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THE RESIDENTIAL SPACE HEATING PROBLEM IN LITHUANIA

Abstract

Several important problems are associated with heating of housing in Lithuania. Residential heating is heavily dependent on fossil fuel, combustion of which contributes to air pollution and atmospheric build-up of carbon dioxide. Subsidies from the State budget to maintain the residential heat price at a below-cost level declined in recent years, but are often still substantial. Eliminating subsidies for heat is politically difficult. Many households face difficulty in paying their heating bill, which has risen greatly in real terms in the past five years. The problem is amplified since most households in apartments are billed on the basis of their floor area, not on real heat consumption. The magnitude of the above problems is heightened by the inefficient manner in which energy is used to heat most residential buildings. This inefficiency concerns losses in transmission and distribution of district heat, high losses through the building envelopes, as well as lack of proper metering and control of district heat. Improving the energy efficiency of heating is recognized as an important goal for addressing the problems outlined above.

This report describes housing and space heating in Lithuania. It discusses the process of privatization and how it affects heating energy use, as well as implementation of conservation measures and retrofitting. It also discusses some of the measures undertaken by both property owners and by governmental agencies that affect heating energy use. The report summarizes results from a number of recent studies of the potential for energy savings in heating Lithuanian multifamily buildings. We discuss barriers to realization of the potential, and institutional and financial approaches for overcoming them. In closing we recommend actions that should be taken soon to move Lithuanian housing along a path to greater energy efficiency.

Introduction

One of the many surprises that came to light to Western observers after the fall of Communism in the late 1980s was the state of the energy system in Central and Eastern Europe (CEU). Although the energy supply problems of Eastern Europe were discussed openly at international meetings, the structure of energy demand was not. In fact, detailed energy balances showing final demands by fuel and by sector were generally "secret," and even elementary quantities, like the numbers of households per dwelling, were often unpublished. Research at the Lawrence Berkeley National Laboratory (LBNL) provided the first published analysis of the structure of energy use in the former Soviet Union (Cooper and Schipper 1991; 1992; Schipper and Martinot 1993) and later Poland (Meyers, Schipper, and Salay 1994; Meyers, Salay, and Schipper 1994) and Estonia (Schipper and Martinot 1994; Schipper, Martinot, and Khrushch 1995; Schipper et al. 1995). In every one of these studies, the inefficiencies of energy use emerged. This article reports research at LBNL that focuses on energy use in housing in Lithuania, a former Soviet republic that achieved independence in 1991.

The crash of economic activity in CEU brought with it a drastic drop in industrial energy use. Residential energy use, however, remains an enigma. Energy use in commercial and residential buildings has always appeared low because housing standards as well as the amount of space in commercial areas stand at one-half to one-third of European levels. But unlike industries, which can be abandoned when their antiquated equipment is no longer economic in terms of energy use, with housing there is literally nowhere else to go.

Energy price shocks since independence have hit the residential sector especially hard. Public health and hygiene, as well as the long-term survival of the buildings themselves, dictate that structures be heated. The importance of a healthy and productive population to economic survival dictates that the occupants have reasonable standards of heat, light, hot water, and appliances. Yet until recently, twice as much energy was used for heating a square meter of space in the Baltic countries, Russia, Poland as was used in the Nordic countries, without occupants enjoying similar comforts.

Wastefully large energy consumption has become an unaffordable burden for both money-short CEU societies as a whole, and for consumers individually. In the case of Lithuania this burden is even more painful, because the Lithuanian energy system is completely dependent on imported fuels (mainly from Russia). Every saved unit of energy means saved hard currency resources and increases the country's security. Energy savings also have environmental benefits. The main sources of energy for space heating in Lithuania are thermal plants burning either heavy oil, or natural gas. Obsolete boilers and absence of exhaust gas purification significantly contribute to both local and regional environmental problems.

This report gives preliminary data on housing in Lithuania. We focus on the actual housing structure now that much of the stock has been privatized—an action that carries with it uncertainty regarding who is responsible for heating energy use, who is responsible for conservation measures and retrofitting, and who benefits from these actions. The paper then discusses some of the measures undertaken by both property owners and by governmental agencies to ameliorate poor heating conditions. The report summarizes results from a number of recent studies of the potential for energy savings in heating Lithuanian multifamily buildings. In closing we recommend actions that should be taken soon to ensure that Lithuanian housing moves along a path to greater energy efficiency. Some signals as to where this path should go can be taken from European countries with similar climatic conditions.

The Lithuanian Housing Stock

In 1990 Lithuania's housing stock was made up of approximately 1.26 million occupied dwellings. Sixty-four percent (810,000) are located in urban areas and 445,000 dwellings (mainly in single houses) are located in rural areas. The distribution of dwellings coincides with urban/rural demographics. During the last 25 years the number of population in urban areas increased from 1.6 million to 2.6 million people and now constitutes around 70 % of total population of Lithuania. Apartments in multifamily buildings contain nearly three-quarters of all urban dwellings (581,000 apartments); the remainder are single houses. Distribution of buildings according to the number of stories and total area is shown in Figure 1.

In 1990, 67 percent of 139,000 residential buildings in urban areas, were erected after 1940. In 1994 of 815,000 urban dwellings, 89.9 percent have central water supply, 89.5 percent have sewerage, 72.6 percent have central hot water supply, 82.7 percent have gas supply, 87.7 percent have central heating and 81.8 have bathroom (shower). Selected indicators on Lithuanian housing as of 1994 are given in Table 1. The average useful area per person, 19.7 square meters, is higher than the Soviet average (16 square meters), but lower than the Estonian average of 21 square meters and significantly lower than living area in Western countries (around 50 square meters in USA, Sweden, or Denmark, around 35 square meters in Germany and Japan).

Table 1. Lithuanian Housing: Selected Indicators for 1994

No. of dwellings (10^3)	1226
In urban areas (10^3)	815
In rural areas (10^3)	411
One room dwelling	206
Two room dwelling	469
Three room dwelling	375
Four room dwelling	119
Five or more room dwelling	56
Total useful area (10^6 m^2)	73 (72*)
Multi-dwelling houses	28.2*
Single-dwelling houses	43.8*
Urban area	45
Rural area	28
Average useful area per dwelling (m^2)	58.3 (57.5*)
Multi-dwelling houses	48.5*
Single-dwelling houses	65.2*
No. of residents (10^3)	3718
Residents per dwelling	3.0 (3.0*)
Multi-dwelling houses	3.7*
Single-dwelling houses	2.4*
Average useful area per person (m^2)	19.7 (19.3*)
Multi-dwelling houses	13.3*
Single-dwelling houses	27.4*
Urban area	17.8
Rural area	23.7

Sources: Statistical Yearbook of Lithuania, 1994-1995. Lithuanian Department of Statistics to the Government of the Republic of Lithuania. Vilnius, 1995.

* - data for 1990 : Republic of Lithuania. National Energy Strategy, Volume 2: Background Material for Strategy Development, Final Report, 1993. IC Consult—ERM —COWIconsult and Lithuanian Energy Institute. Table 1.

Types of Housing

Lithuanian housing is classified into four categories of building ownership: private, state, municipal, and cooperatives. Ownership of housing by enterprises constitutes negligible fraction of total house stock in Lithuania. Single houses and private ownership dominate in the rural areas. Distribution of ownership is more diverse in urban areas. Statistics on the number of dwellings in each of the four categories as of 1990 are given in Table 2 and are shown in Figure 2.

Table 2. Lithuanian Housing in Urban Areas by Type of Ownership, 1990 (thousands of dwellings).

Dwelling size	Municipal	State	Cooperative	Private	Total
1-room	72.6	88.1	13.8	19.8	194.3
2-room	165.6	74.0	46.2	36.8	322.7
3-room	93.6	36.9	31.5	47.5	209.5
4-room	18.9	7.4	8.2	22.5	56.9
5-room	2.1	0.8	0.3	21.4	24.5
Total:	352.7	207.1	100.0	148.1	808.0
Percent:	43.7	25.6	12.4	18.3	100.0

Source : Lithuanian Energy Institute. Unpublished data.

Building Characteristics Affecting Space Heating

Although a major share of Lithuanian residential buildings is one-story wooden or brick houses (Figure 1), the more important type of housing—especially when considering space heating is multidwelling buildings of 4-5 and 6-9 stories. These buildings account for 61 percent of total area in residential urban housing, and around 50 percent of all inhabitants of Lithuania (including rural inhabitants) live in multidwelling buildings.

Depending on the period, three principal building types have been used for apartment buildings in Lithuania since the 1950s:

- Type 1. City buildings with external walls of silicate or baked clay bricks and flat roofs. Standard designs include 4-5, 9, and 12 stories, (Buildings made from bricks comprises up to 30 percents of all apartment buildings).

- Type 2. Panel building with external walls of precast concrete panels and flat roofs. Standard designs are from 5 to 9 stories. (Prefabricated panel buildings comprises more than 60 percents of all apartment buildings)..

- Type 3. Monolithic concrete buildings with flat roofs . Standard designs are 5 to 16 stories. This new type of building was first erected at the end of the 1980s. (around 2 percents of all apartment buildings).

U-values for several typical apartment buildings erected of bricks, prefabricated concrete panels and cast in site concrete, as well as Danish and Lithuanian standards for apartment buildings, are given in Figure 3.

New Housing Construction and Standards

Since 1988, new housing construction has decreased rapidly. Dynamic of new dwelling construction is represented in Figure 4. The size and amenity level of new buildings are higher in comparison with existing average dwellings. For instance, average floor area of apartment in multifamily building built by housing associations is 62.2 sqm. In case of single house - average area of new individual house was 162.7 square meters as of 1995. In 1994, 77 percent of all residential buildings constructed have central heating. Breakdown of materials used for the construction of new multidwelling house facades in different years is presented in Figure 5.

Demand for new dwellings is still high, but the problem for many families is low income. New dwelling construction costs, population real income and construction affordability trends are presented in Figure 6. Few families in Lithuania can afford construction of new dwellings on their own. Market interest rates of loans are too high (from 22 to 34 percent as of 1995) for building construction and State is able to support only negligible number of households. Since 1992, Lithuania has had a program of subsidized construction financing called the "Bustas" program that is replacement of a program that during FSU times provided long term loans for the establishment of housing cooperatives. Loans are currently given at 8% interest rate (5% up to 1995), for 25 years, with 3 years of grace, to cover 80% - 90% of the investments. The "Bustas" program amounts to approximately 3.4% of the state budget. The government intends to slowly reorient the scope and targeting of "Bustas." As of 1995, loans are only provided for the completion of unfinished apartment buildings. As of 1996, Bustas funds will be partly used for rehabilitation of existing house stock. Up to the end of 1994 98461 families applied and were eligible for state support in acquisition of dwellings.

Implementation of new standards for thermal insulation as well as greater awareness about the importance of energy efficiency gained during the 1992 and 1993 heating seasons, during which the amount of district heat supplied was hardly enough to keep average indoor temperature at 13 - 14 C°, while 18 C° was standard indoor temperature before 1991) brought about some changes in the building of new houses. People purchasing new dwellings became more aware of efficient heating and, being more prosperous than average tenants, could afford conservation practices that provide additional thermal comfort.

In summer of 1996 the Ministry of Construction of Lithuania plans to introduce new regulations concerning building thermal technics. This building code was prepared by the Institute of Architecture and Construction in cooperation with Svensk Byggledning AB, and it will be closer to thermal standards of European Union countries. Maximum values for heat transmittance coefficients are presented in Table 3.

Table 3. Maximum values for heat transmittance coefficient U, ($W/m^2 K$).

Type of enclosure	Existing standard	Recommended value (new standard)	Upper limit value U_L (new standard)
Roofs	0.21-0.25	0.2	0.26
Floor on the ground	0.3	0.3	0.39
Walls	0.5	0.3	0.39
Windows, doors and gates	1.9-2.0	1.9	2.5
Linear thermal bridge		0.2	0.26

Source : Lithuanian Ministry of Urban Development and Housing. Building Thermal Technics. State Building Code. Vilnius 1996 (Draft).

Privatization of Housing

Since 1990 the housing distribution by type of ownership has undergone dramatic changes because of privatization of dwellings. Privatization is an important step toward more efficient household energy use since the new owners have a direct interest in reducing the costs of building maintenance and operation, including energy costs. In addition, for energy efficiency improvements private property can be used as collateral for capital investment loans.

Privatization of housing started earlier and was more widespread in Lithuania than in other countries of the former Soviet Union. Because cooperative dwellings had already been a kind of semi-private property with certain restrictions related to the rights to sell or rent and the maintenance of dwellings, privatization efforts were concentrated on state and municipal dwellings.

Privatization of housing was part of a total privatization program launched by the Lithuanian government in 1991. The program allowed individuals to open special investment accounts, which were supplemented by monies from the State according to the depositor`s age and the amount of money deposited into the State Savings Bank. Investment money could then be used for privatizing dwellings or purchasing shares in state-owned enterprises, shops, restaurants, services, and so on. A system of indexes that took into account the state of repairs, amenities, and neighborhood was used to determine a price of the flat. Apartment privatization did not take into account the land on which the building stood. Except for the strips of land on which single, private houses stand—which usually belong to the owner of the house—land in urban areas is still state-owned.

In general flat privatization came first, and only then was spare money invested in enterprise stocks. The privatization of flats in Lithuania did not mean the loss of government subsidies as it did in Estonia; consequently people had no reasons to postpone or to reject privatization. Moreover, people of other nationalities who wanted to leave Lithuania were interested in privatizing dwellings because the flats then became real estate. The prices of Lithuanian real estate were usually higher than in other countries of the former Soviet Union, so it was possible to purchase a larger apartment somewhere else for the money obtained from selling a flat in Lithuania.

The real estate market, which was semi-legal during Soviet time, is undergoing rapid development. In 1994, 33161 dwellings were sold (including new ones). This amounts to 2.7% of the total dwelling stock.

The privatization of individual flats did not equate to private responsibility for buildings. Privatization of existing housing simply grants title to a specific apartment and a share of the common areas of the building as well as the right to sell or rent. New owners are responsible for payment of energy bills, including heating of common areas as well as general maintenance of the building. The responsibility for the building as whole is still an unresolved matter, causing serious concerns related to retrofit of the building stock. However, keeping in mind the restrictions mentioned, most Lithuanian dwellings (around 90%) are already private.

Conflicts have arisen because of contradictions between the real estate restitution act and the privatization law. Some former owners claimed restitution after flats in a house had already been privatized by the tenants. Such situations became almost unsolvable because of the ambiguity between different laws. The number of tenant families, who have to be moved from buildings restituted to owners reached 11,294 as of 1994, but only 494 families were actually moved in that year. Taking into account decreasing rates of construction, accomodation of removed families might be a very serious problem in the future.

Building maintenance problems were not addressed in the privatization law. This situation is much easier for those who lived in so-called cooperative (old style homeowner association) multi-family buildings (12.4 percent of all dwellings), because the members of cooperatives had been responsible for maintenance of buildings all the time. Therefore tenants were used to solving problems together and without external assistance. In the case of former municipal and state property (around 70 percent of all dwellings), municipal district maintenance offices are responsible for building maintenance and tenants must pay an additional amount for services like waste collection, elevator operations, outdoor lighting, and building maintenance, even if all the flats of a building are privately owned. In theory, municipalities should take care of building maintenance and afterward distribute the expenses among the tenants. In practice, tenants have to maintain and rehabilitate the building and pay all expenses themselves.

The majority of the housing stock in Lithuania faces serious problems and needs urgent and costly retrofit. The State has very scarce financial sources even to start rehabilitation. In addition, there is no clear mechanism how to solve possible problems, in case tenants would not want to pay for more costly retrofit of building. In practice, tenants tend to establish owner associations in privatized buildings and take full responsibility for expenses related to the maintenance of housing. Development of owner associations seems to be a promising trend toward solving many problems related to building maintenance, rehabilitation, and heating, because the association is a juridical body interested in reducing building maintenance costs and improving energy efficiency. Around 10% of all apartment buildings in the two biggest Lithuanian cities are maintained by home owner associations as of June 1995.

Institutional Changes in the Energy Sector

Lithuania inherited a legal and institutional framework characterized by a highly centralized energy sector managed by state-owned enterprises supervised by the Ministry of Energy (MoE), with no clear separation between the political and commercial parts of the system.

