Coming in from the cold: The challenge of providing affordable comfort in Central and Eastern Europe

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1. SYNOPSIS

We review energy use for households in Eastern European countries and trace their inefficient use to fundamental problems with the housing system. The transition to more efficient energy use depends on both developing a new housing system, with all its inherent institutions, as well as improving the pricing and metering of energy itself.

2. ABSTRACT

Rapid economic reform in most sectors of Central and Eastern European economies has had a profound impact on energy use there. While energy use in some sectors is changing rapidly with economic restructuring, that for housing has changed only slowly once the shocks of higher prices or cutbacks in supply worked through to individual households. Financial pressures on both households and the state, local, and private entities that buy and distribute fuels, and/or health and environmental costs associated with using solid fuels (including shale and peat) or high-sulfur residual oil, coupled with the possibility of a return to the cold winters that have been absent since 1988 make the matter of affordable comfort one of some urgency. Comparison of space heating use in Central and Eastern Europe (CEU) today shows levels close to those in the U.S., Denmark, and other European countries in the early 1970s, suggesting that important reductions in heating needs can be made even while increasing comfort and reducing costs. However, several fundamental problems confront the transition to a market-based system for energy use in the housing and commercial building sector. This paper shows that these problems, perhaps unique to the building sector, are related to classic market failures. very long adjustment times, limitations on building technologies and housing related institutions, and above all the vexing problems of families adjusting to difficult economic conditions. Because every problem shares social, economic, and technical elements, approaching any of them from only one of these three perspectives will be difficult.

3. 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). While 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 Laboratory (LBL) 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 1995; Schipper, Martinot, and Khrushch 1994; Schipper et al. 1995). In every one of these studies, the inefficiency of energy use emerged. This article reports on further research at LBL that focused on energy use in housing in Eastern Europe.

The crash of economic activity in CEU brought with it a drastic drop in energy use for the production and distribution of goods. On the other hand, energy use for autos shot up, since used cars from Western Europe became easily importable. Buildings and homes, however, remain an enigma. Unlike enterprises, neither the occupants nor the "owners" can simply walk away from them. Not only are housing standards low, 18-22 square meters per capita—one-half to one-third of European levels—but the amount of built space in the commercial and public areas appears to lie at the same low levels. There is literally nowhere else to go. Public health and hygiene, as well as the long-term survival of the buildings themselves against moisture, mold, and decay, dictate that buildings be heated, and 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

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square meter of space in the Baltic countries, Russia, or Poland as was used in the Nordic countries, without its occupants enjoying similar comforts. Something was wrong.

This article analyzes what might be wrong. Our thesis is that the most crucial problems are not technical, i.e., not related to energy per se, but rather they are social, institutional, and economic. To analyze these problems, we compare household energy use, focusing on space heating, in CEU and Western countries. Our purpose is only to provide a quantitative measure of energy use in the East. We then argue that East and West are hardly comparable, listing specific problems and discussing specific challenges to improving energy use in CEU housing. We conclude that while the technical "potential" for reducing the cost of indoor comfort in CEU is very high, this "potential" has no meaning outside the rapidly evolving social and economic situation. Solving the non-technical problems will be difficult and time-consuming.

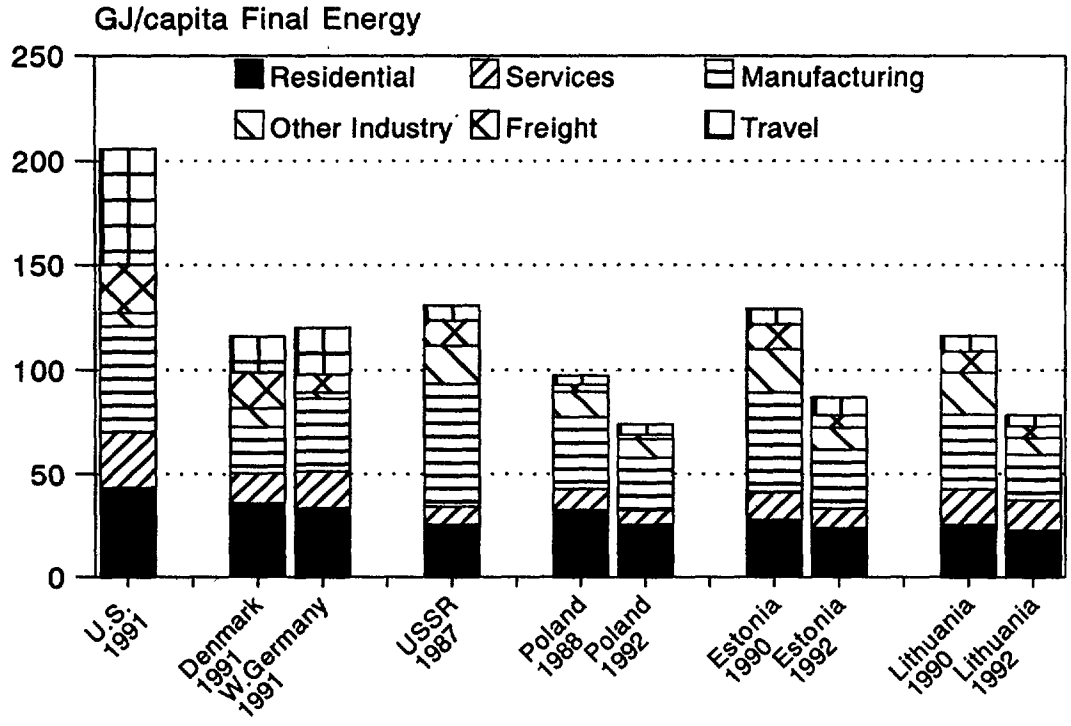
In addition to the LBL reports noted, we draw on recent reports on CEU prepared for the World Bank, including this author's own report on Lithuania. Data on the housing stock and tenure come from each country's most recent housing census. Data on OECD countries are from LBL's data base (see Schipper, Meyers, et al. 1992 or Schipper, Ketoff, and Kahane 1985).

4. HOUSING AND ENERGY IN EASTERN EUROPE

4.1. The Structure of Energy Use

Figure 1 shows per capita energy use in the early 1990s (with the exception of USSR) for major sectors of final demand in several CEU countries, neighbors in W. Europe, as well as in the U.S. Striking is that in 1988-90 the per capita energy use in the former Soviet Union (FSU) and other "Eastern" countries was as great as that in Denmark or W. Germany, in spite of a huge difference in living standards. The two important exceptions are the small amounts of energy used for travel and for the service sectors.

