The annual economic costs of energy efficiency improvements under Illustrative DSM Program are indicated in Exhibit 5-25. Much greater investments are required, peaking at $76 million per year once the program gets fully under way:

Year 1:	$4 million
Year 2:	$5 million
Year 3:	$10 million
Year 4:	$19 million
Year 5:	$38 million
Years 6 - 9:	$76 million per year

5.2.4 Economic Analysis of the Illustrative DSM Program

The investments required for the Illustrative DSM Program are large, especially considering the ability of the Bulgarian economy to finance investment at this time. An economic analysis is required to determine if these costs could be justified.

Exhibit 5-26 shows a summary projection of the annual costs and benefits for the base case and the Illustrative DSM program. The programs achieve break-even by the end of the seventh year.

Exhibit 5–24
PROJECTION OF ECONOMIC COST
BASE CASE – NO DSM

Functional area – Program element	Thousands of US Dollars per Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BUILDINGS:																				
Window coverings	2	2	4	8	17	33	33	33	33	33	33	33	33	33	0	0	0	0	0	0
Caulking, weatherstripping	5	7	14	26	52	104	104	104	104	104	104	104	104	104	0	0	0	0	0	0
Thermostat	3	4	8	15	30	60	60	60	60	60	60	60	60	60	0	0	0	0	0	0
Heating – convert from electric to gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot water insulation	8	12	22	42	84	168	168	168	168	168	168	168	168	168	0	0	0	0	0	0
Flow restrictors	3	5	9	17	34	67	67	67	67	67	67	67	67	67	0	0	0	0	0	0
Water heater timer	2	2	4	8	15	30	30	30	30	30	30	30	30	30	0	0	0	0	0	0
Water heater controls	1	1	2	4	8	15	15	15	15	15	15	15	15	15	0	0	0	0	0	0
High efficiency refrigerator	41	57	107	205	410	820	820	820	820	820	820	820	820	820	820	820	820	820	820	820
Incandescent to fluorescent	7	10	18	35	69	138	138	138	138	138	138	138	138	138	0	0	0	0	0	0
Other lighting upgrades	4	6	11	21	42	84	84	84	84	84	84	84	84	84	0	0	0	0	0	0
Direct load control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal, Buildings	**76**	**106**	**198**	**380**	**760**	**1,521**	**1,521**	**1,521**	**1,521**	**1,521**	**1,521**	**1,521**	**1,521**	**1,521**	**820**	**820**	**820**	**820**	**820**	**820**
INDUSTRY:																				
Energy/production audit	50	70	130	250	500	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0	0	0	0	0	0
Motor O&M	20	28	52	100	200	400	400	400	400	400	400	400	400	400	0	0	0	0	0	0
Compressed Air O&M	10	14	26	50	100	200	200	200	200	200	200	200	200	200	0	0	0	0	0	0
High efficiency motors	50	70	130	250	500	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0	0	0	0	0	0
Drive systems, rotating loads	50	70	130	250	500	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0	0	0	0	0	0
Lighting efficiency	20	28	52	100	200	400	400	400	400	400	400	400	400	400	0	0	0	0	0	0
Interruptible/self-generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Direct load control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy management system	50	70	130	250	500	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	0	0	0	0	0	0
Subtotal, Industry	**250**	**350**	**650**	**1,250**	**2,500**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**0**	**0**	**0**	**0**	**0**	**0**
Total, Bulgaria	**326**	**456**	**848**	**1,630**	**3,260**	**6,521**	**6,521**	**6,521**	**6,521**	**6,521**	**6,521**	**6,521**	**6,521**	**6,521**	**820**	**820**	**820**	**820**	**820**	**820**