Generation and distribution of electricity and heat is the responsibility of the Lithuania Power Corporation (LPC). Until November 1995, LPC operated under the name Lithuania State Power System (LSPS). District heat was also produced by the the state-owned enterprise Siluma, and large industries. LSPS was responsible for distributing heat in major cities through five regional heating enterprises. District heating supplies to small cities was the responsibility of Siluma.

In an attempt to break up the LSPS monopoly, the Government separated the distribution companies and Alytus district heating, the sixth regional enterprise, from LSPS. However, true financial separation was never completely implemented and these activities were reconsolidated under LSPS in the third quarter of 1993. In some cases (in Kaunas city) small local boilers for heating of several buildings as well as the local heating network belong to the municipality.

Seven regional network utilities are responsible for the distribution of electricity, but they have very limited financial autonomy from LPC. The gas supply is provided by state enterprise Lietuvos Dujos, but this sector is now undergoing reconstruction.

There is some uncertainty or overlapping of responsibilities concerning the central heating network. District Heating (DH) companies own all central heating installations up to walls of buildings. All installations inside buildings either belong to home owner associations, or have status of shared property of all owners of apartments in multifamilly building. Nevertheless, according to existing regulations DH companies are still responsible for any damage done in case of accident with central heating system inside the building (like explosion of radiators or pipelines). In addition, any upgrade of heating system inside buildings should be approved by the DH company.

Since January 1995 a new, uniform billing register, including all payment items, has been introduced. Municipal district maintenance offices are responsible for collecting bills from tenants and making payments to heat, water, and electricity suppliers.

Heating of Lithuanian Housing

Space and water heating accounts at present for over 30 percent of the total final energy use in Lithuania. Final heat consumption in Lithuania during the period from 1991 to 1995 is presented in Figure 7. Heat consumption in the residential sector decreased from 7.64 Pcal in 1991 to 4.89 Pcal in 1995, but the percent share of residential sector increased from 24% in 1991 to 54% of total final heat consumption in 1995. According to the Vilnius DH company, households consumed up to 80 percent of heat during 1995/1996 heating season in Vilnius city, despite high concentration of industry in this city.

Central (district) heating—heating provided by a hydronic (water-borne) central boiler in a dwelling or building or by public supply or boilers outside the building—provides heat in 47 percent of all dwellings. Heat production plants use mainly Heat-Only-Boilers (HOB). Only 30 percent of annual heat production comes from Combined-Heat-and-Power (CHP) plants. CHP plants exist in the major cities of the country, i.e., Vilnius, Kaunas, Mazeikiai, and Klaipeda.

The district heating (DH) systems run in the "constant-flow operation" mode, which is necessary for the proper operation of jet pumps (so-called "elevators") installed for each end-use consumer. Residential areas used to obtain hot, highly pressurized water at a maximum temperature of 150 C°. During the 1994/95 and 1995/96 heating seasons in order to save energy DH companies varied temperature of supplied hot water from 70 C° to 120 C° depending on outside air temperature. Consumers in buildings connected to the DH system can not control temperature and flow into their building`s sub-stations and the DH and block systems lack the capacity to meter consumption individually (per dwelling unit). Heat in district heating systems is supplied to the residential consumer on a single-pipe system from a jet pump and heat exchanger (for domestic hot water) in the block. The jet pump system must run at constant flow and therefore crude control is achieved at the central boilers through weather-adjusted water temperature control.

The one-pipe loop system, the most common system in Lithuania, has a three-way diverting control valve, which when correctly installed, allows each radiator to be turned off. However, because of rare use, parts of valves become inoperable due to mineral deposits; others are installed in such a way that if operated they would turn off the whole loop.

The control from the central heat boiler, when operating normally, can result in overheating in some locations and underheating in others due to time delays in the system responding to weather changes and variation in temperature in the networks due to losses. Overheating has frequently been mitigated by opening windows.

According to some evaluations (The World Bank, Lithuania, Energy Sector Review, 1994), DH pipe systems lose around 200 percent of total network water volume a month, whereas a figure of 0.3 percent per month is the norm in modern, preinsulated pipe systems.

The situation concerning energy metering in the two biggest Lithuanian cities, as of June 1995, is presented in Figure 8. There are some changes towards better metering of individual consumption of piped gas and water, but central heating is being metered only at the building level. According to Vilnius DH company, 50 percent of all residential buildings (2000 buildings) had heat meters installed as of the end of 1995. 100% heat metering on the building level is expected by the end of 1996. The DH company reimburses the cost of such heat meters, as it is included in the heating tariffs.

Consumption of electricity is metered and the meters are typically read monthly. Gas metering is also spreading quite rapidly because of both government policy toward compensation of expenses related to the installation of meters and big tariffs for unmetered gas consumption. Gas meters are typically read monthly.

Heat for individual buildings and "block" boilers is supplied by coal, wood, light fuel, natural gas, and other liquid fuels. A breakdown of shares of heating fuels in the household sector is presented in Figure 9. Because of restrictions on district heat during the last winters (1991-1994), people used additional small electrical heaters, even in houses with central heating.

Energy Consumption for Residential Heating

Energy consumption for residential heating includes fuel consumed within buildings and by boilers serving a group of buildings, and the share of fuel used to produce district heat that can be allocated to residential customers. Figure 10 shows energy use in the household sector in Lithuania. Space heating accounts for approximately 70 percent of total residential final energy consumption. The situation did not change a lot in recent years. According to the World Bank household energy survey carried out during the summer of 1995, space heating still accounts for more than 70 percent of total residential energy consumed.

Figure 11 gives residential space-heating intensities in different countries. As we can see, heating intensity in Lithuania is smaller in comparison with that of Poland and Estonia, but it is still high compared with Western European countries. In Lithuania, the decline in heating intensity for households was not because of improvements in energy efficiency, i.e., better thermal insulation, better heating equipment, or energy metering, but because of interruptions in the delivery of oil and gas from Russia as well as unaffordable prices.

According to the results of measuring programs carried out by several international teams concerning heat consumption in typical houses erected of concrete elements in late 1960s or 1970s, energy consumption per square meter varied from 0.6 to 1.6 GJ/year. The mean final energy consumption for space heating per square meter of living area was around 0.8GJ in 1992, according to LBNL estimates.

The foregoing points out that district heat is not the only form of heat used in Lithuania. Roughly half of all dwellings in multi-family buildings receive heat from local boilers using oil, gas, or coal. From preliminary figures provided by the Lithuanian Energy Institute, it appears that heat use per square meter in these buildings is only slightly higher than in buildings supplied by district heating, when combustion losses in local boilers are considered.[1] (Figure 12).. The average shown in Figure 12 includes both kinds of systems (as well as systems that belong to individual home occupants, mostly those in detached dwellings). While there are some uncertainties with these figures, it is not difficult to accept this difference if one believes that those responsible for building boilers have cut back significantly on the provision of heat. That is, indoor temperatures and comfort in buildings where heat is controlled locally may be lower than in buildings supplied by district heat. On the other hand, improving the boilers and related heating equipment in these dwellings represents a major opportunity for saving energy in Lithuania.

Pricing of Residential Heating Sources

As in the other former Soviet Union countries, nominal energy prices have increased one hundredfold or more since Soviet times. Measuring price change in real terms is difficult, especially during the transition from the ruble to talonas, which occurred in the end of 1992, and from talonas to litas, which occurred in mid-1993. Since April 1994 the exchange rate between litas and the U.S. dollar was set to be 4 litas for 1 USD. Figure 13 shows the evolution of real energy prices for main household energy forms in Lithuania. The main increase in heat prices took place during 1993, while the prices of the other energy sources rose the most during 1992.

The energy sector in Lithuania is one of the few in which prices are still administratively set by the government. Until April 1994, the Ministry of Energy, in

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1 The causes are both the poor thermal qualities of district heated buildings and the likely fact that fuel use for boilers in buildings has been cut back by managers.

cooperation with the energy enterprises, evaluated the costs of production including fuel, transmission/distribution, limited provisions for depreciation, and a 10 percent return on assets. Since April 1994 these functions were taken over by semi-autonomous Energy Pricing Council. Price controls for coal, LPG, gasoline, and most other oil products were eliminated in early 1993.

The market prices of coal varied from 150 to 250 Lt/t in 1995. Natural gas price for heating was raised from 0.05 Lt/m^3 in 1993 to 0.5- 0.615 Lt/m^3 for 1995/1996 heating season. Lithuania employs an electricity tariff with different rates for day, night and weekend use to help shave peak domestic demand to levels that the Ignalina power plant can satisfy. The residential daytime price of electricity was raised to 0.16 Lt/kWh ($0.04 USD) in the beginning of 1995, thus keeping electricity as the most expensive heating energy source. Introduction of Value Added Tax for electricity raised the price up to 0.20 Lt/kWh as of the end of 1995, but it is still below the average price in Western Europe, because of cheap nuclear electricity. Night and weekend price of electricity is 0.14 Lt/kWh. Marginal costs of electricity still do not include capital costs of the power plant, the cost of needed safety upgrades, as well as decommissioning costs.

Prices of district heating (DH) are uniform throughout all Lithuania and thus do not reflect local production costs, which in 1993 varied from 48 to 72 litas per Gigacalorie (Gcal). These costs were heavily subsidized by the government, so that tenants paid the equivalent of 15 litas per Gcal, assuming standard calculated consumption, since apartments are not metered. Households paid a price for district heat based on floor area of their dwelling. During the 1993-1994 heating season, the DH price was 0.5 Lt/m^2. The price increased more than twice during the 1994-1995 heating period and reached 1.15 Lt/m^2 or approximately 34.5 Lt (8.63 US $) per Gcal.

According to representatives of Vilnius DH company, average heat production cost in the Vilnius region as of December 1995 was 95.33 Lt/Gcal. Heat production cost for Vilnius city was around 93 Lt/Gcal (heat comes mainly from Combined heat and power plant). Heat production costs in the remote regions are much higher - 130-140 Lt/Gcal, mainly because of high transportation cost and inefficient boilers (sometimes, the local boiler delivered heat both to residential area as well as local industry, but after bankruptcy of industry the operation of boiler is costly). The Vilnius DH company produces 80 % of heat burning natural gas and 20 % of heat is produced burning heavy oil.

Since 1993 district heating is the only major area for cross-subsidization. Household consumption subsidized by higher tariffs for industrial consumers. In March 1993 district heating prices were set at 88 Lt/Gcal for industry, but during the heating season, 80-90 percent of industrial customers disconnected from the system because of high prices, causing a revenue gap. By middle of 1993, the government decided to replace industrial cross-subsidies with an informal cross-subsidy of heat from higher electricity tariffs and direct operating subsidies.

In the beginning of 1995, the heating tariff was due to cover full production costs. Because of higher than expected inflation, however, production costs increased so that the average heat cost recovery for all Lithuania is around 80 percent. Households pay around 83 Lt/Gcal and industry pays 75 Lt/Gcal. Heating is still cross-subsidized from electricity.

In May of 1996, LPC is going to introduce a new tariff structure for heating. One part of the heating bill will be constant, consisting of a heating system maintenance fee (this includes maintenance, repair, upgrade, salaries) and the other part is for heating fuel, which will be paid by tenants during heating season only. This will allow Lithuanian DH companies to accumulate enough money for purchase of heating fuel during the summer and to save some money now being paid as interest for bank loans. LPC expects to reach full heat production recovery for the 1996/97 heating season.

Lithuanian DH companies offer different discounts for heating for owner associations which install modern heat substations. The maximum discount, amounting to 20 percent of heating bill for three years, is offered for systems which include: heat meter, automatic temperature and pressure control, balancing valves, thermostatic valves on radiators and heat exchanger. The minimum discount, 10 percent of heating bill, is offered for heat substations with automatic temperature and pressure control only. The discount also depends on the size of building.

Increased energy prices have created a problem of unpaid debts of energy customers who cannot afford (or simply refuse) to pay their bills. Heat poses a special problem in revenue collection: while electricity to non-paying customers can be shut off, heat supply is mechanically difficult or impossible to stop. The debts mean that little money has been available for new investments, because the state has been forced to pay these debts.

Out of 113,000 single apartments in Vilnius, around 53 percent have arrears in payment of at least 1 litas. However, the situation with debts is more favorable now in comparison with that during heating season 1994/1995.

If tenant`s debt exceeds 700 Lt/apartment local DH company can take the owner of apartment to court and disconnect all energy systems (water, electricity, gas, etc.) except heat supply. Dealing with owner associations, local DH company can disconnect hot water or heat supply for building, but not electricity or gas.

Prospects for Prices of Heating Sources

The projected prices for several grouped energy forms developed for National Energy Strategy of Lithuania are presented in Figure 14. It is assumed that by 1995 consumer prices will be equivalent to anticipated world market prices in the moderate- and fast-reforms scenarios (in the slow-reforms scenario the adjustment is deferred until the year 2000). Energy forms have been aggregated to major groups as follows:

- Solid fuels include coal, coke, wood, and peat. The average prices are calculated taking the coal prices as a basis.
- Transport oil includes mainly diesel and gasoline.
- Boiler oil consists of a mix of heavy fuel oil and heating oil.
- Industrial heat consists of district heat and process heat for the industrial sector.
- Residential heat reflects district heat for the residential and services sector.

The Final Report of the National Energy Strategy was developed during 1993. It is interesting to compare predicted energy prices (in 1990 US $) with real prices at the end of 1995 (in 1995 US $). The natural gas price for cooking and hot water was approximately 4.3 US $/GJ, while the predicted price was 2.7 US $ per GJ. The electricity price was 13.9 US $/GJ, while predicted price was 10.7 US $/GJ. All of these 1995 energy prices are well above the costs of production and include no governmental subsidy.

Residential heat price during the 1995-1996 heating season was around US $ 5/GJ, while the predicted price was US $ 4/GJ. District heating is still subsidized.

Government Policies for Improving the Energy Efficiency of Heating Lithuanian Housing

Many opportunities exist to improve the performance of the heat subsector, both on the demand and the supply sides. Efficiencies can be raised, and losses reduced, in heat production, distribution and end uses. The strategy for the heat subsector as a part of the National Energy Strategy of Lithuania developed by joint team of experts from Lithuania and several Western European countries comprises a few principal elements:

- The district heating network is a principal asset of Lithuanian's energy sector with the potential to provide low-cost heat. Its viability should be maintained.

Investment in plants should give priority to combined heat and power.

- Reducing heat loses should be pursued through cost-effective insulation of buildings and efficiency improvements of industrial boilers and steam systems.
- The district heating network should change from the current constant flow system to a variable flow system and reduce the peak temperature as low as possible. Metering should be involved where cost-effective.
- A system of effective price signals and other financial incentives would facilitate the implementation of energy efficiency investments.
- A lack of awareness and information often permits energy efficiency opportunities to slip by. A more comprehensive and tailor-made information service has to be developed.

According to the National Energy Strategy of Lithuania, the following measures have the highest priority:

Demand side	
Buildings	
Insulation	Pitched roof insulation where feasible Plastic window sheeting, Draft stripping
Refurbish existing buildings	Include energy measures, when buildings are being refurbished for other reasons
New building standards	Implement current building standards (under revision)
Heat supply	
Metering	Install water meters for the heat supply for housing blocks and large consumers.
Control	Install block controls (jet pumps replacement by electric pumps), transfer responsibility for block controls and hot water heat exchangers to heat utility
Industrial boilers and steam systems	Purchase boiler combustion measuring equipment, improve burner and boiler operation, reduce steam and heat loses, insulation, heat recovery and blow down control
Pricing & incentives	
Price signals and supply incentives for conservation	Keep flat rate heat tariff until individual supply and metering becomes economic Consider rebate structure to provide incentives for carrying out insulation and improvements to heating systems within blocks
Supply side	
DH network	
Network improvements	Reduce peak water temperature, dry out existing ducts, purchase termovision camera.
CHP plant	Rehabilitation and repowering of existing CHP.
Heat Only Boilers	
New boilers at Elektrenai and Mazeikiai	Feasibility study of new heat only boilers.
Existing boilers	Improve burner and boiler operation

Together with the Ignalina nuclear plant safety program, the renovation of district heating systems is considered an investment project with the highest priority by the Ministry of Energy. It is estimated that renovation of district heating will require 340,000,000 Lt (85,000,000

US $). However, the Ministry of Energy is focused on upgrading heating plants and distribution, putting housing sector problems aside.