Figure 1: *Final per capita energy use by sector, 1987 - 1992*



Source: Lawrence Berkley Laboratory reports

Comparison reveals that per capita energy use for housing differs by less than ±20% around a rough average of the countries portrayed. More than 25-30% of final energy consumed in the U.S. and W. Europe is for electricity (with no combustion losses), representing mostly electric appliances, cooking, and lighting. These end uses are relatively

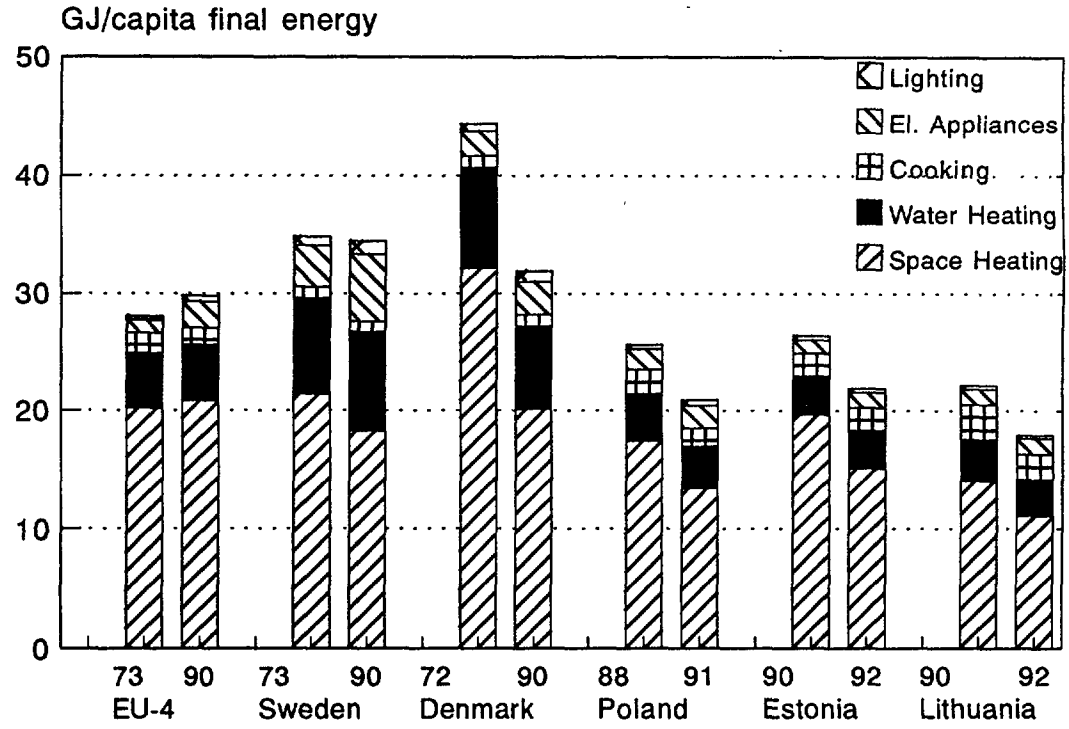
small in Eastern Europe. By contrast, more than 30% of consumption in the CEU countries shown is district heat, mostly space heating, as is most of the consumption of oil and solids. While many consume natural gas for cooking, a great many consumers use gas in cooking stoves (largely unmetered) to heat kitchens and water as well. Although Eastern European homes are much smaller than those in Western Europe or the U.S., the residential share of total energy use in CEU is unusually prominent. This suggests that energy use in Eastern European households is inefficient.

Equally as striking is comparing 1988-90 with 1992 for the three CEU countries where data for both years are shown. Note how energy use for industry and freight fell more than that for housing, with the consequence that the relative importance of housing as an energy consumer increased. Put another way, the collapse of CEU economies brought a similar although proportionally smaller collapse in energy use for production and distribution of goods. But energy was still required to heat and maintain buildings for people and services. The drop in household energy use represented not a contraction of the housing sector but a real decline in comfort.

Fuel mix differs greatly both within CEU and in comparison with the West. The importance of the final use of coal in Poland (and to a certain extent the Czech Republic) stands in contrast to oil and gas in the Baltic states, with electricity use low in all four countries but district heating high. While the Nordic countries share the high use of district heating, they use almost no coal directly and in general far more electricity for all purposes. Coal dominates the primary fuel mix for district heating in Poland as well and has a leading position in electricity generation in most W. European countries and the U.S. Heavy oil and gas share most of the load in the Baltics; coal and gas in the Czech Republic. In all countries, other solid fuels (wood, peat, garbage) supply between 5% and 10% of final energy use for heating.

Figure 2 gives a perspective on the importance of different end uses to the household sector. We show final energy use for lighting, electric appliances, cooking, water heating and space heating for the U.S., an average of four Western European Countries (France, Italy, West Germany and the U.K.), and countries in CEU. For the latter we adjusted each country's space heating use by the ratio of the severity of the climate (as measured in degree-days to 2700 DD), the average for W. Europe and Scandinavia, and by coincidence the figure for all of the U.S. We see that space heating is the most important final energy use followed by water heating. The greatest relative difference is in the use of electricity for lighting and electric appliances, two to three times greater in Sweden and the U.S. (not shown) than in CEU. Figure 2 shows that energy use for domestic water heating (for the most part provided by the same fuel source providing space heating) is surprisingly important. Most central heating systems in W. and E. Europe are hydronic, with boilers in buildings or nearby or heat coming from the public supply. In sharp contrast with Western countries, electricity use for appliances, lights, and cooking is small in CEU, while that for space and water heating is almost insignificant.

