IRP Applied to District Heating in Eastern Europe

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Many municipalities in Eastern Europe are faced with upgrading their district heating systems to reduce emissions from coal burning plants and to reduce the impact of upcoming rate hikes on consumers that will result from the elimination of price controls and subsidies. U.S.-developed integrated resource planning (IRP) principles were applied to assess options for upgrading and/or replacing supply resources in combination with efficiency measures to reduce consumption. Two such assessments were conducted for the cities of Plzen in the Czech Republic and Handlova, Republic of Slovakia.

Consistent with IRP principles, alternate supply and demand-side options were assessed to develop a cost-based mix of resource options. In conjunction with the technical assessment of options, strategies were developed to provide for the acquisition of the resources. These strategies focus on institutional, legal, financial and regulatory issues that must be addressed to acquire the resources. This paper presents the findings of the technical assessments, the strategies developed for the resource acquisition and progress by the municipal governments in the resource acquisition process.

Introduction

The cities of Plzen, Czech Republic, and Handlova, Republic of Slovakia, are examining options for meeting the thermal energy requirements of their citizens with consideration of both economics and the environment. Major energy related issues faced by the cities are:

- The frequent need to replace and/or implement a major rehabilitation of the central heating plants and the transmission and distribution systems that supply the consumers.
- The need to reduce emissions in order to comply with more stringent environmental regulations and improve air quality.
- The need to minimize consumer energy bills, particularly to accommodate the upcoming decontrol of energy prices and to minimize non-payment problems.

The intent of the integrated resource planning (IRP) projects is to present analyses of options to support the cities' decision-making processes, not to provide specific recommendations or guidance for the cities to follow.

Research Methods

Traditional Integrated Resource Planning in the United States is usually performed by a long-established utility under the direction of a utility regulatory commission or pursuant to statutory requirements. There is every reason to expect that the utility will have the means and expertise to fully implement the approved plan. There are several reasons why it is not as easy in Eastern Europe. This section outlines some of the impediments to IRP implementation and describes the approach taken in these studies.

Impediments to Successful IRP Implementation in Eastern Europe

The following are some of the differences in the utility planning environment in Eastern Europe compared to the situation for a major American utility which is experienced in IRP. These represent a substantial challenge and/or opportunity for Eastern European district heating utilities and regulators interested in IRP.

Information Requirements

- Lack of complete data. There is a general lack of data necessary to perform IRP. The exception is production data, which is often available due to the emphasis on central planning. However historical financial data and asset values are particularly difficult to interpret and bear little relevance to IRP under unsubsidized and de-controlled fuel markets.

- Efficacy of energy efficiency for local application. The experience with energy efficiency in other nations may not be readily applicable in Eastern Europe due to (1) differences in building stocks, (2) the quality, availability and cost of materials and equipment, and (3) inexperience in program administration and monitoring of installations.

- New accounting systems. There have been massive changes in accounting practices to meet international standards. These are a substantial challenge for the cities to implement at this time, and it creates discontinuities in the financial record for doing IRP.

- Lack of expertise. Although there is adequate technical expertise for running the utility, there is a general lack of trained specialists in financial, legal, and utility planning matters. This requires "bootstrapping" to try to catch up, often creating dependency on foreign advisors.

Institutional Limitations

- New energy laws. The basic organic law for the energy sector is currently under development. This hamstrings the utility because it does not know what its authorities and responsibilities are. There is a general lack of understanding and/or caution about importing legal frameworks from developed countries which may not be suitable for the redeveloping economies.

- New regulatory law. Regulatory policy and authority awaits parliamentary action. Meanwhile the anti-monopoly and price control agencies continue to play their "traditional" roles. This limits the utilities' ability to formulate business plans which are credible to financial markets.

- Metering and billing. In large apartment blocks there is no apartment-level metering, and billing periods are often for extended periods of time. Consumers often pay a pro-rated bill based on floor area.

- Privatization. Delays in the staging of government privatization of state-owned utilities can impede progress of utility strategic planning until it's complete and well understood.

Financial Limitations

- Limited domestic capital markets. Even four years after the revolution, capital markets are severely limited. Also foreign and multi-national lending institutions concentrate on assisting private firms, not municipal utilities.