Whether it is reasonable to maintain the existing DH system is still an open question. According to some assessments made by Marc Bellanger (BCEOM French Consultants), overall efficiency of Lithuanian DH from the boiler plant to the room of the apartment amounts to 40 percent in the best case. This includes estimated 80 percent efficiency of heat production in the thermal plant (no one knows exactly), 80 percent average efficiency, without thermal regulation, of building network, as well as around 60 percent efficiency of DH network between boiler plant and building heat substations, which seem to be generally in bad state. Substantial heat losses as well as water leakage are very usual for most Lithuanian DH networks.

An alternative strategy to upgrading all of the existing DH system could be gradual switching of heating in suburban areas to local, building level, energy-efficient boilers. DH would be maintained either in the central part of the cities, mainly because of environmental concerns, or in the areas receiving cheap heat from CHP plants (30 percent of total heat production in Lithuania). Such switching would require substantial investment in the beginning, but taking into account huge heat losses in the DH network as well as increasing cost of DH maintenance, it could be very beneficial in the long term. If this strategy were implemented, the implications for housing rehabilitation would need to be assessed.

Estimates of the Potential for Energy Savings in Heating

District Heating Pilot Project for Alytus

The most comprehensive study of the potential for energy savings in providing space heat from supply side was conducted in 1993-94 by Danish Energy Consultants in cooperation with representatives from Alytus Heating Network and the Lithuanian State Power System. This study also involved some proposals concerning the thermal insulation of buildings. The task of the study was to develop proposals for rehabilitating and improving the technical performance of the existing district heating system in the city of Alytus, but the methodology, experience, and conclusions are also applicable for other, similar urban areas in Lithuania.

The results of "District Heating Pilot Project for Alytus" are summarized in the following table:

Table 4. Investments, energy savings and pay-back periods of several district heating rehabilitation measures.

Measure	Project Cost (USD)	Annual Energy Saving, MWh/year	Real pay back period, years	Proposed Action
Main Pumps	332,000	3836	5	Replacing old, fixed-speed pumps with modern pumps including motors
Thermal Relays	65,200	65	8	Replacing old thermal relays with modern control equipment for the domestic hot tap water systems
Energy Meters for Substations	262,400	6000	5	All installations covered by the proposal for rehabilitation of thermal relays should also be equipped with energy meters.
Differential Pressure Control Valves and Flow Limiters	120,400	6000	2	Differential pressure control valves and flow-limiting valves will ensure that the water flow through the consumer installations will be maintained at the desired magnitude, despite changing differential pressure in the mains.
Heating System for Residential Subscribers	1,224,420	4500	<20	Change single-string radiator system to a modern double-string system, including thermostatic radiator valves at each radiator as well as to install metering equipment
Tightening of Windows:				
Strips:	1,001,500	11,657	9	
Plastic Foil:	1,355,000	30,808	5	
Insulation of Pipes and Valve Tap Water in flats	4,218,400	29,604	9.9	Insulate pipes and valves in the basement of each building as well as insulate water supply systems in the flats.
Glazing of Balconies	3,300,000	7,670	<20	
Water Treatment	231,500	26,100	2	Install equipment for partial filtration of the circulating water as well as a magnetic filtration of the water.
Boilers	867,500	26,100	7	Install flue gas analyzers, energy meters for each boiler, gas and heavy fuel oil meters, and improve heat transfer, safety, and redesign of air intakes

Source: District Heating Pilot Project for Alytus, Report C Proposals for Rehabilitation Projects, December 1993, Danish Energy Consultants.

These costs assume that all equipment is to be imported, all labor costs have been priced at the Lithuanian price level. The real payback period was calculated on the basis of "average" forecasted energy prices - 14.4 US $/MWh for heavy fuel oil, and 19.5 US $/MWh for natural gas. All pay-back periods and energy savings were calculated, assuming that each single action would be implemented independently. The estimates give some general ideas about anticipated savings and pay-back periods.

Retrofitting of Standard Panel Building in Alytus

A detailed study concerning retrofitting standard panel buildings was carried out by the Danish group consisting of Rockwool Isolerings Center, BLUKON, and Hartman Consult in Alytus in 1993. This team conducted a study of potential savings in Lithuanian standard multidwelling houses in Alytus. Its importance lay in the fact that real measurements of savings were carried out after real rehabilitation of buildings had been performed. A standard, un-refurbished 30-apartment house was used as a reference building. This project was granted 2.1 million DKK (administrated through the Royal Danish Foreign Ministry and the Danish Ministry of Housing). The design, planning, and the physical work were carried out in a half a year. All the materials were supplied from Denmark. The local labor force varied from 5 to 12 persons under the supervision of Danish technicians.

Insulation of facade elements was performed with 100 mm Thermo Blocks that changed the U-value of the facade from 1.39 $W/m^2 K^\circ$ to 0.32 $W/m^2 K^\circ$. The roof was insulated using 92 mm Rockwool panels and SBS-bitumen, which is elastic and has a great strength. It is not damaged by the expected load even in case of very low temperatures.

The measuring program was carried out to demonstrate energy savings as a consequence of insulating the building. Therefore district heating and gas meters were installed. In addition, six thermohydrographers were installed in similarly located apartments with datalogging of current room temperatures and relative humidity in the rooms in question. Energy savings of 33% or 3.5 Gcal/year per average apartment were achieved compared with the reference house of the same construction.

Several imperfections also should be mentioned:

1. Drafts along the first floor were ascertained because of the lack of floor insulation.
2. Cold bridges were discerned near the windows. Such bridges were caused because it was impossible to make the modular measures of the Thermo Blocks fit completely with the measures of the building.

Keeping in mind the actual costs of the demonstration project, the researchers estimated costs of insulation and roofing for future similar projects. A payback time of 10.8 years was calculated using average Danish prices for heat supply—325 Lt/Gcal. This price seems unrealistic in the near future in Lithuania, because the maximum forecasted heat price according to the Danish Energy Consultants is around 20 US $/Gcal (80 Lt). Therefore, the real payback period should be much longer. It is necessary to point out that only Danish materials were used for the refurbishment of buildings and the use of less expensive Lithuanian-made materials, where possible, would reduce the payback period.

Retrofitting of Panel Buildings in Vilnius

A similar study was performed in 1993 by Lithuanian Danish Developers, Ltd. for evaluation of retrofitting of concrete block buildings in Vilnius using both Western and Lithuanian made materials. That study offered a more comprehensive rehabilitation including construction of a pitched roof with new flats, insulation of walls, glazing of balconies, insulation of the ground floor, installation of new windows, and a new heating system with a new pipe system and radiators. According to the project evaluations, the energy saved is approximately 783 MWh/year (from a total consumption of 1,453 MWh/year to date), equal to a saving of 52%. However because of the extension of space, the saving per square meter is approximately 60%. By using only Lithuanian materials and Lithuanian labor exclusively, the savings may decrease by approximately 10% due to the lower performance of materials and lower quality of work. The pay-back period was calculated assuming Lithuanian heating prices reach a level comparable to the Scandinavian energy prices during next five years. Two pay-back periods were calculated, one for the demo model that included the wide use of Western materials together with some local materials, and another for Lithuanian materials only. The simple payback periods for the demo model and the Lithuanian project price (excluding fees for technicians and not accounting for gains from sales of roof apartments) are

Mainly Western materials	16.2 years
Lithuanian materials	7.9 years.

An economic assessment of the feasibility of the project price was carried out using different price-development scenarios and building lifetimes after reconstruction. The conclusion was that the project is economically feasible if (i) heat prices reach USD 40 during five years, (ii) the building lifetime will be at least 15 years after reconstruction, (iii) the interest of the loan will not exceed 10%, and (iv) Lithuanian costs or limited reconstruction of house will be applied. Evaluations of payback periods are also based on the assumption that tenants would be able to continue paying the same amount of money as they paid for the district heat before rehabilitation, even if the price of heat would be comparable to the energy price in Scandinavian countries. The difficult economical situation and lack of finances could make such payments unaffordable for many tenants. It could also reduce heat supply, and consequently the energy savings would be less.

An interesting proposal was developed by Lithuanian-Danish Developers Ltd. for retrofitting existing block houses in Vilnius. Instead of insulating roofs with blocks, the building of new flats on the existing flat roof as light construction was proposed. The financing will cover the expenses for the new roof and be a part of the energy-saving program, and they will not demand investment into infrastructure.

BCEOM French Consultants Study

A comprehensive study was performed by BCEOM French Consultants (1995) concerning cost-effective technologies for thermo-rehabilitation of typical apartment buildings in Lithuania. The study examined six actual buildings covering 3 material types (brick, cast on site concrete and prefabricated concrete panels), three building periods (1945-1970, 1970-1985, and post-1985), and two heights (3-6 storeys and 7-12 storeys). The pay-back periods were calculated using billing rates for 1995/1996 heating season. The energy consumption of apartment buildings was calculated from the entrance of the building. Some of the buildings included in the study were already equipped with energy meters, so that metered consumption was used for evalutions. All studied dwellings had district heating from regional substation and vertical 1 pipe system. All buildings had rather bad state of windows and roof. Only one building had a temperature control system. Annual calculated energy consumption ranged from 225 kWh/m^2 to 265 kWh/m^2 .

What separates this study from all previous studies is that widespread use of Lithuanian-made materials was proposed and cost-effectiveness of use of local products for rehabilitation of buildings was evaluated. One of the reasons supporting the use of local materials was low price. For example, the cost of Lithuanian-made external insulation is one third of that of imported material.

Proposed rehabilitation of buildings included insulation of roof with high-density mineral wool and installation of new asphalt roofing on the insulation for flat roofs, or simple laying of mineral wool on the slab in case of pitched roof. It was proposed to use Lithuanian made mineral wool costing around 9 US $\$/m^2$. Windows should be replaced by new ones, having 2 or 3 glazing panes. Average price of new Lithuanian made windows was around 600 Litas/sqm. (January of 1996). For wall insulation the brick-insulated panels produced by

Lithuanian enterprise SNAIGE were proposed. Cost of such insulation would be around 30 US $/m^2$.

The insulation of the building must be followed by installation of controls for heat flow in the building. Such equipment is not available in Lithuania and therefore it must be imported. The standard price of full set of regulating equipment, including pressure and flow rate regulators, pumps, fittings, etc. is around 3000 US $. Stair case improvements would include changing of the entrance doors, installation of door closer, replacement of broken panes and weather stripping of windows. Basement would be insulated by mineral wool covered by a plywood board. Hot water pipes would be insulated by 3 cm mineral wool. In addition, the existing heating network should be balanced.

Summary of the case studies is presented in Table 5. The pay-back periods were calculated for different scenarios. Full rehabilitation package usually included roof insulation, window change, wall insulation, temperature control, stair case improvements, basement insulation, pipes insulation and heat system balancing. Partial rehabilitation includes all measures except that windows are refurbished rather than replaced.

Table 5. Investments, savings and pay-back time of several rehabilitation projects for multi-family buildings in Lithuania, BCEOM study.

Building type	Total investment Full rehab./Partial rehab. (Litas)	Existing energy consumption (MWh/yr)	Energy saved (MWh/yr)	Pay back time* (years)
1. Brick, 5-floor, 60 apt., built in 1958	736752 / 369752	1174	717 / 629	14 / 8
2. Brick, 4-floor, 16 apt., built in 1971	401635 / 228035	468	270 / 245	21 /13
3. Brick, 10-floor, 36 apt., built in 1988	627518 / 363618	681	320 / 325	27 /16
4. Cast on site, 3-floor, 12 apt., built in 1987	256049 / 96709	283	130 / 101	27 /13
5. Panel, 5-floor, 100 apt., built in 1964	941115 / 374715	1252	663 / 571	20 / 9
6. Panel, 9-floor, 72 apt.,built in 1978	694565 / 237365	1017	498 / 417	20 / 5

* - Based on rates for 1995/1996 heating season: 2.4 Lt/sqm. or 0.0715 Lt/kWh (if meter is present).

Source : M.Bellanger. Lithuania, Energy efficiency / Housing project. The World Bank pre-appraisal mission.

A general conclusion of the study is that window change and wall insulation have very long pay-back periods - from 20 to 40 years. Insulation and water proofing of flat roofs also have very long pay-back periods, but insulation of roofs with attic using local-made Ecovata is very cost-effective; typical pay-back periods are less than 4 years.

Pay-back periods are much shorter if part of the expenses for roof and wall insulation or window change are considered as building improvement. For instance, considering that 80% of the roofing cost of 10-floor brick building is building improvement, as well as 50% of window change cost and 30% of wall insulation, the pay back period is around 3 years instead of 9 years.

Taking into account the affordability for tenants, an optimal package for a typical prefabricated concrete panel building should probably include window refurbishment, temperature control, stair case improvements, basement insulation, pipes insulation and heat system balancing. The pay-back period of those measures for case No.5 would be less than 5 years at current rates. If tenants took a 10 year loan with interest rate of 15%, 20% heat savings would cover re-payment of the total loan.

SWECO Study

Another important study concerning renovation of residential buildings was performed by Swedish company SWECO. Several typical multidwelling buildings were studied, pay-back periods for different measures were calculated and optimal packages for rehabilitation were offered. Results are summarized in Table 6.

Table 6. Investments, savings and pay-back time of rehabilitation projects for multi-family buildings in Lithuania, SWECO study (assuming 18 ^{0}C indoor temperature).

Building type	Total investment Basic/Optional packages (Litas)	Existing energy consumption (MWh/yr)	Energy saved (MWh/yr)	Pay back time* (years)
1. Panel, 5-floor, 60 apt., built in 1971	253067/441690	705	290/353	12/18
2. Panel, 5-floor, 100 apt., built in 1969	243094/511780	680	270/363	13/20
3. Panel, 9-floor, 32 apt., built in 1985	167328/248748	437	177/197	13/18
4. Panel, 5-floor, 20 apt., built in 1980	90502/167580	186	103/131	12/18
5. Brick, 5-floor, 22 apt., built in 1980	139937/209959	151	99/113	20/26

*-Based on rates - 0.0715 Litas/kWh.

Source: Energy Efficiency/Housing Project in Lithuania. Draft report, Stockholm, Sweden.

Energy savings and pay-back periods were calculated assuming different comfort levels (13 and 18 degrees centigrade). The basic package usually includes: refurbishment of windows, new doors, automatic control of heating system, circulating pump, heat exchanger for heating system, thermostatic radiator valves, balancing valves, two-pipe system and renovation of roof. The optional package includes new insulated pitched roof in addition to mentioned measures.

According to the study, tightening of wall joints for panel buildings has much longer pay-back period (around 60 years) in comparison with external insulation of walls. The most cost-effective measures were refurbishment of windows (around 8 years), new doors (one year), automatic control of heating system and circulating pump (around 3 years) as well as heat exchanger (around 8 years).

The results of the SWECO study are based on actual metered heat consumption in all buildings, which was much lower than expected. Average metered heat consumption per square meter varied from 109 to 167 kWh. According to BCEOM`s calculations, heat consumption should be from 225 to 265 kWh/square meter for the same type of buildings. The gap between metered and calculated heat consumption can be partly explained by lower comfort level (average temperatures inside the metered buildings were around 13 degrees centigrade, where as calculations assume 18 degrees centigrade). Nevertheless, some buildings that had received some upgrades of the heating systems had low heat consumption even with comfort levels of 17 - 18 ^{0}C (Type No.2).

Discussion

The SWECO study found longer payback periods for similar rehabilitation packages than did the BCEOM study because it used actual metered heat consumption as a baseline rather than calculated consumption. Since the actual consumption reflects average indoor temperatures well below the 18 C assumed in the calculations, the energy savings are less and the payback periods longer. This difference highlights the importance of using reliable measured data where possible as a baseline for estimating the cost-effectiveness of various heat saving measures.

The rehabilitation of buildings should be accompanied by renovation of the DH network itself. The district heating efficiency might even decrease after some retrofit of buildings is performed. The DH operates now in a constant flow mode with weather adjustable temperature control. If demand for heat in rehabilitated buildings decreases, DH companies will still have to keep the same temperature of supplied water to heat other buildings. The temperature of returned water will be higher and the boiler will consume less energy raising the temperature, but losses will probably increase, because of higher average temperature of water in the pipelines.