Figure 2: *Per capita residental end uses, adjusted to 2700 deg-days*



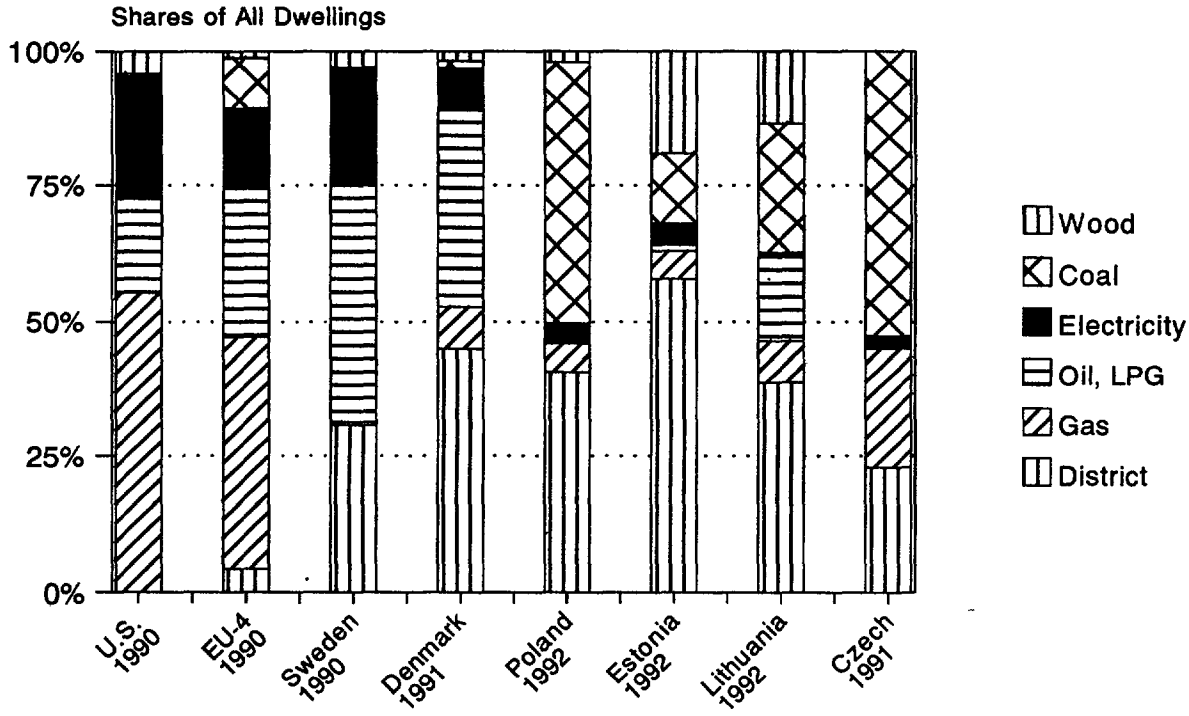
EU-4: France, Germany, Italy, UK

Source: Lawrence Berkley Laboratory calculations

The figure shows data from before economic reform for three CEU countries as well as for 1991-92. These figures are corrected to each country's "normal" year using a long-term average number of degree-days base 18 and then adjusted in proportion to each country's average up or down to 2800 DD C. The winters of 1990 and 1992 were actually 10-15% warmer than normal in Eastern Europe, giving housing occupants some relief from the cold. Economic reform in Poland (starting in 1988) and independence in Lithuania and Estonia (in 1991) brought energy supply problems. Household energy use in 1992 was about 10% lower because of restrictions in deliveries of oil and gas from Russia and the reaction of heat suppliers to the higher price of oil and gas. The drop in consumption in the early 1990s means that dwellings are cold and residents may be anxious to restore heating levels, as apparently has happened in Poland in 1992 and 1993.

Figure 3 compares the share of homes using each main fuel for space heating in a variety of countries. The share of district heating (meaning heat provided by a large-scale grid fed by either large boilers or by waste heat from electric power plants) is very high in CEU, particularly in cities, but equally as high in Sweden and Denmark. District heating in Denmark and Sweden is fired principally by coal, some gas, and renewables; in Poland by coal; in Estonia by oil, gas, and some renewables; and in Lithuania principally by oil and gas. Oil also plays an important role in small boilers in these countries, but its importance in Europe as a whole has been declining in favor of gas, electricity, or (in Sweden and Denmark) district heat.

***Figure 3:** Household heating fuel shares by principal heating fuel.*



For Lithuania, share of total area is used.
Sources: LBL tabulation of country sources.

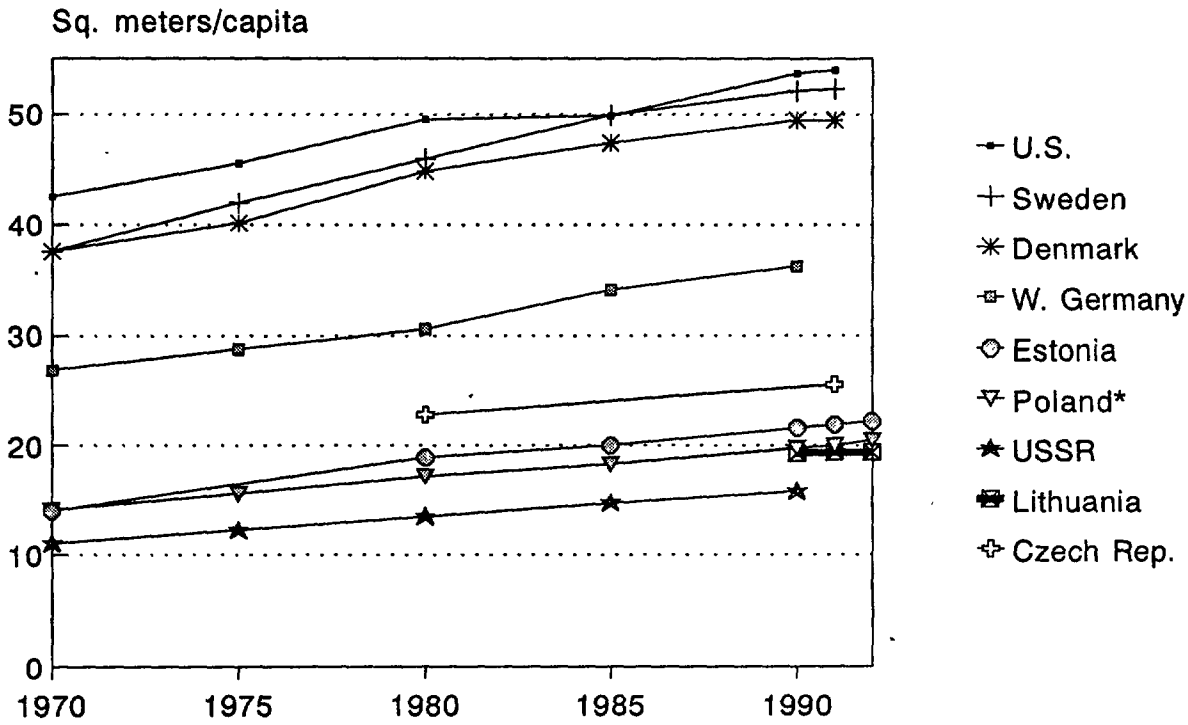
Although district heat receives much attention, roughly one-third to one-half of all dwellings in apartments with hot-water radiators actually receive heat from local boilers based on gas or oil (Lithuania and Estonia) or coal (Poland and the Czech Republic). From figures based on relatively few measurements, it appears that heat use per square meter (intensity) in buildings heated by local boilers is lower than in buildings supplied by district heating, when combustion losses in boilers are excluded. It may well be that where building managers or owners control their own central heat they have throttled back, with or without full agreement of tenants. 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 important but often overlooked opportunity for saving energy in CEU.

For other fuels used directly for heating, the situation is not as complicated. Free-standing dwellings in all CEU countries tend to be private and heated mostly by room stoves, although boilers are not uncommon. Coal and wood

are used in modest quantities in forest and farm areas (as well as peat in Estonia), and some heating oil and LPG is used in the Baltics as well as natural gas in Poland. Households heated with these fuels were forced to cut back drastically.

The differences between East and West are even more dramatic when we consider the size of homes. Figure 4 gives the per capita living space in a variety of countries. The gap between the U.S. or Scandinavia and Western Europe (best represented by Germany) is relatively as great as that between Western Europe and Eastern Europe. Eastern Europeans are crowded both because dwellings are small (typically 60 square meters, i.e., 55 square meters for apartments and 80 square meters for detached homes) and because there are as many as 3.3 people sharing a single home. However, the share of homes in CEU with central heating (i.e., heating elements in virtually every room, supplied by a boiler in the building, an outside source of hot water/steam [district heat], or electric heating in each room) is typically 70%, the same as in W. Europe but less than in Denmark (95%), Sweden (100%), or even the U.S. (80%).

***Figure 4:** Per capita living area in homes.*



Source: LBL tabulations from country building censuses

The structure of energy use in housing in CEU thus differs considerably from that in the West. Some of these differences alone make the comparison with the West tenuous at best. As we see in the following section, even more differences complicate the picture.