BSE COST.WK1

Exhibit 5–25
PROJECTION OF ECONOMIC COST WITH DSM

Functional area – Program element	Thousands of US Dollars per Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BUILDINGS:																				
Window coverings	17	23	43	83	167	333	333	333	333	0	0	0	0	0	0	0	0	0	0	0
Caulking, weatherstripping	52	73	135	260	521	1,042	1,042	1,042	1,042	0	0	0	0	0	0	0	0	0	0	0
Thermostat	30	42	78	150	300	600	600	600	600	0	0	0	0	0	0	0	0	0	0	0
Heating – convert from electric to gas	121	169	314	603	1,206	2,412	2,412	2,412	2,412	2,412	2,412	2,412	2,412	2,412	0	0	0	0	0	0
Hot water insulation	84	118	218	420	840	1,680	1,680	1,680	1,680	0	0	0	0	0	0	0	0	0	0	0
Flow restrictors	34	47	87	168	336	672	672	672	672	0	0	0	0	0	0	0	0	0	0	0
Water heater timer	15	21	39	75	150	300	300	300	300	0	0	0	0	0	0	0	0	0	0	0
Water heater controls	8	11	20	38	77	153	153	153	153	0	0	0	0	0	0	0	0	0	0	0
High efficiency refrigerator	205	287	533	1,025	2,051	4,102	4,102	4,102	4,102	4,102	4,102	4,102	4,102	4,102	0	0	0	0	0	0
Fluorescent lighting (residential)	69	97	180	345	691	1,382	1,382	1,382	1,382	0	0	0	0	0	0	0	0	0	0	0
Fluorescent lighting (commercial)	42	59	109	211	421	842	842	842	842	0	0	0	0	0	0	0	0	0	0	0
Direct load control	188	263	488	938	1,875	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	0	0	0	0	0	0
Subtotal, Buildings	**863**	**1,209**	**2,245**	**4,317**	**8,634**	**17,267**	**17,267**	**17,267**	**17,267**	**10,264**	**10,264**	**10,264**	**10,264**	**10,264**	**0**	**0**	**0**	**0**	**0**	**0**
INDUSTRY:																				
Energy/production audit	500	700	1,300	2,500	5,000	10,000	10,000	10,000	10,000	0	0	0	0	0	0	0	0	0	0	0
Motor O&M	200	280	520	1,000	2,000	4,000	4,000	4,000	4,000	0	0	0	0	0	0	0	0	0	0	0
Compressed Air O&M	100	140	260	500	1,000	2,000	2,000	2,000	2,000	0	0	0	0	0	0	0	0	0	0	0
High efficiency motors	500	700	1,300	2,500	5,000	10,000	10,000	10,000	10,000	0	0	0	0	0	0	0	0	0	0	0
Drive systems, rotating loads	500	700	1,300	2,500	5,000	10,000	10,000	10,000	10,000	0	0	0	0	0	0	0	0	0	0	0
Lighting efficiency	200	280	520	1,000	2,000	4,000	4,000	4,000	4,000	0	0	0	0	0	0	0	0	0	0	0
Interruptible/self-generation	250	350	650	1,250	2,500	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	0	0	0	0	0	0
Direct load control	200	280	520	1,000	2,000	4,000	4,000	4,000	4,000	0	0	0	0	0	0	0	0	0	0	0
Energy management system	500	700	1,300	2,500	5,000	10,000	10,000	10,000	10,000	0	0	0	0	0	0	0	0	0	0	0
Subtotal, Industry	**2,950**	**4,130**	**7,670**	**14,750**	**29,500**	**59,000**	**59,000**	**59,000**	**59,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**0**	**0**	**0**	**0**	**0**	**0**
Total, Bulgaria	**3,813**	**5,339**	**9,915**	**19,067**	**38,134**	**76,267**	**76,267**	**76,267**	**76,267**	**15,264**	**15,264**	**15,264**	**15,264**	**15,264**	**0**	**0**	**0**	**0**	**0**	**0**