One solution to this problem would be switching of DH from existing constant flow mode to variable flow mode and installation of heat exchangers in every building. In that case reduction of heat consumption in a building could be followed by reduction of supplied heat from boiler into network without changing water temperature in pipelines. Overall efficiency of DH system would increase. Local DH company could also get rid of powerful water pumps, which now have to raise water up to 22 floor (in Vilnius), and save a large amount of electricity and reduce the heat production cost. Pay-back period for installation of heat exchanger for heat according to the SWECO report is around 8 years. Calculating real pay-back periods for different projects, one should also include different discounts offered by DH companies on heating bill for upgrading of heat substations. In some cases savings of money because of the discount might exceed money savings due to energy savings.

The cost of upgrade of existing heat substations might reach US $8000. In addition, the installation of heat exchangers and automatic heating control do not change overall DH efficiency substantially. Losses in the district network still remain high. Therefore it might be more cost effective to install efficient local gas boilers for heating of separate multidwelling buildings, because gas network is wide spread in Lithuanian cities and in that case overall efficiency of space heating in Lithuania would increase dramatically.

The Challenges: Cold Lithuanians in Low-Quality Housing

Figure 8 and the various energy sector assessments clearly indicate that, until recently, Lithuania wasted great amounts of energy for heating in all phases: production, distribution, and final use in buildings. The waste arose because of the previous system of non-market allocation of both heating energy and housing, which was built with little concern for thermal losses or comfort. Previously, the state (or no one!) managed buildings and building heat use. Now occupants, in some cases through some emerging form of occupant organizations or other authority, must share the responsibility for allocating scarce resources to thermal comfort. These resources include district heat or fuels burned locally to produce heat, as well as insulation or other materials (or technologies) that substitute for heat in the delivery of comfort. Because of the sudden reduction in available heat supplies in 1991 and 1992, as well as the rapid increase in costs for imported oil and gas, the heating problem is the most urgent of those related to housing. The comfort level of buildings with district heating has improved since the "cold" heating seasons in 1992 and 1993. The average temperatures in the majority of living rooms of multi-family buildings ranged from 16 °C to 19 °C during the heating season of 1994/95. In addition, according to World Bank survey, about 60 percent of tenants in urban areas are satisfied with supplied district heat. Nevertheless, more than 70 percent of tenants indicated that they had financial problems paying their bills. In addition, inevitable increase of district heat price will make greater comfort level hardly affordable for most tenants, unless thermal rehabilitation of buildings takes place.

The more long term problem—one that is more challenging than heating alone—is that of the very poor quality of most homes in Lithuania. This predicament results from the same causes as the heating problem. In the past the quality of construction was poor, amenity levels low (albeit the highest in the former Soviet Union), and maintenance of common spaces lacking. The situation is further aggravated today by emerging private ownership of flats in apartments but no "ownership," and no responsibility, for the apartment buildings themselves. The sudden surge of energy costs boosts the concern over thermal comfort, but in the longer run, the buildings themselves are more valuable than the energy to heat them. Thus, it is housing considerations (dwelling comfort and amenities, dwelling conditions, dwelling value, and so forth) that will dominate concerns, not simply heating. As a result, it is important to imbed concerns about the short-term heat problems in a longer-term strategy to upgrade housing conditions in Lithuania, and to avoid strategies whose only purpose is to save energy.

The most obvious difficulty facing a response to the challenge is the present economic situation in Lithuania. Although the expenses for oil and gas (roughly 1.25 billion USD, of which approximately 16 percent went for housing and about 10 percent more for buildings in the public and commercial sectors) represent an enormous drain on the economy, it is difficult for individuals or the government to muster several billion dollars to improve the quality of the dwelling stock, however attractive such an investment would be. This scarcity of resources means investment in improving housing must be done carefully, so real returns to the economy are generated that will finance yet more energy-saving investment. Virtually no real data exist on energy consumption for heating over various fuels, heating systems, and building types. Not surprisingly, there is little experience in Lithuania (or other countries in Eastern Europe) with retrofit actions to reduce heating demand, showing results and costs. Worst of all, there is little hard information on occupant behavior, i.e., how tenants coped with the rapid reductions in heating comfort imposed from 1990 and beyond.

One important factor that might affect promotion of heating efficiency in Lithuania is the subsidy for heat and hot water provided by the State. Tenants have to pay not more than 15 percent of their income for heat and not more than 5 percent of their income for hot water. In 1995 Vilnius DH company approved 47,593 applications for subsidy in Vilnius city alone (total number of households in Vilnius is around 120,000), and 67,745 applications in all Vilnius region (from around 150,000 households). Around 40 percent of all households get some heating subsidy, so they have little incentive to save energy. The average amount of subsidy is 22.67 Lt/household/month, whereas the heat bill for a typical Lithuanian 50 square meters apartment is around 120 Lt. The subsidy also creates an additional incentive for tenants living in the buildings with local boilers to switch to DH system.

Total amount of State budget expenditures for heating subsidies was 86 mln. litas in 1994 and 124 mln. litas in 1995; projected subsidies for 1996 were 94 mln. litas. The total amount of subsidies for LPC during 1994-96 will amount to 304 mln litas or US $ 76 mln, an amount almost equal to the cost of very substantial DH renovation (340 mln. litas) mentioned in the Energy Strategy of Lithuania.

At the same time, the opportunities for saving heat, providing better housing and greater indoor thermal comfort, and reducing heating costs to both individuals and the national economy are great.

The challenge for Lithuania can be seen from these dimensions:

- Lithuania is squeezed by the sudden high cost of heat, but stuck with a very inefficient housing stock and no means of transmitting those costs directly to more than half of the population.
- Numerous technologies, including those providing for metering of actual heat consumption, could together reduce heat needs in the present housing stock in Lithuania up to 50 percent even after accounting for increases in comfort. But few concrete data exist on the costs and benefits of these technologies, only a sense that many pay off.
- Lithuanians have been hit by more than a 50 percent loss in real income, making even present heating costs (which are as much as 65 percent subsidized) almost unaffordable for many households, so they have few resources to invest in these energy-saving technologies.
- Lithuania has never had a competitive, private housing industry, hence mobilizing materials and the know-how to install energy-saving technologies in housing, and, more important, upgrading the overall quality of the housing stock, will be a long, slow process.
- Despite rapid privatization of apartments, the problem of ownership and responsibility for buildings as a whole is still to be solved.

In the next sections we show how improvements in energy efficiency and comfort could be incorporated into a broad housing rehabilitation program for Lithuania.

The Solutions

Heating needs in Lithuania could be reduced significantly over the long term. It is worth noting that buildings in Denmark in 1973 had about the same heating intensities as homes in Lithuania in 1990, around 200 kJ/degree-day/sq meter of floor area. Danish intensities now lie at about 55% of that value. Studies by the Lithuanian Energy Institute and other specialists suggest the potential for a 50% reduction in heat losses in Lithuanian homes although the cost-effectiveness of achieving this is uncertain. Moreover, Danish authorities foresee at least a 20% reduction in heat losses in buildings by 2010, suggesting that the frontier for heat saving lies far from present practices in Lithuania. Equally as important, most of the net reduction in heating intensity in Denmark was achieved among 1973 and 1983 within ten years. Some of this reduction was due to significantly lowered indoor temperatures (and comfort), but these "sacrifices" were gradually traded for technological means of saving energy, holding down heating intensity from 1983 to the present in spite of gains in indoor comfort.

Thus, modest but rapid reductions in heating need in Lithuania in the short term—and more reductions over the next decade—are possible. But in the West (with the exception of Sweden), the changes were driven primarily by higher heating prices reinforced by metering of individual apartments or houses, and only secondarily by government programs (including subsidies for insulation) or the entry of new, more efficient buildings into the building stock. Proper pricing and metering as well as competitive markets in housing, construction and rehabilitation, building materials, and building trades, all contributed to these improvements. However, these conditions are lacking in Lithuania and improvements probably will be very slow in coming.

Another factor that could complicate the financing of heat-saving investments is the so-called "take-back effect," which refers to the tendency of occupants "take back" some of the energy savings from retrofits in the form of higher levels of comfort. As mentioned earlier, most households are now more comfortable than they were several years earlier. Still, it is likely that there is some demand for higher levels of comfort, if they could be afforded. Thus, it is possible that some households will choose to heat to a higher temperature after retrofit, which would lead to lower-than-expected energy savings. The greater comfort is a tangible benefit, but the result could be that the financial savings (from lower heat charges) would be less than expected, which would make it more difficult to pay back any loans related to retrofit measures.

Measures for Existing Housing

Because of the original designs and poor maintenance over the years, the thermal performance of buildings is unsatisfactory. The lack of metering and the flat-rate heat charge create difficult conditions for providing an economical incentive to efficiency improvements, since consumers would not receive the monetary benefits of any investment they make in improving building performance. Until these deficiencies are corrected, one can only recommend measures that are low cost and offer a clear return in terms of the comfort conditions inside the dwellings. Such measures include window and roof insulation and draft stripping. Both can be carried out by the consumers themselves, who should be encouraged with information explaining the best methods and the benefits they will receive. Roof insulation is poor in many buildings and accounts for a significant part of the total loss from individual dwellings. Insulation is difficult on flat-roofed apartment blocks and also on those individual dwellings that have an attic room built into the pitched roof. It is estimated that about 40% of the individual pitched roof dwellings can be insulated in the roof, which will yield a short pay-back at an estimated cost per dwelling of about USD 60.

Tenants collectively can improve insulation around exposed heating pipes in cellars or other open spaces and insulate hot water storage as well. Tenants can also install flow restricters on hot water taps (showers, kitchen and bathroom sinks) if the water supply is not too hard. (These measures alone applied to apartments where none are already present might reduce hot-water use by 20%.) Unfortunately, tenants in collectively heated buildings have no real incentive to undertake these measures. A meter to measure consumption of the entire building should be installed and a plan worked out so occupants can share savings.

It appears that energy use for heat and water heating in buildings with their own boilers is not as high as for buildings with district heat. Nevertheless, experiences in Estonia and Poland suggest there may be an enormous benefit in replacing old boilers with newer ones outfitted with modern controls, better burners, and even improved emissions controls. These measures can be done without major intrusions into the shell of the building.. Attention paid to building shells dominated efficiency concerns in many Northern European countries in the 1970s, but further research always showed significant economic gains could be made from improving heating systems in buildings.

Some creative short-term strategies are already being tried in Lithuania. Tenants in cold buildings have added plastic or even glass panes to existing windows, caulked cracks, and some insulation around hot water piping. The most striking measure is the construction of covered balconies to reduce heat losses through large windows, or the addition of a new top floor and a very well insulated attic above it, both to make rentable space available and to save heat. The small book produced by the Lithuanian Energy Agency recommends installation of inexpensive plastic barriers on the insides of windows, as well as weather stripping and other quick fixes. These strategies are motivated by households who want better indoor conditions, since none receive monetary rewards for heat saved.

In the medium term, the following measures could be carried out. If these were performed during building rehabilitation, incremental costs would be less than what is expected if the only purpose of the actions is to save heat.

- revamping heat and hot-water circulation pipes
- structural retrofits to improve both the condition and appearance of inner and outer walls as well as to add thermal insulation
- replacing windows whose panes are broken, frames are leaky and rotten, or sashes moldy and decayed
- replacing heating pipes within dwellings with systems permitting individual radiator controls and shunts or bypasses so individual radiators can be turned off. If this is done, individual meters, at least the inexpensive evaporation type, must be installed to create the incentive to use these shunts
- complete metering of each apartment's domestic hot water with installation of a system to provide hot water outside of heating months
- insulating attics and spaces hidden from view that cause air leaks or other thermal problems in apartment buildings
- installing outdoor and indoor temperature sensors to regulate overall provision of heat to the building.

More extensive refurbishment of existing buildings is more costly, especially if it includes providing external wall insulation and replacement of windows. As in Estonia, it is unlikely that individual owners or tenants of flats will borrow money for such capital improvements. Most borrowing has to be done by owner associations for the building as a whole. Interest rates from Lithuanian banks are around 30% per year (inflation is also around 30 percent as of 1995), so that house rehabilitation cannot be based on such loans. The only solution is to create a special fund for loans at 6-8% per year, based upon capital from the government or the World Bank. The Ministry of Housing has stepped in with a decree establishing a loan fund for housing rehabilitation, in which improved energy efficiency can be embedded.

The World Bank could act as a channel for donor organizations to provide loans and possibly grants to building occupants for housing rehabilitation. The program to improve the thermal properties of the housing stock should be a part of a much larger program to encourage more general rehabilitation of housing stock. If thermal improvements are taken together with general upgrading, the costs of doing this are far less than if each step is taken on its own.

Metering heat of individual households may be postponed. Individual metering would require rearrangement of the pipework in addition to the cost of the installation of the metering and billing system. The marginal savings in heat use, particularly when low-costs CHP heat is supplied, are unlikely to justify the investment.

Heat Metering

Proper pricing of heat and other energy forms is an essential ingredient of any strategy to save energy and heat in Lithuania. In the short term, to allocate costs on the basis of usage, heat meters should be gradually installed on every building. Water meters should be installed on the district heating flow into the block for the hot water and heating supply. Billing can then be based on the water flow, which encourages consumers to minimize the water flow and maximize the extraction of heat. A program to encourage the installation of heating meters in multidwelling houses was also launched recently. The tenants get a special heat supply discount rate after heat meters have been installed. In some cases the expenses for heat meter purchase are being reimbursed. Discussions with those responsible for metering projects in Lithuania (and Estonia) have indicated that heating costs could actually *fall* in the short term, because at present tenants may be overcharged for consumption through formulae that include system losses.

Once a building is metered, tenants have some incentive to cut back on heat by reducing flow into the building, but this should be done through a collective decision. Authorities could encourage tenants to "vote" on how much heat to consume, since the tenants cannot individually control their own heat.[2] Throttling back heat to the building will mean some dwellings might be too cold. Some apartments are intrinsically colder than others because they receive little sun during the winter or they are situated on corners rather than sandwiched between others, or they are subject to particularly high winds that increase heat leakage. Apportioning of costs might take these factors into account.[3] Cheap evaporation meters could be installed on apartment radiators and at least a portion of the "consumption" indicated by these meters could be used to figure a family's heating bill.

The impact of building level metering can already be seen in Lithuania. The Vilnius DH company reports, that average consumption of heat in the residential sector decreased by 20 percent in the fall of 1995, compared with previous year consumption. The deputy director of the company explained the decrease as result of heat metering at the building level. A number of tenants implemented simple measures to save energy after they realized that they consumed (and had to pay) a lot.

The issue of how to charge households for heat from collective systems has vexed analysts for years. Sweden has very little individual metering of apartments, but good insulation and controls, combined with interest from tenants through their organization, have resulted in heat consumption below levels in other countries where apartments have individual meters but poorer thermal properties. But the same apartments use more heat, per square meter, than single-family dwellings of comparable vintage and construction, even though the latter have far more surfaces through which heat leaks, and should use more heat. And electrically heated apartments in Sweden with no individual heat metering use considerably more heat than those with individual metering. In Denmark, apartments generally have some form of individual heat metering and use less heat per square meter than single-family dwellings, the reverse of Sweden. Similarly, elsewhere in Europe (Italy, France, Germany), occupants of apartments with independent central heating systems in each dwelling (usually fired by gas) tend to use less heat per square meter than occupants of apartments without individual meters, even though the systems in the unmetered buildings are larger and should in theory use less energy overall. There seems to be no question that metering individual households leads to greater reductions in energy use than just metering buildings.

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2 The study by Dapkus, Stankevicius, Burlingis, and Burneikaite of the Institute of Architecture and Construction, "Economic Mechanisms for Stimulating the Increase of Thermal Insulation for Already Existing Dwelling Houses" (translated for the Bank), considers some form of inverted tariff system where tenants consuming more than a certain amount of heat pay higher rates. Without individual controls and meters, however, this is impossible.