4.2. The Housing Stock: Types and Tenure

Three other features of housing in CEU complete the context. First, most housing is in multi-family dwellings i.e., buildings with four or more dwellings. These comprise as much as 72% of the housing in Estonia and Lithuania and 60% in Poland and the Czech Republic, with a large share of the remaining detached and semi-detached homes and dwellings (mostly farm houses) in rural areas. By contrast, these shares lie between 25% and 55% in W. Europe or North America. Experience in multi-family housing in the West showed actual reductions in heating energy were always less than in detached homes (Schipper, Ketoff, and Kahane 1985). This is likely because technical, economic, and social considerations often hinder tenants and landlords from working together to reduce heating needs in existing large apartment buildings. Indeed, in Sweden it can be shown that heat use per square meter in collectively heated buildings is higher than in single-family dwellings with the same source (oil or district heating). Thus the prominence of multi-family housing with collective heating systems itself presents a challenge to saving energy.

The second feature unique to CEU housing is that most of the multi-family dwellings were built after World War Two, in particular after 1960, as socialist planners tried to increase the supply of urban housing. The detached dwellings are older. Old or young, most structures need repair and rehabilitation. Two key points affect the merit of improving the thermal qualities of buildings. That so many dwellings are in large buildings (with collective heating), most of which desperately need rehabilitation, complicates decisions about improving energy use, since these must be taken at a building-wide level. And the relative youth of these buildings makes it likely that all but the worst will survive many years. But the fact that so much housing needs fixing anyway suggests that if such improvements can be mustered, the extra costs of reducing energy needs will be relatively small.

Finally, building technologies in CEU lag behind those in Western Europe. Judging from building code thermal requirements, walls of apartment buildings from the 1970s had at least twice the heat conductivity as those in the Nordic countries. Windows, while generally of double glazing, were seldom sealed and rarely fit tight. Mechanical ventilation systems are rare. Most of the larger buildings are made with soviet-style large panelized construction with poor insulating and moisture properties. Thus we are not simply dealing with the problem of saving heat, but also of modernizing building design and construction techniques.

The housing stock comprises four principal types of tenure: (1) private, with a small percentage of apartments (except in Lithuania, where most of the dwellings themselves are private) but a sizable share of single-family dwellings, particularly farms in Poland; (2) co-op (relatively important in Poland and the Czech republic); (3) state or municipal (20-80%); and (4) enterprise-owned (10-20%). Enterprise housing, provided to employees by socialist enterprises, is probably in the worst condition and least desirable, particularly since most enterprises want to divest. Housing owned or at least administered by municipal authorities, by contrast, may survive if authorities are able to increase maintenance and make the homes attractive.

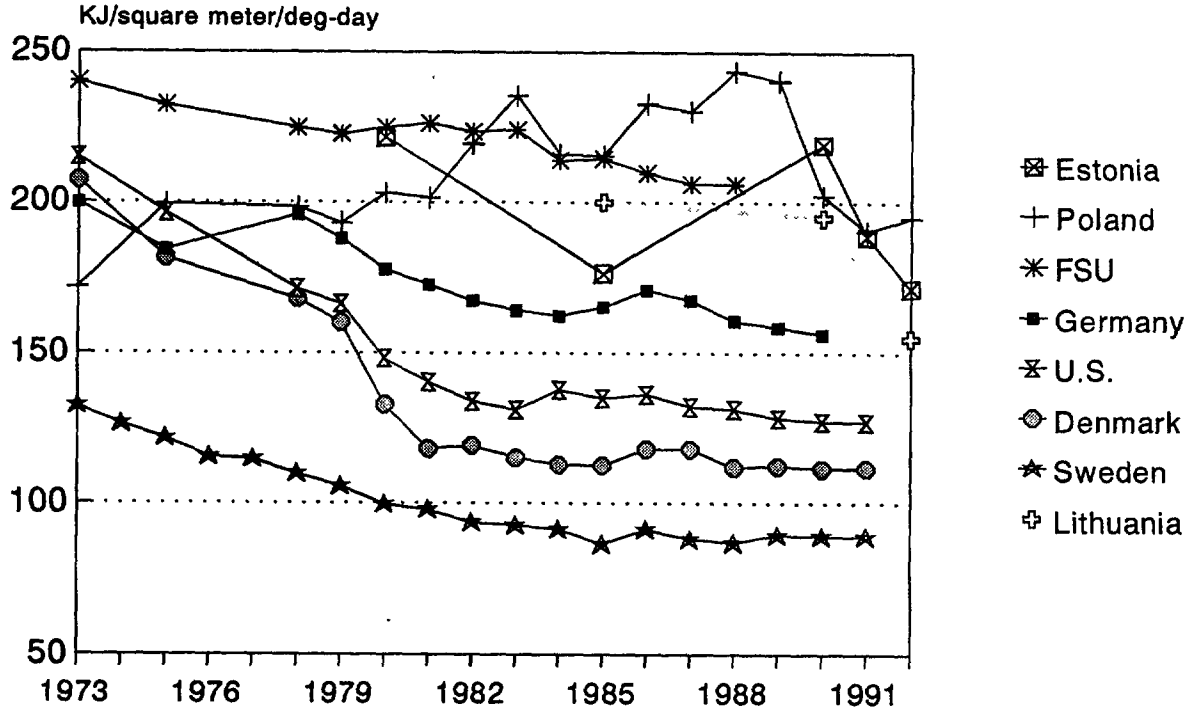
Privatization of some or most dwellings is underway, but the process is complicated (Jaffe, Turner, and Victorin 1994). The strongest traditions of ownership are in the Czech Republic and among farm dwellings in Poland. While ownership is increasing in all countries, its slow march is related to uncertainties of the occupants about the real costs of ownership (including future energy costs) and, in some cases, where they will be employed in the future. Most apartments in Lithuania were privatized by decree, but who owns (or will care for) the buildings themselves remains uncertain. Key to understanding the heating problem then is that the ownership of dwellings is uncertain, and with that uncertainty, the responsibility for making careful investments to save heat is blurred. By assigning responsibilities in apartments to occupants, privatization will contribute to an interest in improving thermal properties, but as we note subsequently, the occupants could be strapped for cash for many years.

The nature of the housing stock in CEU thus works against achieving rapid gains in energy efficiency: collective heating systems, an unclear path for tenure or ownership, and a large number of relatively new dwellings, mostly apartments, not likely to be replaced soon.

4.3. Space Heating

We can now compare space heating among the countries discussed. To do so, we count *useful energy* by assuming that about one-third of the heat in oil or gas burned in the boiler in a building, or 55% of the heat released when wood or coal is burned, is lost to the environment, while all of the heat provided by a district heating system or electric heat is used in the building. Using useful energy is only approximate, but that convention permits us to add fuels, district heat, and electric heat and compare them with the total area heated and the average winter heat needs as measured by degree-days. When these calculations are completed, the picture in Figure 5 emerges. It is no coincidence that the countries of Central and Eastern Europe portrayed have the highest *heating intensity,* as this indicator is called. With poorly maintained collective housing and low levels of thermal insulation as well, the position of CEU housing in this comparison is not surprising. The inability of governments to continue to pour in enormous quantities of heat after the economic collapse is no surprise either.

