Energy Efficiency in a Transition Economy - Romania: Challenges and Opportunities

Violeta Kogalniceanu, ETA Consult
Adam W. Hinge, Sustainable Energy Partnerships
Anke Sofia Meyer, Center for Environment and Resource Economics

ABSTRACT

This paper investigates the industrial market opportunities for energy efficiency development, and the resulting emissions reductions, in Romania. It also identifies the most important political, fiscal, and managerial barriers to large-scale harvesting of the benefits associated with energy efficiency improvements. The analysis is based on recent market assessment work supporting the preparation of a potential energy efficiency financing facility in Romania, and on a number of case studies developed in manufacturing companies of various energy intensive industries in Romania during the last three years.

Introduction

Romania is the second largest country in Central and Eastern Europe (CEE), after Poland, with a population of 22.6 million and Gross Domestic Product (GDP) of approximately $34.7 billion in the year 2000. Romania has experienced a more difficult transition to a market economy than many of its neighbors. But unlike some of its more prosperous neighbors, Romania's economy had been very tightly controlled during the centrally planned, communist regime. After a steep decline in GDP of 29% during the first three years after 1989, Romania witnessed moderate economic growth during the mid-1990s. This was fueled by a pro-growth economic policy that included fuel and power subsidies, state financing of loss making enterprises, and build-up of large inventories -- in short, unhealthy, non-sustainable growth. This is probably the reason for the contraction of the GDP in the late 1990s. After three years of decline, the GDP increased by 2% in 2000, as against 1999.

In 1999, the GDP per capita, expressed in purchasing power parity, was US$ 5,920,[1] but only $1,448[2] at the published exchange rate US$/Romania Lei (ROL). The GDP structure, by category of resources was as follows: Industry, 27.8%; Agriculture, forestry and hunting, 13.9%; Construction, 4.8%; and, Services, 43.5%.

Romania is (together with the Czech Republic) the largest energy consumer and emitter of greenhouse gases (GHG) in Central and Eastern Europe (CEE) after Poland. While it had been fairly autonomous in energy supply, it has become increasingly dependent on imports (about 30%), especially from Russia. Romania's energy intensity and GHG intensity are the highest in CEE and are about three times higher than in UK, France or Germany.[3] Romania's

[1] All monetary units in this paper are US dollars.
[2] Source: Business Central Europe Magazine, February 2001
[3] 1997 data from the International Energy Agency, based on purchasing power parity.

final energy intensity is in the range of 0.9 to 1.1 tons of oil equivalent (toe)/'000$, compared to EU countries which are in the range of 0.21 (Denmark) and 0.391toe/'000$ (the UK).

In 1999 Romania used approximately 34,000 toe primary energy (of which 28% was imported), 14.2% less than in 1998. In 1999 Romania produced 51.2 TWh of electricity, 4.6% less than in 1998, and had a final use of 42.6 TWh, 7.8% less than in 1998. The year 2000 saw an upward turn in primary as well as in final energy consumption. Electricity production in the first 11 months of 2000 grew by 2.9% as against the same period of 1999.

Industrial production dropped fairly significant over the first three years after 1989: by 19%, 22% and 23% in 1990, 1991 and 1992, respectively. This decline stopped in 1993 but then restarted, with drops of 5.9%, 3.3% and 3.1%, respectively, in 1997, 1998 and 1999. In 2000, overall industrial production is reported to have increased by 8.7%, on average, while some industries grew by much more, such as clothing, up 53%; machinery and equipment up 30.6%; metallurgy up 24.6%. Industry remained by far the largest final energy consumer, with 58% and 40%, respectively, of the total energy consumption in 1997 and 1998, although it contributed only 35% and 27.5%, respectively, to GDP.

Energy prices in Romania have undergone a major upward shift, especially since 1997. Gas and electricity tariffs are now pegged to the U.S. dollar, and electricity and gas prices are roughly on par with economic costs for all consumer groups. Subsidization of heat consumption by residential consumers is being phased out.