- Environmental requirements. Western European emission standards have been imposed in an effort to move towards integration with the West. These place large capital demands just to keep the existing systems operating over the next five years.

- Equipment replacements. The capital stock is often worn out or obsolete. Energy production was emphasized in the communist era at the expense of efficiency in production, distribution and use.

Uncertain Markets

- Self generation or bypass. It is not clear that the utility's status as a natural monopoly can be sustained as industrial and private owners move off the system.

- Gas competition. Gas has been priced low for residential users, and many are converting to gas. This undercuts the utility's rate base for financing capital improvements.

- Loss of consumer subsidies. Governments are eliminating means-tested, consumer subsidies in the residential sector. The loss threatens the reliability of future revenue flows as a significant proportion of consumers face rate hikes.

- Fuel prices. There is pressure to raise fuel prices to international levels. Also liquid fuels are still imported from Russia, and the predictability of supplies and prices is uncertain.

- Electricity price. It is not clear what price the utility can negotiate for cogenerated electricity from local distribution companies.

- Industrial survival. The stability of industrial demands is uncertain due to the state of the economy and continuing trade barriers for industrial exports.

Many of these impediments can be seen to require an IRP approach in order to search for robust solutions to these problems. These studies, though limited, are first attempts to support the demonstration of practical solutions to these problems using IRP principles.

Methodology

The planning methodology used for both cities was organized as follows:

1. Analysis of consumption/demand and preparation of forecasts. Energy use information was acquired from the cities, organized and summarized by building type, fuel and major end uses. Forecasts and forecast variants were obtained from the cities or based on professional judgment.

2. Analysis of heat generation (supply) alternatives available to the cities. This includes an assessment of the existing system, the identification of required improvements for obsolescence and emission requirements, and options for new sources and strategies.

3. Analysis of energy efficiency alternatives available to the cities, including building modification and equipment upgrade alternatives for the space and water heat uses in residential and non-residential buildings. Heat loss analysis was performed according to ASHRAE standards, and the cost and availability of measures were gathered from local sources.

4. Integration of supply and demand alternatives to develop a least-cost approach for supplying heat to the cities, including the effect on plant emissions.

5. If possible within project scope, development of sensitivity analysis on the strategies, e.g., for growth and fuel prices, to assess the effects of uncertainty on the preferred strategy.

The results will be presented to the cities as information for making their decisions. Further project-specific assessments and formal business plans for obtaining financing will be required before implementation can begin.

These studies were not able to investigate two important aspects of system optimization: first, little or no information was available on the necessary efficiency improvements in system operations or the delivery system, and second, the study team was not able to optimize on the trade-offs in the economics of electricity production with cogeneration options. These issues await further study.

Case Study 1: Plzen, Czech Republic

The first city selected was Plzen in the Czech Republic. The Czech and American study team worked with the managers and staff of the Plzen heating supply and distribution utilities to prepare this study. This section briefly describes Plzen, its existing system, its system resource needs, the available efficiency resource, supply options, and the results of the integrated analysis.

The City of Plzen

Plzen is the second largest city in Bohemia, with 170 thousand inhabitants. It is an industrial center in the western Czech Republic, on the main business road from the capital, Prague, to western Europe. The major industry in Plzen is heavy machinery manufacturing, producing power plant equipment, turbines, locomotives, etc. Ironically the city has the distinction of being one of those liberated by U.S. troops near the end of World War II, but ceded to the Soviet sphere of influence after the war. It is also well known as the origin of pilsner beer, and the brewery in Plzen plays an important role in the planning of the municipal heating utility.

Major Issues for the City of Plzen

City officials have their own views of the issues they face. Following are the key issues that they identified during several meetings with them:

- Privatization of the system. The city is being given full ownership of the heat distribution system and majority ownership of a privatized supply utility by the federal government. How does the City approach privatization? They have to assume an unfamiliar role, and there are many uncertainties facing them. They want to feel comfortable with the decisions they have to make.

- Environmental regulations. New environmental standards pose a significant burden on a system which uses domestic brown coal extensively. The potential need for large investments puts pressure on the City to act quickly and decisively.