DSM COST.WK1

Exhibit 5–26
BULGARIA
SUMMARY OF DSM PROGRAM COSTS AND BENEFITS

	Millions of US Dollars per Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Base case – No DSM program																				
Buildings:																				
Achieved GWh savings	1	3	5	11	21	42	64	85	106	127	148	170	191	212	220	228	235	243	251	259
Achieved MW savings	0	0	1	2	4	8	12	16	19	23	27	31	35	39	40	41	42	43	44	45
Investment cost ($million)	0.08	0.11	0.20	0.38	0.76	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	0.82	0.82	0.82	0.82	0.82	0.82
Economic benefits ($million)	0.04	0.10	0.21	0.43	0.85	1.70	2.55	3.40	4.25	5.10	5.95	6.80	7.65	8.50	8.79	9.07	9.36	9.64	9.93	10.21
Net benefits ($million)	−0.03	0.00	0.01	0.04	0.09	0.18	1.03	1.88	2.73	3.58	4.43	5.28	6.13	6.98	7.97	8.25	8.54	8.82	9.11	9.39
Industry:																				
Achieved GWh savings	2	4	8	15	30	60	91	121	151	181	211	241	272	302	302	302	302	302	302	302
Achieved MW savings	1	1	3	5	11	21	32	42	53	64	74	85	96	106	106	106	106	106	106	106
Investment cost ($million)	0.25	0.35	0.65	1.25	2.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Economic benefits ($million)	0.07	0.18	0.37	0.74	1.49	2.98	4.47	5.96	7.45	8.94	10.42	11.91	13.40	14.89	14.89	14.89	14.89	14.89	14.89	14.89
Net benefits ($million)	−0.18	−0.17	−0.28	−0.51	−1.01	−2.02	−0.53	0.96	2.45	3.94	5.42	6.91	8.40	9.89	14.89	14.89	14.89	14.89	14.89	14.89
Total																				
Achieved GWh savings	3	6	13	26	51	103	154	205	257	308	360	411	462	514	521	529	537	545	553	560
Achieved MW savings	1	2	4	7	15	29	44	58	73	87	102	116	131	145	146	147	148	149	150	151
Investment cost ($million)	0.33	0.46	0.85	1.63	3.26	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	6.52	0.82	0.82	0.82	0.82	0.82	0.82
Economic benefits ($million)	0.12	0.28	0.58	1.17	2.34	4.68	7.02	9.36	11.70	14.04	16.37	18.71	21.05	23.39	23.68	23.96	24.25	24.53	24.82	25.10
Net benefits ($million)	−0.21	−0.18	−0.26	−0.46	−0.92	−1.84	0.50	2.84	5.18	7.51	9.85	12.19	14.53	16.87	22.86	23.14	23.43	23.71	24.00	24.28
2. Recommended DSM program																				
Buildings:																				
Achieved GWh savings	10	23	48	97	194	388	582	776	970	1,030	1,090	1,150	1,210	1,270	1,270	1,270	1,270	1,270	1,270	1,270
Achieved MW savings	2	6	12	24	48	96	143	191	239	257	275	294	312	330	330	330	330	330	330	330
Investment cost ($million)	0.86	1.21	2.24	4.32	8.63	17.27	17.27	17.27	17.27	10.26	10.26	10.26	10.26	10.26	0.00	0.00	0.00	0.00	0.00	0.00
Economic benefits ($million)	0.42	1.01	2.11	4.22	8.45	16.90	25.34	33.79	42.24	45.04	47.83	50.63	53.43	56.23	56.23	56.23	56.23	56.23	56.23	56.23
Net benefits ($million)	−0.44	−0.19	−0.13	−0.09	−0.19	−0.37	8.08	16.52	24.97	34.77	37.57	40.37	43.17	45.96	56.23	56.23	56.23	56.23	56.23	56.23
Industry:																				
Achieved GWh savings	16	38	79	157	314	629	943	1,257	1,572	1,579	1,586	1,593	1,600	1,607	1,607	1,607	1,607	1,607	1,607	1,607
Achieved MW savings	7	16	34	67	134	268	403	537	671	683	695	707	719	731	731	731	731	731	731	731
Investment cost ($million)	2.95	4.13	7.67	14.75	29.50	59.00	59.00	59.00	59.00	5.00	5.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Economic benefits ($million)	0.84	2.02	4.20	8.41	16.81	33.62	50.43	67.24	84.05	84.92	85.79	86.66	87.53	88.40	88.40	88.40	88.40	88.40	88.40	88.40
Net benefits ($million)	−2.11	−2.11	−3.47	−6.35	−12.69	−25.38	−8.57	8.24	25.05	79.92	80.79	81.66	82.53	83.40	88.40	88.40	88.40	88.40	88.40	88.40
Total																				
Achieved GWh savings	25	61	127	254	508	1,016	1,525	2,033	2,541	2,608	2,675	2,742	2,809	2,876	2,876	2,876	2,876	2,876	2,876	2,876
Achieved MW savings	9	22	46	91	182	364	546	728	910	940	970	1,001	1,031	1,061	1,061	1,061	1,061	1,061	1,061	1,061
Investment cost ($million)	3.81	5.34	9.91	19.07	38.13	76.27	76.27	76.27	76.27	15.26	15.26	15.26	15.26	15.26	0.00	0.00	0.00	0.00	0.00	0.00
Economic benefits ($million)	1.26	3.03	6.31	12.63	25.26	50.52	75.77	101.03	126.29	129.96	133.62	137.29	140.96	144.63	144.63	144.63	144.63	144.63	144.63	144.63
Net benefits ($million)	−2.55	−2.31	−3.60	−6.44	−12.88	−25.75	−0.49	24.76	50.02	114.69	118.36	122.03	125.70	129.36	144.63	144.63	144.63	144.63	144.63	144.63

SUM ECONWKI

Exhibit 5-27 shows a summary projection of the annual net effect (net costs and benefits) of the Illustrative DSM program, and the resulting economic analysis. Based on the annual net benefits (benefits minus costs), an economic analysis is carried out using discounted cashflow techniques. Using a discount rate of 10% and a 20-year investment planning horizon, the following economic evaluation results:

Net Present Value (NPV):