Past Efforts to Promote Energy Efficiency

The Romanian government showed an early commitment to energy efficiency when it set up a specialized entity, the Romanian Energy Conservation Agency (ARCE), back in 1990. Unfortunately, the same government committed very little financial resources to support a national energy efficiency program. At that time, many European Union Programs supported ARCE, and energy efficiency in general, in Romania, through investigation of energy saving potential, preparation of pre-feasibility studies, and capacity building.

Current Energy Efficiency Activities and Programs

Domestic Programs

From 1991 to 1993, ARCE managed a **Grant Program for Energy Efficiency Investments,** from a small public budget specially allocated to this purpose. Although limited to approximately $1.75 million over 3 years, the scheme granted 30% of the total investment costs to 65 applicants and helped save approximately 110,000 toe per year from a total estimated energy saving potential of 2 Mtoe/year.

Between 1991 and 1998, a nationwide **Fund for Research and Development** was in operation. Between 1992 and 1994, ARCE financed 45 applications for a total of over $1.5 million, in the field of energy efficient technologies and strategy studies.

The Romanian Parliament passed the **Energy Efficiency Law** in December 2000. The law requires the Government of Romania (GoR) to integrate Romania's energy efficiency policy in the country's overall energy policy based on the following principles:

market rules; reduced barriers to energy efficiency improvement; better education and information for energy users; cooperation between producers, distributors and users of energy; and, support for private energy service companies.

The EE Law sets a series of obligations for large energy consumers (consumption of more than 1,000 toe/year), in terms of implementing energy efficiency improvement programs, preparing annual energy balances and appointing energy managers, etc. Public building managers have also certain obligations with respect to energy management in their buildings, and preparation of annual energy balance sheets. The Law has also provisions for new energy efficiency standards and labels for appliances and equipment, and it provides fiscal and financial incentives for end users to renew or retrofit energy technologies within their premises.

International Programs

EU technical assistance. The PHARE Program, which granted over 2.765 MEuro for energy efficiency over three years, from 1993 to 1997, was the largest donor in this field. A large number of studies and some small demonstration operations were financed. It is difficult to assess their large-scale impact. The major criticism directed to this kind of funding is the lack of sustainability of any donor program. Once the grants are consumed there is practically no follow up through commercial financing or other project finance approach.

UNDP -GEF. A new financing approach is expected to be facilitated by a project which hasstarted up in early 2001 "Capacity Building for GHG Emission Reduction through Energy Efficiency Improvement in Romania". The total budget of $2,368,000, granted by the Global Environmental Facility (GEF), will be used mainly for capacity building, and for some small investments in energy saving technologies.

Unfortunately, none of these international programs was successful in developing a market for energy efficiency or to raise the appropriate awareness for energy efficiency at the end user or political level. Most of them resulted in "one-off projects" and did not help to secure long term funding for bigger programs.

Investment Activities

The European Bank for Reconstruction and Development (EBRD) approved two projects to support energy efficiency investments in Romania in the mid 1990s:

The Energy Conservation Financing Scheme project had two main objectives: To identify a pipeline of energy conservation projects in industry that qualified for the Bank's financing, and to design several options for the Bank's financing scheme and recommend the most appropriate one. Following a detailed screening process, twenty-four projects with a total investment of $13.4 million were retained as feasible and financially interesting, with an average financial IRR of 34.4% and a total net present value (NPV) of $24.4 million. It was decided that the scheme would be set up as a credit line of Euro 10 M, with an option for additional Euro 10 M at a later stage, to be opened by the EBRD with a Romanian Bank. The

scheme failed, though, mainly because of the refusal of the Romanian bank to take the high risk perceived in financing energy efficiency projects in industrial enterprises, the lack of expertise with energy efficiency projects claimed by the Bank, and more generally, the risk adverse attitude of Romanian state owned banks at that time. Therefore the project was eventually canceled.