- Capital improvements. The City is aware of the shortcomings of the existing system, i.e., everything needs to be fixed simultaneously. Again immediate action is required, but it is risky given the uncertainties.

- Sources of capital. The City is not prepared to go to the capital markets for funds to finance their large capital requirements. They are having to rely on outsiders to advise them on the best strategies.

- Energy efficiency. The need for efficiency programs is a second order concern, but the City recognizes its importance as a means of improving customer service.

- Rate stability. As a municipal enterprise the City wants to maintain the affordability of heat to the system's consumers. Also, rapidly escalating consumer prices could destabilize their revenues by increasing non-payment of bills.

Existing System

The aim of the study was to concentrate on heat consumption for space heating and heating household water. The study's first task on the demand side was to determine the current consumption of all forms of energy in the City and analyze energy flow. A general overview of the consumption of all fuels had never be done before in such detail, so it was difficult to obtain and classify the necessary data. With the help of the City and energy suppliers it was possible to develop an extensive database of consumption of all forms of energy for each building group.

On the supply side the Central System consists of the cogeneration plant, a hot water peaking plant, the brewery's steam plant, the railway steam plant, and a plant which provides steam for industrial load and hot water. The major consuming entities served by the Central System are buildings in the area to the north and south, the train station and maintenance facilities, the brewery, and industrial facilities.

System Resource Needs

The hot water and steam loads for the system were developed in terms of peak thermal capacity (MW_t) in order to relate to supply capacity requirements for four load growth scenarios. The four scenarios were High and Low growth with and without efficiency programs. All scenarios include metering and controls at the heat exchanger stations and/or building boundaries in the base. Although the controls reduce energy use by 10%, all the scenarios include them because metering and controls are required by regulation. The scenarios with efficiency programs reflect customer-side efficiency improvements in the buildings sector obtained through utility acquisition programs. All load growth scenarios include the existing customer base, and differences in High and Low growth scenarios are based on different assumptions about (1) the amount of new construction connected to the system and (2) how many of the customers currently served by local boilers will connect to the Central System. Coal-fired local boilers which do not connect to the system may have to pay an emissions penalty to continue operation, upgrade to cleaner burning coal technologies, or switch to other fuel types.

The resulting load growth rates through the year 2010 for hot water without efficiency programs ranged from no growth in the Low scenario to 0.8% per year growth in the High. For steam loads the range was -0.3% to 0.4%, respectively.

The Plzen Efficiency Resource

The demand-side resource assessment[1] developed estimates of the space and water heat energy efficiency potential in the residential and non-residential buildings sector; limited information was collected on the efficiency potential in the industrial sector. The buildings sector is estimated to account for about 60% of space and water heat energy use, with the industrial sector accounting for the balance. District heat is estimated to provide 56% of building sector heat and hot water energy use and 81% of the industrial sector steam and hot water requirements.

Fifty measures were considered for reducing building sector space and water heat consumption. The efficiency assessment consisted of four steps: (1) selecting those efficiency measures with a positive net present value (NPV), (2) combining the measures with interactive effects in order to avoid double counting the efficiency potential, (3) bundling the measures for each residential building types to estimate residential sector efficiency potential, and (4) extending the estimates to the commercial sector buildings. The 14 listed in Table 1 were determined to be cost-effective based upon having a positive net present value compared to estimated energy prices (not all measures applied to all building types).

The efficiency potential was calculated using three district heat prices as the cost-effectiveness cutoffs for including measures in the efficiency program package: 136, 200, and 350 Kc/GJ. The average costs per GJ of the resulting efficiency packages are 79, 162, and 163 Kc/GJ, respectively, for each package of district heating measures. The efficiency measures are estimated to reduce building sector consumption of district heat by about 40% (see Table 2).