DSM in buildings	$129 million
DSM in industry	$183 million
Total Illustrative DSM Program	$312 million

Benefit/Cost Ratio (discounted, also known as total resource cost, TRC):

DSM in buildings	3.35
DSM in industry	2.28
Total Illustrative DSM Program	2.58

Internal rate of return (IRR):

DSM in buildings	92%
DSM in industry	38%
Total Illustrative DSM Program	48%

Another evaluation is the cost of conserved energy (CCE). In this calculation, the NPV of the annual cost stream is divided by the NPV of the annual energy savings stream to obtain an estimate in $/kWh. This calculation is somewhat distorted, since it puts all costs against energy, giving no recognition to peak demand reduction. However, it does give a direct basis for comparison against the marginal cost of energy supply, which we calculated as about $0.03/kWh. The CCE for the Illustrative DSM Program is significantly lower than supply-side energy, calculated as:

DSM in buildings	$0.013/kWh
DSM in industry	$0.024/kWh
Total Illustrative DSM Program	$0.020/kWh

The values of IRR are well above the common values of minimum acceptable rate of return (hurdle rates) used in project evaluation by the World Bank, EBRD, or other lenders. The cost of the energy conserved is only a little more than half the marginal cost of energy supply. The other economic evaluation criteria all show very positive results, and thus we conclude that the Illustrative DSM program is a very attractive investment for Bulgaria.

Exhibit 5–27
BULGARIA
SUMMARY OF DSM PROGRAM ECONOMIC ANALYSIS

	Millions of US Dollars per Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Summary – net effect of DSM program																				
Buildings:																				
Net achieved GWh savings	9	21	43	86	173	345	518	691	864	902	941	980	1,019	1,058	1,050	1,042	1,034	1,026	1,019	1,011
Net achieved MW savings	2	5	11	22	44	88	132	176	220	234	248	262	277	291	290	289	288	287	286	285
Incremental investment cost ($million)	0.79	1.10	2.05	3.94	7.87	15.75	15.75	15.75	15.75	8.74	8.74	8.74	8.74	8.74	−0.82	−0.82	−0.82	−0.82	−0.82	−0.82
Incremental economic benefits ($million)	0.38	0.91	1.90	3.80	7.60	15.20	22.79	30.39	37.99	39.94	41.88	43.83	45.78	47.73	47.44	47.16	46.87	46.59	46.30	46.02
Net benefits ($million)	−0.41	−0.19	−0.15	−0.14	−0.28	−0.55	7.05	14.64	22.24	31.19	33.14	35.09	37.04	38.98	48.26	47.98	47.69	47.41	47.12	46.84
Net present value ($million)	129																			
Internal rate of return	92.1%																			
Benefit/cost ratio	3.35																			
Cost of conserved energy ($/kWh)	0.013																			
Industry:																				
Net achieved GWh savings	14	34	71	142	284	568	852	1,137	1,421	1,397	1,374	1,351	1,328	1,305	1,305	1,305	1,305	1,305	1,305	1,305
Net achieved MW savings	6	15	31	62	124	247	371	494	618	619	621	622	623	625	625	625	625	625	625	625
Incremental investment cost ($million)	2.70	3.78	7.02	13.50	27.00	54.00	54.00	54.00	54.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Incremental economic benefits ($million)	0.77	1.84	3.83	7.66	15.32	30.64	45.96	61.28	76.60	75.93	75.37	74.75	74.13	73.51	73.51	73.51	73.51	73.51	73.51	73.51
Net benefits ($million)	−1.93	−1.94	−3.19	−5.84	−11.68	−23.36	−8.04	7.28	22.60	75.98	75.37	74.75	74.13	73.51	73.51	73.51	73.51	73.51	73.51	73.51
Net present value ($million)	183																			
Internal rate of return	38.8%																			
Benefit/cost ratio	2.28																			
Cost of conserved energy ($/kWh)	0.024																			
Total																				
Net achieved GWh savings	23	55	114	228	457	914	1,371	1,827	2,284	2,300	2,316	2,331	2,347	2,362	2,355	2,347	2,339	2,331	2,323	2,316
Net achieved MW savings	8	20	42	84	168	335	503	670	838	853	869	884	900	916	915	914	913	912	911	910
Incremental investment cost ($million)	3.49	4.88	9.07	17.44	34.87	69.75	69.75	69.75	69.75	8.74	8.74	8.74	8.74	8.74	−0.82	−0.82	−0.82	−0.82	−0.82	−0.82
Incremental economic benefits ($million)	1.15	2.75	5.73	11.46	22.92	45.84	68.76	91.67	114.59	115.92	117.25	118.58	119.91	121.24	120.95	120.67	120.38	120.09	119.81	119.52
Net benefits ($million)	−2.34	−2.13	−3.34	−5.98	−11.95	−23.91	−0.99	21.93	44.85	107.18	108.51	109.84	111.16	112.49	121.77	121.49	121.20	120.92	120.63	120.35
Net present value ($million)	312																			
Internal rate of return	48%																			
Benefit/cost ratio	2.58																			
Cost of conserved energy ($/kWh)	0.020																			