Figure 5: *Useful energy for residental space-heating intesities.*



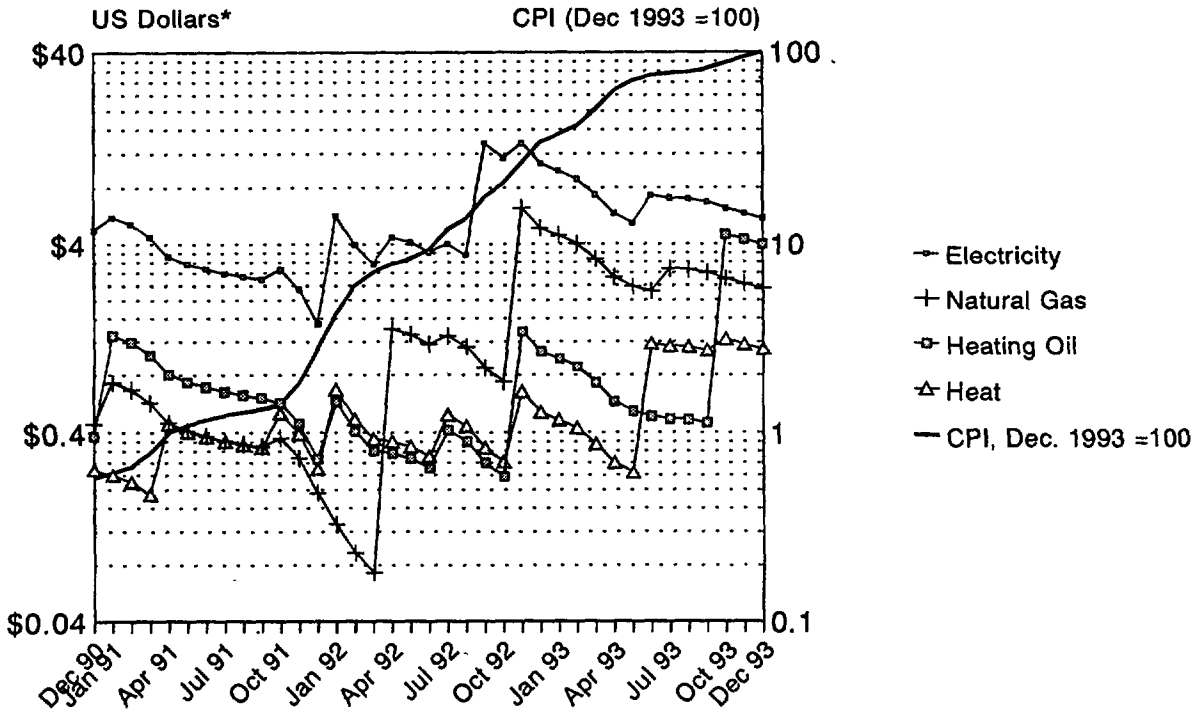
Source: LBL database; degree-days base 18C
District and electric heat 100% efficient; solids 55%, liquids, gas 66%

The decline in heating intensity for households in the countries shown was painful. In Western Europe and the U.S., the drop was touched off by higher fuel prices between 1973-75 and then again between 1979-81, but by 1990 most of the difference between the level of heating intensity in that year and the value from 1973 was caused by improved house insulation, better heating equipment, and only to a small extent, lower indoor temperatures. By contrast, the sudden drop in Poland occurred painfully as the coal market was privatized and consumers reacted to skyrocketing real prices by buying less coal. In Estonia and Lithuania, by contrast, the cutbacks occurred on the supply side, as Russian deliveries of oil and gas to large boilers were interrupted or made unaffordable by huge price hikes. In neither of these Baltic countries do drops in household energy use signify improvements in efficiency, i.e., better thermal insulation, better heating equipment, more controls, or the impacts of metering. And in Poland, the decline was almost exclusively brought about by falling coal demand, prompted by very rapid increases in coal prices.

4.4. Prices and Pricing of Energy

Unlike rapidly falling energy demand, energy prices rose dramatically. Figure 6 shows the evolution of the real prices for primary household energy forms in Lithuania. Time series for Estonia (Schipper et al. 1994) and Poland (Meyers, Schipper, and Salay 1994) look nearly identical in shape, if not in absolute level. While the calculations to remove the effects of inflation are somewhat uncertain, the resulting picture is probably accurate: sharp price increases partly offset by inflation before the next round of price increases. While the figure makes electricity appear expensive, this price is low by world standards (this is also true for Estonia), as is the price for heat. Electricity in Lithuania and Poland is more expensive than district heat for heating purposes, but close to the same "price" in Estonia. In all three countries, however, electricity is "cheaper" than district heating when that district heat is turned off or cut back. Hence many households use electricity as a supplementary source of heat.

Figure 6: *Real energy prices in Lithuania*



** Calculated at 4 Litas/$, using monthly inflation rates*
*** Dec. 1993 = 100*

In general, electricity (and gas for cooking) is sold with little subsidy, although gas prices in Poland still have not reached border levels. Here the "subsidy" is actually the lack of realistic charges for the in-place power plants. District heat is "sold" by billing apartments according to a formula that multiplies a price per area of each apartment times the area, i.e., not in relation to actual consumption. Heat from local boilers is generally included in the rent or billed according to what is paid for fuel. What is crucial is that only roughly 50% of household residents, those in single-family dwellings with almost any system and fuel, and those in apartments with room stoves or their own boilers, pay for space heating and water heating according to actual consumption. Perhaps an additional 10% pay in proportion to the consumption in the entire apartment building; the rest pay in a way that has no relation to actual consumption or comfort.

Actual pricing of energy use varies. Most households pay for actual electricity consumption. Most pay for gas for cooking, although old tariffs in the FSU sometimes charged solely by the number of occupants. For space and water heating, the situation varies building by building and by country. In general, apartments connected to central systems (whether district heat, local boilers, or basement boilers) rarely have meters or controls, and few apartment buildings connected to district heat or local boilers even have meters at the building boundary. Domestic hot water, which is supplied to more than half of the Polish apartments on district heat and a higher share of those in the other countries, is almost never metered, although metering at the apartment level is now gaining acceptance in Lithuania. Single-family apartments in Vilnius have their own metering for domestic hot water; 10% of the buildings in Tallinn have a single meter to measure total supply for both space and water heating. In Poland and the Czech Republic, boilers within individual apartments (*etagenheizung* in Germany) are not uncommon. While the use of solid fuels may be environmentally difficult and on the wane, the use of gas is growing.

On the surface, it would seem that market forces should have set off a wave of improvements in efficiency, and the decline in heating intensity in Lithuania, Poland, and Estonia seem to suggest that. In reality, the fact that roughly one-half of the population does not pay directly for most of its energy prevented a true "economic" reaction from occurring. In Poland, a sharp drop in private use of coal led to the observed decline in heating, while in the Baltics, the decline was principally brought about by the irregular cutoff of supplies from the FSU/Russia or the inability to pay for oil and gas with hard currency. Our best estimate of heating intensity in Lithuania and Estonia, for example, indicates far lower levels than in district-heated buildings. If true, this means that occupants in these buildings are

living under quite different conditions than those in buildings with district heat. It is important to understand this difference, which may reveal how some residents of Eastern Europe have coped—willingly or otherwise—with higher heating costs.