The commercial sector efficiency resource was estimated by applying the percentage of cost-effective energy efficiency in residential buildings to the space and water heating energy use in the non-residential building sector. The estimated commercial sector efficiency resource for 1993 is 489,000 GJ/yr. This represents a 29% reduction in commercial sector energy consumption and more than

Table 1. Cost-Effective Measures

1. Insulate building exterior side walls
2. Weatherstrip elevator penthouse, stairway, doors and windows
3. Weatherstrip windows and doors
4. Revolving or double doors in vestibule
5. Storm windows
6. Zone valves on each radiator and central thermostats with "on time counter" in each apartment
7. Heat recovery vent system in basements
8. Heat reflectors behind each radiator
9. Remove draperies from radiator
10. Low-flow shower heads
11. Flow restrictors on faucets
12. Insulate hot water pipes in unconditioned spaces
13. Hot water flow meters
14. Waste water heat recovery heat exchanger

80% of this resource is supplied by district heat. Industrial sector energy efficiency potential was deemed to be about 15-20% of base use. This is based upon findings of other studies and discussions with facility managers. The cost of acquiring these resources was not available, so they were not considered further.

Finally the energy savings estimates for district heating of 40% were adjusted downward to a 15% reduction in building sector energy consumption and 10% reduction in heat production for three reasons: (1) experience in the U.S. has shown that engineering-based estimates typically predict greater potential than realized, as high as 2:1, (2) the efficiency assessment included all measures and the baseline includes the effect of metering and controls at the heat exchanger or building boundary, estimated to save 10% off the top, and (3) field experience in Krakow, Poland, for the types of measures considered indicates that a reduction of 25% can be achieved[2], of which 10% is from meters and controls. Therefore, the efficiency potential was derated for the integrated analysis phase to follow. However the per unit costs for efficiency were not changed since they are in line with the experience in Krakow.

New Supply Options

The assessment of new supply resources looked at four combinations of life extension of the existing plants and alternative upgrades to the Plzen central heating plant. All options assume compliance with 1997 emissions regulations for both new and existing units. The major distinguishing characteristics (fuel type, size and on-line date) of the Central Plant capacity configurations are:

- **Coal 2003.** Life extension to the existing facilities with the introduction of new coal-fired cogeneration in 2003.
- **Coal 1997.** Retirement of some existing units and introduction of new coal-fired cogeneration capacity in 1997.
- **65 MW Gas.** Retirement of some existing units and introduction of new gas-fired cogeneration capacity in 1997.
- **60 MW Gas.** Retirement of some existing units and introduction of new gas-fired cogeneration capacity in 1997.

The central plant configurations were sized to meet the High and Low load growth scenarios as necessary.

Table 2. Cost-Effective Residential Efficiency Resource with Medium Energy Prices

Building Group	Cost Effective Savings Potential GJ	Cost Effective Savings as a Percent of Use	Percent of Total Cost Effective Savings	Levelized Energy Cost Kc/GJ
District Heat	1,040,000	39	87	162
Total	1,190,000	25	100	148

Integrated Findings for Plzen

This section integrates the results of the efficiency and supply resource assessments to meet the High and Low load growth scenarios; these are

> **Moderate System Expansion.** The loads on the Central System increase with the completion ofa new heat line to connect an additional area for service from the Central Plant per the four capacity configurations presented above. The loads are subject to High and Low growth, and with and without programmatic efficiency. This case considered life extension to the existing Svetovar plant and continued operation as a stand alone system.

> **Full System Expansion.** The loads on the Central System increase with the completion of both new heat lines to add two areas for Central Plant service, including the retirement of the Svetovar plant. The loads are subject to High and Low growth, and with and without programmatic efficiency.

The first step in integrating the efficiency and supply assessments was to identify cases where supply resources were not adequate to meet projected loads and not consider these cases further. In the two expanded system cases, the peak loads and corresponding supply capacities were compared to identify major supply capacity shortfalls that would eliminate any of the load/supply combinations. This comparison showed there to be significant supply capacity shortfalls for the 65 MW Gas configuration in the full system expansion and Low demand case and for the 60 MW Gas configuration in the full system expansion and the High and Low demand cases. As a result, these cases were not considered further in the integration.

The next step characterized the economic and environmental attributes of the cases considered. Economic attributes include the capital cost to implement the supply and efficiency resources, the levelized price (Kc/GJ) of the associated district heat, the typical residential bill, and the level of emissions (particulate, SO_2, NOx and CO). The attributes for the moderate system expansion case, without and with the efficiency program, are shown in Table 3.

In all cases the plant life extension strategy, i.e., the Coal 2003 supply configuration, requires the least capital investment in the period 1993-2000, 40% below the next lowest cost alternative.