The District Heating Rehabilitation Project's main objective is to achieve major energy savings through the rehabilitation of district heating systems in five cities. The project is currently under implementation with EBRD financing of Euro 40 million.

Barriers to Energy Efficiency In Romania

Based on an analysis of existing studies and reports, interviews with managers of industrial facilities and public utilities, and discussions with bankers, grant agencies, and Government officials, a number of barriers were identified which fall into four major categories: ***Macro-economic, Micro-economic, Financial markets***, and ***Information and awareness barriers.***

1. Macro-economic barriers

- **High inflation rate, and the contraction of the economy.** Given the contraction of the Romanian economy (especially of its industry) and the high inflation rate of recent years (155% in 1997, 59% in 1998, 46% in 1999 and 40% in 2000), it is understandable why Romanian manufacturing companies were not encouraged to invest in new energy saving technologies, despite the large potential for cost savings.
- **High tax rates and unstable legal framework.** All Romanian governments after 1990 failed to enact a consistent tax framework with tax incentives for investments, in general, and for energy efficiency, in particular. Frequent changes, unclear or contradictory provisions, and high taxation rates (38% corporate tax, 22% sales tax, 12-18% custom duties, in force until January 2000) have been cited as major barriers to any investment.
- **Distorted price signals.** Again, there was a high uncertainty about the increase of energy prices over the past ten years, especially with the cross-subsidization that was in practice until mid 1999. This gave a poor signal to domestic and foreign investors.

2. Micro-economic barriers

- **The uncertainty of the future for many manufacturing companies was high in the early and mid 90s.** Globalization and dissolution of traditional eastern and central European markets were big challenges to Romanian companies. Many companies were still production orientated, overstaffed and unable to compete internationally, based on quality and costs. Domestic demand is not high enough, and there is substantial financial gridlock that prevents stable growth, unless companies have a good export rate.
- **Romanian industry was predominantly supply focused.** The supply mentality ingrained by decades of centrally-planned, production-oriented industrial activity was preserved for the first four to five years after 1989, especially when state ownership was maintained and the Government kept a certain control over prices, gave

production subsidies or purchased some of the production. This gave the wrong signal and investments continued to be made mainly for production increases, rather than for cost cutting.

- **Poor strategic management.** Despite a fairly good technical background and qualifications, the typical industrial management of the 1990s was dominated by the same old-fashioned management style, with little understanding of global markets, cost control and demand driven growth strategies. Things have started to change for the better with the progress of privatization and the reduction of state intervention since the mid-1990s.
- **Romanian industry continues to be apprehensive towards local financial intermediaries.** Under the previous regime, banks had a poor reputation, for not being customer-oriented and having burdensome bureaucratic procedures. Even though banking practices and attitudes have changed to some extent, industry remains skeptical and generally unwilling to seek financing from traditional financial intermediaries.

3. **Financial markets barriers**

- **Low availability of medium and long-term loans.** The capital available for investments of any kind was and still is scarce in Romania. In the early 1990s, there was very little domestic or foreign capital and the Romanian banks were still state owned and very risk adverse. The primary sources of hard currency funds for Romanian banks are domestic commercial and consumer dollar deposits. Banks have little investment capital of their own and therefore depend on highly volatile, private dollar deposits. The implications of the volatility of deposits for Romanian banks is, of course, high liquidity risks, if their current saving funds are tied up in medium and long-term maturities. Therefore, without having access to longer-term sources of funds - credit lines, for example - Romanian banks are likely to remain inactive in medium and long term financing. This has started to improve in the last two to three years, when some international financing institutions opened credit lines for technology retrofit and modernization, and for Small & Medium Enterprise (SME) development. The general unstable economic climate also plays a role in discouraging long term lending. International capital markets are largely inaccessible to Romanian companies, due to the perceived high country risk.
- **Romanian banks were largely unfamiliar with medium and long term hard currency lending.** Being a new field of activity for the banks, these face different barriers, of which the most relevant for project financing are:
- Skills in project analysis and assessment of volatility and risks associated with energy efficiency projects are currently insufficient in most of the banks interviewed.
- Familiarity with international transactions, except for straightforward export/import financing, is poor, though improving.
- **The risk-adjusted cost of capital is very high.** The transaction costs of identifying, developing and financing energy efficiency projects are high. The development of a sound energy efficiency loan portfolio requires a level of specialization that entails high initial costs. To keep risks at a minimum, banks must develop effective combinations of in-house and advisory expertise on the most attractive elements of this market, the technology and technical trends in energy-using equipment and energy efficient technology, and the most secure and profitable types of financial