EXHB5-27.WK1

5.2.5 Effect of the Illustrative DSM Program on the Demand Forecast

Finally, the net effect of the Illustrative DSM Program was incorporated into the demand forecast, so that annual energy requirements can be seen.

Exhibit 5-28 shows the effect on energy demand. A net benefit of nearly 2 TWh/year is achieved by year 2005.

5.3 ACTION PLAN TO LAUNCH A DSM PROGRAM IN BULGARIA

Implementing DSM appears to be part of a least-cost power sector investment program for Bulgaria. Initiating activities in DSM will require a demonstration project, in order to establish the local context in which DSM technologies, policies, financing mechanisms can succeed.

The Illustrative DSM Program described in this report is based on preliminary data, which is very limited. This limited data is insufficient to fully evaluate the very large investments required.

However, the preliminary analysis in this report serves as a basis for identifying the next steps to implementing the program. These activities should be pursued in parallel to achieve early success. The key actions for the next 1-2 years are summarized below.

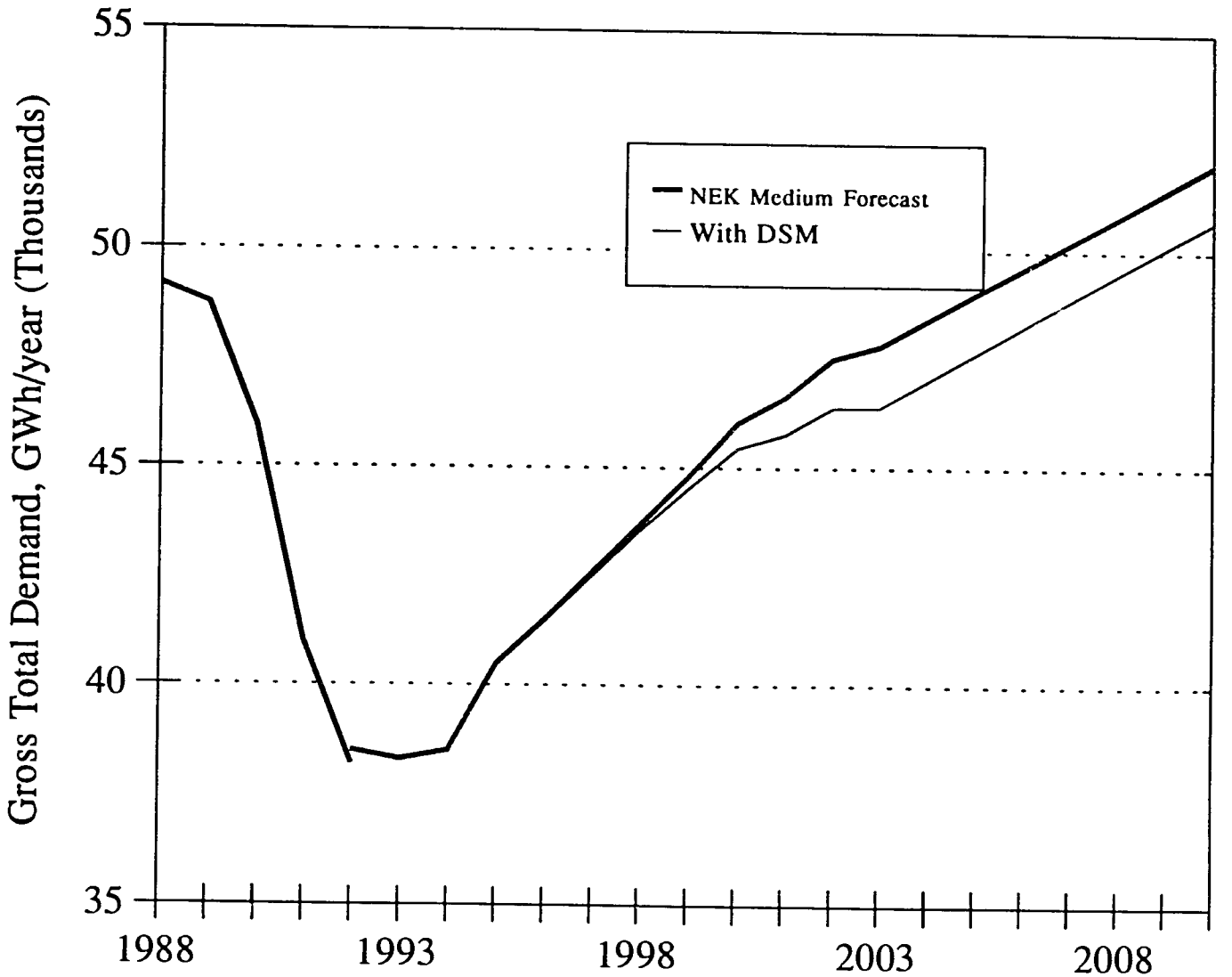
- **Develop and Implement Pilot DSM Programs:** To gain more experience and collect data in Bulgaria, pilot DSM programs for the buildings and industrial sectors should be designed and implemented at one or more distribution branches of NEK. One of the key tasks is the development of the level of incentives or other expenditures to be made by NEK for the program, and the method by which NEK will recover revenues lost by the energy savings. Developing pilot DSM programs also involves a number of tasks to resolve issues such as market research, program design, selection of technical measures, screening of applications, financing options, implementation by private sector firms, collection of payments by NEK, independent evaluation, and program redesign.