A similar analysis was made for the full system expansion. The key effect is to raise cost estimates modestly throughout the results. Also the study did not optimize on the timing and size of the efficiency and supply resources. This may have reduced the costs and emissions somewhat, but it is not likely to change the basic relationships in the results. Finally at this time the City is considering implementing an efficiency package as part of its preliminary decision.

Case Study II: Handlova, Republic of Slovakia

The Town of Handlova in the Republic of Slovakia was the second city selected for study. This section briefly describes Handlova, its existing system, its system resource needs, the available efficiency resource, supply options, and the results of the integrated analysis.

The Town of Handlova

The Town of Handlova is a coal mining community of 18,000 inhabitants located approximately two hours driving north-northeast (150 km) from the Slovak capital of Bratislava. It was developed around the coal mine several centuries ago. The coal mine is the largest company, employing approximately 1400 people. There are several other small industrial companies, most employing less than 50 people. The town's location is in a valley of a beautiful mountain range, and its rich traditions make the town a desirable destination for tourists.

Major Issues for the Town of Handlova

A large portion of the existing Heating Plant and the distribution system is at the end of its useful life and must be converted from steam delivery to hot water. This requires a substantial effort and capital. The current owner, Slovak Energy Company (SEP), is not able and, until recently, not willing to upgrade the system, and it requires the involvement of the towns and other parties. The heating system solution has become a very complex problem, involving technical, economical, social and political issues. The decision on the type of the heat supply system that will be used, i.e., centralized (coal-fired) versus decentralized (gas-fired), is the most important and most visible one, having impacts on: (1) the price of delivered heat to the residential consumer; (2) employment in local coal mine (central, coal-fired system will consume local industrial grade coal dust); (3) emission production; and (4) availability of required capital.

Existing System

The district heating system covers 80% of the current energy demand for space and water heating in the town of Handlova. The heating plant was built from 1937 to 1940 and was originally designed as a cogeneration plant, which supplied the electricity for the coal mine. The last major investment to the plant was in 1954. The steam

Table 3. Economic and Environmental Attributes for Moderate System Expansion

Scenario by Plant Configuration	Capital Cost Million Kc[a]	Cost of Delivered Energy Kc/GJ	% Change in Average Annual Emissions			
			Particulates	SO2	NOx	CO
High Load Growth						
Without Efficiency Program						
Coal 2003	2,157	162	Base	Base	Base	Base
Coal 1997	2,238	170	1	-1	-1	-1
65 MW Gas	2,542	206	-4	-18	-13	-1
60 MW Gas	2,304	199	-4	-17	-12	-1
With Efficiency Program						
Coal 2003	2,643	181	-1	-4	-3	0
Coal 1997	2,724	190	1	-4	-4	-2
65 MW Gas	3,027	225	-4	-19	-14	-2
60 MW Gas	2,790	220	-4	-19	-14	-1
Low Load Growth						
Without Efficiency Program						
Coal 2003	1,515	159	-1	-7	-5	-1
Coal 1997	2,050	180	0	-7	-7	-2
65 MW Gas	2,354	216	-4	-21	-16	-2
60 MW Gas	2,116	208	-4	-20	-15	-2
With Efficiency Program						
Coal 2003	1,945	181	-2	-9	-8	-1
Coal 1997	2,480	200	0	-10	-10	-1
65 MW Gas	NA	NA	NA	NA	NA	NA
60 MW Gas	NA	NA	NA	NA	NA	NA

(a) $1 = 30 Kc

distribution system was built in 1965 and the central heating system was started in 1968. Steam is supplied through the non-regulated heat transfer station. Currently the distribution network consists of 29 heat exchanger stations, 5,300 meters of pipes installed in non-accessible channels and 2,735 meters of pipes on the surface. Due to equipment age and economically ineffective production of electricity, the cogeneration plant has been converted to heat production only. The heat generating plant uses industrial grade coal (brown powdered coal). Boilers with natural circulation are equipped with closed loop coal feed and electrostatic filters.