packaging for energy efficiency investments. For the domestic Romanian banking sector, which is faced with enormous needs to restructure non-performing loans, seek new partners, and establish a viable basis for future operations, the establishment of a small and narrowly focused new line of activities is not a priority. The banks are rightly interested primarily in conservative, traditional lending as a means to regain financial health, such as short-term lending for working capital in financially strong enterprises.

- **The combination of financial and technical skills necessary to successfully develop energy efficiency projects is still rare in Romania.** Domestic banks are generally unaware of the potential for profitable investments in energy efficiency, because the appropriate and accurate information on such opportunities presented in ways which banks can properly understand, is lacking.
- **The perceived risk of financing energy efficiency projects is high.** Energy efficiency projects with returns are based on operating cost savings and not on increased sales revenues. are a new type of product to be financed. Cash-flow based financing is hardly known or practiced in Romania.

4. Information and awareness barriers

- Despite significant technical assistance and capacity building programs, developed by ARCE with financing from donors, there is still a lack of broad understanding of the benefits of energy efficiency investments and the technical capacity to develop bankable proposals for energy efficiency investments. The communication with industry is still fairly poor and the information flow is inconsistent and limited. Management decisions on investments are still taken without full consideration of alternative options, cost effectiveness, etc. There is little use of independent consultants to prepare good feasibility studies or make investment analysis.

Potential Solutions to Overcome the Barriers

The World Bank, working with the GoR, began in 2000 with the preparation of a project designed to address the above barriers to project financing, through the establishment and operation of a specialized Energy Efficiency Revolving Fund (FREE), for which the Global Environmental Facility (GEF) would provide the seed capital. FREE would seek to leverage private sector co-financing to contribute to sustainable energy efficiency financing.

The initial FREE capitalization of about $9 million would be used to make commercial loans to creditworthy customers for energy efficient technologies. The funds would be managed by a professional Fund Manager, under a performance contract, who would make all business decisions solely in a commercial manner within the criteria established for FREE operations. Under the above project, a technical assistance budget of about $1 million will be set aside from the initial GEF grant of $10 M, and will be used for training, capacity building, and project development, outreach, market development, and promotion of the Fund.

It is also expected that the Energy Efficiency Law will help energy consumers develop energy saving programs, and to grow the technology and service markets through specific tools, including fiscal incentives, standards, and other activities that have proven internationally to further energy efficiency.

The Market for Industrial Energy Efficiency Investments In Romania

As noted above, the industrial sector in Romania holds great promise for commercially viable energy efficiency investments. As part of the project preparation for the World Bank/GEF Energy EfficiencyFund, work has been undertaken recently to quantify the market potential, and estimate the actual investment that might take place under certain conditions. For this project, only proven energy saving technologies would be eligible for financing, thus reducing the risk of technical non-performance. Since some of these technologies are new to many applications in Romania, their installation and operation will still need the development of special skills in the engineering trade in Romania. Except for projects carried out under performance contracts, the risks that the technologies will perform and deliver the savings expected will lie with the end user.

The potential market for commercially viable energy efficiency projects has been conservatively estimated at about US$ 210 million. Due to the current economic situation, it is expected that for the first three to five years of the Fund's operation, only projects in creditworthy industrial facilities will be financed. It is expected, though, that the overall market for viable projects should grow dramatically, including also the building sector and municipal services. This estimated near term market for energy efficiency investment in Romania is concentrated in those industrial subsectors that have both good economic/ technical potential, and prospects to have good creditworthy customers. Table 1 below shows the potential investments by industry type, and by technology. (Further details of the analysis can be found in World Bank 2000).