The comparison of East and West is frightening. The housing stock was poorly built and difficult to heat. Almost overnight CEU households were confronted with enormous increases in energy prices *and* a rapid fall in real incomes. Authorities had few resources to hold up safety nets. Yet it would be misleading to depict only the physical and economic parameters of the heating problem. The social and institutional challenges, as we shall see, are much greater than the physical comparison implies.

5. EAST IS DIFFERENT FROM WEST

Consider the multiple pressures facing CEU. When the economies collapsed, industrial production led the way. While the collapse led to reduced demand for fuels (and for freight transportation fuels as well), homes and buildings still needed heat. Robbed of purchasing power, households could not keep up with rising energy costs. With the possible exception of cooperative or municipal housing in Poland and the Czech Republic, no country had institutions prepared to confront the realities of public housing energy management and the transition to both more private ownership and the individual household (or building) management of energy efficiency.

The energy supply situation is tense. For Lithuania and Estonia, the drop in economic activity has made paying for imported oil and gas for buildings difficult. For Poland, there has been no "shortage" of coal, particularly after its price shot up. But the higher prices for other energy sources helped lead to a significant accumulation of debt, either at the household level (unpaid heating bills), within the authorities providing heat, or on the backs of the central government procuring fuels for local or national heating grids. Even without large-scale coal use, the Baltic States face enormous environmental problems (Salay et al. 1993). Lithuania has low-cost electricity supplied by one unit of the Ignalina nuclear plant (a RMBK type, of Chernobyl fame) that is still operating despite many concerns about its safety. This electricity heats many homes in the evenings, often causing local voltages to dip as more and more consumers switch on small room heaters. The use of such small heaters gives the government one additional reason to keep Ignalina running at all costs. Estonia has the largest shale-processing facilities and electric power plants in the world, resulting in cheap electricity that is also attractive as a secondary or primary heat source. More familiar are the coal-based heat (and power) systems in Poland and the Czech Republic, which are a major source of many kinds of pollution, evidenced in part by the rise in popularity of more expensive but cleaner natural gas for single-household heating systems. Thus the governments of CEU face enormous economic pressures because of the economic strains of paying for energy (and energy systems), the political and social strains caused by the interaction of rising heat prices amidst economic collapse, and the environmental risks for the first time openly discussed by authorities, activists, and ordinary citizens alike.

Contrast this situation with that facing the wealthy OECD countries in 1973 or 1979. Governments were for the most part stable. Households had widely differing levels of comfort and energy efficiency for a variety of reasons related both to energy prices and technologies (Schipper, Ketoff, Kahane 1985) and to housing policies (Schipper, Meyers, Kelly 1985), but discomfort and poor housing standards were mostly a function of poverty. All but the wealthiest households were hard hit by the oil shocks, but fuel costs rarely rose about 20% of overall budgets. Social safety nets and, in some cases, pricing policies kept the higher prices from becoming an intolerable burden on all but the poorest households. For most (including politicians), energy became an inconvenience, but not a threat.

The contrast is more subtle. The OECD countries had, for the most part, both public and private well-developed housing systems, with mechanisms (and money) for developing assistance to households to improve energy-use efficiency. Widespread knowledge and accessible know-how within the housing sector provided technologies that saved energy and increased comfort. Aside from those living in apartments with district heat in Sweden, Finland, and to some extent Denmark, most households paid directly for their energy use and exerted some control over consumption and costs as well. All countries had mature housing and equipment industries, research installations, and consumer organizations, as well as housing laws and institutions that, with some adjustment, could support the effort to reduce the cost of comfort. And while environmental regulations were only beginning to bite in the early 1970s, the London smog and subsequent switch away from coal in cities, the development of district heating as a way for better control of fuel combustion, and the awareness of the problems of indoor air pollution (and solutions) as well meant that the oil crises—rather than sidetracking environmental progress—may have indirectly enhanced efficiency both because of the energy conservation that followed and the important role environment played in virtually every discussion of national energy goals

These contrasts are surprising, and far more important that the differences in heating would imply. As large as is the enormous gap between housing and heating technologies East and West, this gap is still smaller than the differences in political, economic, and institutional contexts. This means that it is important not to project "Western" experience too directly towards CEU in the search for solutions. So much of the context that enabled so many energy savings in the West is either absent or immature in CEU. What is special about CEU is that all three contexts interact and shape energy use through both the technologies used and the behavior of people. As these contexts evolve, some rapidly, so will the very nature of housing in Eastern Europe.

6. **THE MULTIFACETED** Challenges of Affordable Comfort in CEU

In the following discussion we consider technical, economic, social/institutional, and political challenges to improving heating in CEU. Our breakdown is somewhat arbitrary, because each challenge has elements of the first three barriers in it, while political problems often hinder change as well.

6.1. Technical Challenges

Aside from the generally low level of building technologies that characterizes most, but not all, buildings in CEU, other technical problems inhibit rapid improvements in energy use.

In the short term, many advocate installing meters, at least to count accurately the heat delivered to individual buildings. However the savings from reducing heat are actually allocated to individual tenants (and the matter is still controversial in Western countries), occupants still need the technical means to reduce heating through metering and controls. For a large number of apartments, this means installing thermostats, valves, and shunts on radiators. Individual metering of heat in flats may be more problematic, because so often a single heat pipe passes through so many different flats. Correct allocation of costs, at least to buildings, is important, but metering itself presents a difficult technical challenge. From an economic point of view, metering does not "solve" space-heating problems, it only defines them in economic terms.

Given elementary controls on radiators and water-heating faucets, individual families can reduce energy use or increase comfort for a given delivery to a building, but large savings can only be achieved if entire buildings and their heat supplies are upgraded and "tuned." These steps must be taken carefully. Insulating the attic of a large building often leads to overheating in the top floors, whereupon occupants open windows, which increases drafts in the lower floors through the stack effect, leading to lower comfort and possibly even increased energy use. Retrofits must be either superficial (i.e., simple measures within dwellings) or thorough to avoid these classic problems. Overcoming them places enormous demands on tradespeople unaccustomed to working with energy-saving technologies.

This care must not stop at the building itself. If a building is heated by its own boiler, the heating system itself be tuned (or even have elements replaced) to be correctly dimensioned for what should be both a lower maximum load and a lower average load as well. Often buildings heated by district heat lie on a relatively small pipeline loop from substations in series with each other. Unless the substation itself is modified and output reduced, there is no guarantee that heat saved from one building will not simply be passed on to other buildings on the same supply loop as higher temperatures. And if occupants of the buildings where savings were made install meters and reduce their heating payments, the authorities could then pass off the loss of revenue to those in the other buildings on the loop, where the savings are "dumped." These are not simply technical problems. They signify that authorities supplying heat must be aware of, and perhaps participate in, the process of significant retrofits of large blocks of housing.