3 It is probably not advisable to encourage tenants to address this problem using individual electric room heaters, an item becoming popular in the Baltic countries. Serious problems arise both because existing building wiring cannot support large numbers of small heaters (we were already told this was the case for individual electric water-heater boilers), and because local or even regional electric supply and distribution might not be able to withstand demand surges that arise when outside temperatures drop and tenants increase their heat demands. This situation occurred in 1991 and 1992 and led to problems with overall voltage, even in the periods outside of the heating season.

One justification for not metering and controlling heating use in some countries was the fact that the capital cost of these technologies was *not* justified by the low value placed on waste heat from power plants. However, huge investments are now required to rehabilitate district heat systems in E. Europe. To the extent that the maximum or even average demands on the systems can be decreased, that reduction will also reduce the investment requirements for new piping, controls, boiler stations, etc. Thus, there is a clear reason for trying to modify both energy demand and peak load in existing buildings where systems themselves are in acute need of repair.

In Sweden the metering issue has been debated for decades. Initially it was argued that savings from using district heating based on cheaper, heavy oil burned in high efficiency, large-scale boilers and distributed in systems with very low losses resulted in lower heating costs than using individual building boilers, so the extra cost of metering would not pay off, at least at pre-1973 oil prices. After 1973, however, this argument was rejected. A second important concern that has blocked individual metering in Sweden is that such metering gives each family an incentive to lower their own heat and "steal" from neighbors, i.e., permit heat from neighbors to leak through their own walls.

Another group of issues raised in Sweden revolves around billing per se: Should rent be "warm" (i.e., tenants pay one sum for rent, inclusive of heat, with the landlord/owner paying the heating costs out of the rent collected) or "cold" (with tenants billed for rent and heat separately according to consumption). The former gives the landlord or owner great incentive to improve the efficiency of the building with no control over the tenants, while the latter gives landlord no incentive to improve the building, but places pressure on tenants to do something about heating costs whether or not they pay by actual consumption. Most often, part of the bill is proportional to what can be read from inexpensive meters or from hot-water system meters, part of the bill from the size of the flat and the number of occupants. A concern related to billing was noted above: in practice, the heating losses of a dwelling depend crucially on where that dwelling sits in the building. Homes lying over or under unheated spaces, those on the corners of buildings, on dark sides of buildings, or on windy sides require more heat than those elsewhere. Should tenants in these flats pay more? On the other hand, these may also command lower rents/prices, at least in the long run.

Improvements for Other Heating Systems

The dominant form of heating in Lithuania is district heating (39 percent of dwellings) followed by large boilers located in basements or in a space accessible to several buildings. (about 15 percent of dwellings) Similar problems as for district heat apply to dwellings in buildings heated by their own boilers (20 percent of dwellings), it appears that heating intensities are higher in buildings using district heating than those using local boilers or their own boilers. In all these cases improvements to the boiler (or indeed a new boiler) can reduce fuel consumption by 20 percent or more, and switching to local fuels, i.e., biomass, could reduce fuel costs drastically.

For detached homes (mostly rural) heated by individual boilers (10 percent of the stock) or by room stoves using solid fuels, incentives already exist for occupants to reduce heating costs, but it is likely they have had to struggle with the sudden increase in fuel prices after 1991. Further treatment of these free-standing homes lies outside of the present report. However, occupants of single-family dwellings have always had an incentive to heat carefully and efficiently. In any case, many of the technologies developed or marketed in response to the needs of multi-family dwellings will have application in single-family dwellings, certainly a desirable "free-rider" effect.

There is a tendency for households to use small portable electric heaters for back-up heat or heat when the main system is turned off. Policies or technical solutions that encourage widespread use of small electric heaters could pose technical problems for building wiring as well as the power system itself. Electricity in Lithuania is currently unsubsidized but still cheap by European standards. It is possible to obtain a tariff that provides off-peak electricity for heat storage systems at night at truly low rates (such already exist in some parts of Lithuania), which is popular in some countries (notably Germany and Britain) for low-cost heating. This is an option Lithuania could expand beyond the limited use of this tariff today, but only with full knowledge of the consequences for its uncertain power system.

Tools for Improving Energy Efficiency of Heating

The tools for improving heating conditions in Lithuania fall into three classes: technologies for saving, controlling, and measuring heat; institutions for overseeing private and public efforts to manage heat; and financial resources for stimulating the first two groups into action.

Technologies to Save, Control, and Meter Heat

Retrofits of the building shell can be carried out using a variety of materials. That improve walls, windows, floor, and ceilings. In principle most of the technologies for saving heat are available in Lithuania. However, reading between the lines of the information we were given, we surmise that materials and technologies available in Lithuania are generally of low quality, and in many cases are unproved there, simply because they have never been used seriously before. Most projects we inspected relied on imported technology, which is of relatively high costs. Thus one cannot really be sure of the cost of carrying out improvements. Equally important, we do not know whether the quality of workmanship will permit the full potential savings to be realized.

All experts consulted agreed that it was important for Lithuania to produce better insulation (of mineral wool). This can take many forms. In additional to batts and rolls, insulation can be built into concrete elements, precut to fit the space in walls between studs as is common in Sweden.

Heat meters that measure the flow of water into a building and the difference between the inlet and outlet water temperatures, indicating heat consumption, are largely imported. There is clearly a market for these that would justify local production, but even in Estonia they are reportedly still imported from Scandinavia and Switzerland. Meters for measuring individual use of domestic hot water need only measure flow, and these are both available and widespread in Lithuania and apparently relatively cheap. Evaporation meters that indicate how much heat has passed through a radiator (but do not actually measure heat consumption), which are common in Central Europe, are cheap and notoriously inaccurate, but can be useful for at least reminding tenants that they are paying for some of their consumption.

Heating controls for individual apartments or entire buildings are not common in Lithuania. Shunting heat out of entire apartments or individual rooms is difficult with single-loop systems. Reducing overall flow of heat to a building as internal demands fall (sensed from occupant controls) or warming of outdoors (sensed with external sensors) is an attractive strategy, but it is unlikely such control equipment can be obtained in Lithuania.

Changes in occupant behavior must also be considered a tool of energy saving. At present, there is no incentive—and little means—for occupants to save heat. However, building and some of apartment metering would change this situation. Occupants are likely to make their dwellings warmer through low-cost measures such as covering unused windows, frequently inspecting weather-stripping or other draft-proofing. Installing flow restricters on hot water taps, and cutting back on hot water use in general also leads to savings. Occupant behavior will rise in importance as more controls are installed so occupants can adjust temperatures.

Institutions and Actors to Save Energy

There are four levels of institutions and actors that can support energy saving in the housing sector. On the highest level, the legal and institutional infrastructure of housing ownership and responsibility (including financing) is itself an "institution." On the next level, suppliers of materials and equipment must be in evidence. On the third level, building and construction trades must be prepared to install and maintain technologies. And on the final, but most important level, individual households must be prepared to pay for improvements and manage their own energy use.

The government has privatized the majority of flats, but important institutions—tenants associations, private or municipal companies that own apartments, a real-estate industry, regular loans for home ownership, etc.—still must be fully developed. On the next level, equipment suppliers exist, but these are still "leftovers" from previous times. It cannot be said that there is a real competitive market in materials and equipment. Similarly, the first generation of private heating consultants, equipment consultants, design consultants, and even small construction companies has appeared in Lithuania. Certainly the skills for improving the quality of buildings are present in Lithuania, but the actors are not organized.

Countless investigations in the U.S. and Europe have shown that proper installation of measures in both existing and new buildings is as important as the technical properties of materials and equipment installed. Common problems include:

- Spaces left between batts of loft insulation permit serious short circuits for heat to escape, offsetting as much as half of the value of added insulation.
- Cavity wall insulation is not fitted correctly to the dimensions of the cavity, permitting air circulation to conduct heat from inside to outside.
- Workers forget to install wall insulation in relatively small spaces (such as near windows).
- Poor caulking above windows or other places where there are horizontal joints permits rain water to enter the wall, leading to rot.
- Caulking of inside apartment doors and thresholds is overlooked, permitting the natural chimney effect to suck air from each apartment into the stairwell/elevator shaft, which in turn sucks in cold air through outside windows and cracks.

Specialists in Western countries have learned—by trial and error—how to overcome these problems. Helping them are diagnostic tools: good data on building energy use, tools for rapid measurements of air infiltration, infra-red thermograph, meters that estimate thermal resistance in existing components and other equipment for "house doctoring." [4] The advantage of experience here is that retrofit teams can spot major problems on a house-by-house basis

[4] The Institute of Architecture pointed out that qualities of the building stock are very poorly known. Even though most apartments were in principal constructed to the Soviet norm SNEP, there is no certainity as to what levels of insulation were installed in fact. This point is not trivial : additional insulation gives more thermal resistance in a harmonic sense. If 10 cm of insulation is added to an existing 10 cm, the effect is to double the existing thermal resistance. If the same 10 cm is added to a virtually uninsulated component, the effect is much greater. From an economic point of view, it is important to find these places where insulation is poorest in buildings.

before time and materials have been expended in vain. These issues represent an opportunity for providers of technical assistance to build public sector know-how on diagnosing and improving the thermal qualities of buildings.

The most important actors in bringing about heat savings are the occupants or owners of homes and buildings. In multifamily buildings the occupants must work together to improve the entire building. The organization of tenants into associations that make decisions, engages professionals to improve the building, and borrow money to do so is the clear step. The Lithuanians might benefit from greater exposure to the various kinds of tenure and tenant ownership in Sweden, Denmark, and Finland, including private building ownership/renting, cooperative ownership of both building and flat, ownership of the flat but "leasing" of the space in the building, and almost condominium style.

Financing Rehabilitation and Energy Saving Investments

The heating problem in Lithuania is also a financial one. Neither individuals nor the country as a whole can afford to pay world prices for oil and gas, which resulted in severe cutbacks of supplies in 1991 and 1992. By the same token, investment funds to reduce heating needs are also lacking, except at extremely high interest rates.

Both funding *and* institutions to lend (and receive) are necessary. It appears that a recent Government Resolution (No. 375, May 16, 1994) will facilitate lending of funds through the housing ministry and national bank, although few details are specified in the resolution itself.[5] Loans can be granted to "fellowships" (tenants' associations), individual owners and apartment maintenance enterprises for a variety of improvements. Thus in principal apartment tenants can receive loans, with the house/apartments as collateral. Given the new adventure of families as borrowers, it would seem that expectations about loan payback should be relaxed, but repayment must begin once construction is finished.

To correct the deficiencies of the privatization law regarding building maintenance responsibilities, the Parliament adopted the "Homeowner association law" in February 1995. According to the law, the main purpose of the association is to manage the living and non-living areas of a building. The law states the associations' rights, such as the right to make transaction, undertake ownership obligations, open a bank account in Lithuania or abroad, obtain credits, etc. The funds of the association are also clearly identified by the law as membership entrance fee, real payments to cover exploitation or repair costs, other payment in connection with the association`s activities, as well as financial grants provided by the State or municipalities.

According to official statistics, Lithuania had about 1850 homeowner associations and 800 dwelling cooperatives (which did not register themselves as associations according to new regulations) in 1994. Lithuania is the first country of the former Soviet Union to develop a potentially workable mechanism for owner associations to borrow money for building rehabilitation. Ideally, associations, by majority decision, would be able to borrow money from banks, using whole building as collateral and obligate all tenants within the building to repay the loan. If individual tenants cannot or will not service their share of the debt, the owner association can legally take them to court to either get payment or to foreclose on their apartment and evict them.

There are still several obstacles to overcome, however. Association membership is neither compulsory, nor automatic. The owners willing to join the Association must apply to the Association Board, and they are admitted in accordance with the Association Status. Nevertheless, the law indicates that owners have to settle all accounts with the Association before having the legal right to sell their apartment. Home owner associations are very heterogeneous. Some are very advanced with a lot of in-house capabilities to manage and

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[5]A similar arrangement has been set up in Poland (Min. of Physical Planning, priv. comm.), making up to $ 70mn US per year available in a revolving fund.

execute building rehabilitation and to repay a loan. Others are still very embryonic with neither technical capacity nor cohesion among their members. Owners have very real fears about losing their apartments. Their confidence in the banking system is low (especially due to recent banking failures). They also have mixed feelings about what Government can do to help or protect them in case they face problems repaying the loan. In the early stages of retrofitting only the very best and dynamic associations should be involved.

One formula for lending is to ensure that the tenant sees the same total (rent + heat + loan for rehabilitation) before and after the loan. This requires a cautious approach to the models used to calculate heat savings. Moreover, clearly few tenants can really afford thorough rehabilitation of their dwellings if the costs we were quoted by those presenting various projects are correct and the pay-back time is more than five years. Yet it would be a missed opportunity if, in the interest of saving money, only heat-saving but not general rehabilitation measures, or vices versa, were undertaken. Thus it is very important to carry out a series of retrofit and rehabilitation projects to determine what can be undertaken profitably in different types of buildings.

Although no one knows how far a given investment into thermal retrofits and building rehabilitation will reduce heating needs, the poor quality of the housing stock in Lithuania certainly makes many basic actions cost effective. Seen from the point of achieving maximum return to money investing in housing, however, only careful experimentation can determine what works best.

Modest investments in simple retrofit measures will lead to some heat savings, but not rehabilitation of buildings in a broader sense. Although there is a reluctance to subsidize interest rates, clearly low-interest loans or grants may have to be provided to be sure that optimal rehabilitation and retrofit is targeted and that the actual construction meets quality standards. There also needs to be arrangements to be sure tenants are not ejected piecemeal or as a group if individuals or an entire group fails to meet payments because the full heating savings predicted are not realized. Doing this right requires a much more careful inspection of the costs of rehabilitation, both those aimed at reducing heat costs and the more general rehabilitation actions.

Moving Forward Carefully—but Quickly

The ideal situation would be to proceed with careful housing rehabilitation, in which buildings are systematically insulated and rehabilitated. The retrofit programs established in Sweden (Schipper 1985; Schipper, Meyers, and Kelly 1985) and Denmark (Schipper 1983; see also Wilson et al. 1989) might be good models, since these both received much evaluation and evolved from energy-focused housing rehabilitation. But both of these programs were underpinned by massive surveys of the building stock and occupants, as well as by a wealth of retrofit experiments. Lacking this experience, authorities in Lithuania must foster rapid information gathering, including encouraging companies (and individuals) carrying out retrofits to come forward with information.

A more modest strategy would first survey the heating systems of households by tenure, dwelling type, and system to determine which kinds of homes are most likely to be in need of rehabilitation and be affected by the problems of collective heating. For these, retrofit should be carried out with rehabilitation, but not before. Similarly, those dwellings in such poor condition as to make even simple thermal improvements ineffective, or useless, because occupants will leave anyway, should be passed over. By contrast, those dwellings so inefficient or poorly heated for which improvement could make them livable should be selected for immediate treatment. Those in the middle—occupants able to cope with higher heating costs/lower comfort through a variety of low cost/no cost strategies—should be "treated" just to the minimum low-cost, self-installed retrofit measures.

How can improvements in the first two groups be financed? There is clearly a role for the multi-lateral development banks to help establish revolving funds or other credits that national authorities can distribute. An efficient mechanism for distributing funds is necessary. Above all, careful measurements are necessary, so the early results can be analyzed to improve practices. But this can only be financed by donations or other forms of technical assistance to pay local firms or universities to organize such monitoring.

In the longer run improvements could also be financed indirectly through some of the revenue generated by heat price increases. In fact, the tight coupling between district heating supply and demand suggests opportunities for "integrated resource planning," because both the future economics of district heating and the importance of large investments in rehabilitating existing systems depend on whether the populations heated can afford the heating provided, whether meters and controls can be installed, and so forth. Heat demand might fall to where parts of the system would be better served by local or individual heating. Authorities should consider packaging district-heating rehabilitation with housing rehabilitation to provide for a balanced investment on both sides of the "meter." This would be particularly attractive where both housing and heating are likely to remain municipal property, or where authorities are saddled with providing income supports or subsidies to permit building occupants to pay their heating bills.