- **Institutional Development**: A parallel step is needed to develop laws and regulations necessary to implement utility Integrated Resource Planning. Within the IRP framework, regulations next need to be put in place to ensure that development of the DSM potential proceeds at the optimum rate. Further, COE and NEK should establish departments responsible for IRP, DSM, and customer service.

Exhibit 5-28

Bulgaria - Total Electricity Demand

Effect of Illustrative DSM Program



- **Load Research and DSM Assessment:** The customer service department at NEK would be assigned to carry out load research, to collect data on energy usage by customers. This project will measure the dynamics of specific loads and then combine these data with statistical and building simulation models to evaluate DSM potential. These additional data should be used to perform a detailed DSM cost-benefit assessment.

5.3.1 Develop and Implement Pilot DSM Programs

5.3.1.1 Introduction

Pilot DSM programs are necessary to determine which technologies and procedures are best suited to Bulgaria. The actions to be taken to develop the pilot programs can be divided into a number of steps, which are listed below and then discussed:

- NEK expenditures and recovery of lost revenues
- Research
- Program Design
- Implementation of Pilot
- Evaluation and Redesign
- Preparation for Full-Scale Development

For DSM to succeed, it is necessary that the Bulgarian electric utilities be given the proper financial incentive, so that their decisions are able to mirror what is best for the country. The recommended incentives for the pilot program are:

- allow DSM capital investments by NEK to earn a rate of return which is high enough to encourage NEK to make the investment;

- allow other (non-capital) DSM expenses incurred by NEK to be recovered through tariffs in the same year they are incurred;

- provide NEK employee incentives based on services and efficiency, rather than energy sales.

One or more NEK distribution branches should be selected for the DSM pilot program. These branches should be representative of industrial and buildings customer load profiles.

Market research of customers would be performed to determine the market segments and target the appropriate markets. A marketing strategy for each program would also be identified. This might mean working with utility personnel and "trade allies," (equipment manufacturers, dealers, builders, electricians, architects, etc. involved in building,

specifying, or buying equipment and buildings). One of the most important aspects of the research is to determine the appropriate incentive level to be provided in a program. Except for the low-income program, the customer receiving the measure should pay a portion of the costs. The relative share between the customer and the utility must be determined.

Program design includes developing the application form, developing the database tracking system, preparing the marketing plan, developing a quality assurance plan, scoping out the evaluation plan, writing the implementation manual, identifying test markets, developing the advertising, and developing an administrative scheme.

To implement the pilot program, marketing and advertising needs to be initiated to encourage customers to participate in the pilot program. Specific transactions are developed and executed. The proposed pilot programs themselves are described in the sections that follow below.

In the evaluation phase, the success of program implementation is determined, including documenting installation of completed projects. The evaluation determines the actual kWh and kW savings from the program, as well as customer satisfaction with the program and its implementation. Based on these results, the program would be modified and improved. A cost-effectiveness calculation would be made to determine if the pilot program should be expanded to a full-scale program.

Full-scale development often will entail training additional field personnel and obtaining the equipment in the appropriate quantities. Once this is ready, the program can be expanded to additional markets.