In some countries the short-term response to rapidly rising prices for some fuels (like coal) led to massive cutbacks in heating and rapid increases in wood use. Elsewhere, particularly in the Baltics, small electric heaters supplanted district heating, and in all countries residents have scrambled to offset some of the effects of cutbacks in heat supply by stuffing cracks, covering windows, or even covering over balconies with glass. These solutions may appear creative, but they can cause problems: Circuit overloading from surges in electricity demand and cutting of heating or plugging up ventilation can lead to damage from moisture and mold; reducing ventilation to kitchens can lead to a build-up of pollutants from gas stoves. This is not to say that household occupants have not found ways of coping with heating cutbacks and in some cases higher costs, only that proceeding too fast with increased prices and metering could have damaging side effects to both buildings and occupants.

Hindered by proper monitoring and often by poor workmanship, the retrofits of buildings that have been undertaken show mixed results, raising the specter of a repeat of some of the bad results experienced in Germany and the Scandinavian countries in the 1970s with their hasty and careless application of measures. There are successes, as

measured by before-after measurements in all four countries, as the Mustamaee experiment in Estonia showed (Rolen et al. 1994). Many other retrofits have been carried out there as well (Schipper, Martinot et al. 1994). Measured retrofits in Krakow, Poland, yielded a 9% saving when other factors were removed (Markel 1994). And there are countless new studies and proposals, including many for high-cost retrofits presented to bi-lateral or unilateral lenders in every country. No one doubts that heating needs can be reduced, but there is considerable uncertainty over which techniques pay off most quickly. In particular, many question the economics of improving wall insulation. Savings so far represent only a small part of the gap implied by Figure 5.

Global estimates of potential savings by leading authorities in each country generally suggest that 20-30% reductions (or more) in heating needs are economic at world energy prices without any radical change in technologies (Mrazek 1992; COWI 1993; Stankevicius et al. 1994; Chyrzakowski and Lis 1991). These strategies usually include building metering, additional roof insulation, weather stripping, new heat exchangers, and sometimes new windows. Lacking any reliable measurements of energy consumption in a large sample of buildings however, authorities and experts in any country are hard pressed to judge the realistic potential for savings. Calculations put forward by authorities in Lithuania, for example, were based on very rough assumptions about heating temperatures and hours as well as the properties of present materials in buildings. Inspection of a wealth of data suggests that no one really knows these parameters well enough to make more than a rough estimate of the savings over a sample of buildings, let alone an individual building. This means that even technical issues about expected energy savings are tough to answer. That would not be an important issue except for the need for heating *costs* to be reduced.

Determining how energy use would change with the application of energy-saving technologies to buildings and heating equipment is almost impossible because gauging how occupant behavior would change in response to different heating conditions is difficult. Indeed, many buildings are underheated because of cutbacks from either local boilers or district heat systems. Under these conditions, occupants may "take back" most of the savings from retrofits by increasing comfort, unless somehow heating prices were rising and such increases were transmitted in a just way to building occupants. This is not a trivial matter. In a classic paper, Scott (1980) shows from both theory and a carefully monitored British experiment that in homes where initial levels of space heating and efficiency were both low, retrofits led to higher total energy use in some cases. In general, some take-back should always be expected, which improves the welfare of the occupants but cuts into the expected monetary savings from heating. In the Mustamäee project, for example, little take-back was observed but this experiment was very carefully controlled. Of course, if occupants are too hot, retrofits may actually lead both to better thermal properties and lower building temperatures.

In spite of these technical difficulties, there seems no doubt that overall heating needs in CEU can be reduced markedly. Aside from simply improving building and heating technologies, authorities need to pin down the most important elements of successful retrofits, translate those into economic terms, and then encourage far more widespread adoption of these techniques. But the economic barriers to this are formidable.

6.2. Economic Challenges

Economic challenges follow two vicious circles. On the supply side, authorities still keep energy prices down, using a hodgepodge of social subsidies to households, direct subsidies to energy companies, or simply letting debt accumulate, while some families simply do not pay their heating bills. This in turn makes it difficult to raise money for improving supply systems.

On the demand side, the fact that 60% of all families live in housing where they do not pay for or control the actual consumption of heat or hot water means that a "free market only" reform that lets all energy prices shoot up (as happened to coal in Poland) is unrealistic anywhere for the foreseeable future. Lacking a means of controlling how much energy is used, families cannot respond to higher "prices" because they cannot individually cut back on consumption without first making important and expensive modifications to their heating systems. Under great pressure from rising costs, families are hard pressed to find necessary funds to make even the smallest investments to reduce heating costs, were these costs recoverable (which they are not). Yet for most countries, the costs consumers are paying for heat, however determined, are still far below what the national economy pays for the primary energy resources to generate the heat. More pressures lurk as prices move upward. Therefore, it may be many years before the average family can afford to undertake significant retrofit investments on its own. And the technical uncertainties alluded to previously make predicting real energy savings, as well as the economic (i.e., cash) paybacks, difficult.

Interest rates are very high in CEU. Since few "mortgage" traditions exist, families are wary of borrowing for the long term at present rates. While it is tempting to allocate some funds to housing at lower-than-market rates, the high rates are symptomatic of the need for capital throughout CEU economies. Breaking the vicious circle of economic

pressures may be possible however, through a bootstrap process of funding careful retrofits with quick (i.e., less than two-year) paybacks, building by building, using the proceeds to finance more retrofits. But the most difficult challenges may be social and institutional, as we shall see.

6.3. Social and Institutional Challenges

The greatest differences between East and West may be social and institutional. We noted previously that in 1973 in Western Europe and North America many of the housing elements that were key to supporting improvements in buildings were well established. These elements are in their infancy at best—or even totally absent—in Eastern Europe.

Among those important elements that would underpin any transition to more affordable comfort are these:

- Basic housing, ownership, mortgage, lending/borrowing, and tenancy laws, including a clear direction for privatization
- A market for owned and rental housing
- Financial intermediaries that can use large public or private funds (as well as funds provided through multinational lenders) to lend funds to renovate buildings
- Tenant or owner organizations that can borrow money to undertake retrofits, assuming all the occupants of a building agree to using the building or indeed their apartments as collateral
- Agreements among tenants on how to share the gains from reduced heating bills, or how to divide up reductions in heating, bolstered by historical records of consumption
- Maintenance organizations that could carry out retrofits, much like chimney sweeps in the past cared for stoves and chimneys. Some progress has been made in establishing a framework for this important activity for Lithuania (Franckevicius et al. 1994)
- Building trades that can carry out responsible retrofits are in their infancy, although the Polish building rehabilitation firm Budimex has established a widely respected reputation and was even invited to help restore the old town in Tallinn, Estonia
- A relatively stable real estate market (and job market), so building owners and occupants can make their own decisions about home improvement over time periods long enough to permit extensive retrofit and rehabilitation measures.