Table 1. Estimated Potential for Commercially Viable Energy Efficiency Investment in the Industrial Sector

	Boiler & Heat Distribution Retrofit			Boiler Replacement			Variable Speed Drives			New Air Compressors			Power Factor Correction		
		Energy Cost			Energy Cost			Energy Cost			Energy Cost			Energy Cost	
Industry Sector	Investment	Savings	Payback	Investment	Savings	Payback	Investment	Savings	Payback	Investment	Savings	Payback	Investment	Savings	Payback
Cement							$ 2,300,000	$ 1,335,000	1.72				$ 570,000	$ 326,000	1.75
Food & Beverage	$ 3,185,000	$ 758,000	4.20	$ 2,300,000	$ 969,000	2.37				$ 3,000,000	$ 770,000	3.90			
Glass & Fine Ceramics	$ -	$ -		$ 315,000	$ 96,000	3.28	$ 294,000	$ 234,000	1.26				$ 165,000	$ 67,200	2.46
Machine Building	$ 7,660,000	$ 2,462,000	3.06	$ 5,000,000	$ 2,680,000	1.87				$ 2,250,000	$ 470,000	4.79	$ 800,000	$ 635,000	1.26
Oil Processing							$ 584,000	$ 310,000	1.82						
Chemicals	$ -	$ -		$ 30,000,000	$ 8,000,000	3.75	$ 307,000	$ 250,000	1.23	$ -			$ 1,200,000	$ 330,000	3.64
Wood Processing	$ 1,700,000	$ 481,000	3.53	$ 1,650,000	$ 595,000	2.82				$ 4,680,000	$ 2,730,000	1.71	$ 1,800,000	$ 130,200	13.82
Pulp & Paper	$ 5,500,000	$ 2,400,000	2.29				$ 20,500,000	$ 3,335,000	6.15				$ 744,000	$ 112,800	6.60
Other							$ 5,000,000	$ 1,575,000	3.17						
Total	$ 18,035,000	$ 6,122,000	2.95	$ 39,265,000	$ 12,330,000	3.18	$ 28,985,000	$ 7,039,000	4.11	$ 9,930,000	$ 3,970,000	2.50	$ 5,279,000	$ 1,801,200	3.30

	Steam Traps			Energy Management & Controls			Process Modernization			Small Cogeneration/Turbines			Total		
		Energy Cost			Energy Cost			Energy Cost			Energy Cost			Energy Cost	
Industry Sector	Investment	Savings	Payback	Investment	Savings	Payback	Investment	Savings	Payback	Investment	Savings	Payback	Investment	Savings	Payback
Cement				$ 822,000	$ 1,807,000	0.45	$ 1,850,000	$ 514,000	3.79				$ 5,642,000	$ 3,982,000	1.42
Food & Beverage	$ 525,000	$ 800,000	0.58	$ 621,000	$ 219,000	2.84				650,000.00	130,000.00	5.00	$ 10,281,000	$ 3,747,000	2.74
Glass & Fine Ceramics				$ 142,500	$ 182,500	0.78	$ 6,600,000	$ 1,150,000	5.74	225,000.00	165,000.00	1.36	$ 7,741,500	$ 1,894,700	4.09
Machine Building	$ 1,200,000	$ 690,000	1.74	$ 472,000	$ 730,000	0.65							$ 17,372,000	$ 7,667,000	2.26
Oil Processing				$ 160,000	$ 224,000	0.71	$ 28,000,000	$ 5,460,000	5.13	15,000,000.00	4,260,000.00	3.50	$ 43,724,000	$ 10,274,000	4.26
Chemicals	$ -						$ -			17,472,000.00	3,619,100.00	4.83	$ 48,978,000	$ 12,169,100	4.01
Wood Processing							$ 32,000,000	$ 28,800,000	1.11				$ 41,800,000	$ 32,726,200	1.28
Pulp & Paper				$ 800,000	$ 1,220,000	0.66							$ 27,544,000	$ 7,057,800	3.90
Other	$ 317,000	$ 355,000	0.89	$ 640,000	$ 500,000	1.28							$ 5,957,000	$ 2,430,000	2.45
Total	$ 2,042,000	$ 1,845,000	1.05	$ 3,657,500	$ 4,882,500	0.75	$ 68,550,000	$ 35,924,000	1.91	$ 33,347,000	$ 8,194,100	4.07	$ 209,070,500	$ 82,007,800	2.55