This brief sketch of a program rests on a key assumption: Lithuania faces housing and affordable comfort problems, and only secondarily an energy problem. The interactions among the elements of the context we noted all concern housing and occupant comfort, for which energy is an important input. But a house or building itself is an even more important element. Also, it is clearly meaningful to develop supplies and suppliers of efficient and comfortable housing, something that goes far beyond energy concerns alone and reaches to the design of buildings, the materials used, the workmanship in construction (or retrofit), and so forth.. Put another way, consumers in wealthy countries typically spend four to five times more for their housing than for the energy to run it. In the long run, this should be the case for CEU as well. When these proportions are recognized, strategies to improve the energy efficiency of housing ought to be embedded in actions designed to provide better housing overall. The varied nature of homes, heating systems, tenure, and the economic situations of occupants suggest no one "solution" or policy formulation. Experiments and real-world experience will undoubtedly change the calculus. And as these situations change, different individuals and groups in each country will emerge with new perspectives on the "challenges" described in this paper.

Above all, the problem of affordable comfort in Eastern Europe must be considered as a human problem, emphasizing that people comprise the links between the challenges outlined in this paper. Although CEU governments have recognized the political threat of cold families, they have only recently moved to learn how people are handling difficult situations. In that sense it is very important to couple politically difficult-but-necessary decisions to increase residential energy prices with bold strategies to reduce energy needs. Doing either without the other can lead to difficult social problems on the one hand or a misallocation of scarce resources (and skills) on the other.

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FIGURES

Figure 1. Lithuanian Buildings in Urban Areas by Height and Area, 1990
Source: Lithuanian Energy Institute. Unpublished data

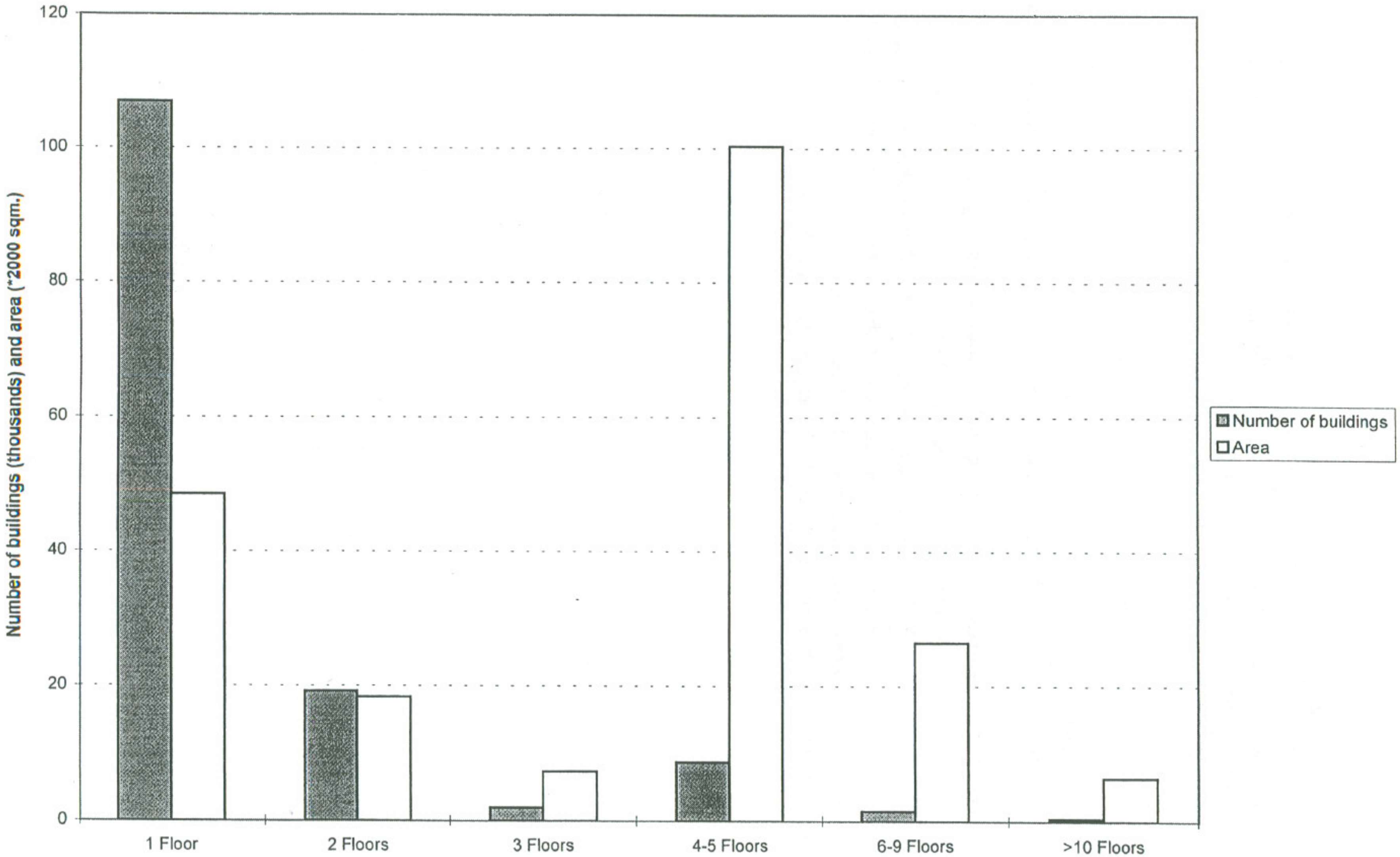

Figure 2. Lithuanian Dwellings in Urban Areas by Size and Ownership, 1990
Source: Lithuanian Energy Institute, Unpublished data

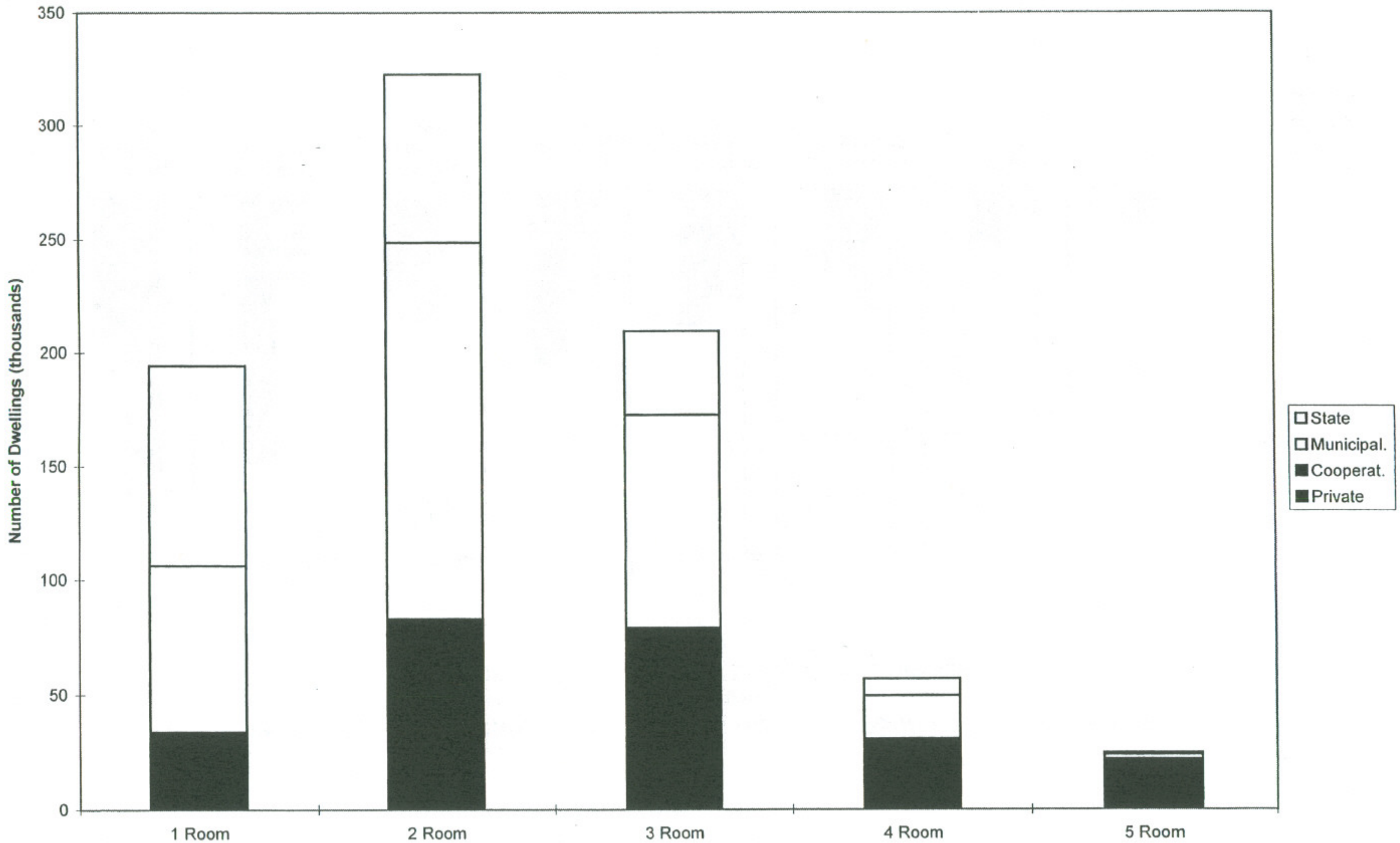

Figure 3. U-values of typical Lithuanian apartment buildings and current Lithuanian standards (maximum value) for apartment buildings

Source: The World Bank. Household Energy Survey. June 1995.

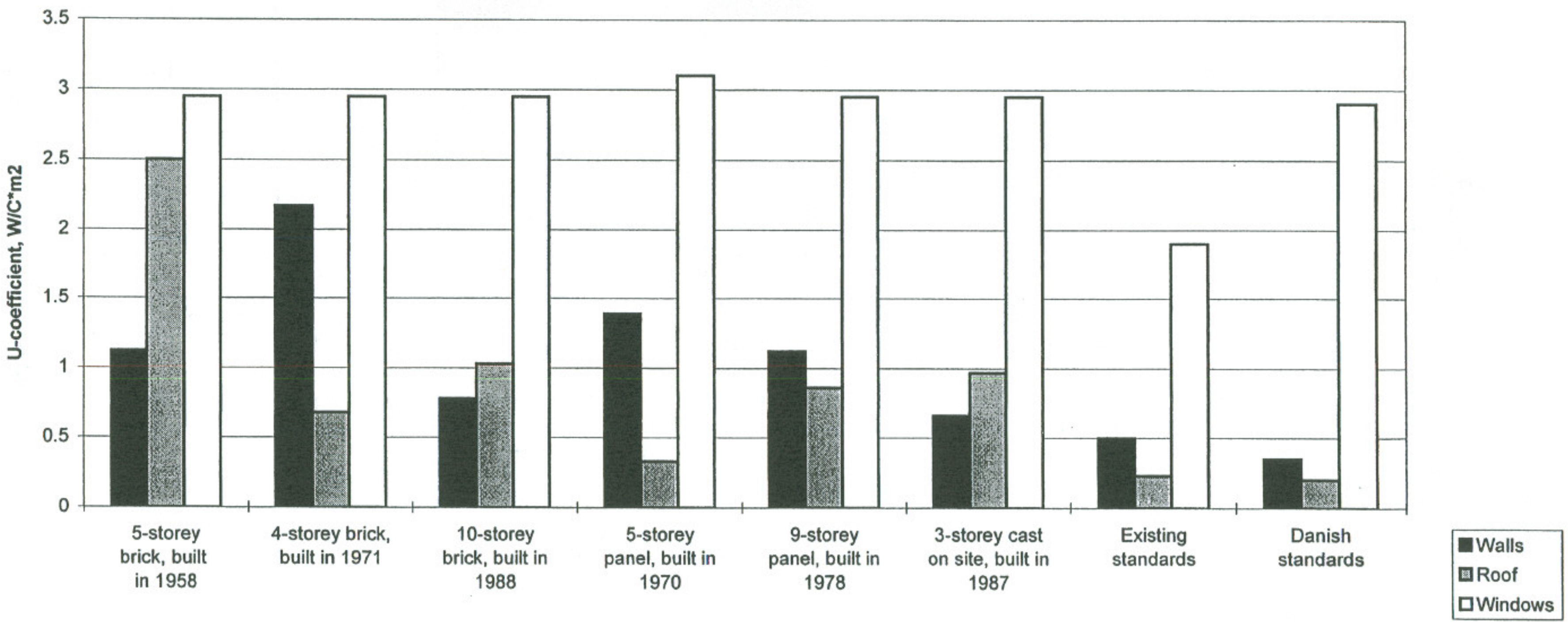

Figure 4. Lithuanian New Dwelling Construction, 1990 - 1995*

Sources: Statistical Yearbook of Lithuania, 1994-1995.

* 1995 estimated based on January-September, 1995 data from Lithuanian Department of Statistics.

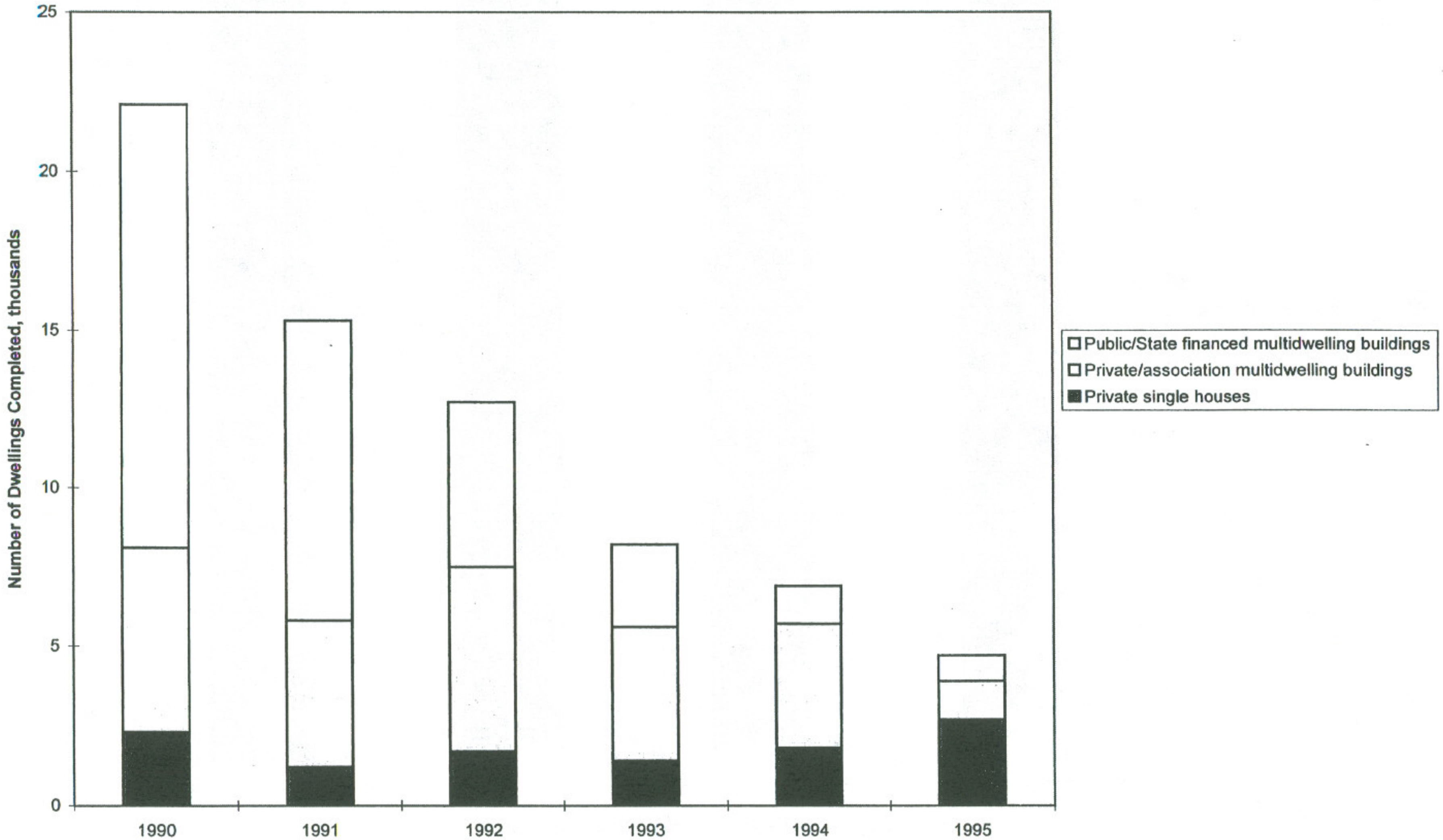

Figure 5. Facade Material in New Multidwelling Buildings in Lithuania
Source: Statistical Yearbook of Lithuania, 1994-1995.