5.3.1.2 Pilot Programs for Buildings

Based on the results of customer research and the funding available, the following types of programs are suggested for the buildings sector:

- Informational Programs

  This program consists of brochures for customers on how to weatherstrip and caulk, add plastic to windows, cover windows during extreme cold, add insulation, select high-efficiency equipment, etc. It also includes advertising to encourage customers to conserve and demonstrate certain measures such as caulking and weatherstripping.

- Building Energy Audits

  For this program, multi-family residential (apartment) buildings and institutional buildings would be audited.

  The audit would evaluate and report to the customer the cost-effectiveness of these measures. The customer could then decide which programs to implement. Incentives would be provided (under other programs) for certain measures.

- Heating System Efficiency Improvement Incentives

  This program would provide direct incentives to customers for improving efficiency of electrically heated homes through:

  - Weatherstripping
  - Caulking
  - Insulation
  - Window and door system modifications
  - Conversion to district or gas heat

- Water Heating System Efficiency Improvements

  - Direct incentives to customers for improving efficiency of electric hot water systems:

    -- Increase insulation on water heater tank
    -- Increase insulation on hot water pipes
    -- Install low-flow shower heads and faucets
    -- Convert to district or gas water heat

- Lighting Program

  - Provide incentives to replace low efficiency lights with higher efficiency lights. Also notes and recommends cleaning windows, fixtures and lamps.

- Conversion Electric Space and Water Heating to Natural Gas or Dual Fuel

  The steps in this process would identify villages and then buildings that could be converted to natural gas or dual fuel using gas as a backup. It would also be necessary to evaluate whether cooking as well as space and water heating should be changed. The steps in the evaluation would include:

  - Identify natural gas pipelines locations.
  - Find villages and towns near the pipeline. Identify those that mainly use electric heat.
  - Perform an cost-benefit evaluation of the conversion.
  - Determine the level of payment and participation by others such as gas company, residences or building owners.

- Low-Income Residential Programs

Specific programs should be developed, aimed at pensioners or other low-income individuals who cannot afford to pay for energy efficiency improvements to their homes.

5.3.1.3 Pilot Industrial Programs

Based on the results of customer research and the funding available, the following types of programs are suggested for the industrial sector:

- Industrial Energy (Electricity) Audits

  This pilot program to co-sponsor audits, with a focus on electricity savings. Incentives to implement cost-effective recommendations from the audits should be provided under the other DSM programs. The audits, therefore, are a step that leads to many additional measures being installed.

- Electric Motor Operations and Maintenance Program

  In this program, experts would perform a one-time review of electric motor efficiency. These experts would most likely be from the private sector, operating under contract from NEK or the customer site with partial funding by NEK. The experts would also train the customers' personnel to perform

periodic reviews of the motors to maintain the efficiency at a high standard. The tasks to be performed include:

- Develop inventory of all motors over 10 kW
- Review efficiency of motors
- Develop specifications for new, high-efficiency motors for new applications or when existing motors wear out
- Perform benefit-cost analysis of early replacement of existing motors
- Survey existing motors for load (kW, kVAR, power factor), voltage on each phase, and efficiency of major motors
- Develop a power demand balance for the plant, under different operating conditions
- Check the tightness of V-belts to avoid slippage
- Review changes in operating procedures to improve energy efficiency
- Identify motors with excessive reactance for replacement or rewinding
- Review motor maintenance
- Evaluate replacement of oversized (underloaded) motors with more appropriate size motor
- Identify any phase-to-phase voltage imbalances and recommend corrections.

Air Compressor Operations and Maintenance Program

This DSM program would review the motor/air compressor loads and the system for leaks. Like the motor O&M program, experts working on this program would provide training so that a review would be performed regularly.

- High-Efficiency Motor Incentives

  The program would provide part of the difference in costs between standard-efficiency equipment and high-efficiency equipment to encourage using high-efficiency equipment.

- Drives and Rotating Equipment Efficiency Incentives

  This program provides incentives for a variety of equipment upgrades pumps, fans, and compressors, as well as drive systems, such as variable speed drives.

- Industrial Lighting Program

  This program would provide incentives to upgrade lighting from incandescent to fluorescent, or from mercury vapor to high pressure sodium.

- Interruptible Tariffs

  The DBC industrial customer survey reported that 62% of the customers responding could curtail part of their load if offered a tariff incentive. This program will provide special tariffs for customers who agree to be used as first priority for load-shedding to prevent blackouts.

- Load Controllers

  This program would provide incentives to pay for part of the cost of installing a load control program and load control equipment to limit peak demand or shift some load off-peak.

- Energy Management System

  This program would provide incentives to install computer equipment to monitor energy usage and reports it to management and plant operators. This feedback allows plant operators to improve the efficiency of the operations. This technology was one of the most common recommendations in the AID-sponsored audits.