System Resource Needs

The load growth projections for the system are based on figures obtained from the Town of Handlova which expects the population to grow by 5.2% overall from 1992 to 2022. Industrial loads are expected to remain constant. Overall demand is expected to increase by 3.2% above 1992 levels; district heating demand is expected to grow by 4.5% overall. The analysis did not consider the likelihood that base space and water heat use may increase due to improved living standards. A single load forecast was used for the remainder of this study. The need for new supply resources in Handlova is the result of the need for a complete retooling of the system's physical plant rather than load growth.

The Handlova Efficiency Resource

The efficiency resource assessment developed estimated efficiency resource in the residential and commercial buildings and the industrial sector. Fifty efficiency measures were considered for evaluation for the residential and commercial building stock in Handlova. Of these 24 were determined to be applicable to more than one building group and were analyzed with respect to energy efficiency potential, cost and availability on the Slovak market. The finalist on the list were the same 14 listed in Table 1 for Plzen.

The economics of the efficiency measures were analyzed in several ways, including present value, net present value, simple payback and levelized energy cost, using the economic assumptions of: nominal discount rate 17.5 %, expected inflation 8.0 %, real discount rate 9.5% and analysis period 30 years. Four levels of fuel prices were investigated to determine the cost-effectiveness cutoff for the efficiency resource: (1) current, still subsidized fuel prices; (2) removal of subsidies; (3) more aggressive and most likely fuel price increases; and (4) prices roughly corresponding to Western Europe's absolute and relative fuel prices. The Level 3 prices were selected for use in the analysis.

The efficiency assessment for Handlova followed the same procedure as in Plzen (see Table 4 for a summary). In addition to the district heat savings reported, residential natural gas consumption can be reduced almost 32%, accounting for almost 15% of the efficiency potential.

Coal consumption can be reduced by about 32%, which represents about 6% of the efficiency potential. The 145 SK/GJ estimated cost of the resource appears to be cost-effective when compared to the current price of 210 SK/GJ for district heat.

The commercial sector efficiency resource was estimated by applying the percentage of cost-effective energy efficiency in residential buildings to the space and water heating energy use in the commercial sector building. The estimated commercial sector efficiency resource is 40,800 GJ/yr.

New Supply Options

The technical and economic evaluation of the heating source alternatives considered: (1) a centralized coal-fired heat/electricity generation system, (2) a centralized dual fuel (coal/gas) heat/electricity generation system, and (3) a distributed gas-fired heat-only system.

Supply Alternative #1: Centralized Dual-Fueled Generation System and Supply Alternative #2: Centralized Coal-Fired Generation System. Both of these alternatives assume reconstruction of two existing boilers, fuel supply equipment, ash removal equipment and hot water manifolds; completion of a new chemical plant for water treatment; new 6.2 kV electrical distribution center, new mechanical room, new hot water heat exchanger station, and limestone preparation equipment; and a new ash dump site. Supply Alternative #1 also requires the installation of new gas-fired hot water boilers, including gas piping.

Supply Alternative 3: Distributed Gas-Fired Heat Generation System. The analysis of the decentralized heat supply was performed for gas fuel only, since it was assumed that small, coal-fired, environmentally friendly heat sources (small boilers) cannot compete with gas-fired boilers due to the high cost of flue cleaning equipment. Electric boilers were not considered due to the high cost of electric energy. This analysis assumes that the decentralized heat supply system will provide heat only to residential and commercial sectors.

Table 4. Cost-Effective Residential Efficiency Resource

Building Group by Heat Source	Cost Effective Savings Potential GJ	Cost Effective Savings as a Percent of Use	Percent of Total Cost Effective Savings	Levelized Energy Cost SK/GJ
District Heat	116,200	46	79	145
Total	147,400	42	100	136

The economic calculations were performed with the following assumptions: 90% financing, real interest rate 9.5%, nominal interest rate 17%, coal price 680 SK/ton, gas price 3,350 SK/m^3, electricity purchase price from the distributor 1,389 SK/MWh, electricity cost from the distributor 2,160 SK/MWh, and required return on investment 14%. The equipment selection and required investment was based on assumption that all the required emission limits will be complied with. Sensitivity analysis was performed on fuel prices, interest and inflation rates, the sale price of electricity, and the timing and size of the required investment.