Case Studies

Company A, Large Pulp and Paper Mill

Company A is Romania's largest integrated pulp and paper mill, located in the North Central region. It produces bleached and unbleached softwood kraft pulp, packaging paper, converted paper products and toilet paper. The enterprise is the most important Romanian manufacturer of wrapping paper and conifer pulp sulphate. Considering the mill's age (25 years) and some maintenance problems, the pulp mill is operating at present at a good capacity load. The company's target is to expand the pulp production to 100,000 tons/annum, as the company is the sole manufacturer of bleached softwood kraft pulp in Romania and in theregion, and this is the basis for many paper mills in Romania. The pulp mill is currently facing problems related to productivity, high maintenance requirements, high operating costs, and product quality. There is a large scope for technology retrofit, which would result in capacity growth, quality improvement, and cost reduction.

The company is a significant energy producer and consumer. It consumes approximately 105,000 MWh per year, of which 70% is bought from the national grid and the difference is generated in-house. The company buys approximately 44,484 thou m^3 / annum (1999) natural gas), both from imports (at \$110 per 000 m^3) and from domestic sources (at \$42 per 000 m^3). For 2000, the average gas price was \$91 per 000 m^3, plus 19% VAT.

Project 1 – modernization of the digestion installation. The production process has a bottleneck in the Kamyr type digestion installation. Modernization of the Kamyr digestion will increase the production capacity from 240t/day to 375t/day. It is also expected to reduce the specific electricity consumption from the current 0.53 MWh/t to 0.45 MWh/t, and the steam consumption from 4.75 to 2.75 t/t. The capacity increase is expected to increase black liquor (a residual product with high calorific value) production from 13.4 to 20.0 t/h, which is used to produce steam in a recovery boiler. The increased productivity together with the energy savings associated with the digestion modernization would result in total savings of \$11.63/t.

The total investment has been estimated at \$1.3 million and the project may be implemented in 9 months. The simple payback period of the project, considering constant energy consumption per unit and a production increase as planned, is 1.62 years, with an IRR of 64% over a project lifetime of 10 years. At 10% discount rate, the NPV equals \$3,737;790.

Project 2 – steam trap installation. Any paper mill is a substantial steam user. Recent modifications in the company, including closing down of some old fabrication facilities and externalization of most of the services, required the steam distribution system to be redesigned. Some of the pipes are oversized and in most cases, the steam traps are not in operation. Most of the steam consumers are operating at low efficiency. Replacement of old, broken steam traps with inverted bucket type, is estimated to cost approximately $ 200,000. The savings from steam losses are calculated at approximately 643,000 $/year. The simple payback period is less than 4 months.

Project 3 – modernization of pulp sorting installation. This is currently the second bottleneck in the process. The sorting machine was built in 1973 and most of the equipment is operating at high-energy consumption and large pulp losses, up to 6% of the output. The project consists of replacing the current technology with a new one, at half the energy consumption per unit. In real terms, this means a reduction by 16.6% of the energy consumption, at an increased capacity (100,000t/y) and with almost no material losses. Electricity per unit of output decreases from 0.2 to 0.15 MWh/t, and steam consumption from 0.7 to 0.42 t/t. The total savings from steam and electricity amount to 3.62 US$/t at a current cost of $12.02/t. Additional savings result from reduced production losses and amount to $450,000 /year.