5.3.1.4 Summary and Expected Results

The pilot programs will obtain experience with DSM technologies and customer response. The pilot programs will also develop and refine the approach for marketing the DSM programs.

The schedule for the program is 80 weeks, as indicated in Exhibit 5-29. There is some overlap because several activities can occur. The longest part of the schedule is in offering the program to the customers.

The budget for the DSM pilot program is $1.5 million estimated as follows:

Program design and administration	$500,000
DSM demonstration in buildings	500,000
DSM demonstration in industry	500,000
Total	**$1,500,000**

Exhibit 5-29
Schedule for Pilot Program Development

Project Start-Up	Week 0
Market Research and Determine Incentive Levels	Week 1-8
Program Design	Week 6-12
Implementation	Week 13-80
Evaluation	Week 60-80
Preparation for Full-Scale Development	Week 60-80

5.3.2 Institutional Development

The actions required in this area include:

- Developing the legislative framework required for IRP in the legislation being developed concerning electricity
- Developing the regulatory framework (the institutions and regulations to carry out IRP according to the law)
- Establish organizational functions at NEK and the sales branches:
  - NEK Planning Department
    - Develops forecasts of demand and availability of supply-side resources
    - Analyzes long-run marginal cost of service
    - Prepares the IRP (supply and demand sides)

- Performs cost-benefit assessments of DSM measures and programs

- NEK DSM Department
  - Develops pilot programs to be implemented by branches
  - Trains branch personnel to implement program
  - Performs evaluations of program impacts
  - May perform major DSM studies for large customers.

- DSM Departments at the Sales Branches or Distribution Companies
  - Implements programs - works with customers, builders, ESCO, and other trade allies
  - Performs audits, or retains an independent firm to perform audits
  - Inspects applications to ensure that measures have been installed
  - Authorizes and pays customer (or ESCO) for measures that have been installed.
  - Carries out customer load research.

5.3.3 Load Research and DSM Assessment

5.3.3.1 Customer Load Research

The characteristics of customers' use of energy is one of the most important factors in determining the future electric sector investment plan. There are very little detailed data on energy consumption by end use over the day or year. End-use load shape data are necessary for the complete analysis of DSM options.

A customer research group should be created at NEK (or other appropriate agency), and provided with the instrumentation required to carry out load research projects.

As part of the load research project, various sectors and types of types of loads are identified. Then, a sample of these loads are metered, and data are collected over a period of time to obtain information on peak demand and load shape.

Load research is usually an on-going process. Its initial use will be for DSM analysis. Later, load research can be used to evaluate the impact of DSM pilot programs. Load research is also used by many utilities for cost allocation and rate design.

The schedule should call for the design and development of the load research program for weather-sensitive loads over the spring and summer, with meters installed in the fall. Recordings would occur over the winter, and data analysis is scheduled for next spring.

Non-weather-sensitive loads such as industrial loads could be surveyed at the same time, or following the winter analysis by rotating the meters. Final results for this study are anticipated within one year, though this monitoring is expected to be on-going.

5.3.3.2 DSM Assessment

Additional data on the costs of DSM measures and develops estimates of program impacts is needed to develop better estimates of the projection of the impact of DSM and for the economic analysis of DSM measures and programs.

In addition to load research, an appliance saturation survey of residential customers is needed to determine appliance saturation. An effective means of developing end-use data is to perform a conditional demand analysis (CDA) of the appliance saturation data. CDA uses statistical techniques to estimate average consumption by the appliances owned in households (refrigerators, water heaters, space heaters, lighting and other equipment). Given a baseline of actual appliance consumption, more accurate estimates of DSM impact can be developed.

Building simulation models should be considered for use in estimating the energy use by the structure or occupants. These types of models are particularly useful for simulating energy use for space heating based on heat losses through walls, windows, floors, and ceilings. The building simulation models would need to be based on survey, audit, or load research data.

Building simulation models can provide a baseline consumption level and then can examine the impact on energy use of installing DSM measures.

Building energy audits should also be performed to obtain data and identify the potential for DSM. These audits will obtain baseline data that cannot be adequately obtained by surveys. Approximately 200 walk-through audits will be performed in institutional buildings.

The detailed data obtained will be used to improve the DSM assessment provided in this report by giving load shape impact data and better data on the cost of implementing measures in Bulgaria. In this report, only peak demand and annual energy impact from a DSM option were considered; the detailed analysis will consider the load shape impact of the measure over the entire year. Detailed analysis uses computer programs such as DSManager (available from Electric Power Research Institute, EPRI).

The detailed DSM assessment is expected to be completed in 10 to 12 months.