Integrated Findings for Handlova

Several combinations of demand and supply alternatives were analyzed to determine overall costs. Both centralized supply alternatives were analyzed with and without the efficiency program; however the distributed gas alternative was analyzed only without the efficiency program since there was no available data to analyze the combined scenario. The analyses were done using a 25 year cash flow analysis. Real analysis was used, with 10% real interest rate over 10 years financing period for both supply and demand alternatives. The price of heat was set sufficient to just cover operating costs and loan repayment, with no return to stockholders. It was assumed that the total load increase would be covered by the heating plant, and, similar to the derating used for Plzen, that efficiency programs could reduce energy consumption by 15% overall.

There were two major questions to be answered by this study: (1) what supply side alternative offers the best value to the users and (2) how much energy can be economically saved by implementing demand side efficiency measures. Table 5 gives the basic economic/ environmental results of the study. Following are the conclusions of the study team:

- The economics of all three supply-side alternatives were, under the same assumptions, very close to each other, with delivered heat price ranges overlapping, thus not giving clear decision-making argument by itself.

- The decision on supply-side alternatives will be based on the availability of fuel, its price stability, emission generation, social and political impacts. Coal from the local coal mine is available until year 2020; its price can be easily negotiated. Its use will help to maintain approximately 400 coal mining jobs.

- By implementing demand side saving measures, the supply side system can be slightly downsized (by not much, 50 million SK) while maintaining required capacity reserve.

Table 5. Economic and Environmental Attributes

Scenario by Plant Configuration	Capital Cost Million SK[(a)]	Cost of Delivered Energy SK/GJ	Levelized Cost per Flat SK/year	Emissions Produced (tons/yr)		
				Particulates	SO2	NOx
Without Efficiency Program						
Centralized Dual Fuel	300	188	11,755	25,218	1,073	256
Centralized Coal-Fired	262	165	10,309	47,334	1,518	344
Distributed Gas-Fired	230	241	15,103	--	--	15
With Efficiency Program						
Centralized Dual Fuel	432	258	10,597	(b)	(b)	(b)
Centralized Coal-Fired	394	237	9,697	(b)	(b)	(b)
Distributed Gas-Fired	NA	NA	NA	(b)	(b)	(b)

(a) not calculated
(b) $1 = 33 SK

- The levelized cost of energy is greater with the efficiency program because substantially greater investments are required with very little offsets in supply--side capital costs. Since growth is minimal in Handlova, but the entire system must be retrofit immediately, there is little opportunity to offset supply-side capital costs with demand-side investments.

- However, the levelized annual cost for the typical apartment dweller is lower with the efficiency program because (1) the higher price for heat is more than offset by reduced use and (2) industrial customers are picking up some of the costs without being included in the efficiency program.

Conclusions

The project teams have demonstrated that it is possible to apply IRP planning techniques from the U.S. to the problems of planning municipal district heating systems in Eastern Europe during a period of economic and institutional transition. The problems are many, and the solutions are sometimes ad hoc. The biggest decisions lay ahead as these cities take on the enormous burden of implementing their decisions while staying within their means. Only then will the test of IRP be complete.

These demonstration projects are of real importance to the many other communities struggling with the same issues. It is much easier to follow the path which has been blazed by these pioneering community leaders. It is clear that the greatest challenge to these studies themselves was to undertake them during a period of comprehensive structural change in society. The Czech and Slovak civic leaders deserve a lot of credit for embarking on this new exploration of Western ideas and techniques in a sincere effort to better serve their communities. We hope that this work will be a temporary, but solid foundation for further efforts to systematically plan the energy future in Eastern Europe.

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Endnotes

1. The information on the Plzen and Handlova efficiency assessments was developed from three upcoming reports from Pacific Northwest Laboratories. These should be available at the time of the ACEEE conference. Tom Secrest is the point of contact.

2. From the paper “Energy Efficiency Energy Savings Potential in Multi-Family Residences in Krakow” by L. C. Markel et al. presented at the 1994 Conference on Alternatives for Pollution Control from Coal-Fired Low Emission Sources in Plzen, Czech Republic. Mr. Markel may be contacted at Electrotek Concepts, Inc., Knoxville, Tennessee.

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