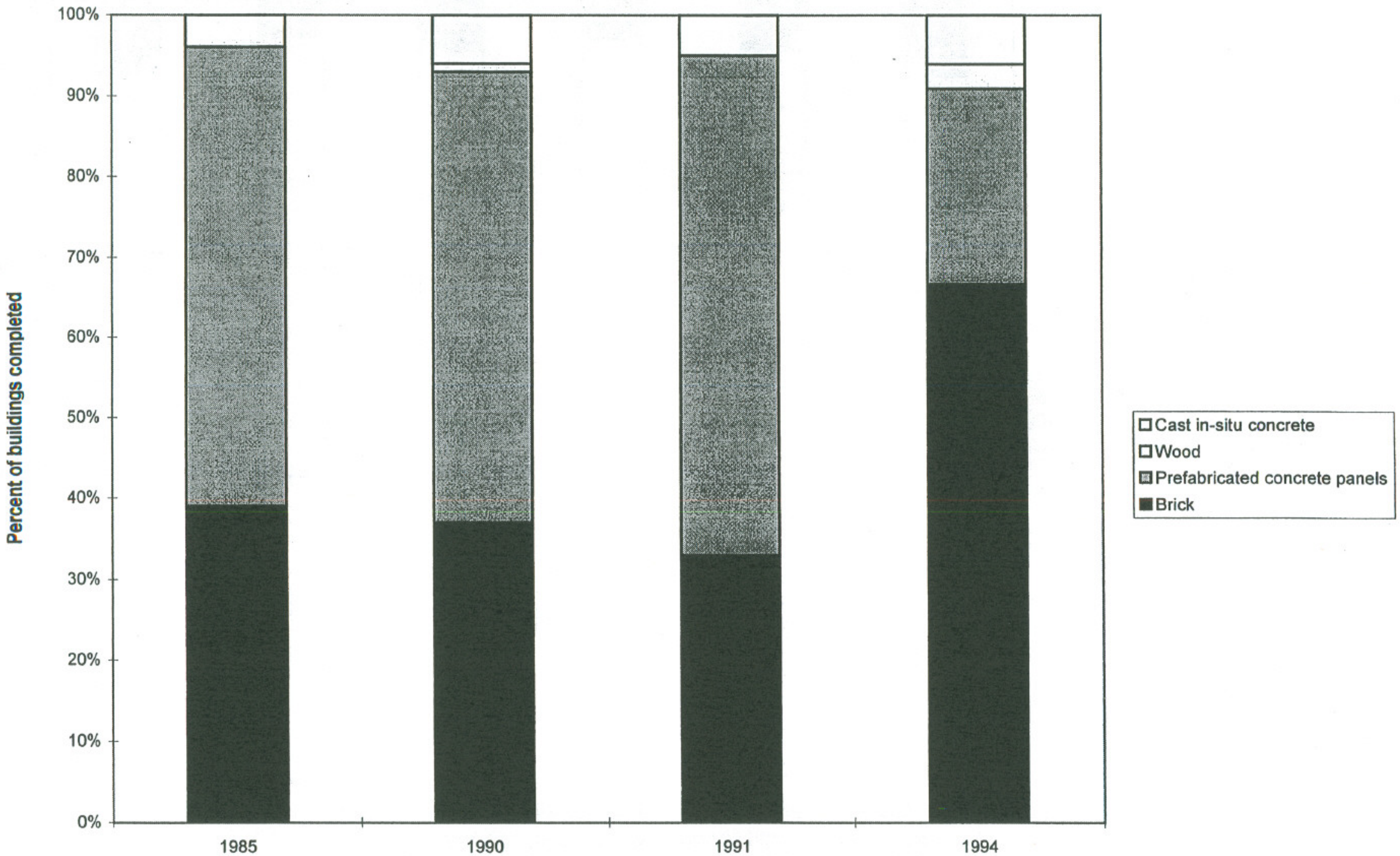

Figure 6. New dwelling construction cost, household income and new dwelling affordability 1991-1994
Source: Construction cost indices. Lithuanian Department of Statistics.

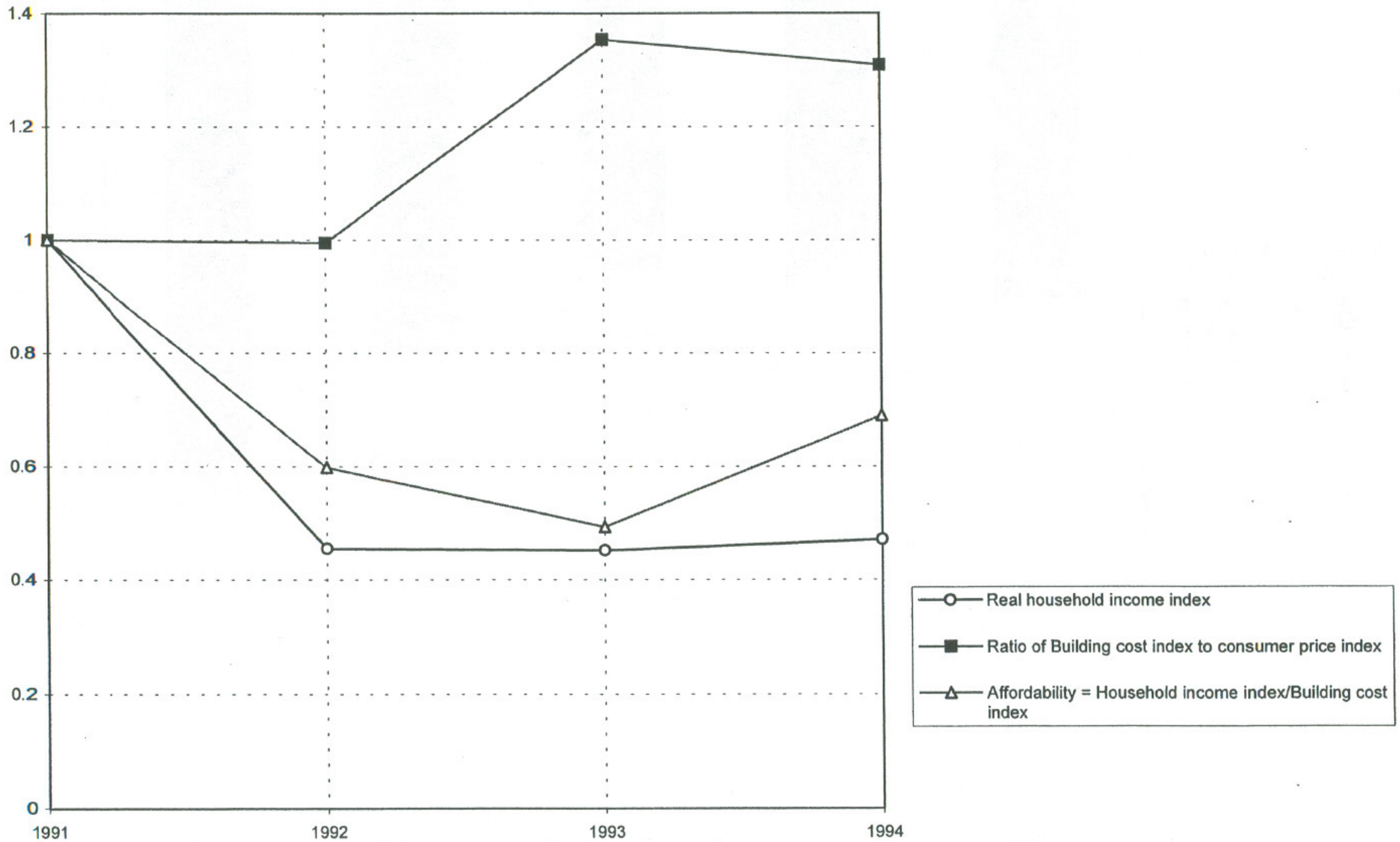

Figure 7. Final Heat Consumption in Lithuania, 1991 - 1995
Source: Lithuanian Ministry of Energy. Balances of electricity, heat, fuel and energy in Lithuania, 1991-1995.

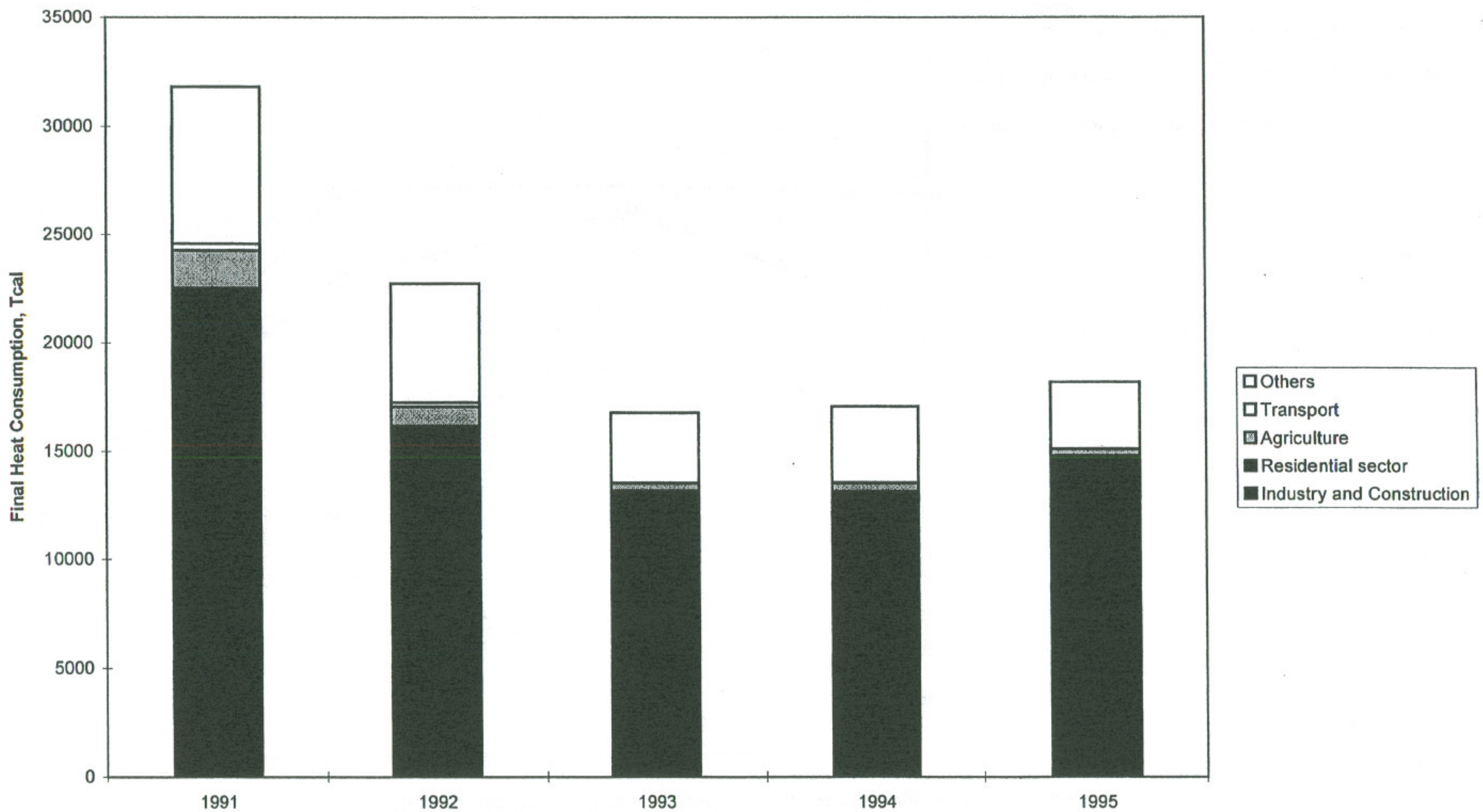

Figure 8. Metering of Residential Energy Consumption in the Two Biggest Lithuanian Cities (June, 1995).
Source: The World Bank. Household Energy Survey. June 1995.

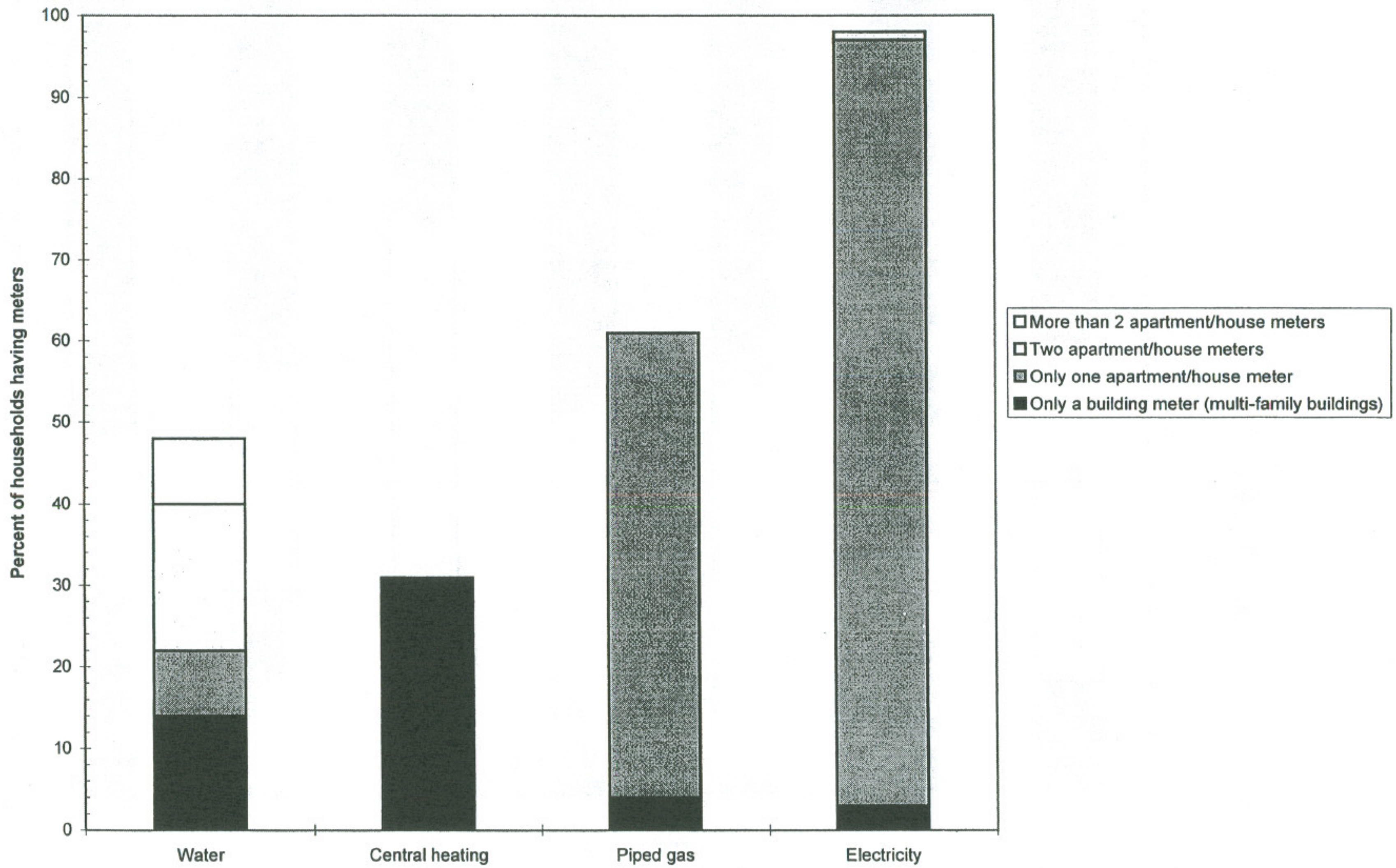

Figure 9. Percent of Households by Main Heating Fuel in Lithuania and Other Countries

Source: Schipper, L., Affordable Comfort in Lithuania: Proposals for a World Bank Loan to support Housing Rehabilitation and Thermal Retrofit, 1994