The total investment costs approximately $800,000. Considering only the energy savings, the project simple payback is 2.92 years with an IRR of 33%, over a 10 year period. Including gains from production losses, the simple payback drops to 1.5 years with an IRR of 70% over 10 years. The discounted NPV (at 10% discount rate) is $2.6M.

Project 4 – new drive system for paper machine. The machine was built in 1966, modernized in 1977 and 1994. The present modernization project replaces the current drive system using DC motors, DC generators and sync generators with a modern AC drive system, using high efficiency motors and variable speed drives (VSDs). The benefits are not only electricity savings of 0.28 MWh/t, but also an important productivity increase from 34,000 to 50,000 t/year, by raising the paper speed in the machine from 400 m/s to 700 m/s. The project saves $11.11/t of paper in electricity costs, representing 45% of the current cost per unit of paper. The project implementation cost is about $1.5 mil, with a simple payback of 3.21 years, and an IRR of 29%. The NPV at 10% discount rate is $1,297,698, over ten-year lifetime.

Company B, Heat Exchanger Manufacturer

The company was established in 1987 through the development of a workshop that used to produce heat exchangers for aircraft and military applications in a larger industrial complex, with which it still shares some utility supplies, including electricity, gas, water and compressed air. The company designs and manufactures aluminum brazed heat exchangers for the automotive industry, for hydraulic devices and equipment (compressors, power transformers, electrical and diesel engines, excavators, bulldozers, etc.) and for the military industry. It exports more than 83% of its production to over 14 countries. The facility uses approximately 1,123 MWh of electricity and about 950,000 m^3 of gas annually.

Project 1 – replacement of air compressors. The company is currently using several compressors, of which two are of the EC10 type (manufactured in Romania 15 years ago). These have high maintenance cost (10 litres of oil per day and compressor) and face spare parts shortage and high losses in the air distribution network. The company experienced a production growth of 43% in 1999, as compared to 1998 and expected another 25 to 30% growth in 2000. The target growth rate for 2001 is 50%. It is therefore expected that compressed air consumption will increase. It is proposed to replace the two existing compressors which have an overall installed power of 110kW, with a new compressor (Kesser type) which has an overall installed power of 66kW at the same air flow of 12Ncm/min (720Ncm/h). The replacement would save 119 MWh/year, representing $6,534/year. In addition to electricity savings, the investment saves maintenance cost in the amount of $3,600/year. The investment cost of this project is $24,000 and the IRR is 32% with a simple payback of 2.93 years.

Company C, Threaded Fasteners and Rivets Manufacturers

The company is a fairly large manufacturing facility (740 employees) that is privately owned by management and employees and located in the Central East of Romania. In 1999, the company's turnover was approximately $9.5 M, of which $3.14 M was exported. The average electricity consumption is 10,200 MWh/year and the gas consumption about 2.27 M m^3 /year, with an annual energy bill of $1.2 M.

A detailed energy audit performed in the company identified eight energy saving projects, with a total implementation cost of $868,000 and a return of $348,000, which represents a 29% reduction of energy cost and gives a simple payback of 2.5 years. We describe below two of the most attractive projects that yield not only energy savings, but also productivity gains.

Project 1 - replacement of gas-fired pigeonhole furnaces with electric induction furnaces. The furnaces have manual controls, with no temperature indication and no exhaust gas indication. The poor efficiency is exacerbated by the fact that furnaces need one hour pre-heating period and remain heated during tooling changes, breakdowns, and meal breaks. The furnaces are estimated to consume 12 m^3 gas/hour (gas meters don't exist). The retrofit project is to install a single induction generator, serving a pair of continuous feed induction furnaces to serve three press lines. The significant operational savings are identified as follows:

- 40% reduction in energy costs. The average thermal efficiency for heating will increase from 2,870 KWh/t for gas to 210 kWh/t with electric heating, a 90% reduction of specific consumption. The equivalent energy cost are $23.6/t for gas heating and $14.7/t for electric heating.
- Additionally, there will be reduced wastage of product (currently at 10%) resulting in raw material savings; increased product quality and productivity; improved working environment for operators; and, reduced wear on dies by reduction in surface scale formation.