It is not difficult to believe that these problems cannot be overcome, but solutions take time because of the number of stakeholders and interest groups that may form. Whether to meter apartments individually for heat, and how to do so, are still debated in the Nordic countries (see, for example, Nyberg 1976 or Bostadsdepartement 1983). But it would be foolish to examine only technical and economic parameters of the heating problem in CEU and then declare victory. Positive interaction between building occupants, building trades, and the various intermediaries cannot be taken for granted, especially when one thinks of the history of CEU countries since World War Two, when fears of informers often made neighbors on the same floor strangers. Ironically it may seem strange for authorities to encourage privatization of apartments first and then immediately urge that the dwellings (and buildings that house them) be signed over to an intermediary as collateral for rehabilitation loans. Indeed, the World Bank intends to use focus groups and other interviews as part of an upcoming household energy survey in Lithuania to gauge occupants' attitudes towards their comfort, how it can be improved, and by whom.

6.4. The Political Challenge

CEU governments are now democracies. Of the countries examined closely here, Poland has seen many governments since reform in 1989, but changes have come unexpectedly in the other countries as well, including the fission of the former Czechoslovakia. Politics are still unstable. Energy costs for many families have risen to dominate household budgets, causing real pressure on the thinly stretched social net and even political pressures on governments bent on staying the course of economic reform. In each country we studied (as well as many others), decisions about raising rents and energy prices, privatization, and so forth have been postponed because of worries over political and social instability. Negotiations to develop new building codes, important housing institutions, and even retrofit programs

often drag on in spite of the obvious need. Leaders in CEU know they can only push their citizens so far. The challenge is to find the right pace as well as the right cushion for people to fall back on.

7. UNEXPECTED CONSEQUENCES OF THESE CHALLENGES

An important consequence of the present situation, exacerbated by economic conditions, is that there is not a great demand for improving housing in general or the thermal performance of buildings in particular. Taking measures to save heat, while simultaneously renovating entire buildings, results in a cost of saving energy and improving comfort that is low, but the total package of renovation is probably beyond the means of present occupants and their expected incomes. Taking measures only to save energy represents an option with a total lower cost but with a much higher cost per unit of energy saved/comfort gained, since many of the fixed costs of these improvements, like scaffolding and the opening of walls to replace heating pipes, can only be amortized against energy savings. But even in this, strained public and private finances make it difficult for anyone to break the vicious circle and make sensible investments in upgrading the thermal characteristics of the stock, although some efforts are underway, particularly in Poland. A more rapid pace of demonstrations in a wider variety for buildings, carried out over several heating seasons, is desperately needed to reduce the risks inherent in large-scale retrofits.

A second consequence is that the real supply side for energy-efficient heating/affordable comfort is slow to develop, even though energy prices have skyrocketed more than those for most building materials. While many Western entrepreneurs, often backed by their governments, are offering or demonstrating efficient technologies, most of these measures are beyond the means of local authorities or private citizens, and often hard to justify economically, even when calculations using world energy prices are used. Donor missions often are besieged by hopefuls looking for "funding" of particular projects, but there is little activity to develop retrofit techniques and strategies or policies that could proceed without a lot of risk-taking from the outside.

The final consequence of this impasse is one that supply-side experts are now confronting: the economics of future heat supply. The choice between renovating or extending district heat or concentrating instead on local boilers in buildings (or even in individual dwellings) depends critically on the "equilibrium," i.e., the long-run demand for heat that would be reached once users were paying the real costs of supplies. This equilibrium is important because district heat needs a high density of sales per square kilometer for success. But better metering and retrofits might reduce heat demand significantly and instead lead to expanded use of smaller boilers, most likely based on natural gas. We could estimate these levels by noting that heating levels in Denmark (and to some extent the U.S.) in 1970 lay at close to those of the CEU in the late 1980s. Since Danish heating intensity was reduced by more than 50% in 20 years, and that in the U.S. by about 35%, it seems reasonable to expect that the buildings in CEU can be improved over time. But over what period? And to what level of heat demand? Neither engineering techniques nor econometric ones give a meaningful estimate of long-term space-heating demands because the present situation is so far from its previous equilibrium. This uncertainty itself means that it is important that heat-supply-and-demand schemes be coordinated, even if they are not financed out of the same funds or run by the same institutions. Indeed, the strongest case for a kind of integrate resource planning can be made for the major cities of CEU, since supply and demand are so critically dependent upon each other and the complementary investments made on each side.

8. MOVING FORWARD CAREFULLY—BUT QUICKLY

Time (and patience) are scarce. The 1985 and 1987 winters saw deadly cold and the breakdown of systems in both Eastern and Western Europe. But 1988 was very close to normal, and subsequent winters have been 5% to 15% warmer than normal. Coupled with cutbacks in supplies, CEU has managed in these winters. But what of a return to a really cold winter? Supply systems need renovation, but so does housing. And the need to raise prices to cover costs is still held back by both the concerns for the welfare of families and by the fact that so few can respond to higher prices by cutting back in the short term and by rehabilitating their homes. In this conclusion we propose a modest scheme of triage.

We have seen that high aggregate heating levels in CEU mask three classes of consumers. Those with stoves or their own heating systems have either generally cut back on heating drastically or switched to cheaper fuels (including secondary fuels). These households are found primarily in rural areas, although some apartments with their own central heating are included. About 20-25% of households in CEU are in buildings with their own heating central supply, and through managers, they have some control over total heat supply. The remaining 40-50% of families rely on heat from district heat or large boilers serving several buildings and are at the mercy of others (usually the city or

state) for comfort. Heating levels are probably highest in these buildings. What should be done to raise comfort and lower costs, or at least restrain the inevitable rise in costs?

The ideal case would 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 CEU must foster rapid information gathering, including encouraging companies (and individuals) carrying out retrofits to come forward with information. But the Swedish and Danish programs were also expensive.

A more modest strategy would first survey the heating systems of the three groups of households by tenure, dwelling type, and system to affect a "triage" strategy: 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. However, this is problematic in some countries. When the Energy Ministry in Estonia approached an important lender for funds for "free" low-cost devices (window inserts, weather stripping), they were rebuffed with "banks do not give away things, we lend money" (A. Niitenberg, priv. comm. 1993).

How can improvements in the first two groups be financed? Here is clearly a role for the multi-lateral development banks to help establish revolving funds or other credits that national authorities can distribute. Governments in Poland and Lithuania have proposed such funds. But an efficient mechanism for distributing funds is necessary. Above all, careful measurements are necessary as well, 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, such improvements could also be financed indirectly through some of the revenue generated by price increases, a strategy that might have some political appeal.

In fact, the tight coupling between district heating supply and demand suggests a true case of "integrated resources 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. Without this economic feedback between supply and demand, many district heating systems may be unaffordable. With good feedback, however, heat demand might fall to where parts of the system would be better suited to 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.

9. CLOSING REMARKS

This brief sketch of a program rests on a key assumption: CEU faces housing and affordable comfort problems, and only secondarily an energy problem. The reasons are several. First, 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. But this also goes far beyond the energy dimension of affordable comfort. 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—much less one technical or economic calculus—to apply to the housing sector of any one country. Experiments and real-world experience will undoubtedly change the calculus constantly. 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 coping. 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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