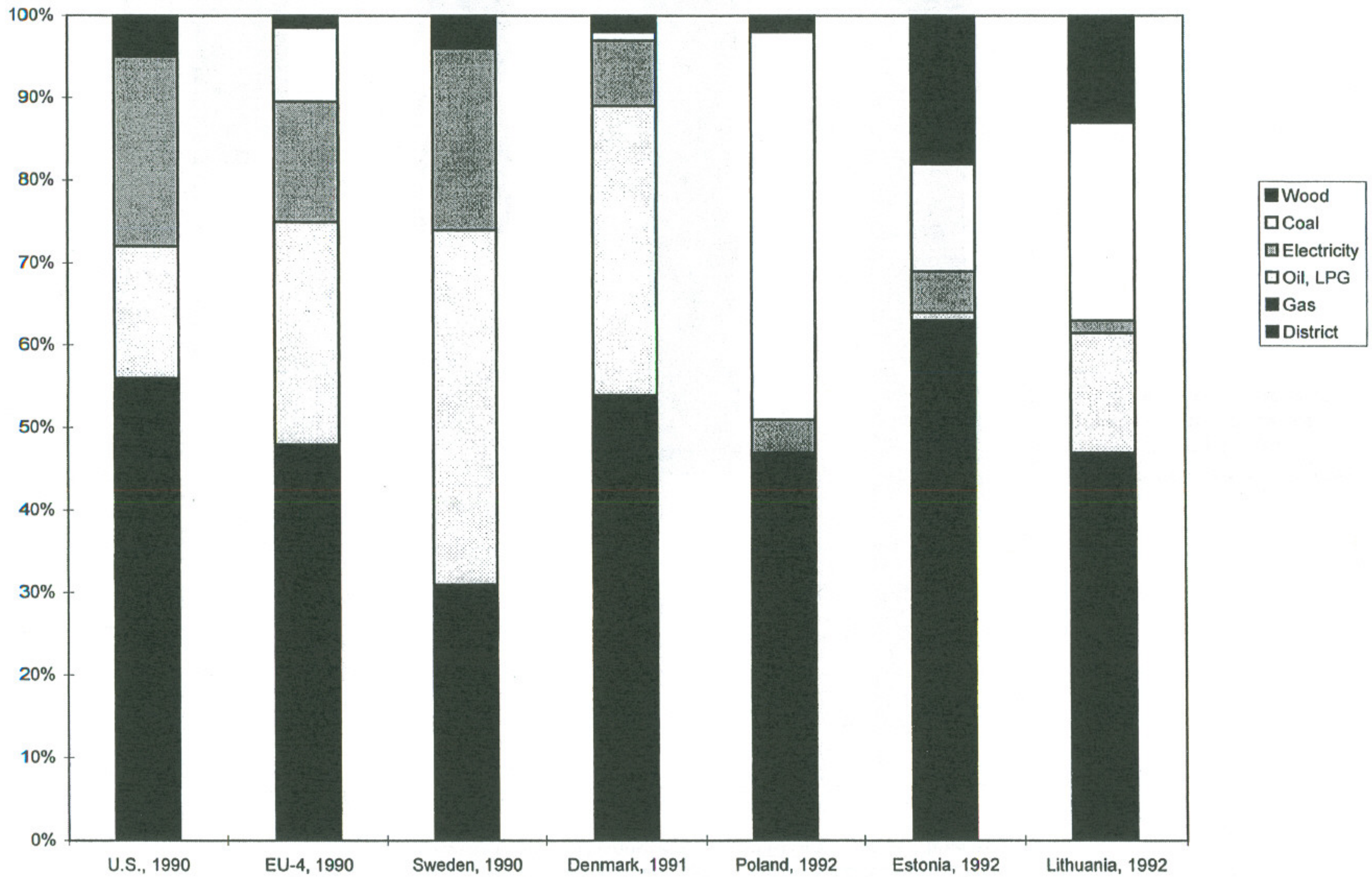

Figure 10. Per Capita Household Energy Use in Lithuania, 1990

Source: Schipper L., Affordable Comfort in Lithuania: Proposals for a World Bank Loan to support Housing Rehabilitation and Thermal Retrofit, 1994

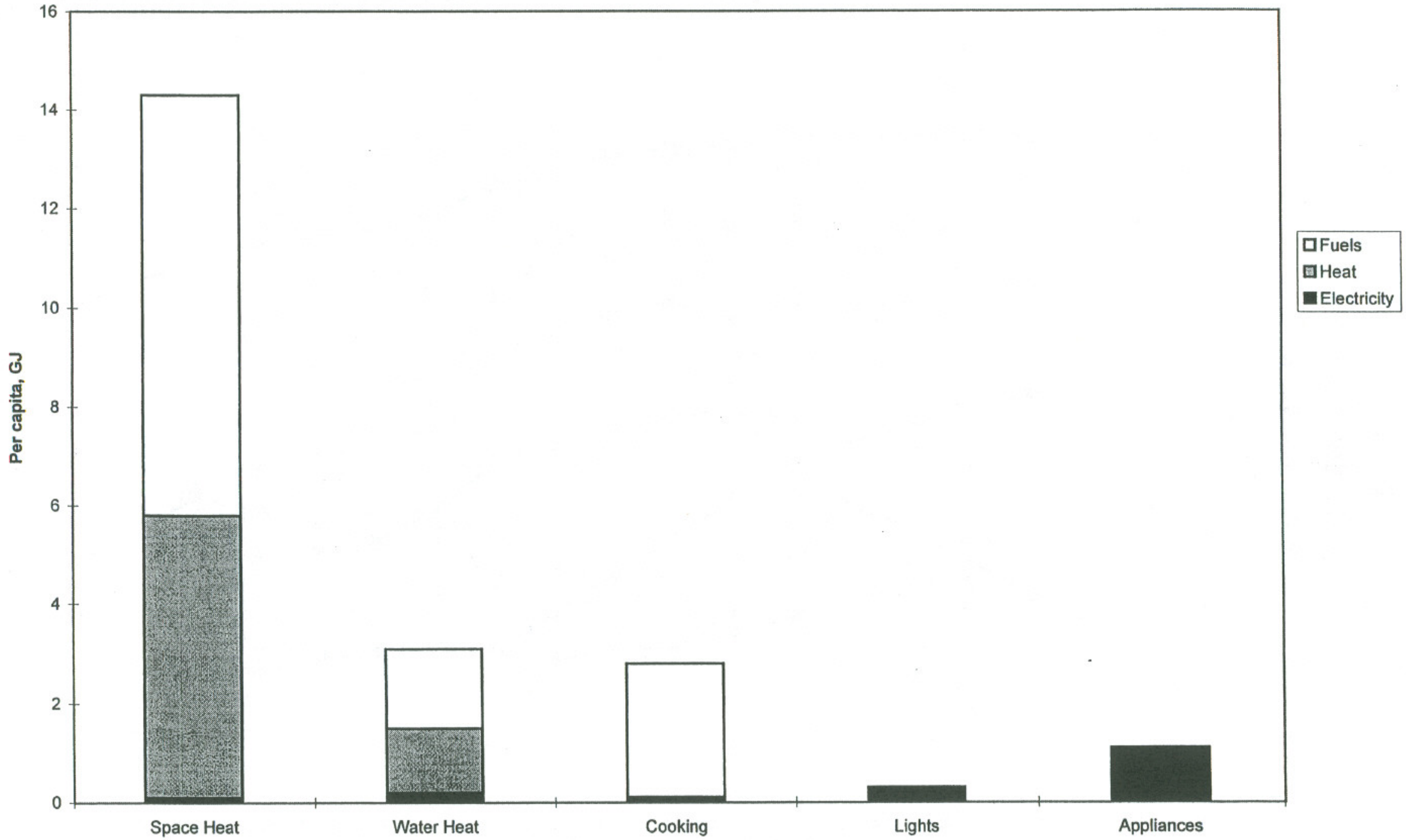

Figure 11. Residential Space Heating Intensity in Lithuania and Other Countries (Useful energy).
Source: Schipper L., Affordable Comfort in Lithuania: Proposals for a World Bank Loan to support Housing Rehabilitation and Thermal Retrofit, 1994

Figure 12. Space Heating Intensities in Lithuania. Buildings with Own Boilers/Stoves or District Heat
Source: Schipper L., Affordable Comfort in Lithuania: Proposals for a World Bank Loan to support Housing Rehabilitation and Thermal Retrofit, 1994

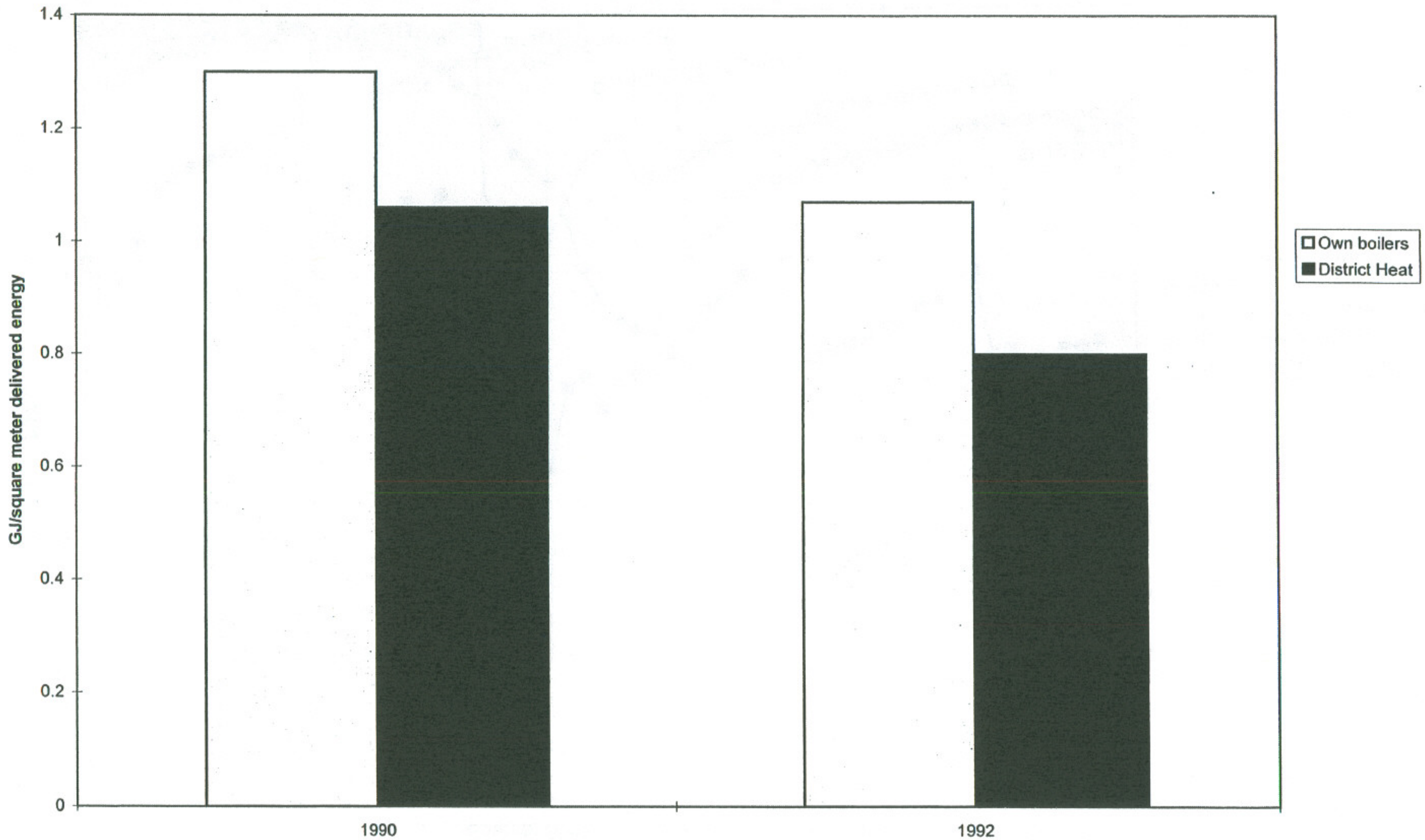

Figure 13. Real Energy Prices in Lithuania (Price Level of Dec.1995).
Source: Statistical Yearbook of Lithuania, 1994-1995.

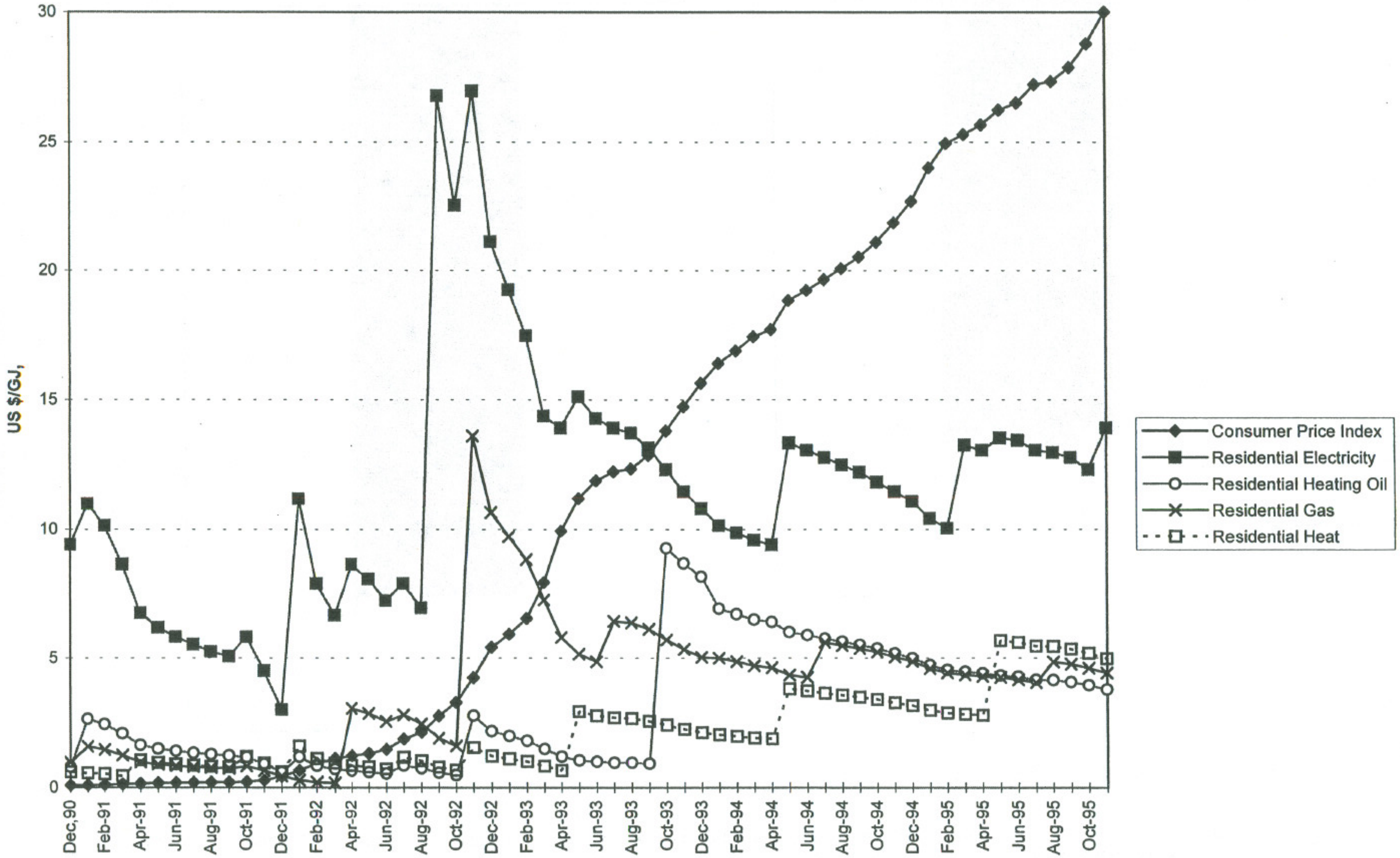

Figure 14. Projected Domestic Consumer Prices for Energy Sources in Lithuania.
Source: Republic of Lithuania, National Energy Strategy. Final Report, 1993.