The project cost is $111,000 and the annual operational savings are $28,000, which gives a simple payback of 3.6 years and an IRR of 24.7%. If the additional $8,000 benefit from increased saleable production is counted, the payback is reduced to 2.8 years.

Project 2 - boiler house upgrade. Heat for space heating and production needs is produced in three boilers, of Romanian origin, manufactured in 1971. Two are currently in operation and the third one is out of service. These are all dual fired (gas and oil) boilers for steam generation. Process steam demand has dropped considerably due to change of technology and the boiler house capacity is oversized. Steam is also used for space heating and domestic water services, with a poor efficiency. Boilers are manually controlled and the combustion efficiency was measured at 61%. There is only a common gas meter for Forging Workshop and Boiler House and hence the gas consumption is not measured. The majority of steam traps are passing steam and no condensate is recovered to the boiler house.

The boiler upgrade consists of installation of new dual fuel burners with automatic control; installation of a new, small boiler for summer time; installation of automatic blowdown with heat recovery; installation of automatic blowdown with heat recovery; replacement of steam traps; and insulation of steam mains. Total project cost is estimated at $205,000 and the savings are $71,000/year. This gives a simple payback of 3.46 years and an IRR of 29% over the seven-year lifetime.

Company D, Dairy

This is a private, medium-sized dairy, located in the center of Romania. The company processes approximately 16 million liters of milk annually, for the production of cheese, butter and ice cream. It consumes approximately 1.64 million m^3 /year of gas and 2,270 MWh/year of electricity, with a total energy cost of $287,000. The total annual energy saving potential was estimated at $98,880 with an implementation cost of $99,310, giving a simple payback of one year. Many of these measures are quick payback maintenance or "housekeeping" measures, plus installation of an economizer for two steam boilers, energy management, and others. One of the projects is presented below.

Project 1- installation of a new, variable capacity compressor at the Ice cream factory. The ice cream factory has three cold stores and five freezers operating at - 23 to - 25 ^{0} C, using 50% of the total electricity consumption. In addition to this, there is a blast freezer and two ice cream machines. Each store is cooled using ammonia evaporators. There are a total of eight 3 cylinder, 2 stage reciprocating compressors, of Romanian manufacture serving all the refrigeration circuits connected in parallel. None of the compressors has capacity control, which makes the efficient operation at variable loads impossible. In normal practice, three or four compressors are on line during daytime periods, and two or three compressors at night. A multi-stage compressor, or a variable capacity screw compressor having a 5: 1 capacity turn down could replace the existing compressors. Improved refrigeration capacity control could be obtained by installing a single reciprocating or screw compressor. Annual energy savings of 220,000 kWh representing $13,200 are estimated against the implementation cost of $50,000, giving a simple payback of 3.78 years. Quality and safety of the refrigeration process will also be highly improved.

Conclusions

Romanian industry has tremendous energy saving potential, with very good financial returns. Over a five year period, the potential investment for projects considered as feasible and cost effective for commercial financing, amounts to approximately $206 million. The corresponding savings are estimated at around $81 million, indicating an average payback period of 2.5 years. The most attractive projects with very short paybacks (less than 1.5 years) require investments of approximately $7.25 million, yielding savings of $7.9 million. Despite those attractive financial returns, very few investments in energy efficiency were made in the past.

A number of barriers were identified, including high and unpredictable inflation rate, scarce medium and long term financing, high risk-adjusted cost of capital, and limited awareness and understanding of energy efficiency financing.

The World Bank and the Global Environment Facility are developing a project to reduce some of the barriers by setting up a specialized facility for energy efficiency project financing. It is expected that this facility, together with the new Energy Efficiency Law and other activities should yield a significant increase in energy efficiency investment in the coming years.

References

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